1 Emergency preparedness in the face of zoonotic disease outbreak

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Outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities and countries in which they occur and should be prepared for and managed accordingly; however this is not always immediately recognised. Zoonotic disease emergencies may occur due to: Emergence of new diseases with unknown but potentially severe epidemic potential; Incursions of known zoonotic diseases into countries or districts which had been historically free or had previously eradicated the disease; or, Epidemics of known endemic zoonotic diseases, due to either inadequate preventive or control measures, or unknown but rare ecological events.

Serious zoonotic diseases are emerging or re-emerging around the world, with increased human and livestock population, and increased travel and trade. Recent experience with SARS and HPAI particularly has sensitized international organizations and led to the incorporation of emerging infectious diseases (EID) into wider global disaster risk reduction frameworks and strategies. This in turn has led to Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources, to tackle previously neglected zoonoses which otherwise can cause disastrous outbreaks. However, inclusion of zoonotic disease outbreaks / incursions in an emergency preparedness and response framework is a major challenge for developing countries, when considered against their many pressing development needs. Although

outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities in which they occur and should be prepared for and managed accordingly, this is not always immediately apparent to resource-poor governments. The disaster of a zoonotic outbreak may occur at several levels, e.g. the damage caused by the disease to human and / or animal health, loss of smallholder income as a result of livestock market disruption, or damage and loss caused by the disease control program. In some cases smallholders will ignore the presence or impact of the disease, but will find the control program a disaster if it means killing their livestock (especially without compensation). Some zoonoses, with known or observed pandemic, bioterrorism or transboundary potential, are easily assimilated into recognized disaster risk reduction frameworks, and also attract global and national attention. However, because of the insidious manner in which other zoonoses emerge, they may not be recognized as emergencies or disasters until they have spread extensively, compounding the misery and costs of control they eventually cause.

Action Plan

Drivers for strengthening national frameworks for emergency zoonoses preparedness include:

- Increasing risks of zoonotic disease emergence or re-emergence with increased human and livestock population and increased travel and trade; and
- Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources to tackle both newly emerging and previously neglected zoonoses which otherwise can cause disastrous outbreaks.

- The policies, institutions and stakeholders engaged in preparedness for and response to zoonotic disease emergencies are critical to their effective management. These will determine the success or otherwise of management and control efforts at least as much as, if not more than, detailed technical understanding of the disease.
- International disaster management frameworks should and are being applied at the national level in many countries. Effective and implementable national emergency preparedness plans are the key to managing emergency zoonotic disease risks.
- Operational and systems research into adequacy of zoonotic emergency preparedness in different countries can facilitate investments which will increase their long term

  resilience in the face of future zoonotic threats.

International frameworks

International efforts in disaster risk reduction have been crystallized as the "Hyogo Framework for Action: (HFA) Building the resilience of nations and communities to disasters". This framework applies to natural disasters such as earthquakes and tsunamis and also directly applies to human disease epidemics.

The International Strategy for Disaster Risk Reduction (ISDR) includes epidemics of human diseases within this framework, however ISDR staff may neglect this aspect to concentrate on natural events, despite data on UN ISDR Prevention web which show that epidemics are among disasters with high mortality. Significantly the economic costs of epidemics are often not calculated.

At the regional level, ASEAN has created the first legally binding HFA-related instrument with their ASEAN

Agreement on Disaster Management and Emergency Response (AADMER). AADMER is a proactive regional framework for cooperation, coordination, technical assistance, and resource mobilization in all aspects of disaster management, including emerging infectious diseases (EID). The AADMER gives priority to disaster risk reduction and proposes the inclusion of all stakeholders such as NGOs, private sector, and local communities as a key to effective disaster management.

From the HFA, global organizations have developed supporting sectoral plans, e.g. the FAO/WHO framework for developing national food safety emergency response plans(WHO 2010), which contains excellent broad principles highly relevant to zoonotic disease emergencies, and the WHO strategy on health sector risk reduction and emergency preparedness (WHO 2007).

National frameworks

A strong framework of national preparedness is the key to managing known disease risks and there are many models around the world. While broad international frameworks have been developed, effective response involves preparedness at national and lower levels. There is also a need for sectoral plans at international and national levels e.g. the UN Medical Directors' Influenza Pandemic Guidelines (UN 2011), and Australia's Emergency Animal Disease (EAD) framework.

Research on policies, institutions and stakeholders involved in zoonotic emergency management

Comparative research is needed to determine the applicability of successful emergency management frameworks to the management of zoonotic disease outbreaks In individual developing countries, and associated gaps in national arrangements and opportunities for integration of action between agencies. Examples of some web-available emergency zoonoses preparedness plans and policies developed in south-east Asian countries

and sub-Saharan Africa, and demonstrate the relative lack of inter-sectoral planning in some areas are freely accessible.

Research on **decision making in the face of zoonotic emergencies** is particularly useful for improving risk management and risk communication procedures. Austin *et al* (2012) point out that:

"the criteria and timing for policy response and the resulting management decisions are often altered when a disease outbreak occurs and captures full media attention. Political and media influences are powerful drivers of management decisions if fuelled by high profile outbreaks. Furthermore, the strength of the scientific evidence is often constrained by uncertainties in the data, and in the way knowledge is translated between policy levels during established risk management procedures.."

Research on preparedness and response to different types of zoonotic emergencies

I. Emergence of a new zoonosis with severe epidemic potential

In recent years, a number of previously unknown viruses or new recombinant strains of known viral pathogens have emerged and caused major disruption due to their potential to cause global pandemics. Some key examples are SARS, Nipah virus and H5N1 HPAI. Each of these has required both pre-existing and newly developed policies and procedures, and linking mechanisms for institutions and stakeholders, to develop and implement responses, at the local sub-national, national and international levels. Research on the effectiveness of these responses from the perspectives of different stakeholders can yield valuable lessons for future preparedness.

If a previously unknown disease is seen to be causing significant human mortality or morbidity, very stringent medical policies and procedures may need to be

applied in the absence of complete or any information about the pathogenicity and epidemiology of the disease.

- Measures to prevent person-to-person spread may require sound medical and hospital barrier nursing procedures as close to the outbreak location(s) as possible. Prior education of frontline medical staff and availability of PPE and appropriate biocontainment facilities are highly desirable.
- Legal powers should be available and implementable to prevent people moving to or from quarantine areas. Medical authorities may require support from police.
- Governments and politicians must be helped to understand the necessity for such measures, and for how long they may be required.
- Risk communication to the affected and potentially affected communities is needed to support societal response and reduce panic, with attention to social and cultural contexts.
- Global or regional trans-national risk management and reporting measures may be required according to the International Health Regulations (WHO 2007) and the OIE Animal Health Act.

Adequate technical response must also be developed including measures such as:

- Diagnostic criteria and tests.
- Urgent surveillance and applied research to determine the source and extent of the infection.
- Vaccine development and registration if appropriate or feasible.
- Mechanisms to tap into global expertise quickly and efficiently.

When an animal reservoir is suspected and/ or confirmed, or if the main expression of disease is in

animals, appropriate short and long term control or eradication measures need to be developed and implemented. Operational and systems research may be needed in the following areas.

- Discovery of livestock and / or wildlife reservoirs creates different implications for action and for involvement of different institutions and stakeholders.
- Policies of stamping out or short or long term movement controls for infected or highly at risk livestock populations may in some situations be technically sound but unfeasible due to market pressures and other issues including:-

    - ✓ lack of legally empowered, trained, equipped and supervised field staff;
    - ✓ lack of adequate compensation policies or the funds and practical means to implement them; or
    - ✓ Impact of loss of livestock on smallholders' livelihoods and / or cultural practices.
- Value chain analysis of movements of livestock and livestock products, coupled with a disease risk analysis framework and cost benefit analysis of proposed controls and disease impacts, may be urgently needed to devise control programs which do not impose unnecessary burdens on smallholder farmers and others in the value chain, leading inter alia to non-compliance with poorly devised programs;
- Cultural and social implications and acceptability of disease control actions in different livestock sectors may need careful examination at many local and sub-national levels;
- Involvement of wildlife in the disease epidemiology will raise a wide range of ecological and sometimes

social issues depending on the species and environments involved. Prospects for compartmentalization and reduction of risky contact between wildlife reservoirs and people and/or susceptible livestock will need assessment.

II. Incursion of a known zoonotic disease into a country or part thereof which is historically free or has previously eradicated or effectively controlled the disease

Some zoonotic diseases e.g. rabies, are so feared that they have been well controlled or eliminated from their host animal species in most developed countries, and programs of varying effectiveness operate in many developing countries. Without global eradication, however, risks of incursion and re-establishment remain and may intensify as global trade and travel increase. These incursions may not appear as emergencies at first and hence spread to the point where they become major disasters, diverting scarce medical and veterinary resources from other programs.

Early detection of new incursions of serious zoonotic diseases is the key to their effective control before they cause too much damage and spread too far to be easily and economically containable. Research is needed into novel and cost -effective ways to deliver early detection (e.g. Desktop Flutracker for community based surveillance, "a tool that allows users to conveniently and accurately track the appearance and spread of flu in any community in the continental United States http://www.tamiflu.com/flutracker/) and the availability of :

- Health and veterinary / agriculture services which are aware of potential major disease risks and ideally have some surveillance programs for them.
- Community capacity building and education about key disease risks and reporting mechanisms.

- Field staff or community members who can respond to community concerns or observations, and either report to health / veterinary services or collect adequate specimens and transport them to be tested.
- Diagnostic facilities with equipment, reagents, trained staff and quality assurance procedures.

Once a serious zoonotic incursion has been diagnosed, application of appropriate technical measures is desirable as quickly as possible, to contain and if possible eliminate the disease from the recently infected area. A number of key non technical elements are also needed, namely:-

- Appropriate legal powers, instruments and policies to implement them, based on contingency / preparedness plans for dealing with such incursions, ideally agreed jointly by senior government agencies and other relevant stakeholders.
- Mechanisms for providing emergency funding, including cost-sharing arrangements between key stakeholders, to address such incursions adequately and in a timely manner.
- Mechanisms / policy framework to ensure high level commitment and coordination of government and other stakeholders to support decision making and funding of economically and technically preferred control / eradication options.
- Arrangements for organization of emergency response which are easily understood / grafted onto existing government structures.
- Trained staff in relevant agencies who can initiate / manage the response.
- Economic expertise to conduct prospective / retrospective cost:benefit analysis.
- Planning and project management expertise and authority to develop and implement agreed long term disease control measures /programs.

- Budgets to assist in control, and compensation to animal owners where culling occurs. Prospective research into the availability of these elements and their customization to local
- conditions, particularly at the national and sub-national levels, is highly desirable.

III. Epidemics of known endemic zoonotic disease, due to either inadequate preventive or control measures, or unknown but rare ecological events.

Some endemic and effectively ineradicable zoonotic diseases such as anthrax periodically cause unexpected outbreaks in areas not suspected of being infected, which should if possible be handled as emergencies to reduce risks. Likewise the possibility exists of future emergence of rare but known diseases such as SARS in new ecological niches. These outbreaks ideally require:-

- Rapid response based on contingency plans, sound policy, adequate funding and stakeholder commitment;
- Retrospective risk analysis of why the epidemic(s) occurred including the impact of ecological, social and cultural factors;
- Development and implementation of new policies and procedures customized to the local situation and then generalized to prevent or promptly respond to further epidemics in future over as wide an area as possible; and
- Capacity building particularly in at risk communities and the professionals and agencies which serve them.

Prospective research on the adequacy of national and sub-national preparedness and the capacity of smallholder communities to respond to such outbreaks is highly desirable. A case study of the emergence of Nipah virus and different responses in Malaysia and parts of South Asia illustrates the complexity of the policy responses, institutional involvement

and stakeholder engagement required to a previously unknown zoonotic disease in different ecosystems. A case study of management of several rabies incursions in Indonesia and Africa, nested in a wider background of rabies management in Africa, illustrates the impact of different dog: human ecosystems on drivers for rabies spread and persistence, the difficulty of mounting timely responses to incursions and particularly of amassing sufficient resources to mount effective rabies control programs.

IV. Key researchable areas for management of zoonotic disease emergencies

Operational and systems research is needed on many issues including:-

- Application of international disaster risk reduction frameworks in regional, national and sub-national plans for severe zoonotic outbreaks
- Sectoral and intersectoral awareness of zoonotic potential to cause disasters and multi-stakeholder involvement in policy formulation for prospective outbreaks
- Risk assessments allowing prioritisation of zoonotic emergency disease threats
- Availability of disease outbreak preparedness plans and policies which have been agreed by all relevant agencies
- Availability of agreed emergency funding and decision making arrangements to allow outbreak response plans to be implemented
- Capacity of national and local staff, value chain participants, livestock owners and communities to respond effectively
- Evaluation of mechanisms and implementation procedures for compensating owners for livestock destroyed in stamping out programs
- Availability and application of vaccines etc to combat specific diseases

V. Challenges and opportunities for zoonotic emergency management

Challenges	Opportunities
Developing rapid response systems which can work at national and sub-national levels	Assessing the applicability of proven rapid response models in different developing country contexts
Customising zoonoses emergency control policies to suit local conditions	Assessing the economic, social and cultural implications of proposed or existing policies
Including zoonotic emergencies in national disaster risk reduction plans	Assessing the economic, social and cultural impacts of zoonotic epidemics and mechanisms for inclusion in disaster reduction frameworks
Finding mechanisms for rapid resourcing of zoonotic emergency responses	Assessing cost-sharing arrangements between international and national agencies which will support timely control and eradication programs for zoonotic emergencies
Giving legal authority for necessary rapid control action for zoonotic emergencies which are appropriate for developing countries	Determining successful legal arrangements in place around the world and sharing lessons learned
Evidence-based decision making in the face of uncertainties Capacity building at all levels for emergency preparedness and response	Research on effective rapid decision making by relevant local, national and international institutions Research on best and most cost effective systems and impacts of past activities

References: -On request-

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2 CCHF: An Emerging Tick-borne Metazoonosis

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Emerging zoonoses are those diseases that are caused either by apparently new etiological agents or by previously known agents appearing in places or in species in which the disease was previously not known to occur, but shows an increase in incidence or expansion in geographical, host or vector range. Emergence and re-emergence of zoonotic diseases may be any one of the following categories: a known agent appearing in a new geographic area, a known agent appearing in an unsusceptible species or a previously unknown agent detected for the first time. The survey of human pathogens totals up to 1,407 pathogens, with 177 (13%) species regarded as emerging or reemerging. Among all known pathogens, 208 (14.7%) are caused by viruses or prions, 538 (38%) by bacteria, 317 (22%) fungi, 57 (4%) protozoa, and 287 (20%) by helminths. Of these pathogens, 868 (61%) are identified as zoonotic. Further, among a list of 177 pathogenic species which are associated with diseases considered to be 'emerging', 132 (75%) are zoonotic.

CCHF is a tick born viral zoonotic disease caused by virus of genus *Nairovirus* of *Bunyaviridae* family. The disease is distributed globally which can be correlated by the global distribution of the tick vector (*Hyalomma* tick) which is responsible for viral transmission. The disease has been recognized by different names as Asian Ebola, Hungribta (blood taking), Khunymuny (nose bleeding) or Karakhalak (Black Death) in the different parts of world. In the last 2 years, in India, CCHF is emerging as an important zoonotic disease and a potential threat for the persons associated with animals as farmers, animal handlers and veterinarians due to its potential transmission from animal to human. However, human- to-

human transmission also reported in some cases in various countries.

1. **History**

CCHF was first described in the Crimea, Russia in 1944 by soviet scientists during an outbreak which involved 200 cases of CCHF in soviet military personnel. They called it Crimean hemorrhagic fever (CHF). Later in 1956 it was found that the causative agent was identical to a virus isolated from a patient in Congo and the name CCHF was adopted after that.

2. **Epidemiology and geographical distribution**

CCHFV has a most extensive geographic distribution among all tick viruses and it is widespread in Eurasia and Africa. The geographic distribution pattern of disease coincides with the distribution of *Hyalomma* tick vector. The virus is reported from about 30 countries which include Africa (Uganda, Sudan, Democratic Republic of Congo, Nigeria, Mauritania, Senegal and South Africa etc), Southeast Europe (Kosovo, Russia, Bulgaria, Greece and Turkey etc.), Middle East (Iraq, Iran, Saudi Arabia and Oman) and Asia (Kazakhstan, Tajikistan, Uzbekistan, Pakistan, China and India).

In Africa, due to limited sanitary facilities, virus surveillance is difficult. In the last decade lesser than 100 cases were reported in Africa and most of the cases occurred in South Africa. In 2003, outbreak occurred in Mauritania and in 2008, a nosocomial outbreak was reported in Sudan.

In Europe, Bulgaria is the only country where CCHF is endemic but outbreaks have been recorded with increased number of cases in other countries like Kosovo, Turkey, Albania, Ukraine and South-west of the Russian Federation. Between 1997 and 2009, a total of 159 CCHF cases were identified in Bulgaria. In Turkey also, an increased number of CCHF cases were reported between year 2002 and 2009. CCHF is also widespread in Asia and middle-east. Recently in September of 2010, an outbreak was reported in Pakistan's

Khyber Pakhtunkhwa province. So, India is always at potential risk of acquiring CCHFV from its neighbors.

Seasonal variations have been reported in the occurrence of CCHF. In Iran, higher number of cases reported in August and September. In Pakistan high incidence is common between March and May, and again between August and October, showing biannual surge. Climatic change is always a contributing factor for the occurrence of disease that affects the reproduction of tick population resulting in increased incidence of tick born infections.

The first documented outbreak of CCHF in India was reported from Ahmedabad, Gujarat province of western India in December 2010. Four human deaths occurred among which the first victim a 32-year old housewife of Korat village in Sanand died on January 3rd, 2011. The 35-year-old doctor treating her died on 13th January, 2011 and an accompanying nurse died on 18th January, 2011. The National Institute of Virology (NIV), Pune confirmed the positive testing of CCHFV, identified for the first time in India. A 25-year-old doctor working as a medical intern became the next victim of CCHF virus and died on 31st January. He was the second doctor and fourth victim overall to die of deadly disease in Ahmedabad. All deaths have occurred in less than a month. The death pattern shows that all the persons died of CCHF were living in close association of livestock or were the doctors treating the infected cases.

Transmission from tick or animal-to-human: Animals do not show clinical signs but may act as a source of infection for humans. The virus is transmitted from animals to humans either by direct contact with blood or tissue of infected animal. The tick biting or crushing of tick on skin or mucous membrane may be potential routes for transmission of CCHFV from tick to human.

Human-to-human transmission: Human- to- human transmission occurs by direct contact of virus contaminated

blood or tissues from infected patient. This may occur primarily in hospital setting causing nosocomial infection. Aerosol or airborne infection is also reported in Russia. There may be horizontal transmission from a mother to her child which indicates the need of preventive measures for in-house outbreaks of CCHF.

3. Reservoir and vector:

Like other tick born zoonotic agents, CCHFV follows an enzootic tick-vertebrate-tick cycle. There is no evidence of clinical disease in animals but a wide range of domestic and wild animals act as reservoir for CCHFV. The CCHFV has been isolated from various domestic and wild animals including cattle, sheep, goats, hares, hedgehogs, mice (*Mastomys* spp.) and domestic dogs. On serological testing the antibodies against CCHFV has been found in various wild and domestic animals even in a Tortoise in Tajikistan. Most of the birds are thought to be resistant to CCHF infection; however some reports are available in ostriches where experimentally infection was produced. In South Africa, cases have been reported where the persons working in commercial ostrich slaughter house suffered from disease. Birds may transfer the virus infected ticks even though they themselves remain non-viremic.In a study recently CCHF was detected in the ticks from migratory birds in Morocco. So the migratory birds may be a reason of transport of virus from one place to other distinct places. Apart from migratory birds, international trade and transport of livestock carrying ticks may transport virus from one country to other.

Tick act as both reservoir as well as vector for CCHFV. CCHFV can infect a number of ticks of *Ixodidae* family but particularly ticks of genus *Hyalomma* are the most common and efficient vectors of CCHFV. Transovarial, transtadial and venereal mode of transmission of virus is found in vector. So the tick remains infected throughout its life and transfer virus from one generation to next generation. Immature

ticks feed on the blood of small animals while the mature tick transfer infection to large animals including domestic livestock.

4. Clinical features and pathogenesis:

CCHFV infections are asymptomatic in animals and birds are thought to be resistant. Humans are the main victims to this disease. The course of the disease can be divided into four phases- incubation, pre-hemorrhagic, hemorrhagic and convalescence. The incubation period depends on the mode of infection. Infections acquired via tick bites usually become apparent after 1-3 days. Exposure to blood or tissues results in longer incubation period. In Indian cases, the incubation period ranged from 7-12 days through the later mode.

Pre-hemorrhagic symptoms are non specific and include fever, chills, severe headache, dizziness, photophobia, myalgia and arthralagia. This phase may last for 1-7 days. The hemorrhagic phase develops suddenly lasting for 2-3 days. A petechial rash may be the first symptom both on the internal mucosal surfaces such as mouth and throat and on the skin. They are followed by ecchymoses and other hemorrhagic phenomenon such as hematemesis, melena, epistaxis, hematuria, and hemoptysis. Hepatomegaly and spleenomegaly can be seen in some patients. There may be rapid kidney deterioration. Death may occur in many cases. The mortality rate is 30% and the case fatality rate is up to40%. In Indian cases death occurred due to cardio respiratory arrest, multiorgan failure and disseminated intravascular coagulation (DIC) and gastrointestinal bleeding in one case. In patients who survive recovery begins 10-20 days after onset of illness. Recovery may take up to a year.

No clear pathogenesis is described for CCHF. Endothelial damage is a common feature leading to capillary fragility and accounts for the characteristic rash and contributes to hemostatic failure by stimulating platelet aggregation and degranulation. Thrombocytopenia occurs and dysregulation of the coagulation cascade leads to DIC. Proinflammatory cytokines are important in pathogenesis and the IL-6and TNF-α

level are significantly higher in fatal CCHF.A study shows that viral genome can be detected from saliva and urine of infected patient. In CCHF there is increased serum ferritin level which can be used as a marker for disease activity and prognosis.

5. Public health importance:

Humans readily succumb to CCHFV infection. However domestic animals are either refractory or undergo mild infection with transient viremia sometimes, but they act as a main source of infection for humans. Persons living in close contact with animals are at the high risk of getting CCHF. Veterinarians and farmers may castrate, dehorn, attach ear tags and immunize young animals and thus expose themselves to the virus infected blood. They may have broken skin or scratch on the skin through which they may get infected. Consumption of unboiled or uncooked meat and milk of infected animal may be a potential source of infection. There is lack of evidence of disease in urban consumers of meat but the infected animal may reach to abattoir to pose a potential threat for workers and meat consumers. Exposure to aerosols while working with infected animals and in the hospital setting are the potential hazards. The population in the infected or infection prone area should be aware of the potential routes of infection and the safety measures to be taken to avoid the infection. CCHFV may be used for bioterrorism or as a biowarfare agent. Due to this it is included in CDC/NIAID Category C Pathogen.

6. Diagnosis:

To save the patient and to prevent the further transmission of disease, early diagnosis is essential. The key indicators to suspect CCHF infection includes compatible clinical manifestations like fever and bleeding, history of tick bite, travel to endemic area and contact with infected cases and tick infested animals. The disease should be differentiated from the other VHFs, malaria, dengue, yellow fever, Kyasanur forest disease, rickettsiosis and leptospirosis. The knowledge of ecology and endemicity of CCHFV should be kept in mind to proceed with further diagnosis. The methods of diagnosis

include virus isolation, immunological assays like ELISA and molecular diagnostic methods like reverse transcription-polymerase chain reaction (RT-PCR).

CCHFV can be isolated from the blood, plasma and tissue of infected patient for the diagnosis. Virus isolation should be performed in a high bio-containment laboratory. A variety of cell lines including vero, BHK-21, LLC-MK2 and SW-13 can be used for virus culture. Cell culture can detect only high virus concentration and only useful during first five days of disease. Generally the virus produces no or little cytopathic effects so it can be identified by immunofluorescence assay using specific monoclonal antibodies. The traditional method of animal inoculation of newborn mice is more sensitive than cell culture and also detects the virus for longer period. The virus isolation by cell culture is of limited value because it needs a biosafety level-4 laboratory (BSL-4) which is unavailable in most of the endemic areas. In the first few days of illness usually the patients do not develop a measurable antibody response so the serological tests are useful in the second week of illness. There are various serological tests available for detection of CCHFV but these tests are of limited use in fatal cases as patients generally die without developing antibodies. The conventional serological test for CCHFV like Complement fixation, heamagglutination inhibition and immunodiffusion suffered lack of sensitivity and reproducibility. This problem was solved by Indirect Immunofluorescence assay (IFA) and Enzyme-linked immunosorbent assay (ELISA) for the detection of IgM and IgG antibodies. Both IgM and IgG can be detected up to 7-9 days of illness by indirect FIA. ELISA has replaced the conventional methods for antibody detection. IgM can be detected up to 4 months and IgG persist for 5 years post - infection but its level decrease.

Molecular diagnostic assays such as reverse transcriptase polymerase chain reaction now serve as the front-line tool in the diagnosis of CCHF. PCR based methods are

sensitive, specific, rapid and can be done without the need to culture the virus which requires BSL-4 facility. Molecular epidemiology can also be performed by this technique. A further improvement on the conventional RT-PCR assay has been the advent of automated real-time PCR based assays. The real-time PCR is more advantageousover conventional RT-PCR methods with respect to sensitivity, specificity and time taken for detection. Real- time PCR also offers less contamination rate. There are various detection chemistries available for the real time PCR like SYBR green, TaqMan and molecular beacon etc. There are several real-time RT-PCR assays reported till now for CCHFV detection. Some important assays developed for CCHFV detection are SYBR green, TaqMan and TaqMan-Minor Groove Binding (MGB) probe based assays.

7. Treatment:

In case of CCHF, treatment is mainly supportive. It includes careful management of fluid and electrolyte balance depending upon the severity of illness. Currently there is no specific antiviral therapy for CCHF approved by United States Food and Drug Administration (FDA) for human use. Ribavarin, a guanosine analogue is found effective against CCHFV. CCHFV is susceptible to ribavirin *in vitro* [58]. According to some reports oral and intravenous ribavirin is effective for treating CCHFV infections. In India one case recovered by the oral administration of ribavirin and discharged after ten days. Passive immunotherapy using specific immunoglobulin CCHF-Venin is also found beneficial in CCHFV treatment.

8. Prevention and control:

The prevention and control should be both at community level as well as in nosocomial set up. Minimizing human contact with suspected livestock and reducing the tick burden in the animals are the primary and most important preventive measures. Animals should be carefully monitored for tick infestation and treated by appropriate acaricidal agents

particularly before slaughter or export. Wearing fully covered clothes and use of tick repellent is recommended to prevent tick attachment on the body surface. The unpasteurized milk and uncooked meat should not be taken. Human- to- human infection mainly occurs in the nosocomial setup by the contact of infected blood or tissue. So use of protective clothing, gloves, goggles and face-masks reduces the chances of exposure. Safe burial practices with proper use of disinfectants should be followed. Veterinarians, research workers, slaughter house workers and medical professionals should take utmost care to reduce the contact with suspected material. They should take the prophylactic treatment after high risk exposure. Laboratory and research workers are advised to follow stringent biosafety precautions during handling the pathogen and the work should be carried out under BSL-4 facilities. Virus can be inactivated by using 1% hypochlorite and 2% glutaraldehyde. Heating at 56°C for 30 minutes also destroy the virus.

9. Vaccination: Vaccine against CCHF is not available in most of the countries. However a formalin inactivated vaccine derived from suckling mouse brain has been used in Bulgaria and former Soviet Union. There is no vaccine available for animal use.

10. Conclusions:

- CCHF is an important tick borne multi systemic zoonotic disease the ability to cause death in human beings
- Now CCHF is world wide in distribution and has been reported from most of the countries including India
- Tick bite, contact with infected material and nosocomial routes are the main routes of infection
- *Hyalomma* tick is the main vector
- This disease is not much important in animals as animals are asymptomatic but domestic livestock play a vital role in the transmission of disease to humans

- Climatic change is always a contributing factor for the occurrence of disease that affects the reproduction of tick population resulting in increased incidence of tick born infections
- Persons associated with animals like veterinarians, farmers and slaughter house workers are also at the high risk of getting the infection
- Disease can be controlled and prevented by personal protection, tick control and early stage treatment
- Ribavirin antiviral drug is the choice of treatment applicable only in early stage of disease

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3 Molecular detection of zoonotic pathogens

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Zoonoses are those infections that are naturally transmitted between vertebrate animals and humans. Worldwide, 60 % of human infections are zoonotic in origin, an estimated 75% of emerging infectious diseases are zoonoses and a large proportion originate from wildlife. Three out of 5 new human diseases appear every year are zoonotic in nature. Almost 80% of agents with potential bioterrorist use are zoonotic pathogens. In the present scenario for achieving the target of health to all diagnosis and control of zoonotic pathogens is a key factor.

Animal diseases are a major and increasingly important factor reducing livestock productivity in developing countries in particular. The most promising applications of biotechnology to livestock systems lies in the improvement of animal health and production, in areas such as assisted reproduction, increased disease resistance, nano-based and refined diagnostic techniques, and increasingly improved vaccines with effective delivery systems. Use of DNA biotechnology in animal health may contribute significantly to improved animal disease control, thereby stimulating both food production and livestock trade. Application of advanced diagnostics and monitoring systems will only add the much needed impetus to this sector and hence augur well in the rapid development.

The sharing of ecological niches by the human beings and animals has also precipitated in the promulgation of an array of disease problems. Multiple venues encourage or permit the public to come in contact with animals, resulting in millions of human-animal contacts each year, thus paving way for the transmission of many high-risk pathogens to man through

various ways. These infections not only have devastating impact on animal and human health but also severely affect the national and international trade, which makes the matter of animal health a priority issue across boundaries, thus contributing to considerable medical, public health, legal, and economic effects.

Over the past century, microbiologists have searched for more rapid and efficient means of microbial identification to aid in better diagnosis and control of deadly diseases. The identification and differentiation of microorganisms has principally relied on microbial morphology and growth variables. Pathogens circulating in animal populations can threaten both animal and human health, and thus both the animal and human heath sectors have a responsibility for their control and eradication, which is possible by use of swift and efficient diagnostic methods.

Anton van Leeuwenhoek first observed living microorganisms using his simple microscope in 1676, a discovery largely considered as the first milestone in the history of diagnostic microbiology. The role of microorganisms in diseases was clearly recognized 200 years after Leeuwenhoek found his little "animalcules", when Robert Koch established his famous "Koch's postulates" establishing the relationship between pathogen and disease. In 1869, Johann Friedrich Miescher, discovered a weakly acidic substance of unknown function which was later named, deoxyribonucleic acid, or DNA. Loeffler and Frosch discovered the first animal virus in 1898 when they described the foot and mouth disease virus. James Watson and Francis Crick discovered the molecular structure of DNA in 1953. Walter Gilbert and Frederick Sanger, in 1977, developed new techniques for rapid DNA sequencing, which made it possible to read the nucleotide sequence for entire genes, a discovery which revolutionized molecular diagnostics. The 1970s saw the use of nucleic acid hybridization and DNA probe, which were deemed powerful

tools in molecular biology, microbiology, virology, genetics, and forensics etc. Kary Mullis conceived and developed polymerase chain reaction (PCR) in 1983, a technology for rapidly multiplying fragments of DNA, which has led to huge advances in the field of molecular diagnostics in the past 20 years. The nucleic acid amplification technology has opened a new century for microbial detection and identification.

Advances in molecular biology over the past 10 years have opened new avenues for microbial identification and characterization. With the emergence of present scientific and advanced molecular biology tools, the scenario and perspectives of disease diagnosis has taken a rapid leap towards advancement in identification of many disease agents. In this respect, molecular methods have superseded many traditional methods owing to their high specificity and sensitivity along with the ability to deliver rapid results. In many cases, post-mortem necropsy and histopathology have been the primary methods for the diagnosis of diseases that affect animal's health. However, these methods often lack specificity and many pathogens are difficult to detect when present in low numbers or when there are no clinical signs of disease. Direct culture of pathogens is also widely used. However, these methods are time-consuming and costly. Efforts to overcome these problems have led to the development of DNA-based diagnostic methods including polymerase chain reaction (PCR) amplification techniques. The techniques offer high sensitivity and specificity, and diagnostics kits allowing rapid screening for the presence of pathogen DNA.

The molecular diagnostic methods can be broadly classed into three categories: PCR-based, identification/characterization of amplicon and the genotyping methods. The emergence and re-emergence of diseases strongly indicate the need for the development of powerful and robust new diagnostic methods. A brief description of the methods and their application in animal health is given hereunder.

1. Nucleic acid amplification/analysis

The development of polymerase chain reaction (PCR) in the early 1980s has revolutionized the field of molecular biology. The technique consists basically of the enzymatic synthesis of millions of copies of a target DNA sequence using a thermostable DNA polymerase and a succession of cycles that includes denaturation of the template DNA, hybridization of specific DNA primers to the template and extension of the primers. Thus, PCR provides a method for obtaining large quantities of specific DNA sequences from small amounts of DNA, including degraded DNA samples. Although PCR is widely used in an increasing number of applications, those in the area of microbiology and diagnosis of infectious diseases have undergone outstanding advances in recent years.

a. Specific assay/ conventional PCR

PCR has proved to be a boon for the diagnosis of bacteria implicated in causing animal diseases, when compared to the tedious cultural and isolation methods followed. In many cases the clinical samples are subjected directly to PCR and have the advantage of bypassing the isolation and culturing procedures entirely, thus quickening the whole process of diagnosis, with the added advantage of higher accuracy and sensitivity. The technique has been employed in the detection of brucellosis, leptospirosis, tuberculosis, campylobacteriosis and related bacteria which have fastidious growth requirements. Others include pneumococcosis, meningococcal diseases, Johne's disease, *Burkholderia*, *Bartonella*, *Listeria*, *Salmonella* and *E coli* infections, etc. The advantage of this method is evident in the diagnosis of *Mycobacterium* infections when culture results are not available.

Conventional PCR has also been used for studying viral pathogenesis and epidemiological work, besides diagnosis. Rabies virus can be detected at very low counts and even from decomposed tissues, a scenario where FAT can fail. Other

major canine viral diseases where PCR based detection has been used include canine parvovirus, canine distemper and feline infectious peritonitis. The technique has been successfully applied in the diagnosis of poultry viral affections like Marek's disease, reticuloendotheliosis virus, infectious bronchitis virus, Newcastle disease virus, lymphoproliferative disease virus and infectious bursal disease virus. PCR based detection has been harnessed to diagnose many equine viral agents too: equine herpes virus (EHV) 1 and 4 in aborted equine fetuses and nasopharyngeal swab specimens, equine infectious anaemia and African horse sickness virus, to name a few. Others include, foot and mouth disease, bovine viral diarrhea, blue tongue, louping ill, rinderpest, bovine luekaemia, maedi-visna viral disease and rotaviral infection among the ruminant viral diseases; porcine respiratory and reproductive syndrome, pseudo rabies, hog cholera among the swine diseases.

The technique has been successfully used for the detection of animal parasites ranging from blood flukes, malarial parasites to nematodes. PCR methods have been applied to differentiate eggs, larvae within vectors and organisms from clinical and tissue samples.

b. Multiplex PCR (mPCR)

The technique has been useful in detection of many pathogens. Multiplex PCR in combination with a heteroduplex mobility shift assay has proved to be a valuable tool for monitoring the emergence of new subtypes of influenza viruses arising through the phenomena of antigenic drift and shift. The subtypes of influenza viruses A, B and influenza virus C have been identified and differentiated in a single reaction. Multiplex PCR has been used for the detection of *Brucella* spp. and *Leptospira* spp. from aborted bovine fetus, thus detecting and differentiating two organisms causing abortions in bovines at similar time of pregnancy. Other applications include the diagnosis of salmonellosis, campylobacteriosis, brucellosis,

listerisosis, arcobacteriosis, pasteurellosis, leptospirosis and other bacterial diseases wherein various genes have been targeted to differentiate the causative organisms to the species level.

The diagnosis of helminth infections can be complicated by the sympatry of several species in endemic areas often resulting in poly-parasitism of hosts. The assays to differentiate up to eight different species have been developed targeting hookworms. Similar techniques have been developed for *Diphyllobothrium* infecting animals and humans, since it is difficult to discriminate among individual species by morphological criteria alone. Multiplex PCR assays have also been developed for the differential diagnosis of *Taenia* spp. In co-endemic areas, mPCR can simplify diagnostics by replacing several individual tests with one molecular assay.

c. Nested PCR

Nested PCR is deemed as a rapid alternative to time-consuming cultural protocols, especially for bacteria like *C. burnetii* from clinical samples (blood, buffy coat, etc.) with increased specificity and sensitivity. *Campylobacter*, the most common cause of acute bacterial gastroenteritis in the developed world, has been detected from meat through nested PCR. Semi nested PCR methods have been developed for the detection of *Shigella* and toxigenic *Vibrio cholera* from environmental water samples by an enrichment broth followed by semi-nested PCR procedure. The technique has also been used to screen samples from sea water and organic material to detect *Vibrio parahaemolyticus*, and is preferred over the conventional most probable number (MPN) culture technique. Several nested PCR methods for detecting *Salmonella* have also been developed utilizing primers based on specific gene sequences. Nested PCR for detection of *Cl. perfringens* in feces and meat has been reported to be 103 times more sensitive than single PCR. A two-step PCR can increase the speed of identification of parasitic eggs from different species and

genera, a concern particularly in endemic areas where multiple infections exist. Molecular techniques based on genomic sequence detection like nested PCR is assumed to be significant for the rapid diagnosis and identification of the *Filoviridae* group of viruses and their serotypes. These techniques have been gradually accepted as new standards over virus isolation for detection of these viruses in acute-phase serum samples. Among these, the two-step nested RT-PCR approach is routinely practiced in almost all laboratories worldwide.

d. Real-time PCR

The development of real-time (RTi-) PCR represents a significant advancement in many molecular techniques involving nucleic acid analysis. Real-time PCR assays have been directed at bacterial pathogens such as *E. coli* O157, *Campylobacter*, *Listeria monocytogenes* and *Salmonella* Enteritidis, *Yersinia pestis*, *Bacillus anthraces*, *Coxiella burnetii* and for the detection and differentiation of MAP from other mycobacteria, all of which are zoonotic pathogens. The quantification of *Salmonella* on chicken egg shell surface has also been done through the application of this technique. Standard laboratory protocols have also been developed for an early detection of foodborne zoonotic in animal origin food products and for the cross-border monitoring of livestock.

A simple multiplex real time PCR system was designed recently for the general and simultaneous detection of influenza A, B and C viruses, members of the *Orthomyxoviridae* family, originating from both animals and humans. Similar tests are available for the differentiation of various serotypes of foot-and-mouth disease and classical swine fever. Real time PCR has also been devised for the differentiation of various members of the family *Filoviridae.*

In the diagnosis of various fungal diseases, testing using real-time PCR offers several advantages over conventional

methods. The combining of target amplification and detection in a single, closed-reaction vessel, reduces the possibility for environmental contamination with amplified nucleic acids. This is particularly important for fungal diagnostics owing to their ubiquitous presence in the environmental. Methods have been standardized for the diagnosis and differentiation of *Candidia*, *Aspergillus* and dermatophyte infections, which remain among the most common communicable diseases worldwide. Further, the quantitation of fungal nucleic acid by using real-time PCR testing may have important applications in predicting clinical progression in transplant patients, differentiating colonization and disease, and monitoring the efficacy of antifungal therapy.

e. Reverse transcription-polymerase chain reaction (RT-PCR)

RT-PCR is mostly used to detect viruses and the viability of microbial cells through examination of microbial mRNA. Several workers have used RT-PCR for diagnosis of Japanese Encephalitis (JE) and other related flaviviruses, frequently and successfully targeting genes and/or segments of genes, from clinical samples (blood/CSF) of human, swine and horses. Some modifications of RT-PCR RFLP analysis are successfully used to distinguishing West Nile virus and JEV from experimentally infected animal brain, spleen and serum sample. A range of RT-PCR assays targeting several regions of the genome have been used for the differentiation of the various genotypes of norovirus and Chikungunya virus. In case of environmental samples, RT-PCR has been increasingly applied to detect a range of rotaviruses in water and shellfish. The RT-PCR based tests allow rabies diagnosis even in the situation that precludes virus isolation. The technique also finds application in detection of specific target protein in the CSF of bovine spongiform encephalopathy affected animal.

f. Microarrays

The method has been used to compare interstrain, intraspecific variations in bacteria at the genomic level. Technique has been used for the detection and differentiation of *Campylobacter* spp. directly from fecal and cloacal swabs. Other organisms include *Salmonella, L. monocytogenes, E. coli, P. multocida, M. hyopneumoniae, M. avium paratuberculosis, H. parasuis, R. equi, B. anthracis,* etc., wherein variants of the assay have been applied.

DNA microarrays have been used to rapidly identify reassorted influenza A virus strains of swine origin. A cDNA microarray detection device for porcine reproductive and respiratory syndrome virus (PRRS), Group A Rotaviruses, ND virus and foot and mouth disease virus (FMD) has been developed. Based on microarray hybridization, a diagnostic test for coronavirus infection has been developed using eight coronavirus strains: canine coronavirus, feline infectious peritonitis virus, feline coronavirus, bovine coronavirus, porcine respiratory coronavirus, turkey enteritis coronavirus, transmissible gastroenteritis virus, and human respiratory coronavirus .

g. Nucleic Acid Sequence Based Amplification (NASBA)

NASBA-based detection methods have been used for detection of pathogens in food and water including, *Campylobacter* spp. (Cools *et al*., 2006), *Escherichia coli*, *Salmonella* Enteritidis, *Listeria monocytogenes*, *Cryptosporidium parvum*, etc. The NASBA technique has been used to develop rapid diagnostic tests for several pathogenic viruses with single-stranded RNA genomes, like influenza A, foot-and-mouth disease, severe acute respiratory syndrome (SARS)-associated coronavirus, Newcastle disease virus, classical swine fever virus, and porcine reproductive and respiratory syndrome virus. Even as the cross-species viral infections are becoming more common, there is an imperative

need for detecting animal viruses to control potential infection in livestock. With the high sensitivity and specificity offered by the NASBA technology, various agents have been successfully detected and differentiated.

h. Loop-mediated isothermal amplification (LAMP):

The technique has been applied in the diagnosis of many important animal diseases. LAMP assays have been developed to detect *Salmonella*, *Campylobacter*, *L. monocytogenes*, *Y. pseudotuberculosis*, *Bacillus cereus*, *E. coli* from meat and clinical samples. Also, the test has been employed in the detection of *B. anthracis* spores in tests using blood specimens. LAMP offers a good diagnostic value in the detection of surra infections. The sensitivity of the assay has been determined for the detection of *Theileria equi*, *Babesia* and *Trypanosoma congolense* in field-derived bovine blood samples. The technique has found application as a useful diagnostic tool for examination of *Cryptosporidium* spp. in samples for clinical laboratories as well as for water industries. The assay is available for the diagnosis of *Fasciola hepatica*, *Fasciola gigantica*, *Clonorchis sinensis*, *Opisthorchis viverrini*, *Schistosoma mansoni*, and *Schistosoma japonicum* from animal samples and is found to be specific.

A rapid and sensitive reverse transcriptase loop-mediated isothermal amplification (RT-LAMP) is useful for H5N1 highly pathogenic avian influenza (HPAI) virus, and *Filoviruses* like JE and Chickungunya.

i) Biosensrs

A new approach to the detection of either the agent or antibodies is the development of biosensors. This type of assay involves the use of a receptor (usually an antibody) for the target pathogen or a disease-specific antibody and a transducer which converts a biological interaction into a measurable signal. Some of the transducer technologies under development

include electrochemistry, reflectometry, interferometry, resonance and fluorimetry. Biosensors are frequently coupled to sophisticated instrumentation to produce highly-specific analytical tools, most of which are still in use only for research and development due to the high cost of the instrumentation, the high cost of individual sample analysis, and the need for highly trained personnel to oversee the testing.

j) Nanotechnology

The term 'nanotechnology' is broadly defined as systems or devices related to the features of nanometre scale (one billionth of a metre). This scale of technology as it applies to diagnostics would include the detection of molecular interactions. The small dimensions of this technology have led to the use of nanoarrays and nanochips as test platforms. One advantage of this technology is the potential to analyse a sample for an array of infectious agents on a single chip. Applications include the identification of specific strains or serotypes of disease agents, such as the identification of specific influenza strains, or the differentiation of diseases caused by different viruses but with similar clinical signs, such as vesicular viral diseases. Many research groups are considering the use of chip assays that detect a number of agroterrorism agents in each sample. Small, portable platforms are being designed to allow pen-side testing of animals for diseases of concern. Another facet of nanotechnology is the use of nanoparticles to label antibodies. These labelled antibodies can then be used in various assays to identify specific pathogens, molecules or structures. Examples of nanoparticle technology include the use of gold nanoparticles, nanobarcodes, quantum dots (cadmium selenide) and nanoparticle probes.

Additional nanotechnologies include nanopores, cantilever arrays, nanosensors and resonance light scattering. Nanopores can be used to sequence strands of DNA as they pass through an electrically-charged membrane. Cantilever

sensors are comprised of a thin, flexible beam made of silicon coated with DNA that can bind to a selected target sequence. These sensors can be placed in a microarray format to detect numerous DNA targets in a single sample using different wavelength-emitting detection molecules for each target. Nanosensors are comprised of a nanowire that is coated with any biological recognition substance. After chemical interaction with target analyte, a change in electrical conductance of the nanowire can be measured. Resonance light-scattering technology is based on the use of nano-sized metallic particles. These particles can scatter light when illuminated so that specific levels of intensity and differing emitted colours can be easily detected, differentiated and quantified. This can greatly increase the sensitivity by which biological molecules can be measured. Nanotechnology is still primarily in the research stage, with the focus on the detection of bioterrorism agents. It is anticipated that many of the specific nanotechnologies will eventually be applied to the diagnosis of zoonotic diseases in the future.

2. Characterization/ identification of amplicon

a. Automated sequence analysis -

The technique is being routinely used for the detection and identification of bacteria, virus, fungi and parasites alike, thus helping to combat infectious animal diseases. The sequence databases include GenBank, RefSeq and KEGG among others. The sequences of any microbe can be accessed from these databases and subjected to comparison for determining the similarity or heterogeneity with the standard sequences.

Sequencing finds application in genotyping and phylogenetic studies can be used to determine the origin/source of the strain responsible of introducing the disease within a country. The recent pandemic outbreaks of HPAI and swine flu; *E. coli* O104:H4 panic in Europe, are illustrations of

application of this technique for effective diagnosis and containment of animal and foodborne diseases.

b. Polymerase Chain Reaction – Enzyme linked Immunosorbant assays (PCR-ELISA)

PCR-ELISAs have been in use since the late 1980s and have developed into an assay for detecting specific sequences within polymerase chain reaction products. Though many methods are available for detecting specific sequences, PCR-ELISAs are useful for detecting and differentiating between multiple targets.

PCR-enzyme immunoassay has been applied for the detection of *Streptococcus pneumoniae, E. coli, Salmonella, Mycoplasma, C. jejuni, L. monocytogenes* and *Mycobacterium tuberculosis*. The method has been validated for the detection of infectious pancreatic necrosis virus**,** Peste des petits ruminants (PPR), FMD and for the detection and subtyping (H5 and H7) of avian type A influenza virus. The technique finds application in detection of *Leishmania infantum, Schistosoma* and the malaria parasite from both clinical and field samples.

c. Nucleic acid hybridization assay

Commercially available nucleic acid hybridization probes, under the brand name AccuProbes, were introduced in 1992 by Gen-Probe, Inc. for use with a limited number of fungi. Initially, AccuProbes were available for *Histoplasma capsulatum, Blastomyces dermatitidis, Coccidioides immitis* and *Cryptococcus neoformans*. A DNA-DNA hybridization method, developed using probes consisting of radiolabelled DNA fragments of *Salmonella* Typhimurium for detection in foods has been in use.

d. Single-strand conformation polymorphism (SSCP)

The bacterial 16S rDNA primers conservative region has been used as a universal primer in order to establish a

detection method for identification of pathogenic bacteria including *E. coli, Salmonella, S. aureus, Bacillus cereus, L. monocytogenes* and *Bacillus licheniformis*. Direct SSCP analysis of amplicons from seven taxa, including, *Toxocara vitulorum, T. cati, T. canis, T. leonina, Baylisascaris procyonis, Ascaris suum* and *Parascaris equorum* indicates the usefulness of the SSCP-based approaches for the identification of ascaridoid nematodes to species.

3. Genotyping or molecular epidemiology studies

It refers to the carrying out of epidemiological investigations to determine the primary sources of infection with the ultimate aim of improving public health. Multiple methods are available for etiological source tracking and to determine the distribution of pathogens. Some of the tools that are essential for these studies are typing technologies that can be used to link the affected population to the sources of bacterial contamination. Equally important is the ability to rule out non-related isolates from a particular outbreak, which would likely confound the epidemiological investigation of an outbreak.

a. AFLP

AFLP analysis combines the beneficial traits of restriction digest analysis and PCR amplification for genotyping. It has been successfully used in typing schemes for *E. coli* O157:H7, *Salmonella*, *Shigella*, *Borrelia* and *Yersinia*, allowing researchers to separate isolates within specific serogroups. AFLP is also useful for species differentiation, as in *C. jejuni* and *C. coli* isolates and to distinguish isolates within each species. AFLP has not yet found broad utility to parasites, and a few reports are available on its applications to parasitic nematodes and to protozoa, including members of the genera *Trypanosoma*, *Cryptosporidium*, *Eimeria* and *Plasmodium*.

b. Arbitrarily Primed-Polymerase Chain Reaction (AP-PCR)

This method has been applied to differentiate *Brucella abortus, B. melitensis, B. canis* and *B. suis* targeting the 16S rRNA gene. Typing methods employing this technique have also been used in *Staphylococcus, Streptococcus* and *Leptospira.* AP-PCR has been used for typing isolates of *Cryptosporidium parvum* and *Eimeria* spp. The identification of differentially expressed genes in ileal Peyer's Patch of scrapie-infected sheep has been done using RNA AP-PCR.

c. Multi Locus sequence typing (MLST)

MLST studies of bacteria involve stretches of nucleotide sequence of ~500bp from seven loci of what are known as the housekeeping genes. Sequence data are readily compared among laboratories and lend themselves to electronic storage and distribution. Furthermore, MLST can reduce the need to transport live bacteria, since nucleotide sequence determination from PCR products can be achieved from killed-cell suspensions, purified DNA, or clinical material. A web site for the storage and exchange of data and protocols for been established (http://mlst.zoo.ox.ac.uk). While MLST is particularly suited to long-term and global epidemiology, as it identifies variation which is accumulating slowly within a population, the data can be used in the investigation of individual outbreaks. A number of studies have focused on the development of MLST methods for foodborne pathogens and comparison of results of MLST to more established methods. The methods has been used and validated for a number of organisms including *B. cereus, B. henselae, C. albicans, Salmonella* spp., *C. jejuni, C. neoformans, E. coli, E. faecalis, E. faecium, H. influenza, H. pylori, Leptospira spp., N. meningitides, S. agalactiae, S. aureus, S. dysgalactiae, S. enteric, S. epidermidis, S. pneumoniae, S. pyogenes, S. suis* and *V.vulnificus* (http://www.mlst.net/databases/default.asp).

MLST has also been applied in case of filarial parasites, *Coccidioides immitis, Leishmania* spp., *Cryptosporidium hominis, Ehrlichia ruminantium, T. evansi* and *Giardia lamblia.*

d. PFGE

Currently, PFGE is often considered the ‘‘gold standard’’ of molecular typing methods for bacterial foodborne pathogens, such as *Salmonella, Shigella, E. coli, Campylobacter, Listeria, Yersinia* and *Vibrio*. The method has also been used in case of *Borrelia* spp. It is used by the PulseNet program to identify widespread outbreaks of bacterial foodborne illness. The most common enzymes used for the different foodborne pathogens include *Xba*I, *Bln*I, *Spe*I, *Asc*I, *Not*I, *Sma*I or *Kpn*I. Further, the standardized PFGE protocols can be used to achieve high inter-laboratory reproducibility, which in turn can be useful in developing, maintaining and sharing data among national and international databases. Electronic database libraries of the different PFGE profiles of *Salmonella enterica*, *L. monocytogenes*, and STEC strains have been created in different countries. In these libraries, the PFGE profiles can be compared with each other much more quickly than by just the naked eye. Under the aegis of Indo-German Collaborative project, a web based database, Indian Listeria Culture Collection (ILCD) of characterized strains of *Listeria* has been created. The database (http://www.icargoa.res.in/ilcd) contains geographical source of the strain, source of isolation (animal/human), phenotypic and genotypic characteristics, and DNA fingerprint. This is an interactive web based database and the data can be exchanged between laboratories electronically.

e. Random Amplified Polymorphic DNA (RAPD)

The simplest method for defining the heterogeneity among isolates with no molecular insight in the genome lies in the use of RAPD. This technique has been used

successfully in the detection and differentiation of a number of pathogenic strains of bacteria and also for determining the mode of transmission of a given organism. Studies have shown that RAPD markers can be useful for the identification and differentiation of species and strains of a range of parasite groups, including protozoa and helminths. The technique has been applied to differentiate the seven species of *Eimeria* infecting the domestic fowl. The foodborne bacteria have wide application of this technique as evident by its use across various genera of bacteria like *Salmonella, Campylobacter, Listeria, E. coli, Vibrio, Aeromonas,* etc. DNA amplification fingerprinting (DAF), a modification of RAPD has been attempted to determine heterogeneity in case of noroviruses, rotaviruses and adenoviruses (http://www.biology-online.org/biology-forum/about14156.html?hilit=STH).

f. RFLP

Microbes can be compared by digesting their chromosomal DNA with a restriction endonuclease and separating the DNA fragments by gel electrophoresis. PCR-RFLP has been widely used in typing *Campylobacter, Salmonella, E. coli, Brucella abortus* isolates, Birna viruses, infectious laryngo trachitis virus and infectious bursal disease virus. PCR-RFLP assays have been used successfully ito characterize species and strain differences in the *Echinococcus s*pp. and to differentiate *Taenia saginata, T.solium a*nd *T. asiatica* with high specificity.

g. ERIC and Rep-PCR

Many investigators have examined the potential value of two classes of small DNA repeats dispersed throughout the chromosomes in a variety of bacteria. Primers targeted against ERIC (enterobacterial repetitive intergenic consensus) and Rep (repetitive extragenic palindromic) sequences produce different band patterns depending on the location of repeats within an isolate. Both techniques have been applied to *Brucella, V.*

parahaemolyticus, *E. coli* and *Listeria.* The techniques have also been used in case of *M. tuberculosis* and *M. ulcerans*, the profiles produced wherein have been useful to categorize the strains into three subgroups related to their endemic region.

h. Ribotyping

Ribotyping is a form of RFLP analysis that relies on differences in the location and number of ribosomal RNA (rRNA) gene sequences present in the bacterial genome for genotyping. Differences in the number of rRNA genes and genetic variability in the regions flankingi the rRNA genes leads to the production of distinct restriction fragment band profiles that can be used to discriminate between bacterial strains. In previous studies, *Salmonella* genomic DNA has been digested with restriction enzymes, such as *Pvu*II, *Pst*I or *Sph*I, and hybridized with probes specific for either the 16S or 23S rRNA genes. Ribotyping has been used to differentiate *Clostridium difficle, Staphylococcus aureus, C. diphtheria, Bacillus subtilis. E. coli*, *Yersinia* spp. and *Shigella* isolates. More recently automated ribotyping systems, such as the Riboprinter Microbial Characterization System, have been used for typing *Campylobacter, Salmonella* and *E. coli.* The technique has also been used to differentiate *Giardia*, *Toxocara canis* and *Ancylostoma*. The method is highly reproducible and allows for easier analysis due to the lack of inter-user variability.

i. Variable number of tandem repeat (VNTR) analysis and multiple locus VNTR analysis (MLVA)

Over the past 15 years there have been major advances in the sequencing of bacterial genomes. Through these sequencing projects, it was discovered that many bacterial genomes contain regions with directly repeated DNA motifs. VNTR analysis utilizes differences in the number of repeated copies at specific loci among strains to carry out the genotyping analysis. The single region of repeated motif is

often referred to as an array. When using VNTR for genotyping, it is typically necessary to look at multiple array regions to gain increased discrimination. The approach of using multiple VNTR loci for typing is referred to as multiple locus VNTR analysis (MLVA. To design a VNTR/MLVA protocol, the genome sequence data for the bacterial strain of interest are screened for likely repeat arrays. Once the regions are identified, PCR primers are designed based on the regions flanking the repeat array that will allow amplification of the repeat array. Following amplification, PCR products are separated and the product sizes are determined to detect the number of repeats in the array. Differences in the number of repeats present are used to distinguish different strains. With MLVA, multiple repeat arrays are examined to give an overall genotypic profile. One of the prime pathogens for which MLVA methods were developed is *E. coli* O157:H7. Methods have also been developed for various Salmonella serotypes, *Shigella*, *B. anthraces*, *Yersinia pestis* and *Mycobacterium tuberculosis.* The approach has been used to differentiate *B. abortus, B. ovis, B. melitensis, B. neotomae B. suis* and *B. abortus* sequence.

Conclusion:

Molecular diagnostic methods which are specific and sensitive have been described to detect microbes in animals and vectors and for genotyping studies. These techniques are valuable research tools in their present form and have the ability to replace conventional methods when a suitable method, which is simple, rapid, specific, sensitive and inexpensive, is applied.

PCR-based diagnostics have all the potential to become the standard diagnostic test in situations where either the micro-organism level is low, differentiation between morphologically identical organisms is required, or whether the immune response to the infection is uninformative. The strong demand for improved diagnostic methods will surely lead to

the development of PCR-based test kits suitable for field application in the next decades. The molecular tools for epidemiological studies will provide information on the role of polymorphisms in interactions between pathogens, hosts and vectors. Consequently, this will lead to a greater understanding of the aetiology and epidemiology of diseases. These DNA-based tests have had a transformational impact upon research into disease problems in both the veterinary and medical sciences. Although many systems have been developed, few have proceeded towards field trials or large-scale clinical evaluation, with PCR application to the routine analysis of biological samples, still a major diagnostic challenge. In order for molecular biology to fulfill the promise of improved diagnosis and to be adopted by regulatory authorities, thorough trials of new methods are required and the results of these must be disseminated. In recent years, the development of new molecular techniques or methods has increased significantly. However, reports of application of these techniques on a routine basis in diagnostic laboratories are few. Moreover, there have been little or no attempts made to standardize and harmonize protocols between laboratories at a local, national and international level. The disadvantage of not employing such standardized methods may lead to anomalies in the diagnosis and interpretation of epidemiological data, which may yield biased results and hence question the validity of reporting of a variety of infectious disease states.

Advanced genomic, genetic and proteomic technologies offer huge scope for research in the veterinary field. There is also a range of ‘‘emerging’’ technologies, such as specific and universal microarrays, mass spectrophotometric approaches, biosensors and ‘‘laboratory-on-a-chip’’, nano-technological systems, some of which could have a significant impact in the future. Clearly, there is an urgent need for improved and practical molecular-diagnostic techniques and their critical validation for the accredited laboratory to assist in the

monitoring and control of diseases in companion animals and livestock.

In conclusion, molecular diagnostic techniques have a significant role to play in diagnosis of zoonotic pathogens, although their adoption will never replace conventional methodologies, which continue to be the cornerstone of modern bacteriological methods. Adoption of advanced molecular diagnostic methods in veterinary medicine and health has accelerated the growth of the sector by way of better preventive methods for control of zoonotic infections along with improved production.

References: -On request-

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4 Parasitic zoonoses in India: An overview

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Introduction

According to WHO zoonosis is defined as 'any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa'. Here, the infectious agents are parasites (helminths or protozooans) and so called parasitic zoonoses. Large number of parasites infecting the animals leads to production losses and death in animals. Domesticated animals involves in production of milk, meat, wool, hides etc. play a critical role in human nutrition and socio-economic development. Livestock products like meat, milk, eggs and offal are source of protein, energy, calcium and micronutrients, contributing around 13% of calories and 28% of protein worldwide (FAO, 2011). In lower-income countries like India, livestock do not only provide a regular supply of nutrients, but also serve as a direct source of income and employment, contribute to crop production through the provision of manure and traction power, and act as capital assets usable as future investment revenue.

The zoonotic parasites circulating in environment are a significant burden on human health and well being and there are multiple transmission pathways that place people at risk. Worldwide, zoonotic diseases make a significant contribution to the entrenchment of poverty in poor rural communities who derive income from livestock production. Developing countries including India is currently undergoing changes with respect to climate change, environmental degradation, deforestation and river basin management, socioeconomic development and the

industrialization of livestock production. These complex ecological changes have the potential to modify the interactions between hosts, vectors and parasites and these altered interactions impact on the distribution, prevalence and severity of disease.

Based upon mode of transmission of parasites, the parasitic zoonosis is classified as Food-borne parasitic zoonoses (Meat-borne, Fish-borne, Water-borne, Snail and crustacean-borne, Vegetable/Vegetation-borne) and Vector-borne zoonoses. In general, food-borne zoonotic parasites are helmints and protozoa. Amongest helminths, about 20 species of trematode, 12 species of cestode and at least 12 species of nematode are zoonotic importance. Amongest protozoa, about 20 species are recognized as zoonoses. The major factor which is contributing in transmission of zoonotic parasites between human and animals are:- lack of awareness and education, unhygienic living condition, lack of sense of self-hygiene, food habits, lack of clean water, encroachment in forest areas etc.

Meat-borne zoonoses

The traditional practice of consuming uncooked or partially cooked meat places many people at risk of acquiring food-borne parasitic zoonoses, particularly *Taenia solium* and members of the genus *Trichinella*. The *T. solium*, taeniasis and cysticercosis infection complex involves two distinct disease transmission processes and requires both humans and pigs to maintain the lifecycle. *T. solium* has public health significance because humans can also be inadvertently infected with cysticerci following the ingestion of eggs through poor hygiene or contaminated food and water. Human cysticercosis cases are not involved in perpetuating the lifecycle but are clinically important since cysticerci may form in the brain causing

neurocysticercosis, leading to seizures, epilepsy, neurological sequelae or death. In India, incidence of *T. solium* infection in human is well established and has been recorded to vary from 0.75 to 1.0 percent in certain communities particularly those who remain in contact with pig population especially in rural areas. The prevelance of metacestode of *T. solium*, *Cysticercus cellulosae*, in muscle of pig is much higher ranging from 2.0-28.8 percent in the country.

Trichinellosis is a direct zoonosis caused by infection with nematodes of the genus *Trichinella* and is one of the most widely distributed parasitic zoonoses worldwide. Infection occurs via the consumption of encysted larvae in the muscle of infected animals and involves an enteral phase associated with excystment, sexual maturation, reproduction and larval penetration of the intestinal wall and a parenteral phase associated with the migration of larvae, via lymphatic and blood vessels, to striated muscles where they encyst in a nurse cell complex. Clinical symptoms in humans are related to the number of viable larvae consumed and are typically associated with the parenteral phase. There are few stray reports of *T. spiralis* in some mammalian hosts in India e.g., cat and civet cat from Kolkata, *Bandicota bengalensis* and pigs from Mumbai. So far, there is no report of *Trichinella* infection from man in India.

Toxoplasma gondii is of great zoonotic importance with cats as the key definitive hosts with unusual wide range of intermediate hosts exceeding 200 species of animals including man. Man suffers from toxoplasmosis with a wide spectrum of pathological conditions particularly the congenitally infected children and immunosuppressed adults. Congenital infection occurs only when a woman has a primary infection during

pregnancy. Infection can be acquired either through ingestion of raw or under-cooked meat containing tissue cyst or ingestion of sporulated oocysts contaminating food and water. Toxoplasmosis in human beings is widespread but its prevalence varies from place to place, it ranges from 0 to 90 percent. In India, antibodies to *T. gondii* have been demonstrated at significant levels in normal human population as well as in higher number in persons keeping contacts with animals. Seropositivity has been demonstrated both in the vegetarian and non-vegetarian population and *Toxoplasma* infection in human in country have been documented. Antibodies to *T. gondii* have been demonstrated in 9.7 to 33.7 percent case of sheep, goats, pigs, cattle, buffaloes, camels, horses, cat and dogs. Dubey (1987) reviewed toxoplasmosis in domestic animals in India and came up with the conclusion that clinical toxoplasmosis is not known in India. However, few case of abortion were seen in goats with antibody titer of 1:64 or above (IHA titer) and neonatal mortality was seen in goat born to dams with titers from 1:8 to 1:26 from Parbhani (Maharastra). Dubey et al. (1993) reported a high seroprevalence of *T. gondii* in goats from Kumaon region in India.

Fish-borne parasitic zoonoses

The World Health Organization (1995) has estimated that the number of people currently infected with fish-borne trematodes exceeds 18 million, but worldwide the number of people at risk, including those in developed countries, is more than half a billion. Though the list of potential fish-borne zoonoses that might be quite large, only fewer are very important like opisthorchiasis, intestinal trematodiasis, anisakiasis or

diphyllobothriasis. Flukes belonged to Family: Opisthorchiidae (*Clonorchis sinensis, Opisthorchis viverrini, Metorchis conjunctus*), have long been known to cause serious disease in certain areas of the world. Cholangitis, choledocholithiasis, pancreatitis, and cholangiocarcinoma are the major clinical problems, associated with the long chronic pattern of these infections. A total of 17 million people around the world are estimated to be infected with these liver flukes. In India, infection with these flukes in human has been not reported.

This is the most important fish-borne zoonosis caused by a cestode (tapeworm) parasite. Species of the genus *Diphyllobothrium* are responsible for most reported cestode infections in humans. The zoonosis occurs most commonly in countries where it is a frequent practice to consume raw or marinated fish. At least 13 of about 50 species of *Diphyllobothrium* have been reported from humans. Because diphyllobothriasis is considered a mild illness and is not normally reportable. The common symptoms includes abdominal pain, diarrhoea, nausea, weakness, pernicious anaemia and some neurological symptoms. The zoonosis occurs most frequently in communities that have food preferences for wild-caught fish prepared in a variety of ways. From India, human infection has been not reported in recent years.

Sparganosis is an infection of man with larval stage of the species of genus *Spirometra* of dogs and cats. Man gets infection by eating raw or undercooked infected copepods acting as the first intermediate host. Amphibians, water snakes, fish, birds and some mammals acts as second intermediate host. Man may also get the infection from these second intermediate hosts. Some years back, a case of human sparganosis was

reported from Jodhpur, Rajasthan. Recently, *Spirometra* eggs from the faeces of dog have been identified at department of Veterinary Parasitology, Junagadh which was bringed for the treatment at Teaching Veterinary Clinical Complex, Junagadh.

Gnathostoma spinigerum is a stomach worm of cats and dogs. Man is less frequent host for this parasite and is responsible for an aberrant infection with larvae of this worm. Man acquires infection from contact with meat of infected intermediate host like fish, amphibians and birds. The parasite has been reported from a cat in Madras, in dogs from Kerala and more frequently dogs from Assam. In 1945, subcutenous infection of larvae of *G. spinigerum* in human has been reported from West Bengal.

Water-borne parasitic zoonoses

Cryptosporidial infections have been reported in faeces of many species of wild and domesticated animals from several countries. There is only one authentic report on the occurance of *Cryptosporidium* infection in animals in India based on a brief investigation made in calves of zebu and buffalo around Izatnagar-Bareilly reveling cryptosporidial oocyst in faeces of four zebu and one buffalo calves. The oocyst detected appeared to be *C. parvum*. On the other hand, human case of cryptosporidiosis are on the record from Vellore, Kolkata, Varanasi, Mumbai, Kashmir, Madurai and Chandigarh associated with diarrhoea in children in India. It is not known how cryptosporidia cause disease in humans. *Cryptosporidium* infection has been described only in recent years. In early 1980s the onset of AIDS in the United States brought attention to the association of *Cryptosporidium* spp. with diarrhoea illness in 21 patients with AIDS.

Entamoeba histolytica is a primary cause of amoebosis disease in human beings. The disease is largely confined to man but it has zoonotic potential. Clinical amoebosis is a major health problem in India besides in other countries. Poor sanitary conditions, lack of self-hygiene and socio-economic status are the factors responsible for the widespread transmission of *E. histolytica* infection from person to person. Man acquires infection by the ingestion of food and drinks contaminated with cyst of *E. histolytica*. A high prevalence (20-30 percent of the population) has been recorded in various states of the country.

Giardia intestinalis is a common intestinal falgellates cause diarrhoea and epigastric distress. The incidence has been reported to vary from 1 % to as high as 50 % in different parts of the worlds including India. The mode of transmission of infection is through ingestion of contaminated food and water with mature cysts. The cysts of this species can also cause infection in dogs, cats and beaver which are suggested to be potential reservoirs for transmission of this zoonotic infection to man.

Balantidium coli are the only ciliate pathogen causing diarrhoea, ulceration of intestine in man and pigs. The infective stage is the cystic stage of *B. coli* and infection to man occurs by ingestion of food and water contaminated by cysts of human origin usually. The parasite is of zoonotic importance and when transmission occurs from pigs to man by ingestion of food and water contaminated with cyst of pig origin. Balantidiosis in humans is more common who live in hot and humid climate and remain directly associated with pig colony.

Snail, crustacean and Vegetation-borne parasitic zoonoses

Fasciolopsis buski is a common intestinal flukes of pig and man. The species is widely prevalent in pigs in India, particularly in Assam, Orissa, Bihar, Utter Pradesh, foothills of Uttrakhand, Madhya Pradesh and tamil Nadu. On an average 33-60% of undescribed pig population carry *F. buski* infection. Human infection with *F. buski* occurs when the freshly taken out water caltrops and water chestnuts are peeled off by teeth without proper cleaning. This method of eating raw water fruit results in ingestion of large number of matecercariae. The flukes cause inflammation, ulceration and sometimes abscess formation in duodenum and jejunum. Human infections with *F. buski* in India are on record.

Paragonimus westermanii infection occurs in lungs and rarely in the brain, spinal cord and other organs of pig, dog, cat, cattle, fox, and other wild carnivores and man. Human infection with *P. westermanii* flukes occurs through ingestion of raw or inadequately cooked fresh water crab or crayfish containing metacercaria of the fluke or ingestion of metacercaria with contaminated hand by handling the crabs or crayfish. Reports of human paragonimiosis were recorded from Asia and Africa. In India, isolated foci of paragonimiosis in human existed in Madras, West Bengal, Assam and Manipur. In recent past, 39 cases of young persons, in 11-30 years of age group, were reported from Manipur showing symptoms of recurrent haemoptysis having *P. westermanii* flukes. They had eaten raw crabes.

Gastrodiscoides hominis is the amphistomes, commonly found in the caecum of pig and rarely in large intestine of man. Man accidentally gets infection through ingestion of raw or under-cooked aquatic vegetation harbouring a large number of infective metacercariae. Depending upon

severity of infection, inflammation of intestine and diarrhoea occur. The parasite is widespread in different part of India amongst pig population. There is no recent report of human infection in the country.

Fasciola hepatica and *F. gigantica* are the common flukes infecting the ruminants. Man rarely gets the infection through consumption of raw and uncleaned aquatic vegetations or drinking water of the ponds having metacercariae. Clinical manifestations of infection are abdominal pain, irregular fever, diarrhoea utricaria, anaemia and eosonophilia. Human infection was reported from some European and Latin American countries but there is no report in the recent past of human infection with *Fasciola* spp. in India.

Vector-borne zoonoses

Changing climate is not the only driver for alterations in the dynamic interaction between arthropod vectors of zoonotic parasites and their hosts, including humans. A suite of other factors ranging from urbanization and deforestation to changing demographics in both developing and developed countries, the impact of the recent economic crisis, increased global movement of people and animals and follow-on effects of major catastrophes. The following vector-borne parasites are implicated wtth zoonotic potential: Parasites of simian malaria (*Plasmodium knowlesi*), *Trypanosoma cruzi, Leishmania infentum, L. braziliensis, Babesia microti, B. divergence, B. duncani, B. venatorum, Thelazia callipaeda, Dirifilaria immitis, D. repens*. Since 2004, a simian malaria parasite, *Plasmodium knowlesi*, has been implicated in human disease. Specifically *P. knowlesi* has been confirmed in several human cases of malaria diagnosed from Malaysian Borneo, Thailand, Myanmar, and the Philippines. Certainly, reports of simian

malaria in these neboure countries compel India to keep preparedness and knowledge about this parasite.

Soil-borne zoonoses

Zoonotic infections caused by dog and cat hookworm species, *Ancylostoma caninum, A. braziliense and A. tubaeforme* can also occur and the pathogenic nature of the infection is dependent on the migration of larvae to ectopic sites in the paratenic human host. Cutaneous larva migrans (CLM) is the most common disease described, other clinical manifestations include eosinophilic enteritis, eosinophilic pneumonia, myositis, folliculitis, erythema multiforme or ophthalmological manifestations. Cutaneous larva migrans is predominantly associated with *A. braziliense*. Since *A. braziliense* is rarely reported in South-East Asia, with just a few reports from Malaysia, Indonesia and Laos, it is not clear what hookworm species were the cause of these CLM cases, possibly *A. ceylanicum* or *A. caninum*. *Ancylostoma ceylanicum* on the other hand is endemic in South-East Asia with a wide geographic range, encompassing Indonesia, Borneo, Malaysia, Philippines, Thailand and Laos. Many case reports have been published on cutenous larval migrants in human being in recent years from different parts of India.

Visceral larval migrans (VLM) in human beings is produced mainly by ingestion of food and water contaminated with the infective eggs of *Toxocara canis* and *T. cati* inhabiting the intestine of dogs and cats, respectively. As the worms cannot complete their development in man, larvae undergo a prolonged migration through various tissues of the human host. Heavy infections occur particularly in children with a craving of eating dirt or frequently fondling with their pets infected with ascarid worms. This condition may lead to myocarditis,

encephalitis, granulomas in liver, lung together with diffuse inflammations. In India many reports of VLM has been published in recent past.

Conclusion

Effective prevention and control of the zoonotic parasite infections discussed above have been and will be difficult to attain as it has strong link with socio-economic status and cultural background of people of India and world. Further, it is necessary to create awareness towards the hygienic practices, use of clean water and discourage the cultural taboos. The strategies to control the zoonoses, mass chemotherapy in endemic region can be practiced in both human and animals. Moreover, in future to facilitate the implementation of any control efforts the following points should be considered:

1. Improved diagnostic tools are badly needed, especially those that can differentiate the various species;
2. Guidelines for designing and implementing epidemiological studies are needed in order to obtain the impact data required by public health agencies in setting priorities;
3. The role of reservoir hosts in maintaining transmission in the absence of infected humans needs investigation in order to design sustainable control strategies;
4. Social/anthropological studies are needed to better understand the cultural and behavioral traits of people with regard to food choices in order to develop education strategies aimed at influencing risky behavior;
5. Development of improved aquaculture systems that can prevent or mitigate the transmission of trematodes; and
6. Long-term pilot control projects are needed to compare efforts targeted at multiple high risk factors identified in risk assessment studies with the current mass chemotherapy strategy

References: -On request- ********

Wild Life Disease Ecology

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Ecology (or epidemiology) of wildlife disease is the study of interactions between hosts and pathogens as they relate to behavior, biology, the environment, disease transmission, susceptibility, evolution, climate and impacts of diseases on wildlife populations and communities. Pathogens are natural components of ecosystems that may also be limited by environmental conditions or distribution and behavior of their hosts and vectors. Many pathogens are an intrinsic part of biological diversity and ecological complexity of natural, healthy ecosystems. Although occurrence of disease in wildlife can be a natural phenomenon or anthropogenically driven, there is an increasing trend toward appearance of novel or introduced diseases with severe consequences for wildlife populations.

Chytrid fungus (*Batrachochytrium dendrobatidis*) has impacted amphibian species globally, white-nose syndrome (caused by the fungus *Geomyces destructans*) is threatening cave-roosting bats in North America, diclofenac acid has caused dramatic population declines of Asian vultures, sylvatic plague in black-tailed prairie dog (*Cynomys ludovicianus)* colonies continues to be a major impediment to recovery of blackfooted ferrets (*Mustela nigripes*), and a transmissible cancer is causing declines of Tasmanian devils (*Sarcophilus harrisii*).

Disease in wildlife populations is not a natural regulatory process when novel causative agents are introduced into native ecosystems. When combined with other stressors on habitats and populations, particularly fragmented populations, disease in wildlife may present serious conservation and management consequences and concerns for wildlife managers and scientists. Diseases in wildlife can influence reproduction,

survival, fitness, and abundance of wildlife populations and can affect biodiversity within ecosystems and present an additional threat to many populations, especially those with limited abundance (i.e. threatened and endangered species).

Some pathogens can also be transmitted among conspecifics, other wildlife species, domestic animals, and humans, posing risks to human and animal health and resulting in significant economic impacts. Many exotic diseases have emerged or re-emerged in wildlife populations as threats throughout the world including foot and mouth disease, Rift Valley fever, and Ebola hemorrhagic fever. Emerging zoonotic (transmitted between animals and humans) diseases (e.g., AIDS, SARS, rabies, Ebola) have increased concern for public health and stimulated importance of collaborative approaches that integrate human, domestic animal, and wildlife health. Some of the factors driving disease emergence include increasing host populations, invasive species, environmental changes, rapid long-distance transport of pathogens, pathogen evolution, changes in land-use, increased interaction among humans, domestic animals and wildlife, trade in wildlife meat and products, privatization of wildlife, baiting and feeding, and other highly artificial management activities that greatly enhance risks for disease introduction and establishment.

Of primary concern to wildlife ecologists and managers is how to respond to these increasing disease threats. In general, there are 4 main reasons to consider management actions to control wildlife diseases: 1) some wildlife pathogens infect humans, 2) some pathogens may affect the health of domestic animals, 3) pathogens may have important effects on wildlife populations, and 4) wildlife diseases may have important effects on ecosystems and their functions.

Prior to initiating wildlife disease management actions, it may be valuable to conduct a risk assessment to evaluate likely human health risks, identify specific management objectives, determine likelihood of success, evaluate uncertainty, and consider alternative strategies. Understanding transmission, pathophysiology, epidemiology, and ecology of pathogens and how they interact with wildlife hosts is essential for developing effective strategies to prevent or manage disease in wildlife. Better understanding of these concepts will enable wildlife managers and scientists to address disease challenges. In most situations, management involving veterinary treatment, such as wildlife rehabilitation, is limited due to difficulties associated with accessing free-ranging wildlife, inability to adequately monitor elusive individuals and species, inadequate funding to support large-scale treatment programs, and ethical concerns related to invasive veterinary intervention.

Approximately 75% of recent emerging infectious diseases have been zoonoses and 80% of them are from wildlife

Disease	Year of Emergence	Wildlife Hosts
Monkeypox	2003	Prairie Dog
SARS	2003	Civet Cat
West Nile Virus	1999	Birds
Hantavirus	1993	Small Rodents
AIDS	1981	Nonhuman Primates
Lyme Disease	1975	Small Rodents

Moreover, rehabilitation and palliative care that allows unapparent disease carriers to survive may jeopardize health of entire populations. Medical treatment centers may also inadvertently function as transmission sites where disease spread is exacerbated.

Preventing introduction of disease into susceptible populations is a paramount responsibility of wildlife professionals, and is the most effective method of disease management. Measures designed to prevent disease occurrence including, but not limited to, appropriate planning, import and transport restrictions, decontamination and sanitation measures, and formation of physical or immunological barriers (e.g., fences to separate wildlife from domestic animals, vaccines), have been the tools most commonly used by wildlife managers. When determining appropriate disease management strategies, managers should consider no management action, some level of disease control, or attempted eradication of the pathogen.

Clinical and pathological lesions: Refer ppt slides

Conclusion

- diseases play a major role in wildlife
- pathogen-host-environment interactions are the determinants of diseases
- pathogen pollution is a major wildlife threat
- disease can 'spill over ' from wildlife to domestic life stock and humans
- wildlife diseases are the source for many human emerging diseases

wildlife disease ecology thus need to be studied both for the conservation and human welfare.

References: -On request-

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6 An overview of Zoonotic disease of equine

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Relationship among men and equines exists since antiquity and is evident from variety of roles equines play in the mechanized world, including agriculture. In India, it is significant in mountainous and arid terrains, where approach through roads is not possible. Because of intricate co-existence, zoonoses find a position in India, which has a paradoxical situation to deal with. On one hand, age-old diseases affect indigenous equines and may act as a potential source of infection to elite horses while on the other hand, germplasm of exotic origin pose the danger of the ingress of exotic diseases to indigenous equids. This situation is not known in any developed part of the world. Further, army is maintaining equines for transport of logistics especially in difficult hilly terrain and a perceptible threat is always there for its eruption in indigenous population.

Zoonoses are those diseases and infections which are naturally transmitted between vertebrate animals and man. The basic assumptions in this definition include (i) the diseases are shared by man and animals, (ii) the sharing is bi-directional and (iii) the sharing occurs under natural conditions and is not based on experimental evidence. The 'One Health' concept involving a convergence of animal, human and environment is gaining momentum now-a-days, wherein management of zoonoses and cross-species diseases has assumed central position.

Over the last several decades, there is one new emerging disease every year on an average of which approximately 75% are zoonotic in nature (Manojkumar and Mrudula, 2006). The emergence and re-emergence of zoonotic

diseases poses a great threat to veterinarians, public health professionals and general public. Certain individuals are at higher risk of zoonotic diseases including pregnant women, infants and children, immune compromised persons, elderly persons, individuals under stress of antibiotic therapy, veterinarians, animal handlers and animal health workers. To safeguard the public health from pathogens of zoonotic infections, application of skills, knowledge and resources of veterinary public health is essential.

Table: List of some important equine related zoonoses

	Etiological agent	Reservoir	Zoonosis type/ transmission	Symptoms	Distribution
Japanese encephalitis	Flavivirus	Cattle, horse, swine, birds	Meta/ mosquito, bite	Horses: No apparent disease, death, Human: encephalitis	Asia, Australia
Equine encephalitis virus complex (EEE, VEE)	Togavirus	Horses, mules, donkeys, Wild, birds, fowl	Meta/ mosquito bite	Horses: No apparent disease, encephalitis, death Human: encephalitis, encephalomyelitis	USA, Carribean island
Rabies	Rhabdovirus	Mammals	Direct/ animal bite	Horses: paralytic or dumb form Human: excitation, paralysis, death	World wide
Hendravirus	Paramyxovirus	Fruit bats	Direct/ ingestion	Horses: Acute respiratory syndrome, death in 1-3 days Human: flu like symptoms renal failure and cardiac arrest in acute form and meningoencephalitis in chronic form	Australia

Glanders	*Bukholderia mallei*	Horses, mules, donkeys	Direct/ contact/ ingestion/ inhalation	Horses: pulmonary, nasal, cutaneous or mixed form Human: Granulomatous to pustular lesions, septicemia	Asia, Mediterran ean
Salmonellosis	Salmonellae (non-typhoidal)	Fowl, swine, sheep horses, dogs, cats, rodents, reptiles, birds, cattle	Direct/ ingestion	Horses: enteritis, septicemia Human: gastroenteritis, focal infection, septicemia	Worldwide
CDAD	*Clostridium difficile*	Multiple species	Direct/ ingestion	Horses: colitis, diarrhoea Human: Acute diarrhoea	Widespread
Leptospirosis	*Leptospira interrogans*	Cattle, buffalo, horse, dog, swine, rodents, sheep, goat, wild animals	Direct/ ingestion	Horses: Fever, icterus, conjunctivitis, recurrent uveitis, abortions, stillbirths Human: headache, muscular pain, vomiting; neurologic, respiratory, cardiac, gastrointestinal manifestations	Widespread
Dermatophytosis (ringworm)	*Microsporum, Trichophyton* spp	Cattle, sheep, goat, dog,	Direct/ contact	Horses: Mild to severe mimicking pemphigus foliaceus	Widespread

Anthrax	*Bacillus anthracis*	Cattle, sheep, other animals	Direct/ ingestion/ inhalation / insect bite	Horses: fever, colic, dyspnea, subcutaneous oedema, sudden death. Human: cutaneous, pulmonary, gastrointestinal forms.	Worldwide
Rhodococcosis	*Rhodococcus equi*	Horses	Direct/ ingestion/ inhalation	Horses: Bronchopneumonia, enteritis, arthritis, death in young foals Human: Pneumonia	Widespread
Brucellosis	*Brucella* spp	Goats, cattle, pigs, seal	Direct/ ingestion/ inhalation /insect bite	Horses: fistulous withers, poll evil Human: non-specific to undulant fever, malaise, arthritis, bacterimia, orchiepididymitis	Worldwide

Bacterial Zoonoses

Glanders

Glanders is a fatal infectious disease of horses, donkeys, and mules caused by *Burkholderia mallei.* In last two decades, the occurrence of outbreaks amongst equines is steadily increasing and thus is currently considered as a re-emerging disease (Wittig *et al*., 2006). In India, the disease has re-emerged in several parts of the country during recent years (Malik *et al*., 2009). Glanders is commonly manifested in three forms namely pulmonary, nasal and cutaneous glanders or

Farcy. These forms are not clearly distinct in most outbreaks, and may occur simultaneously. Chronic forms are more common though, the acute form typically progresses to death within about a week. The acute form is more common in donkeys and mules than in horses. Many cases of glanders are latent and clinically asymptomatic.

Respiratory tract discharges and skin are potent source of disease transmission. Animals to animals and animals to man transmission are by inhalation, ingestion of contaminated material or through skin abrasions. It is easily transmitted to humans, with 95% case fatality. All infected infected material must be handled in the laboratory under conditions of strict biocontainment. Glanders has been eradicated from many countries by statutory testing, elimination of infected animals, and import restrictions. The disease is still prevalent in Eastern European, Asian and African countries (Al-Ani and Robertson, 2007).

Organisms are Gram-negative nonsporulating, nonencapsulated, nonmotile,aerobic rods. Media containing glycerol augment their growth. Guinea-pigs are highly susceptible, and are used for testing of infected material. Intraperitoneal injections are given to attempt to elicit the Strauss reaction.

The mallein test is a sensitive and specific clinical test for diagnosis of glanders, where mullein PPD is inoculated intradermopalpebrally and a delayed hypersensitivity reaction is indicative of the presence of the disease. The complement fixation test is the most accurate and reliable laboratory test available. Many other tests are now being used including ELISA and PCR. The close genetic relationship between *B. mallei* and *B. pseudomallei*, together with the high genetic variability of *B. pseudomallei*, complicates the differentiation of these organisms by either serological or molecular tools (Godoy *et al*., 2003). No suitable vaccine is available at present (Wagg *et al*., 2006).

Anthrax

Anthrax is an acute disease of mammals, caused by a spores of *Bacillus anthracis.* This is a fatal infection which has been used as a biological weapon extensively owing to its highly pathogenic nature and efficiency of transmission. Horses are considered to be less susceptible and may show pyrexia, colic, dyspnea and subcutaneous oedema, or sudden death. In human beings, a variety of clinical forms including cutaneous, pulmonary and gastrointestinal are reported. Transmission of anthrax is through inhalation, ingestion, or contact of infective spores with abrasions (Weese, 2002). Transmission of anthrax is through spore forms. Spores are formed on exposure of vegetative form to air. Therefore the carcasses should not be opened. Dixon *et al*. (1999) have reported 95% of human beings having cutaneous form of anthrax often accompanied with a history of contact with animals or animal products. Cutaneous form of anthrax can be cured if diagnosed early and treated properly.

The handling of living organism requires physical containment and tedious in nature, thus it is essential to rely heavily on molecular tools. Standard PCR targeting *pag* and *cap* genes residing on pOX1 and pOX2 plasmids, respectively have been in use (Inoue *et al*. 2004). Daffonchio *et al*. (1999) reported that a RAPD marker specific for the *B. cereus* group was identified and the restriction enzyme analysis of this RAPD specific fragment with *Alu*I distinguished *B. anthracis* from other species of the *B. cereus* group. Ellerbrok *et al*. (2002) described that rapid and sensitive identification of pathogenic and apathogenic *B. anthracis* was carried out by real-time PCR, thus allowing confirmation or exclusion of potential attacks approximately 2-3 h after the material had arrived in the laboratory. A rapid detection protocol suitable for use by first-responders to detect anthrax spores using a low-cost, battery-powered, portable Raman spectrometer has been

developed (Zhang *et al*. 2005), using surface-enhanced Raman spectroscopy (SERS) on silver film over nanosphere (AgFON) substrates.

Leptospirosis

Leptospirosis is a disease of worldwide significance that infects many domestic and wildlife animal species and humans. Leptospirosis is caused by serovars of *Leptospira interrogans*. *L. interrogans* is considered to be the most widespread zoonosis in the world.

Disease can spread between animals through contact with infected urine, contaminated water sources, food, bedding or human hands, venereal or placental transfer or bite wounds. *Leptospira* can survive in manure up to 2 months. Stagnant or slow moving water provides a suitable habitat. The organism can survive up to 20 days in water. That is why outbreaks increase during periods of flooding. Fever, shivering and muscle tenderness are among the first signs of acute infection. Rapid dehydration may develop subsequently. In subacute infections, the animal usually develops a fever, anorexia, dehydration, and increased thirst. Animals with liver involvement may develop icterus. Conjunctivitis may occur in chronic infections. Mortality in neonates and renal dysfunction in a stallion have also been encountered.

Veterinarians may contract infection through contact of mucous membranes or skin lesions with urine or tissues from an infected animal. Human leptospirosis is highly variable, ranging from asymptomatic infection to sepsis and death, though rare (Ellis, 1998). Headache, muscular pain, nausea, and vomiting are common symptoms; however, neurologic, respiratory, cardiac, ocular, and gastrointestinal manifestations can occur. Prevention involves early diagnosis, reducing contact with affected animals and the use of protective accessories (Ellis, 1998). Diagnosis of leptospirosis can be difficult and may involve antigen detection (PCR), serological

evaluation, histopathological examination, culture, and dark field microscopy (Ellis, 1998).

Methicillin-Resistant *Staphylococcus aureus*

Hospital originated methicillin-resistant strains of *Staphylococcus aureus* (MRSA) are pathogens of serious concern in human and equine hospitals because of the high degree of antimicrobial resistance (Seguin *et al*., 1999) and transmission between infected horses and veterinary personnel. Although health care personnel may remain asymptomatic and transmit the organism to susceptible patients, clinical MRSA cases in human health care professionals have been reported. Personal hygiene and judicious use of antimicrobial drugs decrease the chances of acquisition of MRSA by equine veterinarians.

Diarrhoeal Diseases

Diarrhoea in horses can be of multietiologic origin including some pathogens having zoonotic potential. The identification of etiological agent is possible only in less than 50% of cases even with very sophisticated and advanced diagnostic procedures. However undiagnosed cases may be infectious and zoonotic.

Salmonellosis

Salmonellosis is one of the leading causes of bacterial enteric diseases and are associated with the consumption of animal products and fresh produce contaminated with *Salmonella* (**Foley *et al*., 2008)**. Salmonellosis, caused by serotypes of *Salmonella enterica* sp *enterica*, affects humans, horses, most mammals and birds. Infection with a virulent, multi drug resistant strain of *S.* Typhimurium, DT104, was reported in horses (Weese *et al*., 2001), which causes high mortality in human beings. Acute toxic enterocolitis, chronic diarrhoea, pyrexia of unknown origin and septicemia may be

exhibited. It occurs due to stresses like excessive traveling, shipping, training, hospitalization or antimicrobial therapy. Diagnosis is based on isolation of bacteria from faecal samples. Affected animals are considered potentially infectious since *Salmonella* are shed intermittently and therefore, repetitive negative culture testing is necessary. Faecal-oral route leads to zoonotic transmission of salmonellosis. Although relatively high number of organisms is required to cause clinical disease, antibiotic use, immunosupression or any associated disease may significantly lower the number of organisms required for causing clinical disease. Following strict personal hygiene, adopting protective measures and disinfection significantly reduces the probability of zoonotic transmission. *Salmonella* survives in environment for a long period but is susceptible to most of the common disinfectants.

Clostridium difficile associated diarrhea (CDAD)

C. difficile is an anaerobic bacterium that causes colitis in horses human beings and other animals. Infection in neonatal foals is associated with necrotizing enterocolitis and horse, with typhlocolitis (Perrin *et al*., 1993). The organism is a common nosocomial pathogen in human patients and causes pseudomembranous colitis associated with antibiotic therapy.

Equine CDAD ranges from mild to per acute disease which may prove to be fatal and affects all age groups. Diagnosis of *C. difficile* is based on identification of bacterial toxins in faecal samples. *C. difficile* is an important human pathogen resulting in disease following antibiotic therapy, hospitalization or other stressful conditions. Sporicidal agents like 5-10 % bleach solution can effectively clean the contaminated areas and equipments.

Brucellosis

Brucellosis is a zoonotic disease having economic significance. Though it has been eradicated from Europe, Australia, Canada, Israel, Japan and New Zealand, yet it

remains an uncontrolled problem in regions of high endemicity such as the Africa, Mediterranean, Middle East, parts of Asia and Latin America. Brucellosis organisms are small, non-motile, aerobic, facultative intracellular, Gram-negative coccobacilli.

All domestic species can be affected with brucellosis except cats which are resistant to *Brucella* infection. Horses are relatively resistant to infection; however, disease can occur and brucellosis can be transmitted from horses to humans. Considering the damage done by the infection in animals in terms of decreased milk production, abortions, weak offsprings, weight loss, infertility and lameness, it is one of the most serious and economically significant diseases of livestock. It is also a major impediment for the trade. Death may occur as a result of acute metritis, followed by retained fetal membranes.

Equine disease is commonly seen as fistulous withers and poll evil. Diagnosis is based on seropositivity because *B. abortus* is difficult to isolate. Human brucellosis is considered to be an occupational disease that mainly affects slaughterhouse workers, butchers, and veterinarians.
Transmission occurs through contact of infected animals or materials with skin abrasions. Human brucellosis can be highly variable, ranging from non-specific, flu-like symptoms to undulant fever, arthritis, and orchiepididymitis in males. The chronic form can result in fatigue, depression, and arthritis. Serologic and cultural testing should be performed in all horses with fistulous withers. Sero-conversion takes approximately 2 weeks, so repeated serologic testing of acute lesions is required. Prevention of infection involves early diagnosis, barrier precautions and careful handling of laboratory materials.

The disease is conventionally diagnosed by plate and tube agglutination tests serologically. However for rapid diagnosis several molecular tools are being applied. A Light

Cycler-based real-time PCR (LC-PCR) assay has been developed by Qeipo-ortuno (2005) to evaluate its diagnostic use for the detection of Brucella DNA in serum samples.

Rhodococcus equi infection

Rhodococcus equi is recognized as a pathogen in people infected with the human immunodeficiency virus (Capdevila *et al*., 1997). The role, that contact with horses plays in these cases, is not very clear.

R. equi appears to be most important among all cases of bacterial foal pneumonia between one to six months of age. *R. equi* is a pleomorphic gram positive coccobacillus ,a pathogen of macrophages. Pathology caused by *R. equi* is chronic pyogranulomatous pneumonia, foals may be presented as acute cases because the initial phase of disease often goes unnoticed. Other extrapulmonary involvements may be polysynovitis, septic arthritis, uveitis, subcutaneous abscesses, ulcerative lymphangitis, nephritis, hepatic or renal abscession. *R. equi* is found in the soil of most farms and equines can acquire the infection through inhalation. Amongst equines, morbidity rates of 5-17% with mortality rates of 40-80% was reported by Elissalde *et al*. (1980).

Farms that have endemic problems with *R. equi* are usually contaminated with a higher proportion of virulent strains (Takai *et al*.,1991). A 85 Kb plasmid was shown to be essential for virulence and containing genes for virulence associated proteins (Vap) A through H. Vap A has been proposed as a target for antibodies in diagnostic tests, besides conventional agent isolation and identification.

Viral zoonoses

Rabies

It is fatal viral disease caused by a *Lyssavirus*, causing encephalomyelitis in virtually all the warm-blooded animals,

including man. The rabies in equines is difficult to diagnose because of variable clinical signs. The furious form, common in several animal species, is not common in horses. The paralytic and dumb forms are most common in horses (Green, 1997). During initial stages intense rubbing or biting of inoculation site as a result of paresthesia is seen. Other signs encountered during initial stages are lameness and colic (Green *et al*., 1992). Since rabies shows an array of symptoms in horses, this should be suspected in cases of acute encephalitis or neurological disease. Affected animal usually dies within 2-5 days after the onset of clinical signs, however it may take a longer period of up to 2 weeks in some instances.

Rabies may be ruled out during initial stages based on history, diagnostic tests for other diseases and the progression of the disease. However initially rabies must be considered and all requisite precautions must be taken. Tissues of rabies infected animal have the potential to infect with higher concentrations in the central nervous system, saliva and salivary glands. Rabies virus is most commonly transmitted through contact of saliva with broken or abraded skin and mucous membranes. Veterinarians in equine practice are less likely to suffer from this disease in comparison to those in small animal or wildlife practice.

Arboviral Encephalitidis

Several mosquito-borne arboviruses cause encephalitis in equines, which is one of the most important viral zoonosis. These are eastern (EEEV), western (WEEV) and Venezuelan equine encephalitis virus (VEEV) (Weaver *et al*, 1999). Arboviral encephalitides exhibit an array of highly variable clinical signs which simulate other causes of encephalomyelitis. Disease may be very mild or inapparent to peracute encephalomyelitis with sudden death. Human form of the disease is characterized by fever, drowsiness, paralysis, convulsions and comma. The patients recovered from the

disease may suffer from mental retardation, epilepsy and blindness. WEE is relatively less severe in man. VEE causes a systemic febrile illness in man and a small proportion may develop encephalitis. VEE virus may cause abortion in pregnant women.

None of the arboviruses are directly transmissible from horses to human beings as high level of viraemia is not produced to infect mosquitoes and disseminate disease. In fact, both horses and humans are considered as dead end accidental hosts. Handling of infected carcasses may pose a risk, however, there is only a limited evidence of acquiring infection by handlers.

Hendravirus (morbillivirus) pneumonia

First report of Hendra virus (equine morbillivirus) pneumonia from Australia causing death of 14 horses and their trainer by Murray *et al*., 1995 added this dreaded infection in yet another emerging zoonosis of equine origin. Presence of antibodies in a significant percentage of fruit bats suggested that they act as reservoir hosts. It is suspected that infected urine or reproductive fluids of bats are involved in transmission, although the virus is not highly contagious.

In horses, the disease presents acute form; period from onset of signs to death is only 1–3 days. Fever, anorexia, and depression are the initial signs after an incubation period of 8–11 days with maximum of 16 days (Barclay and Paton, 2000). Signs of respiratory illness progress and thick frothy yellow nasal discharge are common characteristics in terminal stages. Differential diagnoses should be done with shipping fever, acute circulatory catastrophes, poisoning, acute bacterial infections, and intoxications such as anthrax. Serious influenza like signs predominate in human beings. Close contact between naturally affected horses is essential for transmission of disease.

Protozoal zoonoses Cryptosporidiosis

Cryptosporidium parvum is an enteric protozoal pathogen that causes enteric disease in animals and human beings. Equine cryptosporidiosis is associated with immunodeficient animals and foals (Netherwood *et al*., 1996). *Cryptosporidium* are shed from asymptomatic horses. Infected animals shed infective oocysts. The symptom in human beings is profuse watery diarrhoea. A prolonged and potentially fatal disease may occur in immunocompromised people. Diarrheic animals are responsible for zoonotic disease because of higher rate of shedding. oocysts are susceptible to high and low temperatures but are mostly resistant to conventional disinfectants.

Giardiasis

An important intestinal protozoal disease of human beings caused by *Giardia intestinalis.* Twenty five per cent of adult horses may shed *Giardia*. In human beings the main clinical sign is varying degree of diarrhoea. Zoonotic transmission occurs by faecal-oral route.

Fungal zoonosis Dermatophytosis

Dermatophytosis (ringworm) is a fungal skin disease caused by *Microsporum* or *Trichophyton* species. In horses, *T. equinum* is the common cause of dermatophytosis. Disease in horses can mimick pemphigus foliaceus, an autoimmune skin disorder (Stannard and White, 2002). It also affects human beings and can be transmitted through direct and indirect routes.

Ringworm infection was the most common zoonotic disease among veterinarians in Britain. Recognition and quarantine of infected animals, personal hygiene, and environmental disinfection are important for prevention of zoonotic transmission of disease. Contaminated areas or instruments should be cleaned thrice with stabilized chlorine dioxide disinfectants or a 10% bleach solution. Blankets,

equipment, brushes, and other items should also be disinfected or discarded.

Parasitic zoonosis

Mange

Mange is characterized by pruritus, caused by *Sarcoptes equi*, *Psoroptes equi* and *Chorioptes bovis* var. *equi* in equines. Pruritus, raised skin tips, hairleass patches with skin folds, grey scabs and crusts, fetlock eczema and/or verrucose dermatitis are typical signs of these diseases. Eczema of fetlocks result in scab formation, skin hypertrophy and superimposed grey deposits. Human may be infected by direct contact during animal handling like grooming.

Veterinarians can play a key role in detection of emerging zoonotic diseases because of their close contact with both animals and owners. Considering the increasing concern about the use of zoonotic pathogens as bio-weapons, veterinarians may play important role in early detection of bioterrorism-associated outbreaks of zoonoses.

References: -On request-

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Zoonotic diseases status update in india

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"*Infectious disease is one of the few genuine adventures left in the world. The dragons are all dead and the lance grows rusty in the chimney corner...*"- Dr . Hans Zinsser (1878-1940), the American physician-cum-bacteriologist wrote in his book ' *Rats, Lice and History*', on the mighty success over ferocious Epidemic typhus outbreak that swept away millions of soldiers and civilians during World War I. The ominous struggle of infectious agents against human existence on the planet earth continues throughout centuries, even after significant advent has been made in the field of antibiosis and immunization. Consequently, the infectious agents pose serious perils to the human civilization in terms of survival, socio-economic status and all the more, to the equilibrium of ecosystem, where we live in. The nature's fury under certain circumstances like, unheralded disasters (natural calamities such as flood, earthquake, drought) and undesirable human factors (deforestation, war, bioterrorism, population explosion), which are quite often believed to be intrinsically linked, put an interrogation to the creation itself.

Dr. Tom R. Frieden, present CDC Director expressed his views on the atrocious Ebola crisis of the previous year as, " *We live in a world where we are all connected by the air we breathe, the food we eat and by the airplanes that can bring the disease from anywhere to anywhere in a day. That's why it's so important to strengthen the global health security and work with countries all around the world, so that they can do a better job finding threats..*"(T imes of India, August 25, 2014). In fact, the entire world community, particularly of the developing world, including India, is increasingly being engaged in a nagging war against the invisible enemies in the form of dreaded emerging infectious diseases, especially the zoonotic diseases, causing huge economic losses on account of

heavy mortality and morbidity of livestock wealth and mankind as well as national and international trade restrictions. This review is envisaged to brief the status update of zoonotic diseases with special mention to Indian subcontinent.

Zoonotic diseases and its impact

Classically, the term 'zoonoses' is collectively referred to as " *those infectious diseases or their agents naturally transmissible between animals and human beings*" (WHO, 2009) – comprising of two Greek words -' *zoon*' means animal, and ' *noses*' means diseases. This term was first coined and used by Rudolf Virchow to define the animal diseases communicable to humans under natural circumstances. With the recent advent of novel diagnostic tools, a total of 1415 diseases infecting human beings have been documented so far, out of which approximately 60.3% (853) are zoonotic in nature; and out of 175 infections that are emerging or re-emerging, about 75% (132) are zoonoses (Jones *et al*., 2008). It is noteworthy here that a significant number of these diseases have remained 'masked' or 'neglected' infections for long, and could only be identified in the recent past. On economic grounds, the World Bank report (2010) has mentioned a direct loss of US $2 billion and an indirect loss of $20 billion on account of zoonoses. The greatest burden on human health and livelihoods, amounting to about 1 billion cases of illness and millions of deaths every year, is caused by zoonotic diseases that are persistent regional health problems around the world (Karesh*et al*., 2012), leading to the global losses exceeding US $200 billion in terms of trade, tourism and taxable revenues (Sherman, 2010; Naicker, 2011; Okello*et al*., 2011; Asokan*et al*., 2013).

The diverse animal species enhost for innumerable etiological agents (bacterial, viral, mycotic, rickettsiael, prion, parasitic, chlamydial), which later on prove to be potential zoonotic threat to the existence of mankind. The concept

embedded in this regard would be materialized with a simple instance that, considering there are 50,000 known vertebrate species and presuming each of them has 20 endemic viruses (an under-estimate), then the existence of more than 1 million vertebrate viruses (20,000 in bats alone) could be roughly estimated. Only 2,000 or so, viral species have been described so far; hence, 99.8% of vertebrate viruses remain yet to be divulged (Atlas *et al*., 2010). Imagine the large potential for future zoonotic emergence! Being the case with viral infectious diseases only, the case of other pathogenic classes is beyond intuition, which urges for the maintenance of zoonotic pathogen inventory to recognize the disease at the preliminary stage of outbreak.

Of late, many of the zoonotic diseases have been reported to be emerging or re-emerging at a faster pace in recent times and have become synonymous to the terror unleashed by the nature, and left the global community panicky, such as Methicillin-resistant strain of *Staphylococcus aureus* (MRSA), SARS, bird flu, swine flu, Q- fever, Multi-drug resistant (MDR) and extremely drug resistant (XDR) strains of tuberculosis, Middle East Respiratory Syndrome-Corona Virus (MERS-CoV), Leptospirosis, Japanese encephalitis and dengue (Malik *et al*., 2013).The most recent global threat has come in the form of Ebola virus infection. In this context, most of the domesticated and wild vertebrates as well as many invertebrates that serve as the source of food for the people, are capable of harbouring zoonotic bacteria, viruses, or parasites. Therefore, increasing demand for food due to an expanding population has led to a substantial susceptibility of our populations to food-borne zoonoses. Pathogens in the livestock production chain are at particular risk, with repeated outbreaks from meat, eggs, milk, and cheese, or meat by-products incorporated into foods as flavouring, oils, or stock (Karesh*et al*., 2012).

Indian scenario:

India ranks first among top 20 countries at the interface of poverty and the burden of zoonoses in the Global Burden of Disease (GBD) (ILRI, 2012). In India, about 40 important zoonotic diseases have been frequently reported, which include swine flu, bird flu, tuberculosis, salmonellosis, leptospirosis, rabies, brucellosis, Japanese encephalitis, dengue, chikungunya, anthrax, plague, kyassanur forest disease, glanders, listeriosis, campylobacteriosis, Q-fever, infections caused by *E. coli* and *Chlamydia* spp., rotaviruses, Crimean-Congo Haemorrhagic fever as well as foodborne illnesses caused by bacteria such as *Salmonella* spp., *Listeria monocytogenes, Campylobacter* spp., verotoxic*E. coli*, viruses like caliciviruses; and parasites like *Echinococcus* spp., *Taenia* spp., *Cryptosporidium* spp., *Toxoplasma gondii*, *Entamoeba spp*., *Giardia spp*. etc. causing heavy mortality and morbidity in man and animals as well as huge economic losses to the country (Malik *et al.*, 2013).

Bacterial zoonoses:

1. Anthrax: Although it can be found globally, it is more often a risk in countries with less standardized and effective public health programs.Being endemic to different states of India, like Tamil Nadu, Karnataka, Odisha, Chattisgarh and Andhra Pradesh, the reports have documented around 205 human cases due to anthrax, with majority of cutaneous anthrax (Patil, 2011). In the endemic belt, it is a sporadic disease in cattle which crossed near about 500 reported deaths in a span of three years. Of late, an outbreak of anthrax claimed the lives of 6 cattle in Nadia district of West Bengal (Business Standard, August 2, 2014) and around 40 suspects in West Bengal (DNA India, May 25, 2015). Epidemics in the country have generally been reported between July to September and also in November and January, coinciding with the post-monsoon months across the country; still, many cases of anthrax go

unreported. Thus the available reported outbreaks only provide an index of the magnitude of the disease in India and could be an underestimate of the extent of problem.

2. Tuberculosis (TB): India has the highest tuberculosis burden in the world, accounting for nearly one-quarter of the global incidence, with an estimated economic loss of US$43 billion and 100 million productive days lost annually, costing more than Rs. 13,000 crores in India per year. Tuberculosis is estimated to kill 3,00,000 Indian people annually; i.e., one death every 2 minutes, which makes India, the nation most susceptible to tuberculosis in the world (Golechha, 2015).

In India, as many as 3.3 million people are suffering from one or the other type of TB. As many as 9.4 million cases of TB are detected worldwide every year. Two to three per cent of the newly detected cases are also found to be drug-resistant and when the patients abandon the course of treatment mid-way, this proportion of non-resistant cases rises to the range of 14 – 17% (Down To Earth, 2014).

The socio-economic statistical analysis reveals that 67% rural and 75% urban patients are in debts on account of treatment and loss of workdays (ICMR Bulletin, 2002). However, with the introduction of Revised National TB Control Programme (RNTCP), in absolute numbers, mortality due to TB has reduced from 3.3 lakhs to 2.7 lakhs and the prevalence has reduced from 40 lakhs to 28 lakhs annually; to worsen the situation among new TB cases, 5% of the patients belong to pediatric age-group (0-14 yrs) (DGHS Report, 2014). The burden of 'zoonotic' TB under-estimated as 'human TB' could be exemplified by a study conducted in India wherein, 7.1% of pharyngeal swabs from cattle were positive for *M. tuberculosis*. Overall, one-third of the world's population is currently infected with TB; of which those who do not receive treatment, about 5-10% will develop TB at some point of time in their lives. Zoonotic TB is more likely to present as extra-

pulmonary, and prevalence of extra-pulmonary TB is a crude proxy for zoonotic TB (ILRI, 2012).

The recent years witnessed TB acquiring a deadlier edge in the country in the form of new entity-ominously called Totally Drug-Resistant TB (TDR-TB) organism that has been isolated at Hinduja Hospital (Mumbai). TDR-TB is the result of the latest mutation of the bacilli after Multi-Drug-Resistant TB (MDR-TB) and Extremely Drug-Resistant TB (XDR-TB) (The Times ofIndia, Jan 07, 2012).

3. **Brucellosis**: In India, brucellosis costs Rs. 350 million in the form of food animals and man days of labour. Human brucellosis is causing physical incapacity and loss of 3 million man-days of labour, annually. So far as impact of the disease is concerned, sero-positive animals have higher rates of abortion, stillbirth, infertility, calf mortality and lameness. This is associated with lower milk yields (around 25% milk losses in aborted cows) (ILRI, 2012). Usually infected females will abort only once, although they may remain infected their entire life. Sero-prevalence of bovine brucellosis in India is reported to be 22.18%, 13.78 and 12.82% by ELISA, RBPT and MRT respectively (Trangada*et al*., 2009). As per the International Livestock Research Institute (ILRI, 2012), the prevalence rate of the disease in India were reported 13% each in shoats and in bovines, 7% in camels and 5% in other species (chicken, pigs, and dogs). Among the high-risk occupational groups like livestock-keepers/abattoir workers, the prevalence was 11%, and among suspect hospital patients, 7%. A larger study in India found that 2% of patients in the general hospital population tested positive for brucellosis. The order of countries with multiple surveys and high prevalence (>15%) of combined human and animal brucellosis are as follows: Togo, Mali, Ivory Coast, Zambia, Niger, *India*, Sudan, Cameroon and Burundi (ILRI, 2012). The scarce data published up till now represents only the tip of the iceberg and the true prevalence remains to be estimated.

4. Q-fever: Q-fever (Query fever) is an important bacterial zoonotic disease having worldwide distribution with the notable exception of New Zealand (Angelakis and Raoult, 2010). The researchers round the globe testifies the disease one among the 13 global priority zoonoses (ILRI, 2012) and a largely neglected zoonoses (Porter *et al*., 2011). The multitudinous transmission pattern of this particular pathogen adds up to the severity of infection as evidenced in the 2009 Netherlands outbreak which resulted in forced culling of 51,820 small ruminants and implicated in >4000 human cases. Presently, the infection is emerging or re-emerging (Natale*et al.*, 2012) as well as endemic in many parts of the world and its prevalence has been confirmed in at least 51 countries, including India (Malik *et al*., 2013). Q-fever is associated with a wide clinical spectrum ranging from asymptomatic or mildly symptomatic seroconversion to fatal disease (Angelakis and Raoult, 2010). Classified as a Category 'B' critical biological agent by the Centre for Diseases Control and Prevention, this organism has been considered as a potential weapon for bioterrorism (CDC, 2011). Of late, World Organization for Animal Health has recently classified Q fever as a notifiable disease (AVMA, 2009).

According to a recent report by ILRI (2012) in community studies, its prevalence was found as follows: bovines- 28%, other animals (cats, dogs, horses and poultry)- 26%, shoats- 15%. Among the febrile patients in hospitals, 0-40% (average 8%) had antibodies to Q- fever. The countries with multiple surveys and high prevalence (>15%) were included in the order, Nigeria, Zimbabwe, *India*, and Egypt (ILRI, 2012). The Q-fever infection grossly remains under-diagnosed and unreported. In a recent study in IVRI, Izatnagar, *C. burnetii* organism have been isolated from bovine blood samples and 03 of these isolates were sequenced, analyzed and got released by GenBank, as first ever sequences of cultured isolates of *C. burnetii* form India (Malik *et al*., 2010). The working group has

also succeeded in detecting the organism from the bloody droppings of a free roaming bird (Das *et al*., 2013).

5. Leptospirosis: Leptospirosis is known to be endemic in India since the early 20th century.This emerging zoonosis is caused by a spirochaete- *Leptospira* belonging to the family- Leptospiraceae, comprising of 13 pathogenic species with more than 260 serovars and 6 nonpathogenic (saprophytic) species with more than 60 serovars (Adler and Moctezuma, 2010). The disease is contracted from the urine of infected rat or contaminated water sources. The population at high-risk includes mainly, farm workers, rice field workers, sugarcane cutters, cattle rearers, fishermen, slaughter house and sewer workers. South East Asia is considered as a hot spot and in some areas, it is the second most common cause of fever, next to malaria. The outbreaks of leptospirosis have been reported from coastal Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Karnataka and Andaman periodically over the last two decades, due to farming and inadequate rodent control. In the last decade, there has been a rapid rise in the incidence of leptospirosis in North India. The community surveys performed in India unveiled the prevalence of this pathogen in 34% of swine, 29% of bovines, 14% of small ruminants, 16% of wildlife and 24% of humans (ILRI, 2012).

Parasitic zoonoses:

***1. T. solium*Cysticercosis**: *T. solium* is unique in its infectious nature, because the cysticercus stage can infect humans and cause cysticercosis. Approximately 50 million people worldwide are estimated to have cysticercosis infection, although estimates are probably low, since many infections are sub-clinical and there are relatively few population-based data on prevalence. Cysticercosis is endemic in many regions of Central and South America, sub-Saharan Africa, India, and Asia (Moyano*et al*., 2014). In humans, cysticerci may lodge in the brain and cause neurocysticercosis (NCC), one of the most

important causes of acquired epilepsy in endemic areas. In fact, the disease being described as the 'biological marker ' for socio-economic development of community especially, in terms of sanitation and hygiene, since the transmission is mainly mediated by way of accidental ingestion of eggs shed with the stools by the carrier. There is ample evidence for the widespread occurrence of NCC caused by *T. solium* in India. It is likely that the disease is under-reported in India, because due attention has not been given to this neglected disease and systematic population-based studies are lacking.

The disease is widespread virtually in all states of India. There are only few reports from Kerala, where the level of education and standards of hygiene are high, and from Jammu and Kashmir, a Muslim majority state due to the prohibition of pork consumption by religion.Cysticercosisappears to be more prevalent in the northern states like, Bihar, Uttar Pradesh and Punjab (Prasad *et al*., 2008). Anywhere between 26 and 50% of all Indian patients presenting with partial seizures are diagnosed with a solitary cysticercus granuloma (SCG), on the CT-scan (Zoonoses and Food Hygiene News, 2007). In community studies, the average prevalence in pigs was 17% and those among humans was 11% (ILRI, 2012).

2. Cystic echinococcosis (Hydatidosis): The disease is caused by cysts formed by the larval stage of cestode tapeworms, *Echinococcusgranulosus, E. ortleppi, E. intermedius* or *E. canadensis* in intermediate hosts, including humans. All these parasites have canines (usually, domestic dogs) as definitive hosts and a variety of ungulates, particularly farm animals, as intermediate hosts. Man is generally an aberrant intermediate host in which the hydatid cyst develops, usually in the liver or lungs as a space-occupying lesion, which can result in considerable morbidity. More than 90% of human cases occur in the eight endemic regions in North Africa and China. The descending order of disease endemicity is as China (Tibetan plateau), followed by Turkey, India, Iraq, Iran, and

Afghanistan. So far, as the impact of the disease is concerned, the annual global burden has suggested approximately one million DALYs are lost, which is likely to be a substantial underestimate. In addition, the losses to the global livestock industry are around US $2 billion lost annually and the cost of illness is around the same (ILRI, 2012).According to the statistics given out by WHO, the annual societal cost of cystic echinococcosis amounts to US $150 million in the subcontinent of India alone.

3. Leishmaniosis: Visceral Leishmaniasis (VL) or kala-azar is endemic in 88 countries, but 90% of all reported cases occur in just 5 countries namely, Bangladesh, Brazil, India, Nepal, and Sudan. The incidence of kala-azar in India is among the highest in the world. At present, Visceral Leishmaniasis, caused by *Leishmaniadonovani,* is a serious public health problem in Indian subcontinent, especially in Bihar state (Bhunia*et al.*, 2013). The disease, though is widely prevalent in the country, conversely, information on epidemiology of kala-azar in India still remains scanty. Nevertheless, the information on kala-azar epidemiology will be valuable to comprehend the current status of the disease. This anthroponosis makes approximately 200 million persons on the Indian subcontinent at risk for VL, and the annual incidence is near about 4,20,000 cases. The disease affects mainly poor rural communities; Hd80% of all cases in the region are reported from Bihar (Haske*et al*., 2012).

Viral zoonoses:

1. Rabies: Rabies is one of the most feared zoonoses. Most cases are concentrated in a handful of countries with much of the burden in Asia (Bangladesh, *India*, Myanmar, Pakistan, China). Most (60%) cases of rabies occur in children between 0 and 12 years of age and Coleman *et al*. (2004) estimated a weighted average DALY of 33.1 for rabies-associated mortality. Roughly 36% of the world's rabies deaths occur in India each year; in India, the disease has been estimated to

claim about 20,565 human lives annually through the bites of dogs (whose number in the country has been estimated to be around 27 million, of which 75.2% are stray dogs) in more than 96% of cases. The incidence of animal bites is 17.4 per 1000 population (Chugh*et al.,* 2008). About 15 million peopleare bitten by animals, mostly dogs, every year and need post-exposure prophylaxis.Human rabies cases account for 5,54,621 DALYs; 49.7 DALYs/ 100,000; US $11.25 million post-exposure prophylactic treatment cost (Otte and Grace). The total dog bite cases in India are 1.74 crore leading to 14 lakh human vaccinations. The human and animal rabies cases in the country costs Rs. 300 and Rs. 100 crores, respectively (Garg, 2007).

2. Japanese Encephalitis (JE): Japanese encephalitis (JE) is a vector-borne viral disease that occurs in South Asia, Southeast Asia, East Asia, and the Pacific. It has been reported that the incidence of JE is increasing in South Asia and South East Asia, while in East Asian countries, which implement control programmes, incidence has declined or remained stable (Erlanger *et al*., 2009). The expansion of JEV in South East Asia in the last few decades has been associated with increasing irrigated rice production and pig farming. Globally, JE is a leading cause of fatal encephalitis and irreversible neurologic damage, with approx. 50,000- 67,000 cases and 15,000 deaths annually, out of 597.5 million people at risk in endemic regions (WHO, 2012) and in India, about 300 million are at risk. In India, the disease has been reported from 24 states/union territories but remains endemic in north-eastern region and east-central UP. In the last 20 years, JE has claimed more than 6,500 lives of children in the country inclusive of a major outbreak in 1978 which claimed 1,072 lives (Sinha, 2009). There is high mortality in piglets with a huge economic impact in swine market. In equines, there is 2% morbidity during outbreak and mortality is upto 5%.

Certain other zoonotic infections, due to rickettsial, mycotic and chlamydial agents remains unravelled, so far, due to the dearth in timely as well as appropriate diagnostic strategies employed. Zoonotic diseases are more easily prevented than treated, provided, these are rapidly diagnosed or identified and prompt measures have to be taken for prevention or control. Nevertheless, many emerging zoonoses are not easily identified, because the clinical signs observed are not highly specific or distinguishable from other clinical infections, or the animals are healthy carriers. It is noteworthy to mention in this regard that Veterinarians have historically led the medical world in clinical knowledge of zoonotic diseases and on their methods of prevention and control. Veterinarians are challenged when a new emerging zoonosis occurs, as they are more likely to encounter it in domestic animals or to diagnostic laboratories that are familiar with the wide variety of possible diseases that may afflict wildlife. Emerging and endemic zoonoses share many common characteristics that could be exploited in combined and collaborated intersectoral 'One-Health approach' (Malik *et al*., 2013; Vergis *et al*., 2014), rather to address zoonotic diseases as a whole and provide benefits for all global partners, than a compartmentalized one. Hence, it is righteously alleged to follow the quote, ' *Think Globally, Act Locally*', to make the ideas of ours into action for a noble cause.

References: -On request-

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Food safety and quality: Emerging importance

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Introduction:

The term food quality and safety are used synonymously but differ in their attributes. Food safety refers to all such hazards that make food harmful to the health of the consumer, whereas, food quality includes all attributes that can influence the value of a product in question in the eyes of a consumer. In includes sensory quality (colour, size, firmness, odour, taste, touch etc.) as well as hidden attribute (nutritional Quality, sanitary/ Safety Quality, genetic Makeup, shelf life).

In recent year's public concern about the safety of foods of animal origin has increased due to problems arising from bovine spongiform encephalopathy (BSE), dioxin contamination, outbreaks of food-borne bacterial infections, as well as growing concern about veterinary drug residues and antimicrobial resistance in micro-organisms. Pasture and silage are often home-grown at the dairy farm. Food safety hazards that often occur in pasture and silage include dioxins and mycotoxins. Post-process contamination from the factory environment is a very common means by which commercially processed foods are contaminated. Environmental contamination can come from ingredients used in processing, whether directly or indirectly, worker's hands, shoes, walls, floors, and a myriad of other sources.

Food safety hazards related with animal feed can be classified as biological (microorganisms transmitted mainly by food, such as *Salmonella* spp. and *Campylobacter* spp.), chemical (include natural toxicants, such as mycotoxins and marine toxins, environmental contaminants, such as

mercury and lead, and naturally occurring substances in plants) or physical (like glass, metal , animal faeces). Each hazard is associated with particular sources and routes of contamination and exposure. Hazards may be introduced with source materials or via carryover or contamination of products during handling, storage and transportation.

The safety of food from animal origin starts with safe animal feed. Therefore feed manufacturers, farmers, food operators and nutritionist have primary responsibility for food safety. Quality assurance and feed-food safety are therefore of paramount importance to all chance involved in the production chain. For, animal nutritionist, maximizing the animal production with minimum inputs remains important criterion, but now there is also a need to achieve a satisfactory balance between inputs, production, food safety and customer satisfaction.

Common Adulterants in Feeds and Fodders:

Adulteration is defined as the admixture of a pure substance with some cheaper and low quality substance. It is done intentionally usually to get extra profit. In costly feed ingredients like oil seed cakes and feed from animal origin like fish meal, adulteration is done by spraying urea in order to raise protein content. The common contaminants of adulterant are husk, sand/ silica, dirt and saw dust. The common methods to detect these adulterants are sieving, winnowing and soaking in water. The amount of Acid Insoluble Ash is the good guide to the amount of sand or other dirt which may be present. Determination of peroxide content and free fatty acid in oily materials is indicative of rancidity and duration of storage, respectively.

Table 1: Common Adulterants of Different Feed Ingredients.

Feed Ingredient	Adulterant
Groundnut cake	Groundnut husk, urea, non-edible oil cake
Mustard cake	*Argimona maxicana* seeds, urea
Soybean meal	Urea, hulls, saw dust
Deoiled rice bran, wheat bran	Ground rice husk, saw husk
Fish meal	Common salt, urea, crustaceans, feather meal, sand
Mineral mixture	Common salt, marble powder, sand, lime stone
Meat and bone meal	Sand, leather meal, blood meal, rock phosphate
Shell grit	Sand, dust
Molasses	Water
Rice broken/kani	Marble, grit
Dicalcium phosphate	Calcite powder, rock phosphate

Certain spot test can be done to identify the presence of undesirable and incriminating factors and quality of feedstuffs (Table 2). Application of spot test in feed ingredients and mixed feeds is rapid compared to elaborate chemical tests.

Table 2: Most Commonly Used Spot Test.

Constituent	Test	Remarks
Thiram (pesticide in maize)	100g sample+50ml CHCl3 % shake (5min.) Filter the content with Whatman filter paper1. Add few crystals of cuprous iodide to filtrate and shake.	Filtered chloroform extract turns amber to brown colour with 1-2min-indicative of thiram.
HCN in feeds	Dip filter paper into 1% picric acid solution & dry. Than dip 10% sodium carbonate solution & dry	The sodium picrate paper turns orange & brick red if positive for HCN.

	and preserve in stoppered bottle. Take test material in test tube and add few drops of CHCl3 & stopper tube tightly.	
Argimona seeds	Prepare water extract of test feed and add concentrate nitric acid	Appearance of brown-reddish colour indicates presence of Argimona seeds.
Mahua cake	To water extract of test feed add conc. H2SO4	Violet or pink colour- presence of Mahua cake.
Linseed meal	Test feed is treated with 1-2 drops or more of dilute H2SO4 in micro test tube. The mouth of test tube is covered with a disk of filter paper moistened with a drop of reagent.	Depending upon the amount of HCN produced a more or less intense blue colour appears.
Common salt	To 1g sample, add 10oml distill water, stir & filter. Add 8ml HNO3 to filtrate	White turbidity indicates presence of salts
Leather meal	Pick up brown to black particles from sample and place on Petri dish, add 3-5 drops of ammonium molybdate, stand for 5-10min.	No colour change-Leather meal; Greenish yellow colour- Meat & bone meal.
Fish meal quality (presence of NPN)	Put 2-3g of test sample in a 100ml beaker and add 10-15ml distill water & stir. After 2-3min, add 3-5frops of test extract on white porcelain plate and add 2-3 drops of mercuric-potassium iodide alkaline solution.	Heavy or orange colour indicates presence of NPN. Intensity of orange colour of precipitate depends on amount of NPN.
Decomposition	5g test sample in 250ml	Test paper darkens

test (animal & marine product)	flask. Prepare cork to fit 2.25" of filter paper strip pinned to bottom & moistened with saturated lead acetate. Add 50ml dilute H2SO4 (5ml acid+45ml distill water) & insert cork. Stand for 16h.	quickly, if sample is badly decomposed.
Hoof or horn	Place 2-3 particles of amber colour test sample into evaporating dish, add 5ml glacial acetic acid, stand for 60min.	Test particles if hard & tough- hoof & horn; soft & swollen – gelatin.
Urease activity in soybean meal	Spread the sample uniformly on Petri dish, glazed paper with white background. Spray cresol red (0.1% solution) & thymol blue(0.1% alcoholic solution) reagent mixture (80ml cresol red, 20ml glycerol/ sorbitol, 2g urea & few drops of thymol blue) & examine for colour.	Inadequate heat treatment- particles (<10%) slowly develop red coloration. Excessive heat treatment- No particles show red coloration.
Urea	Mix 10ml of indicator solution (rub 0.15g Bromothymol blue powder with 0.1N NaOH solution, make 50ml with distills water) with 10ml urease solution (0.2g urease in 10ml water) in a watch glass. Using clean tweezers, dip pieces of filter paper (No.5) in solution (to avoid uneven distribution of indicator and enzyme, wet entire	Moisten urea test paper with few drops of distill water. Sprinkle feed evenly over the paper. A dark blue colour will develop is urea is present.

	paper at one time by lying in surface of solution). Allow paper to dry in place free from ammonia, strong air currents, heat. Paper should be orange when dry.	

Feed Microscopy:

Feed microscopy is commonly used for confirming the adulteration and identifying the adulterants (AOAC, 1980) apart from physical evaluation and spot test for quick evaluation of feed quality. Feed ingredients, adulterants and contaminants must be studied under low and high magnification for distinguishing feature whether coarsely or finely ground. Physical characteristic such as shape, colour and particle size, softness, hardness and texture of the feed are examined at low magnification of 8x to 50x. It is useful method to identify impurities/ contaminants and evaluating the quality of feed ingredients. It also serves as a useful method for identifying missing ingredients in finished feed.

Feed quality either be quantity or qualitative. Qualitative feed microscopy identifies and evaluates ingredients and foreign materials, either alone or in mixtures, via surface features (stereomicroscopy) or via cellular or internal particle characteristics (compound microscopy). Quantitative microscopy is proportioned measurement of each ingredient in finished feeds or of contaminants and adulterants in ingredients. Acceptance or rejections decisions of incoming ingredients can ne dine based on microscopy. The basic equipment for feed microscopy is stereomicroscope with wide field eyepiece (magnification range 7-45 x) and zoom objective.

Animal Feed Safety and Risk Assessments:

It is important to establish guidelines that are broad enough to cover the requirements of all ingredients and are flexible enough to allow for differences in ingredient types. Safety assessments are often multifaceted.

The integrity of safe feed production chain can be threatens by wide range of substance like,

- ✓ Biological: All food pathogens like Salmonella, Clostridium, Botulism, Prions etc. (Table 3)
- ✓ Non-Biological:
  - Chemical: Pesticide & drug residue, heavy metals, plant toxins, feed additives etc.
  - Physical: Glass, wood, stone, plastic, metallic objects, radionuclide's etc
  - Miscellaneous: Genetic modified crops, novel and functional foods, etc.

Table 3: Principal biological agents transmitted through animal feed

Category	Feed/ Feed ingredient	Dried/fermented forage	Pasture or grazing land	Waste food/ garbage
Infectious agents transmissible to humans from farm animals i.e., zoonoses	*Bacillus anthracis spiralis, BSE, Salmonella, E.coli, ND virus*	Toxoplasma	*Bacillus anthracis spiralis spores; Mycobacterium spp. From wild life sources; E.coli; eggs of cysticercus*	Trichinella
Infectious agent or their products which cause disease in both farm animals & humans		Clostridium botulinum toxin, Listeria monocytogens		
Non-zoonotic infectious agents causing epidemic diseases in farm	Viruses of African swine fever, foot & mouth disease			Viruses of African swine

animals which may result in human hardship.	& swine fever			fever, FMD & swine fever
Non- infectious agents which cause disease from farm animals & humans.	Fungal hyphae & spores causing allergic diseases	Fungal hyphae & spores causing allergic diseases		
Products of non- infectious agents which cause disease from farm animals & humans.	Mycotoxins	Mycotoxins	Mycotoxins	

Toxins in animal feed:

The various feed ingredients should be analyzed for the toxins present in them, which are otherwise injurious to the health of animals. The examples of toxins in the various feed and fodder are given in Table 4.

Table 4. Some anti-nutritional factors in agro-industrial by product feeds

Feedstuff	Inhibitors toxin	Deactivation process
Cottonseed meal	Gossypol cyclopropene fatty acids	Adding iron salts; rupturing pigment gland
Soybean meal	Trypsin inhibitors an unidentified factor, Hemagglutinins, Goitrin	Heat; autoclaving
Linseed meal	Cyanogens, Anti-B6, Linamarin, Linatin,	Water treatment
Raw fish	Thiaminase	Heat
Lucerne meal	Saponins: pectin methyl esterase	Limit amount feed
Rapeseed and Mustard	Isothiocyanate, Thioglucoside, Goitrin	--------

	Thyroactive materials	
Groundnut meal	Aflatoxin	Treatment with ammonia or ammonium hydroxide
Castor seed meal	Ricin, Heamagglutinin	
Peanut meal	Aflatoxin, goitrogen, Protease inhibitors, saponins	
Guar meal	Protease inhibitors	
Beet pulp	Saponins	
Sesame meal	Mineral binders	
Sunflower meal	Chlorogenic acid, tannins	Supplementing with Methyl donors (Methinine & Choline)
Safflower meal	Oxalates, Phytate in hull fraction	
Mango seed kernel	Tannins	

Pesticide Residue and their Effects:

Pesticides are very essential and invaluable input in modern day agriculture due to fact that pests, diseases and weed destroying 1/3rd of the crop or commodity during growth, harvesting and storage e.g. insecticides, rodenticides, herbicides and fungicides. Most of the pesticide molecule or their metabolites are xenobiotics and are reported to have toxicity related health problems like ***carcinogencity, teratogenicity, mutagenicity, genotoxicity, neurotoxicity*** and many other adverse effects.

The occurrence of pesticide residue in ecosystem may have a threefold impact on man, by reducing the reproductive capacity of his environment or by contamination of either his food or work environment. Man and animals are exposed to low level of pesticide residues in air, water and food chain for a prolonged period of time. *Man is the ultimate consumer of pesticide*.

Pesticides enter into the Animal Body through contaminated feed and water and skin pores when sprayed on animal body surface for killing ecto parasites.

Pesticides can be divided into three major classes.

1. Compound rapidly metabolized and excreted e.g. endosulfan, methoxychlor, chlorpyrifos, 2,4-Dichlofophenoxyacetic acid, deltamethrin, diazinon etc. The risk of residue in animal product is considered to be quite limited.
2. Compounds with detectable accumulation in the animal e.g. Chlordane, alpha hexachlorocyclohexane, lindane etc. These compounds can be found for some weeks after exposure of the animals.
3. Compounds with high accumulation e.g. DDT, dieldrin/ aldrin, endrin, hexachlorobenzene, beta hexachlorocyclohexane, heptachlor etc. These compounds can be found in animal products for weeks or months after exposure of the animals.

The risk managements for these compounds should consist of regular checking of feed ingredients from those areas in the world where these compounds are still in use.

Veterinary Drugs/ Feed Additives:

⇨ Now a days extensive utilization of medicine in veterinary practices due to increasing intensification of animal production, the prophylactic use of drugs as a precaution against diseases, hormonal drugs to maintain reproduction, tranquillizers to reduce stress and growth promoters is increasing.

⇨ Typically three kinds of risks are associated with the use of antibiotics /similar compounds viz. toxicological risk of human being, allergenicity to particular drug and risk of development of resistant strain of bacteria.

⇨ Residues of veterinary drugs can be present in feed when ingredient of animal origin (terrestrial and aquatic) is used, but this is not very significant route of exposure.

- ⇨ It also important to take into account then illegal use of drugs in animal feed which may result in unsafe residue in meat, milk or eggs e.g. chloramphenicol/ nitrofurans in shrimps and chloramphenicol in milk powder.
- ⇨ The excessive dosages and inappropriate use of drugs and additives can pose a serious risk to public health through the development of resistances to certain antibiotics and intrinsic toxicity of certain products.
- ⇨ To check for carryover of antibiotic veterinary drugs and coccidiostats, at industry level, HPLC methods are frequently applied for their detection.

Mycotoxin Residues in Animal Products- Impact on Human Health:

Mycotoxins are ubiquitous and wide spread at all levels of food chain. Feedstuffs could simultaneously contain various mycotoxins from different sources of molds (Table 5) and maximum limits of aflatoxin level in foods and feeds (Table 6).

Table 5: Mycotoxins commonly identified in feed ingredients and their effect on animals.

Major class of Mycotoxins	Mold	Nature of toxin & effects
Aflatoxinn (b1,l B2, G1, G2, M1, M2)	*Aspergillus flavus; A. parasiticus.*	Hepatotoxin, Immunosuppresion, carcinogenic, teratogenic; reduced feed intake, Reduced production,
Trichothecenes (3-or 15-acety-deoxynivalenol, Deoxynivalenol, nivalenol, fusarenon X (type- B trichothecenes), T-2 tosin, HT- 2 toxin	*Fusarium sp.*	Dermatoxins, immunologic effects, hematological changes & digestive disorders, weight loss, reduced milk production.
Zearalenone (ZEA)	*Fusarium graminearum*	Estrogenic (vulvovaginitis, enlargement of uterus) & reproductive disorders (low

		birth weight, reduced litter size, abortion, swollen vents, reduced egg production.
Ochratoxin (OTA)	*A.* ochraceus Penicillium spp.	Nephrotoxins (nephropathy, kidney dysfunction, gout), immune-suppression; Retarded growth, feed refusal, mortality.
Fumonisin (B1, B2, B3)	Fusarium moniloforme F. proliferatum	Neurological disorders, leukoencphalomalacia, blindness, head butting & pressing, incordination, liver damage, pulmonary edema, pancreatic lesion.
Eargot alkaloids (Ergometrine, ergosine, ergotamine, clavines)	Claviceps purpurea, Cla. paspaspali, Cla. fusiformis	Nervous or gangrenous syndrome.

Table 6: Maximum limits of aflatoxin level in food and feeds: in U.S., & India

Countries	Product	Species
United States (ppb)		
0.5	Milk	Human
20	Any food, except milk	Human
20	Animal feed	All species
India (ppb)		
50	Animal feed	Poultry and livestock

Control of Mycotoxins:

The current emphasis is on reducing the deleterious effects of the pe-formed mycotoxins and thereby enhancing production. Strategies to reduce the impact of mycotoxins include

- Plant breeding for mould resistance
- Efficient harvesting
- Storage practices to minimize contamination

- The development of potential commercially applicably techniques for decontaminating such commodities
- The most effective methods of neutralizing mycotoxins in feed by binding them to an inert compound before they can be absorbed from the intestine

Genetically Modified Organisms (GMO) and Novel Foods

Modern biotechnology, i.e *genetic engineering* or *genetic manipulation*, can now transfer the hereditary material across species boundaries. This can broaden the range of genetic changes that can be made to food and can expand the spectrum of possible food sources. The accelerating pace of developments in modern biotechnology has opened a new era in food production and this may have a tremendous impact on world food supply systems. However, there are considerable differences of opinion among scientists about the safety, nutritional value and environmental effects of such foods.

Overall, it is argued that the consequences of some gene transfer methods are less predictable when compared to those of traditional plant breeding methods and considerable scientific evidence will be needed to clear these foods from points of view of nutrition, food safety and impact on the environment. GM crops encompass many real and feared health risk, rigorous safety assessment is needed before these crops are permitted for use.

Urbanization, Nutrition and Food Security

In 2020, the world population is projected to reach 7.6 billion, an increase of 31% over the mid-1996 population of 5.8 billion. Approximately 98% of the population growth occurring during this period will take place in developing countries. While urbanization is a global phenomenon, it has been estimated that between the years 1995 and 2020 the developing world's urban population will double, reaching 3.4 billion. Such population growth poses great challenges to world food

security and food systems. Further extension of improved agriculture and animal husbandry practices; use of measures to prevent and control pre- and post-harvest losses; more efficient food processing and distribution systems; introduction of new technologies including the application of biotechnology, and others will have to be exploited to increase food availability to meet the needs of growing populations. Growing urbanization and associated changes in the way food is produced and marketed have led to a lengthening of the food chain and potential for introducing or exacerbating food borne hazards.

Animal feed safety system

The FAO /WHO 2000 report that the criteria for safety assessments should be made explicit and objective and that differences in the application of the principle of substantial equivalence. The animal feed safety system is to develop and implement a comprehensive, risk based preventive animal feed safety system that minimizes, reduces or eliminates the risks to animal and human health that can arise from animal feed. The regulatory body as mentioned below needs to certify for an innovative or new food or food product prior to its release for human or animal consumption.

Codex Alimentarius Commission (CAC)

Since 1962, CAC has been responsible for implementing the joint FAO/WHO food standards program.

Codex committee on food hygiene (CCFH)

This committee has overall responsibility for all provisions of food hygiene prepared by codex commodity committee and develop general principles, codes of practice, guidelines for food hygiene and microbiological criteria.

Legal Aspect for Feed Safety:

In India the quality control is regulated by to a statuary body Bureau of Indian Standards (BIS). It was established under BIS Act, 1986. Bureau has set up subcommittees for animal feeds called Animal Feeds Sectional Committee, which

has been specifically set up to check the quality of animal feeds and feed ingredients. The members of animal feeds sectional committee are the eminent nutritionist taken from the:

- Indian Council of Agricultural Research (ICAR) institutes
- State Agricultural Universities
- Feed Industry
- Government departments having specialization in Animal Nutrition
- Feed Technologist concerned with Animal Husbandry Activities.

Conclusion

Food safety is a matter of major concern gaining importance around the world as there is challenge before feed manufacturers, farmers, food operators and nutritionist to meet the increasing demand of human food as well as animal feed. Agricultural scientists are making efforts to find new feed resources, developing improved varieties of crops with higher production and supply more nutrients, developing GM crops etc. To ensure that the materials are safe to use require both long term and short term approaches. Still there is need to develop procedures for safe processing and treatment and the feed users and regulating agencies need to understand the origins and methods of processing the materials so that monitoring systems can be established to confirm the levels and presence of any unsafe materials.

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9 Assessment and monitoring of water quality parameters

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Exercise

Analysis of water is becoming increasingly important in order to monitor the water quality. Physical, chemical, biological and microbiological analysis of water is essential to assess the quality of water to provide pure water to the public for drinking and other domestic purposes. Water analysis is also necessary to find out whether water is suitable for the specific industrial purpose, and if not so, to choose them on receiving waters and as far as possible to protect the source from contamination.

Collect the water sample from different water bodies during your field vsit and check for the following paramaters

Microbiological paramaters

Most probable number (MPN technique) approach is used for estimating coliforms, E. coli and faecal streptococcal counts which are the indicators of sanitary quality of water. This technique is also useful in the quality assessment of foods that may have extremely low number of organisms. With the stopper in position, shake the sample bottle vigorously to achieve a homogeneous dispersion of bacteria.. Arrange fermentation tubes (15) in three rows of five tubes each in a test tube rack. Make serial dilutions by adding 0.1ml and one ml. of the sample to five tubes each of single strength broth and 10ml sample to five tubes of double strength broth. Incubate the tubes at 35°±0.5 ^{0}C for 24 -48 hrs. Record readings of presumptive coliforms, *E. coli* and faecal streptococcal counts

Physicochemical paramaters

1. Temperature: Measurement of temperature is an important parameter required to get an idea of self purification

of rivers, reservoirs and control of treatment plant.Immerse the thermometer directly in the water body for a period of time sufficient to permit constant reading. If it is not possible to take reading directly then collect water in a sample bottle, nearly one litre, and measure the temp. by dipping the thermometer in the sample. Record temp. in Celsius scale to the nearest 0.1^0C.

2. pH: pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. It is a measure of hydrogen ion concentration, or more precisely, the hydrogen ion activity. pH determination is usually done by electrometric method which is the most accurate method and free of interference. is defined as the logarithm (base 10) of the hydrogen-ion concentration. Thus if (H+)=10-6 moles/1. Then pH=6.pH is an important factor in water chemistry, since it enters into the calculation of acidity and alkalinity and process such as coagulation, disinfection, softening and corrosion control. In principal, electrometric determination of pH involve the measurement of the EMF of a cell comprising an indicator electrode responsive to hydrogen ions and a reference electrode both immersed in the test solution. The indicator electrode commonly used is glass electrode and the reference electrode is calomel electrode.

3. Electrcal Conductivity: Electrical conductivity is a measurements are often employed to monitor desalination plants and are further used to test surface and groundwater. In coastal regions, conductivity data can be use to decide the extent of penetration of sea water into the ground water.EC is a measure of a water's capacity to convey electric current. E.C is directly proportional to its dissolved mineral content. The unit of a E.C. is micromhos/cm. Since electrical conductivity varies directly with temperature of the sample, the result is usually reported at 25^0C.

4. Colour: Colour is a common constituent of many natural waters and it is caused by metallic substances, such as iron and manganese compounds, humus materials, tannin, algae, weeds and protozoa. Industrial effluents also contribute

colours to water supplies. The standard method for colour comparison involves the standard colour solution prepared by using potassium chloroplatinate and cobaltous chloride. Colours can be compared visually or photoelectrically.

5. Turbidity: Turbidity is an important parameters for characterisizing water quality. In most of the waters turbidity is due to colloidal and extremely fine dispersion. Suspended matter such as clay, silt, finely divided organic and inorganic matter plankton and others microscopic organisms also contribute to turbidity. Turbidity can be determined by its effect on the scattering of light which is termed as Nephelometry.

6. Total dissolved solids (TDS): The total amount of dissolved chemical species in water is called total dissolved solids, abbreviated TDS, and is a good general measure of the concentration of ionic substances in water.Gravimetric method used to determine the total dissolved solids is to take a known volume of the sample of water, filter it, and carefully evaporate the water. When all the water has evaporated, a dry residue will remain consisting of the constituents that were previously dissolved in the water. The dry residue can be weighed in order to determine the weight of the dissolved solids in mg per liter of water.

7. Acidity: Acidity is usually caused by the presence of free carbon dioxide, mineral acids such as sulphuric and weekly dissociated acids. Acidity is usually determined by titration with 0.02 N sodium hydroxide solution and is expressed in calcium carbonate.

8. Alkalinity: The alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of natural or treated water is due to the presence of bicarbonate, carbonate and hydroxide compounds of calcium magnesium, sodium and potassium, Borates Phosphates and silicate also contribute to alkalinity. The determination of alkalinity provides an idea of the nature of salts present. If the alkalinity is to hardness calcium and magnesium salts are only present. If the alkalinity

is greater than hardness it indicates the presence of basic salts-sodium and potassium in addition to those of calcium and magnesium must be present that are not carbonates usually these are sulphates. Alkalinity is directly determined by titration with 0.02N sulphuric acid using phenolphthalein and methyl organism indicators.

9. Total hardness: Hardness is deemed to be the capacity of water for reducing and destroying the lather of soap. Calcium and magnesium are the principal cations causing hardness. The hardness of water varies considerably from place to place. The hardness of water reflects the nature is in contact. Generally, Surface waters are softer than ground waters. Hard waters are reported to cause no harmful effects upon the health of consumers. The use of hard waters however is limited because of excessive soap consumption in homes and laundries. Among the methods available for the determination of hardness, the EDTA titrimetric method is the precise one and can be performed rapidly. In alkaline condition, EDTA reacts with Calcium and Magnesium to form a soluble chelated complex. Calcium and Magnesium ions develop wine red colour with eriochrome black T indicator under alkaline condition. When EDTA is added calcium and magnesium divalent ions get complexed resulting in a sharp change from wine red to blue which indicated end point of the titration. At higher pH i.e at about 12, Magnesium ion precipitate and only calcium ion remains in solution. At this pH Muroxide indicator is added calcium gets complex resulting in a change from pink to which indicates and point of the reaction.

10. Chloride: Chloride is the common anion found in water and sewage. The presence of chloride in natural waters can be attributed to dissolution of salts deposits, discharge of effluents from chemical industries, sea water intrusion in coastal region etc. Chloride in drinking water are generally not harmful to human beings. Higher concentration however, may affect some persons who already suffer from disease of heart or kidneys. Regarding irrigation water, chloride is the most

troublesome anion. Chlorides are generally more toxic than sulphates to most plants. Chloride is determined by titration with standard silver nitrate using potassium chromate as an indicator.

11. Fluoride: Fluoride ions have dual significance in water supplies. High concentration of fluoride causes dental fluorosis. At the same time, concentration less than 0.8 mg/l results in dental caries. Hence it is essential to maintain the fluoride concentration between 0.8 to 1.0 mg/l in drinking water. Among the many method suggested for the determination of fluoride the ion selective electrode method and the SPADNS method are the most satisfactory and applicable to variety of samples. In SPADNA method, fluoride react with Zirconium-SPADNS Solution and the 'lake' gets bleached due to formation zirconiumfluoride. Since bleaching is function of fluoride ions, it is directly proportional to the concentration of fluoride.

12. Sulphate: Sulphates occur naturally in water as a result of leaching from gypsum and other common minerals. In addition, sulphates may be added to water system in several treatment processes. Sulphate causes a problem of sealing in industrial water supplies and problem of odour and corrosion in waste water treatment due to its hydrogen sulphide. Sulphates is determined by turbidimetric method, sulphates ions are precipitated as barium sulphates crystals of uniform size in acid medium scattering of light by the precipitate is measured by Nephelometer.

13. Phosphate: The presence of phosphate in water and waste water analysis has a great significance. Phosphate in large quantities in fresh waters indicates pollution, through sewage and industrial wastes. It promotes growth of nuisance microorganisms. Though phosphate posses problems in surface waters, its presence is necessary for biological degradation of waters. Phosphate is determined by stannous chloride method. Ammonium molybdate reacts with phosphate to form

molybdophosphoric acid which is reduced to blue coloured complex 'molydbenum blue' by the addition of stannous chloride. After 10 minutes but before 12 minutes, measure the colour using a spectrophotometer at 690 nm.

14. Nitrate: The presence of nitrate in water indicates organic pollution. Significant sources of nitrate are chemical fertilizers, domestic effluents, industrial discharge etc. Excessive concentration in drinking water is considered hazardous for infants because in their intestinal track nitrates are reduced to nitrites which may cause methemoglobinaemia. Nitrate is determined by cadmium-reduction techniques as well as phenol disulphonic acid method.

15. Dissolved oxygen: Oxygen is dissolved in most waters in varying concentrations. Solubility of oxygen depends on temperature, pressure and salinity of water. It is essential to the life of fish and other aquatic organisms.

16. Bio chemical oxygen demand (bod): BOD is defined as the amount of oxygen required by bacteria and other microorganisms in the biochemical degradation and transformation of organic matter under aerobic conditions. The basic principle underlying the BOD determination is the measurement of the dissolved oxygen content of the sample before and after five days incubation at 20^0C. But this is only applicable to surface water. In the case of industrial effluents dilution technique is needed. Usually dilutions more than one has to be made for each sample. The degree of dilution has to be determined by the analyst and at least one of the dilution should contain about 50% of DO after 5 days incubation.

17. Chemical oxygen demand (COD):COD test determine the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The COD method is recommended as a supplement to BOD test. The COD test is widely employed as means of measuring the pollution strength of domestic and industrial wastes. The major advantage of COD test is short time required for evaluation. COD is an important parameter for stream and industrial waste studies and

control of waste treatment plants. The organic matter gets oxidized completely by potassium dichromate in the presence of sulphuric acid to produce carbondioxide and water. The excess pot. Dichromate remaining after the reaction is titrated with ferrous ammonium sulphate solution. With the help of modern photometry and the related chemistry, the broad spectrum of water analysis can be dealt with economically. The spectroquant analysis system makes it possible for every user to conduct highly sensitive and enact analysis with a reasonable cost performance ration.

References: -On request-

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10 Veterinary drug residue in animal food products: Risk factors and significant impact on public health

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Introduction:

Veterinary drugs are critically needed to meet the challenges of providing adequate amounts of food for the growing world population. Drugs improve the rate of weight gain, improve feed efficiency, or prevent and treat diseases in food producing animals. However, the benefit of improved productivity is not obtained without the risk associated with residues that remain in the tissues of treated animals at the time of slaughter or residues in animal derived products (meat, milk, eggs and honey) that poses a health hazard to the customer. There are many factors influencing the occurrence of residues in animal products such as drug's properties and their pharmacokinetic characteristics, physicochemical or biological reactions of animal body and processes on animal products. The most likely reason as improper usage, extra-label or illegal drug applications, long acting drugs and the most obvious is failure to keep the withdrawal period.

History:

People concerns in the food safety has been shaken by incident involving chemical contaminants. The 1962 publication of the book Silent spring by Rachel Carson drew public attention to the dangers of pesticides in the environment and in food. The association of diethylstilbestrol (DES) with cancer in the daughters of women treated with this hormone also raised questions about the safety of using DES as a growth promoter in animals. In addition, there have been incidents of illegal use of hormones in animal production, reports of drug

residues in milk, and considerable public debate about bovine somatotropin (BST) use in dairy cattle.

Incidence of veterinary drug residues

In many countries indiscriminate use of veterinary drugs for animal diseases or as feed additives resulted in to occurrence of drug residues in food products. Different studies have been conducted by Babapour *et al*. (2012) in Iran reported low level of heavy metals and gentian violet residue from catfish. Other studies conducted in Nigeria also revealed the detection of antimicrobial drug residues in commercial eggs (Kehinde *et al*., 2012), in meat from slaughtered cattle (Ibrahim *et al*., 2012). Furthermore, oxytetracycline and penicillin G from milk (Desalegne *et al*., 2014), and tetracycline from cattle beef (Addisalem *et al*., 2012) were detected in Ethiopia. Currently, the joint FAO/WHO Expert Committee on Food Additives (JECFA) has also reported various veterinary drugs and other environmental substances residues food products (JECFA, 2013).

Factors responsible for the development of drug residues in animal products:

Veterinary drug residues are one of the major problems for food contamination. Veterinary drugs and agricultural chemicals usage according to label directions will not result in residues at slaughter (Doyle, 2006). However, possible reasons for such residues include:

- Not following recommended label directions or dosage (extra-label usage)
- Not adhering to recommended withdrawal times
- Administering too large a volume at a single injection site
- Use of drug-contaminated equipment, or failure to properly clean equipment used to mix or administer drugs
- Dosing, measuring, or mixing errors; allowing animals access to spilled chemicals or medicated feeds

Animal effects- age, pregnancy, congenital, illness, allergies

- Chemical interactions between drugs
- Variations in water temperature for fish species
- Environmental contamination
- Improper use of agricultural chemicals such as pesticides (CFIA, 2014).

Animal factors:

a) Age and species of animal:

Weaning status and the age of the animal affect drug disposition. For instance, the study conducted on comparisons of the pharmacokinetics of norfloxacin nicotinate between weaning and unweaned calves revealed that total body clearance time was increased in weaned calves, possibly due to increased weight from the presence of rumen fluid (Gips and Soback, 1996). Elimination half-life of apramycin is longer in calves than in adult cattle, possibly due to the immaturity of the drug clearance system (Kaneene and Miller, 1996). It has been reported that there is an extensive species variation among animals in their general ability to excrete drugs in the bile; example, chicken are characterized as good biliary excretes, whereas sheep and rabbit are characterized as moderate and poor excretes (Riviere *et al*., 1991).

b) Disease status animal:

The disease status of an animal can affect the pharmacokinetics of drugs administered, which can influence the potential for residues (Boothe and Reevers, 2012). This can occur either when the disease affects the metabolic system (and consequently drug metabolism), or when the presence of infection and/or inflammation causes the drug to accumulate in affected tissues. For example, cattle with acutely inflamed mastitis quarters, apramycin penetrates these areas of the body, and concentrations of the drug have been observed at ten times over the level recorded from cows without mastitis. Ketoprofen levels in milk increase during clinical mastitis. In calves with experimentally induced fascioliasis, the elimination half-life of

antipyrine was increased. The proposed mechanisms for these changes were the changes in liver function by fascioliasis, which changed the processing of drugs through the liver (Korsrud *et al*., 1993).

Extra-label drug use (ELU):

Extra-label Drug Use (ELU) refers to the use of an approved drug in a manner that is not in accordance with the approved label directions.

- ELU occurs when a drug only approved for human use is used in animals
- When a drug approved for one species of animal is used in another
- When a drug is used to treat a condition for which it was not approved
- The use of drugs at levels in excess of recommended dosages

For instances, the use of phenobarbital (a drug only approved for humans) to treat epilepsy in dogs and cats and the use of enrofloxacin solution as a topical ear medication (only approved for use as an injection) are the common ELU in veterinary medicine (Gillian, 2003). The families of drugs and substances currently prohibited for ELU in all food producing animals are chloramphenicol, clenbuterol, diethylstilbestrol (DES), dimetridazole, ipronidazole, furazolidone, nitrofurazone, sulfonamide drugs in lactating dairy cattle (CFR, 2006).

Improper withdrawal time

It is the interval necessary between the last drug administration to the animals and the time when treated animal can be slaughtered for the production of safe foodstuffs (Kaneene and Miller, 1997). The withdrawal time (clearance period) is the time for the residue of toxicological concern to reach a safe concentration as defined by the tolerance. Depending on the drug product, dosage form and route of

administration, the withdrawal time may vary from a few hours to several days or weeks.

Potential effect of veterinary drug residues on public health

The major public health significances of drug residue are development of antimicrobial drug resistance, hypersensitivity reaction, carcinogenicity, mutagenicity, teratogenicity and disruption of intestinal normal flora. Rationally, there is no product from treated animal should be consumed unless the entire drug administered has been eliminated. This is called zero tolerance, where this concept is in fact equivalent to the idea of total absence of residual amounts. However, because of the improvement of analytical techniques value of zero tolerance became smaller and smaller that depicts parts per million (ppm), parts per billion (ppb) and parts per trillion (ppt) concentration.

Development of drug resistance

Resistant microorganism can get access to human, either through direct contact or indirectly via milk, meat, and or egg. The use of antibiotic in livestock production has been associated with the development of human antibiotic resistance (Landers *et al*., 2012). The animal fed with the low prophylactic level of antibiotic may develop bacteria evolving resistance to this antibiotic during the preparation or consumption of food of animal origin. Human being obtains drug resistant bacteria such as Salmonella, Campylobacter, and Staphylococcus from food of animal origin (Chang *et al*., 2012).

Drug hypersensitivity reaction

Allergic reactions to drugs may include anaphylaxis, serum sickness, cutaneous reaction, a delayed hypersensitivity response to drugs appear to be more commonly associated with the antibiotics, especially of penicillin (About 10% of the human population is hypersensitive), but in animals the extent

of hypersensitive to the drug is not well known. Certain macrolides may also be responsible for liver injuries, caused by a specific allergic response to macrolide modified hepatic cells (Darwish *et al*., 2013).

Carcinogenic effect

The potential hazard of carcinogenic residues is related to their interaction or covalently binding to various intracellular components such as proteins, deoxyribonucleic acid (DNA), ribonucleic acid (RNA), glycogen, phospholipids, and glutathione.

Mutagenic effect

Several chemicals, including alkalizing agents and analogous of DNA bases, have been shown to elicit mutagenic activity. It has a potential hazard to the human population by production of gene mutagen or chromosome breakage that may have adversely affects human fertility (Foster and Beecroft, 2014).

Teratogenic effect

The well-known thalidomide incident involving a number of children in Europe was a direct testimony to the hazard that may occur when such agent is administered during pregnancy. Benzimidazole is embryo toxic and teratogenic when given during early stage of pregnancy because of the anthelminthic activity of the drug. In addition to embryo toxicity including teratogenicity, the oxfendazole has also exhibited a mutagenic effect (El-Makawy *et al*., 2006).

Disruption of normal intestinal flora

The bacteria that usually live in the intestine acts as a barrier to prevent incoming pathogen and causing diseases. Antibiotics may reduce the total number of the bacteria or selectively kill some important species. The broad-spectrum antimicrobials may adversely affect a wide range of intestinal

flora and consequently cause gastrointestinal disturbance. For example, flunixin, streptomycin and tylosin in animals, and also use of vancomycin, nitroimidazole and metronidazole in humans are known for this effect (Cotter *et al*., 2012).

Safety evaluation for veterinary drug Residues

Acceptable daily intake (ADI):

It is the amount of a substance that can be ingested daily over a lifetime without appreciable health risk. Calculation of ADI is based on an array of toxicological safety evaluation that takes into acute and long-term exposure to the drug and its potential impact. The FDA will calculate the safe concentration for each edible tissue using the ADI, the weight in kg of an average adult (60 kg), and the amount of the product eaten per day in grams as follows.

Safe concentration= [ADI (µg/kg/day) x 60 kg] / [Grams consumed/ day]. (CFR, 2006).

Maximum residue limit (MRL): It is defined as the maximum concentration of a residue, resulting from the registered use of an agricultural or veterinary chemical, which is recommended to be legally permitted or recognized as acceptable in or on a food, agricultural commodity, or animal feed. The concentration is expressed in milligrams per kilogram of the commodity (or milligrams per liter the case of a liquid commodity).

Calculating withdrawal time

The withdrawal period or the milk discards time is the interval between the time of the last administration of a veterinary drug and the time when the animal can be safely slaughtered for food or the milk can be safely consumed. Withdrawal times are determined in edible, target tissues by FDA/CVM during the drug approval process. These target tissues are most commonly the liver or kidney. On the other hand, for the drugs for which a muscle tolerance has been

established, even if a violative residue is found in the kidney or liver a violative residue is not found in the muscle, the carcass would not need to be discarded. Table 1 gives MRLs set for milk from cows.

Table 1: Maximum Residues Limit (MRL) (ug/kg) for veterinary drug residues.

Antibiotic	MRL (ug/kg)	Antibiotic	MRL (ug/kg)
Benzyl penicillin & Ampicillin	4	Neomycin	100
Amoxycillin	4	Sulphonamides	100
Oxacillin	30	Trimethoprime	50
Cloxacillin	30	Spiramycin	200
Dicloxacillin	30	Tylosine	50
Tetracycline	100	Erythromycine	40
Oxytetracycline	100	Quinalones	75
Chlortetracycline	100	Polymyxine	50
Streptomycin	200	Ceftiofur	100
Dihydrostreptomycine	200	Cefquinome	20
Gentamicine	200		

Table 2: Drug with drawl period to prevent veterinary drug residues.

Antibiotic in Lactating cattle	Route of Administration	Withdrawal Times	
		Milk (Hour)	Meat (Day)
Amoxicillin	Intramammary	60	12
	Injectable	96	25
Ampicillin	Injectable	48	6
Cefapirin	Intramammary	96	4
Cloxacillin	Intramammary	48	10
Erythromycin	Injectable	---	14
	Intramammary	36	14
Novobiocin	Intramammary	72	15
Penicillin-G	Intramammary	72	15
	Injectable	48	10

Prophylaxis measured to avoid drug residues in food products

Pharmacological principles:

Most pharmacokinetic parameters have been determined in healthy animals. Yet diseased animals would be expected to altered physiology. The half-life will increase if CL is reduced due to an increased Vd. This would result in increased elimination a half-life by a factor of six. Doubling dose of the drug should only prolong the approved withdrawal time by one half-life; however, doubling the half-life as a result of the disease would double the necessary withdrawal time pathophysiologic states.

The residue prevention strategy which include the followings:

- Herd health management; all food animals should be maintained in a clean and healthy environment whenever possible.
- Read the label and administer the drug properly.
- Pay attention to withdrawal times and prevent extra-label drug use
- Mark and identify all treated cows.
- Keep a written record of all treatments, including date of treatment, diagnosis
- Discard milk from all four quarters of a treated cow.
- Do not exceed recommended dose levels and do not combine several antibiotics.
- Prevent careless use of pesticides and insecticides, as well as cleansing and sanitizing agents.
- Make individuals and organizations aware of the problem through education by veterinary personnel, organizations, and literatures and governmental agencies.
- Rapid screening procedures for the analysis of antibiotic residues and instant grading and prohibition of food containing antibiotics more than MRL.
- Processing of milk help for the inactivation of antibiotics.
- Development of simple and economic field test to identify drug residue in edible animal products.
- Ethno-veterinary practices may be promoted.

Conclusion:

The use of veterinary drugs in food-producing animals has the potential to generate residues in animal derived products and poses a health hazard to the consumer. The most likely reason for drug residues may result from human management, such as improper usage, including extra-label or illegal drug applications, failure to keep the withdrawal period, including using overdose and long-acting drugs. There is also limited information on the magnitude of veterinary drug residue worldwide. Hence, an extensive work has to be carried out to prevent the occurrence of residues and specified time period is strictly followed for withdrawal of medication from food of animal origin prior to ready for human consumption.

References: -On request-

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11 Food-borne zoonoses and control strategies

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Estimates suggest that almost half of the population of the world is affected by water-borne and food-borne infections. Food-borne zoonoses are defined as 'those diseases contracted from eating foods of animal origin' such as milk, meat and eggs. This is a broad definition and covers a wide spectrum of pathogens such as bacteria, viruses, and parasites, although the most important on a day-to-day basis are mainly bacteria. Food-borne zoonoses are an important food safety issue worldwide and have also become an important cause of decreased economic productivity in both developed as well as developing countries. Rapid industrialization, change in food preferences and food habits, mass food processing and lack of effective food quality control system has led to the emergence of many food-borne pathogens. More than 250 known diseases are transmitted to humans through food.

Food producing animals (cattle, sheep, goats, pigs, chickens and turkeys) and their products are the major sources for many of zoonotic organisms, which include *Salmonella* spp.,*Campylobacter* spp., *Listeria monocytogenes*, *Escherichia coli*, *Yersinia enterocolitica*, *Clostridium* spp., *Brucella* spp., *Staphylococcus aureus*, *Vibrio* spp., *Aeromonas* spp., etc. as well as food-borne viruses namely Norwalk and rotaviruses along with some food-borne parasites such as Toxoplasma, Sarcocystis, Cryptosporidium, Trichinella, Taenia, Diphylobothrium etc. These organisms can contaminate animal/poultry carcasses at slaughter or cross-contaminate other food items, leading to human illness and cause huge economic losses.

Typical transmission pathway

An animal suffering from a disease, which may not be apparent, creates a product of either milk or body tissue in which the causative organism is present. This product is either

further processed or directly passed to a final consumer who then either with or without cooking eats the contaminated item, and in susceptible cases develops the disease after a variable incubation period.

Some of the important food-borne bacterial zoonoses

In many countries of the world, bacterial food-borne zoonotic infections are the most common cause of human intestinal disease. *Salmonella* and *Campylobacter* account for over 90 % of all reported cases of bacteria-related food poisoning world-wide. Poultry and poultry products have been incriminated in the majority of traceable food-borne illnesses caused by these bacteria, although all domestic livestock are reservoirs of infection. Other important bacterial zoonoses are cause by *Listeria monocytogenes*, *Escherichia coli*, *Yersinia enterocolitica*, *Clostridium* spp., *Brucella* spp., *Myocobactreium spp.*, etc. Some of these important food-borne bacterial zoonoses are described as follows:

Salmonella

Salmonella infections are prevalent all over the world among various species of domestic as well as wild animals besides poultry, ducks, birds, amphibians, reptiles and rodents. More than 2541 serovars of *Salmonella* are identified so far. Salmonellosis caused by non-typhoidal species is not only more prevalent but has also shown an increasing trend world over with majority of cases being caused by *S. Enteritidis* and *S. Typhimurium*. In India, human salmonellosis is endemic and one of the most widespread zoonosis. *Salmonella* organism has been isolated from a variety of foods including pork and pork products, beef, chevon, mutton, fish, milk and its products, fruit juice, fruits and vegetables and egg shells. Animals may be asymptomatic carriers of Salmonella. They may also suffer clinical disease with intestinal disturbance, septicaemia and death. Transmission usually follows ingestion of infected food, or direct or indirect contact with animal faecal material. In humans symptoms include sickness, diarrhoea, abdominal pain and fever. The most significant serotype in terms of mortality

is *S. typhimurium* DT104, which shows a 3% mortality rate, being multi-drug resistant to many of the antibiotics.

Campylobacter

Campylobacter are a major cause of gastroenteritis throughout the world. This particular pathogen is widespread and present in many farm animals. In particular, poultry are very susceptible to heavy bacterial loading. Under normal circumstances, the animals show no sign of disease, although there have been cases of abortion in sheep being linked to *C. jejuni*. The bacterium has been isolated from pigs, birds, cattle, dogs, cats, unpasteurized milk and water supplies. Infection occurs mainly following consumption of faecal contaminated undercooked carcasses especially poultry, or of milk. The organism is capable of surviving freezing and has been shown to survive for several months in frozen poultry, minced meat and certain chilled foods. The most common symptoms of *Campylobacter* infection include diarrhoea, abdominal pain, fever, headache, nausea and vomiting. Symptoms usually start 2–5 days after infection, and last for 3–6 days. Severe complications, such as Guillain-Barre syndrome, may follow*Campylobacter* infection.

Listeria

L. monocytogenes is considered emerging because the role of food in its transmission has only recently been recognized. The disease is most often associated with consumption of foods such as soft cheese and processed meat products that are kept refrigerated for a long time because *Listeria* can grow at low temperatures. Outbreaks of listeriosis have been reported from many countries. Several outbreaks of listeriosis associated with consumption of milk and dairy products have occurred in India. It has been isolated from the milk of cow, buffalo and goat in India. It has also been reported from Seafood, beef, raw milk, vegetables and fresh raw fish. Animals can carry the bacterium without appearing ill and can contaminate foods of animal origin, such as meats and dairy products. Unpasteurised (raw) milk or milk products made

from unpasteurized milk may contain the bacterium. In most cases, infection occurs following ingestion of contaminated foodstuffs. Clinical onset usually follows fever, headache, nausea and vomiting, and symptoms similar to a severe chill. Abdominal cramps, stiffness of the neck and photophobia may also be present. The condition may progress with organ involvement, including endocarditis, internal lesions, metritis, septicaemia and meningitis. Focal necrosis in the placenta may occur with spontaneous abortion, premature birth or infective transfer to the baby at birth. A fatality rate of higher than 20% of clinical cases has been seen when treatment is not made, or is not started quickly.

Escherichia coli

E. coli forms a part of most mammalian bacterial gut flora. It has a vast array of serotypes: some are benign, whereas others are dramatically pathogenic. This can vary from species to species; a benign form in one animal may be a deadly organism in another. The particular serotype of major concern is O157:H7, which was first identified as a major cause of serious outbreaks of food poisoning. This serotype is variously known as entero-haemorrhagic E. coli (EHEC), shiga toxin-producing E. coli (STEC) or verocytotoxin-producing E. coli (VTEC) O157. Many outbreaks and sporadic cases have been reported due to STEC in developed as well as developing countries. It is transmitted to humans primarily through consumption of contaminated foods, such as raw or undercooked ground meat products and raw milk. Symptoms of the diseases caused by EHEC include abdominal cramps, haemorrhagic colitis, haemolytic uraemic syndrome etc. The National *Salmonella* and *Escherichia* Centre, Kasauli conducted an epidemiological survey of *E. coli* O157 in different regions of India during the 10-year period (Seghal *et al*., 2008), in which a significantly high percentage of *E. coli* O157 was isolated from meat, milk and milk products, seafood and water.

Yersinia enterocolitica

Of the same bacterial genus as plague, it is transmitted to humans by ingestion of foods as diverse as meat (pork, beef and lamb), oysters, fish and raw milk. It causes acute-onset of gastroenteritis with diarrhoea and vomiting, marked fever and abdominal pain. The pain can be so severe that it mimics appendicitis and has also led to misdiagnosis of Crohn's disease. It is capable of producing clinical complications which include septic arthritis, colonisation of existing wounds, bacteraemia and urinary tract infections. Luckily it is rarely fatal.

Clostridium spp.

Clostridium perfringens, the causative anaerobic bacterium of many cases of gas gangrene, may also cause a food-borne disease. Widespread in the environment, and an inhabitant of the gastrointestinal tracts of humans and animals, it is often found in foodstuffs as a result of faecal contamination. As with other forms of clostridial diseases, it is the production of exotoxins by the pathogen that causes the main damage, especially where the ingested food carries a large inoculum, or heavy toxin load. The usual pattern of disease is linked to the ingestion of a number of viable *C. perfringens* organisms that may produce clinical symptoms of abdominal cramps, diarrhoea and fever.

Botulism as a complex of disease state arises from contact with *C. botulinum* or its associated neurotoxin. There are seven types of botulism toxin associated with the bacteria, designated by the letters A–G. Only the A, B, E and F toxins are known to cause illness in humans. Often associated with ducks, geese and some other types of poultry, it can also be found in cattle and horses, which can act as hosts and amplifiers for some strains. The disease usually begins 18–36 hours after the ingestion of the toxin. Early signs include gait difficulties, dysphagia and impaired vision. Respiratory distress, muscle weakness, and abdominal distension and constipation may appear progressively.

Brucella

Brucellosis is a widely prevalent and economically very important bacterial disease caused by *Brucella* species, of which *B. abortus* and *B. melitensis* are the main causes of occupational zoonosis in farmers, veterinarians and workers in meat industry. It is common in organized herds and in areas with high rainfall and humidity. Source of infection in human is through the drinking of infected raw milk or unpasteurized milk, handling of aborted foetus, fluids and foetal membranes, slaughter house workers and butchers contract infection while handling foetuses, after births or by contact with vaginal secretions, veterinarian gets infection during rectal examination without wearing gloves and while conducting post mortem examination, through skin abrasions and conjunctiva. There are losses due to abortion in the affected animal population, loss of progeny and reduced milk production. In humans disease is clinically characterized by chills, profuse sweating, weakness and fatigue, insomnia, sexual impotence, headache, arthralgia and generalized malaise, which last for weeks and months; commonly shows remissions (hence also known as undulant fever).

Mycobacterium

Tuberculosis caused by *Mycobacterium bovis* needs no introduction. Human-to-human spread of resistant serotypes of *M. tuberculosisis* now more significant than the bovine form acquired from dairy products. Ingestion and inhalation are the most common mode of transmission. Consumption of infected milk and milk products is the mode by which food borne zoonoses occur. It is a chronic disease of man and animals causing development of tubercle in vital organs. The pulmonary tuberculosis is the most common form, characterized by cough, fever, fatigue, weight loss, chest pain and night sweat in human beings.

Some of the important food-borne viral zoonoses

Numerous viruses can be found in the nature, but only a few are commonly recognised as important food borne

pathogens. These can be classified into three main groups, according to the type of illness they produce:

- Viruses that cause gastroenteritis such as Norovirus, Enteric adenovirus (types 40/41), Rotavirus (group A – C), Sapovirus, Astrovirus, Coronavirus.
- Enterically transmitted hepatitis viruses (Hepatitis A and E); and
- A third group of viruses that replicate in the human intestine but cause illness after they migrate to other organs, such as the central nervous system or the liver such as Enteroviruses.

Food borne illness has been documented for most of these viruses, but recent studies show that the Noroviruses (NoV) and hepatitis A virus (HAV) are by far the most common cause of illness by this mode of transmission. Some large food borne outbreaks have occurred with group B and C, rotaviruses, and waterborne outbreaks have occurred with hepatitis E virus. These viruses are spread by the faecal-oral route, cross-contamination and infected food handlers. Rotaviruses, classified in the reoviridae family, are ubiquitous and have been isolated from a variety of mammalian species. Rotavirus has been recognized as one of the most common cause of severe gastroenteritis in a wide variety of animal species including children, calves and piglets worldwide.

Outbreaks of rotaviral gastroenteritis are frequently observed in institutional settings such as hospitals, nursing homes, day-care centers, and schools. The incidence is higher during winter season in temperate climate whereas, no seasonal variations for tropical countries. However, certain studies reported higher incidence during rainy season. In developing countries, Norwalk viruses are so common that a very high percentage of children develop immunity at an early age. Generally the illness that results from Norwalk viruses is mild and brief. Foods are contaminated with Norwalk viruses via the faecal-oral route and contaminated water. Salads, insufficiently

cooked clams and oysters, ice and water are the most commonly implicated foods. Common symptoms in viral food borne zoonoses include nausea, vomiting, diarrhea, abdominal cramps, headache, fever/chills, muscle aches. Symptoms usually last 1 or 2 days. However, during that brief period, people can feel very ill and vomit, often violently and without warning, many times a day.

Some of the important food-borne parasitic zoonoses

Food-borne parasitic zoonoses cause death and serious diseases in humans and animals worldwide, and are of both public health significance and socioeconomic importance. Food borne parasitic infections have been recently identified as an important public health problem having considerable economic impact in terms of morbidity, loss of productivity and health care costs. Poor sanitation and traditional methods of food preparation accelerated the spread of food borne parasitic infections. Some of the important food-borne parasitic zoonoses are described as follows:

Toxoplasmosis

Toxoplasma gondii is possibly the most wide spread and prevalent protozoan parasite on earth, infecting approximately half a billion people. *Toxoplasma gondii* is a parasite of domestic and wild cats that potentially is capable of infecting all vertebrates. Toxoplasmosis can be transmitted to humans via several routes. Although a major source of infection is thought to result from contamination of the environment with oocysts shed in cat faeces. Transmission of *T.gondii* by ingestion of tissue cysts in raw or under cooked meat from a variety of livestock and
game animals has been documented as another major source of human infection. It is characterized by retinochoroiditis and encephalitis, and abortion in pregnant women (especially at first trimester). In animals, it causes abortion especially in sheep.

Sarcocystosis

Sarcocystis spp., like *T .gondii,* is coccidian protozoan which have a global distribution. Humans acquire *S. hominis* by consumption of uncooked beef containing zoitocysts. *Sarcocystis hominis* is only mildly pathogenic in humans, causing stomach pains, nausea and diarrhoea; Sporocysts begin to be passed in the faeces after 14 to 18 days (11 to 13 days after infection with *S. suihominis*). *Sarcocystis suihominis* is acquired by eating zoitocysts in under cooked pork. *Sarcocystis suihominis* is more pathogenic than *S. hominis*, causing stomach pains, nausea, diarrhoea and dyspnoea within 24 hours of infection.

Cryptosporidiosis

Cryptosporidium spp. are spore-forming parasitic protozoans found widely in the environment in an extensive variety of foodstuffs, including salad and vegetables, raw meat and meat products, offal and milk, usually associated with contamination arising from animal faecal matter. *Cryptosporidium parvum* is considered to be a particularly significant pathogen. Calves, lambs and deer have been identified as asymptomatic animal reservoirs, capable of shedding viable organisms in their faeces. Human infection follows either direct contact with animal faeces or consumption of inadequately cleaned or cooked products. Following a pre-patent period of between 2 and 14 days and in individuals with no underlying risk factors, there is profuse self-limiting watery diarrhoea, with abdominal pain and cramps, and a low fever that may last up to 7 days.

Taeniosis or Cysticercosis

Taenia solium (tapeworm of pigs) and *T. Saginata* (tapeworm of cattle) have cosmopolitan distributions with the former being more widespread in the rural areas of Latin America, Africa and Asia. Cysticercisis is caused by the intermediate stages of the tape worms *Taenia solium* and *Taenia saginata*. It is clinically characterized by abdominal pain, anorexia, nausea, diarrhoea and constipation, loss of body

weight and debility. Nervousness and insomnia may also occur. Human beings are universally susceptible to taeniosis. Infection is more common in low socio-economic group of the people. Larvae (*Cysticercus cellulosae* – measly pork) and (*Cysticercus bovis* – measly beef) fully develop in the different predilection sites, such as heart, diaphragm, internal masseter, tongue, neck, intercostals and abdominal muscles, less commonly brain, liver, lung, kidney and eye after reaching to the blood by penetrating the intestinal wall when infected eggs are consumed. This is the infective stage for human beings. Man gets infection by ingesting measly beef or pork undercooked. Cysticercosis is more serious than taeniosis in humans. It recognized as:

- **Myocysticercosis:** Muscular cramps, pain and muscle fatigue.
- **Ocular cysticercosis:** Presence of cysticerci in vitreous humor and anterior chamber of eyes leads to uveitis, iritis, retinitis and palbebral conjunctivitis.
- **Neurocysticercosis:** Signs depend on the location of the cyst found on the brain. Usually it found in the meninges, cerebral cortex and ventricles. So, symptoms of meningitis, epileptic encephalitis, headache, ataxia, nausea, vomiting and visual disturbances may be observed.

Trichinellosis

It is a type of food-borne helminthosis, caused by *Trichinella spiralis*. Trichinellosis can occur where humans eat raw or improperly cooked meat or meat products from infected pigs, wild boars, horses, walruses, dogs and many other domestic or wild mammals. Number of larvae ingested by humans determines the clinical disease. Usually 10 to 100 parasites per gram of muscle cause clinical signs. It is clinically characterized muscle soreness and pain due to irritation, enteritis, edema of upper eyelids, thirst, profuse sweating, chills and eosinophilia, and eventually, death due to myocardial and respiratory failure may occur.

Control strategies

Control of food borne disease is a multifaceted process, as there are no vaccines available for most food borne pathogens. The prevention of infection requires control measures at all stages of the food chain, from agricultural production on the farm to processing, manufacturing and preparation of foods in both commercial establishments and the domestic environment. The general strategy of control is to understand the mechanisms by which contamination and disease transmission can occur well enough to interrupt them. Increasing liberalization of trade, and increasing competition in the international market place, have meant that live animals, animal feed, food ingredients and products are now sourced on a global stage, affording the opportunity for zoonotic pathogens to be disseminated widely. The public health veterinarian needs to be proficient in setting up surveillance systems to monitor trends, establish priorities, inform policy-makers and control interventions. Understanding the likely routes of infection and the life cycle of the pathogen allows selective measures to be applied in a focused way, breaking the transmission route at its weakest point. Different basic steps to prevent the occurrence of these food borne infections are discussed below.

Step 1: Control the disease in the animals

The effective control in the food chain requires the incidence of infection in animals to be reduced. The health of consumers is inextricably linked to the health of food producing animals and the importance of herd and flock health cannot be underestimated. The incidence of zoonotic disease in animals may be reduced by the use of vaccination, clean foodstuffs and water, and good housing and husbandry practices. Overcrowded or unsanitary conditions can often lead to overt disease or unthrifty animals, requiring more therapeutic support for them to maintain sufficient health to attain slaughter weight or to continue to be productive. A reduction in infection rates has a dramatic effect on the

incidence of infection further down the food or product chain. The associated lower levels of contamination produce a lower likelihood of illness.

Step 2: Reduce contamination at harvesting

When eggs are picked out, or cows milked, the application of sensible hygiene precautions is essential. Eggs should be free of droppings and cleaned and date marked. In dairies, the udder of the cow and the milking machinery should be as clean and hygienic as possible, with subsequent disinfection after each milking. Pipe work and items such as clusters should be maintained and replaced as necessary to maintain adequate operating parameters. Milk should pass to a bulk tank and be subsequently chilled rapidly for later transport and pasteurization. At abattoirs, tight veterinary inspection both pre- and post-slaughter must be practiced. Animals that display heavy faecal contamination should be cleaned or rejected. Slaughterhouse controls should prevent or reduce onward transmission into the food chain, with rejection of suspect carcasses. Prompt refrigeration of meat and careful cleaning of the carcass can reduce bacterial contamination drastically.

Step 3: Retailing controls

Disinfection of working tools and areas, along with personal and premises hygiene procedures protect consumers and workers from zoonotic infection. Sourcing products from assured suppliers, temperature and environmental monitoring, and the separation of cooked and raw products reduce the possibility of amplification and transmission of infection. The tight control of 'use-by' and 'sell-by' dates is mandatory, as is periodic inspection by public health officials, and the implementation of monitoring of refrigeration and freezer plants.

Step 4: Domestic precautions

In the home, consumers should use common-sense measures, including disinfection of surfaces and equipment, personal hygiene procedures and thorough appropriate cooking

techniques. Using a refrigerator correctly and observing sell-by dates would prevent many cases of food poisoning.

There are several factors that continually contribute to the occurrence of outbreaks of food-borne disease and often several of these occur simultaneously, thus amplifying outbreaks. These factors include: contaminated raw ingredients (including water), inadequate refrigeration or storage, insufficient cooking, cross-contamination between raw and cooked food, poor personal hygiene of staff, poor general hygiene on premises, and untrained staff. Robust food safety management systems with adequate process controls are essential with good manufacturing practice and hazard analysis and critical control points (HACCP). Prior to establishing HACCP, good food hygiene standards must already be in place, particularly in the following areas:

- Infrastructural and equipment requirements.
- Food safety specifications for raw materials.
- The safe handling of food (including packaging and transport).
- Sanitation (cleaning and disinfection).
- Water quality.
- Maintenance of the cold chain.
- The health of staff.
- Personal hygiene.
- Training.
- Food waste handling.
- Pest control.

These standards are designed to control hazards in a general way and they are clearly prescribed in the Codex Alimentarius.

Conclusions

Food-borne zoonotic diseases are caused by consuming food or drinking water contaminated by pathogenic (disease-causing) micro-organisms such as bacteria and their toxins, viruses and parasites. They enter the body through the

gastrointestinal tract where the first symptoms often occur. The risks of contamination are present from farm to fork and require prevention and control throughout the food chain. To protect consumers from these food-borne zoonoses, an integrated approach to food safety from the farm to the fork is needed to be adopted.

References: -On request-

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National and International Food Safety Standards

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Introduction

Food safety is an issue of increasing concern worldwide and prioritisation of food safety as an essential public health function was advocated recently by the World Health Assembly. Better monitoring and surveillance demonstrates that the main burden of food-borne disease is due to microbiological pathogens of animal origin and this has important implications for the veterinary profession at both the international and the national level. The possibility of chemical residues in food is also causing growing anxiety amongst consumers (OIE, 2002).

The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. Highlights of the Food Safety and Standard Act, 2006. Various central Acts like Prevention of Food Adulteration Act 1954; Fruit Products Order 1955; Meat Food Products Order 1973; Vegetable Oil Products (Control) Order, and Edible Flour (Control) Order, 1967; Milk and Milk Products Order, 1992 etc. will be 1947; Edible Oils Packaging (Regulation) Order 1988; Solvent Extracted Oil, De- Oiled Meal repealed after commencement of FSS act, 2006 (Food safety act, 2006).

Food recalls are an everyday event. Three million people die each year from food and water borne illness. Each year, in the United States alone 48 million people get sick;

128,000 are hospitalized and 3,000 die from food borne illness (Matthew Turner, 2013). Because of these facts the U.S. food and drug administration (FDA) food safety modernization act (FSMA) was signed into law by President Barak Obama on January 4, 2011.

The World Organization for Animal Health (OIE) has a SPS responsibility for elaborating standards and related texts for the prevention, control and eradication of animal diseases and zoonoses, while the Codex Alimentarius Commission (CAC) elaborates standards and related texts for both safety and suitability aspects of food control. CAC and the OIE have strategies and mechanisms in place to co-ordinate and integrate food safety activities across the production to consumption continuum and so enhance the safety of foods of animal origin on a world-wide basis. A part of OIE's strategy was the setting up of a permanent Working Group on Animal Production Food Safety to review, develop and/or contribute to international food safety standards and guidelines, incorporating good animal production practice (including veterinary aspects) as it relates to food safety and taking into account a risk-based 'production to consumption' approach. With regard to strategies and mechanisms to integrate and implement food safety activities and develop good animal production practices, the OIE and the CAC work in close collaboration and with the support of the specialised services in FAO and WHO.

National laws

Prevention of Food Adulteration Act, 1954

The Act was promulgated by Parliament in 1954 to make provision for the prevention of adulteration of food, along with the Prevention of Food Adulteration Rules, 1955 which was incorporated in 1955 as an extension to the Act. Broadly, the PFA Act covers food standards, general procedures for sampling, analysis of food, powers of authorized officers, nature of penalties and other parameters related to food. It deals with parameters relating to food additives, preservative, colouring matters, packing & labelling

of foods, prohibition & regulations of sales etc. Like FPO, amendment in PFA rules are incorporated with the recommendation made by the Central Committee of Food Standards (CCFS) which has been setup by Central Government under the Ministry of Health and Family Welfare comprising members from different regions of the country. The provisions of PFA Act and Rules are implemented by State Government and local bodies as provided in the rules. Prevention of Food Adulteration Act, 1954 will be repealed from the date to be notified by the Central Government as per the Food Safety and Standards Act, 2006. Till that date new standards are specified, the requirement and other provisions of the PFA Act, 1954 and Rules, 1955 shall continue to be in force as a transitory provision for food standards.

Meat food products order, 1973

Meat and Meat Products are highly perishable in nature and can transmit diseases from animals to human-beings. Processing of meat products is licensed under Meat Food Products Order, (MFPO) 1973 which was hitherto being implemented by Ministry of food Processing industries w.e.f. 19.03.2004 on being transferred from the Directorate of Marketing Inspection, Ministry of Agriculture. The main objectives of the MFPO, 1973 are to regulate production and sale of meat food products through licensing of manufacturers, enforce sanitary and hygienic conditions prescribed for production of wholesome meat food products, exercise strict quality control at all stages of production of meat food products, fish products including chilled poultry etc. Under the provision of MFPO all manufacturers of meat food products engaged in the business of manufacturing, packing, repacking, relabeling meat food products meant for sale are licensed but excluding those manufacturers who manufactures such products for consumption on the spot like a restaurant, hotel, boarding house, snack bar, eating house or any other similar establishment. Depending on the source of meat the

manufacturers are licensed under category A, B & C. Presently, 279 units are licensed under MFPO as on 01.04.09.

Milk & Milk Product Amendment Regulations - 2009 (MMPR-09) DIVISION (MMPO, 1992 has been renamed as MMPR, 2009)

Consequent upon de-licensing of Dairy Sector in 1991 under Industrial Development & Regulation Act, the Department of AH and Dairying & Fisheries had promulgated the Milk and Milk Product Order (MMPO) 1992 on 9/6/92 under section 3 of the Essential Commodities Act 1955. The objective of the order is to maintain and increase the supply of liquid milk of desired quality in the interest of the general public and also for regulating the production, processing and distribution of milk and milk products. As per the provisions of this order, any person/dairy plant handling more than 10,000 liters per day of milk or 500 MT of milk solids per annum needs to be registered with the Registering Authority appointed by the Central Government.

There is no restriction on setting up of new dairy units and expansion in the milk processing capacity, while noting the requirement of registration is for enforcing the prescribed Sanitary and Hygienic Conditions, Quality and Food Safety Measures as specified in Vth Schedule of MMPO-1992. In order to comply the provisions of Para 5 (5) (B) of MMPO-92, two inspection agencies i.e. National Productivity Council (NPC) and Export Inspection Council (EIC) of India have been notified for annual inspection of registered dairy units on rotation basis. Now it has been subsumed as milk and milk products regulations under Section-99 of the Food Safety& Standards Act-2006.

Food Safety Standards Act-2006

It is almost six decades since the food regulation was made in independent India. Tremendous progress made in agriculture, food processing and changing food habits in population coupled with long pending demand from stakeholders for integrated food laws as well as obligation

under WTO have necessitated the birth of new food safety and standards act 2006 and is in operation from august 2011. The salient feature of this act: (1) multi-level, multi-departmental control to integrated line of command; (2) integrated response to strategic issue like novel/genetically modified foods and international trade; (3) power to licensing for manufacture of foods to the commissioner of food safety and designated officers (4) single reference point for all matters relating food safety standards regulation and enforcements; (5) regulatory regime to self-compliance through management system; (6) graded penalties depending on the gravity of offence (V. Sudarshan Rao, 2013)

FSSAI has been mandated by the FSS Act, 2006 for performing the following functions:

- Framing of Regulations to lay down the Standards and guidelines in relation to articles of food and specifying appropriate system of enforcing various standards thus notified.
- Laying down mechanisms and guidelines for accreditation of certification bodies engaged in certification of food safety management system for food businesses.
- Laying down procedure and guidelines for accreditation of laboratories and notification of the accredited laboratories.
- To provide scientific advice and technical support to Central Government and State Governments in the matters of framing the policy and rules in areas which have a direct or indirect bearing of food safety and nutrition.
- Collect and collate data regarding food consumption, incidence and prevalence of biological risk, contaminants in food, residues of various, contaminants in foods products, identification of emerging risks and introduction of rapid alert system.
- Creating an information network across the country so that the public, consumers, Panchayats etc receive rapid, reliable and objective information about food safety and issues of concern.
- Provide training programmes for persons who are involved or intend to get involved in food businesses.

- Contribute to the development of international technical standards for food, sanitary and phyto-sanitary standards.
- Promote general awareness about food safety and food standards.

An Act to consolidate the laws relating to food and to establish the Food Safety and
Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.

International food safety Standards

Globalization is a process that includes removal of trade barriers and growing financial and economic integration between nations. And globalization brought countries together mainly in trade. Our country also countersigned on agreement, namely sanitary and phyto sanitary (SPS) and technical barrier to trade (TBT) etc. which prescribe number of quality requirements. The SPS agreement necessitates maintenance of standard guide line and recommendation formulated by Codex Alimentarius commission (CAC) and world organization for animal health (OIE) reference for food safety and animal health respectively in global trade. Some of the countries restricted import of meat, milk and other animal products from India for absence of appropriate standards for conformity with OIE requirements (R. N. S. Gowda, 2008, Dr. G Srinivasan, 2008).

ISO is an independent, non-governmental international organization with a membership of 163 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges. Various International Standards are prepared. The ISO 22000 family of International Standards addresses food safety management. The consequences of unsafe food can be serious and ISO's food safety management standards help organizations identify and control food safety

hazards. As many of today's food products repeatedly cross national boundaries, International Standards are needed to ensure the safety of the global food supply chain. The ISO 22000 family contains a number of standards each focusing on different aspects of food safety management.

There is absence of much required HACCP system in many of the organizations or institution associated with import/export certifications towards fulfilment of OIE requirements concerning animal environmental conditions. Safe food for humans in ways is dependent on safe feed to animals. If the animals are not given safe feed they remain as potent toxic meat and animal products. The FAO, in its conference in Porto where the theme for meeting was "Food Safety and Quality" as affected by animal feed stuff has drawn up worry list in which many challenges for professionals worldwide are veterinary drugs, mycotoxins, infectious agents, chemicals and genetically modified organisms.

WHO in May 2000 highlighted animal feed that some of the food poisoning out breaks in human were related to as a source of contamination causing public health concern like BSE, dioxins, pesticides residues, antibiotics and mycotoxins etc. as a results some of the coutries are imposing ban on certain feed ingredients/ feed additives to ensure safe food from safe feed (R. N. S. Gowda, 2008).

Conclusion:

Consumer except food to be always safe. However despite great advances in technology, production of safe food is a public health problem worldwide. National and international food safety standards are the way to manage future safe food production. Science based and systematic, food safety management systems are tool to assess hazards and established control systems that emphasize on prevention of food quality deterioration at every stage of processing. Adoption of proper food safety standards provide Indian food industries greater potentiality in the international market.

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Overview of Disaster Management

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Disaster management refers to a proactive approach which aims to reduce the negative impact or consequences of adverse events and is not merely response and relief. The term 'reduce' is used here since disasters cannot always be prevented, but the adverse effects can be minimized. It is a multi system process based on the key principles of planning, organizing, and leading in addition to coordinating and controlling.

Because of its large geographical size, India often faces natural calamities like earthquakes, floods, cyclones, drought and landslides occurring frequently in different parts of the country. Natural disasters in India are recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought (NDMA, 2008). Natural disasters cannot be prevented, but their impact on people's and animals' lives can be reduced to a considerable extent. A lack of well-developed disaster management plan results in a severe loss of human and animal life and property. Most disasters can be predicted (flood, cyclone, drought) and some are unpredictable which strike suddenly (earthquake) and disrupt socio-economic life. It is quite often a panicky situation where all services are disrupted. Longer the period of external rescue and relief operations, more is the suffering of the affected communities. Animal are abandoned by the owners, dying and lying wherever they are, unattended, rotting, giving scope for epidemics.

Emergency *vs.* disaster situation

An emergency and a disaster are two different situations: Emergency refers to a situation in which the community is capable of coping. It is a situation generated by

the real or imminent occurrence of an event that requires immediate attention of emergency resources.

On the other hand, a disaster is a situation in which the community is incapable of coping. It is a natural or human-caused event which causes intense negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond; therefore the community seeks the assistance of government and international agencies.

Types of disasters

Disasters are often classified according to their causes as either natural or man-made and based on the speed of onset as sudden or slow.

Classification based on cause:

I. Natural Disasters - These types of disaster naturally occur in proximity to people, structures or economic assets and pose a threat to life and assets. They are caused by biological, geological, seismic, hydrologic, or meteorological conditions or processes in the natural environment.

1. Cyclones, Hurricanes or Typhoons

Cyclones develop when a warm ocean gives rise to hot air, which in turn creates convectional air currents. Cyclones occur when these conventional air currents are being displaced. The term hurricane/typhoon is a regionally specific name for a "tropical cyclone". In Asia they are called 'typhoons'; in the Indian and Pacific Oceans they are called 'cyclones'; and over the North Atlantic and Caribbean Basin, they are called 'hurricanes'.

2. Earthquakes

An earthquake is a trembling or shaking movement of the earth's surface, resulting from plate movements along a fault-plane or as a result of volcanic activity. Earthquakes can strike suddenly, violently, and without warning at any time of the day or night.

3. Tsunami

A tsunami is a series of water waves generated by a submarine earthquake, volcano or underwater explosions,

meteorite impacts or other disturbances above or below the water surface have the potential to generate tsunamis. The infamous 2004 Indian Ocean tsunami is the deadliest of natural disasters killing nearly 230,000 in 14 nations bordering the Indian Ocean. The deadly potential of tsunamis is potentiated by the fact that the intensity of a tsunami is very tough to predict even when the location and scale of the earthquake is known.

4. Floods

This phenomenon occurs when water covers previously dry areas, i.e., when large amounts of water flow from a source such as a river onto a previously dry area, or when water overflows banks or barriers.

5. Landslides

The term landslide refers to the downward movement of masses of rock and soil. Landslides are caused by one or a combination of factors like change in slope gradient, increasing the load on the land, shocks and vibrations, change in water content, ground water movement, and removal or changing the type of vegetation covering slopes, rains, floods, earthquakes, etc.

II. Man-made Disasters -These are disasters or emergency situations of which the principal, direct causes are identifiable human actions, deliberate or otherwise. Apart from "technological disasters" this mainly involves situations in which civilian populations suffer casualties, losses of property, basic services and means of livelihood as a result of war, civil strife or other conflicts, or policy implementation. In many cases, people are forced to leave their homes, giving rise to congregations of refugees or externally and/or internally displaced persons as a result of civil strife, an airplane crash, a major fire, oil spill, epidemic, terrorism, etc.

Classification based on speed of onset:

1. **Sudden onset**: Little or no warning, minimal time to prepare. For example, an earthquake, tsunami, cyclone, volcano, etc.

2. **Slow onset**: Adverse event slow to develop; first the situation develops; the second level is an emergency; the third level is a disaster. For example, drought, civil strife, epidemic, etc.

Disaster Management Cycle

Disaster management is a cyclical process: the end of one phase is the beginning of another, although one phase of the cycle does not necessarily have to be completed in order for the next to take place. Often several phases take place concurrently. Timely decision making during each phase results in greater preparedness, better warnings, reduced vulnerability and/or the prevention of future disasters. The complete disaster management cycle includes:

1. ***Mitigation*** (preventing or minimizing the effects of future emergencies): This phase includes activities that prevent an emergency, reduce the likelihood of occurrence, or reduce the damaging effects of unavoidable hazards. Mitigation activities should be considered long before an emergency.

2***. Preparedness*** (preparing to handle an emergency): This phase includes developing plans for what to do, where to go, or who to call for help before an event occurs; actions that will improve your chances of successfully dealing with an emergency. For instance, posting emergency telephone numbers, holding disaster drills, and installing tsunami warning system are all preparedness measures.

3. ***Response*** (responding safely to an emergency): It includes actions taken to save lives and prevent further property damage in an emergency situation. Response is executing the preparedness plans into action. Seeking shelter from a cyclone or leaving out of the buildings at earthquake are both response activities.

4. Recovery (recovering from an emergency): It includes actions taken to return to a normal or an even safer situation following an emergency. Recovery includes getting financial assistance for the repairs.

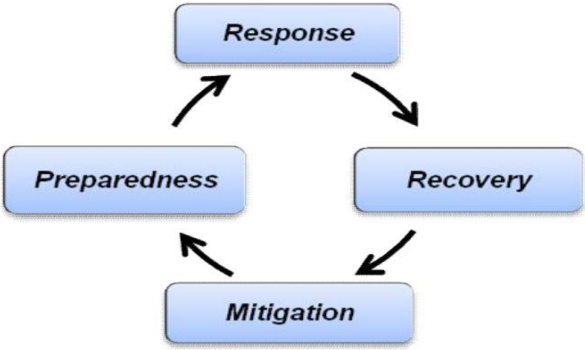

Fig.: Disaster management cycle

Disaster management in animals

With increasing globalization, the persistence of Trans-boundary Animal Diseases (TADs) anywhere in the world poses a serious risk to the world's animal, agriculture and food security and jeopardizes international trade. Recent animal health emergencies, including Foot and Mouth Disease (FMD) and bird flu have highlighted the vulnerability of the livestock sector to serious damage by epidemic diseases and its reliance on efficient animal health services and practices at all levels. The significance of animal diseases (including zoonoses) on human health and welfare is also being increasingly recognized.

Epidemics, epizootics, respiratory diseases, parasites (internal and external), other bacterial and vector-borne diseases occur after most of disasters. Usually post-disaster relief measures are focused on the human beings as first priority. Due to many reasons, livestock get little or no attention. This makes animals more vulnerable to disasters than human beings and the resulting impact of disasters on animals is high and long lasting. Under disaster situations, due to extreme stress, immunity goes down, coupled with starvation, the animals as well as human beings become more susceptible to infections, diseases with the associated risk of spread in the

form of epidemic. The role of veterinary departments and veterinarians becomes crucial in such a situation.

The risk of epidemics increases after natural disasters because of exposure to many kinds of disease causing bacteria, viruses, fungi and parasites spread by flood waters, debris and stress that lowers the immunity combined with animal housing in emergency animal shelters where communicable disease agents build up in the environment and pass to others.

Table 1: Some common diseases encountered post disaster

Rabies, leptospirosis, E. coli, plague, Lyme disease, Rocky mountain spotted fever, ringworm internal parasites (*Toxocara*, *Ancylostoma*, *Giardia*), external parasites (fleas, scabies, mites)
Most common diseases during flood are: Poultry: Avian Influenza and Newcastle disease, brooders pneumonia. Pig: Classical swine fever, foot and mouth disease (FMD), Japanese encephalitis. Sheep and Goat: PPR, pasteurellosis, flea, scabies and mite infestation, etc. Cattle: PPR, FMD, HS, anthrax, malignant edema, tetanus (Lockjaw), botulism, foot rot and mastitis

These diseases should be monitored and where appropriate, animal disease control procedures should be implemented to prevent the spread of diseases. In specific instances, restocking should be considered after going through the necessary quarantine period. Vaccination against those epidemics and anthelmintics and treatment campaigns should be made.

Disasters that could lead to an emergency situation in the animal husbandry sector:

Emergency situations in animals may arise primarily due to the following four categories of risks:

(A) Natural Disasters **–** As mentioned earlier India is vulnerable to most types of natural disasters and its vulnerability varies from region to region and a large part of the country is exposed to these natural hazards which often turn into disasters, causing a significant disruption of the social and

economic life of communities arising from the loss of life and property, including livestock.

(B) Infectious Diseases **-** Emergency animal diseases are not always the same as exotic or foreign animal diseases. Outbreaks of infectious diseases are of many types:

i) Any unusual outbreak of an endemic disease in exponential frequency causing significant change in the epidemiological pattern of that particular disease.

ii) The appearance of a previously unknown disease in a particular region.

iii) Animal health emergencies caused due to non-disease events, for example, a major chemical residue problem in livestock or a food safety problem such as hemorrhagic uraemic syndrome in humans caused by the contamination of animal products by verotoxic strains of *E. coli*.

iv) Deliberate introduction of exotic microorganisms in a targeted region.

(C) Fodder Poisoning **-** Accumulation in chemicals in plants leads to poisoning which is a potential danger to grazing animals. In order to keep a check on such cases, awareness among the local community must be created so that they take proper care of their animals and prevent them from eating poisonous toxic materials. Based on the above approach, the following activities should be undertaken:

i) Listing of the various poisonous materials, including braken fern, *Lantana camara*, parthenium, rati (*Abrus prectorus*), dhatura (thorn apple), kaner (oleandar); cyanogenic plants like immature maize, sorghum banchari, cereal affected with egrot, India pea; nitrate and nitrite containing plants, etc.; and the measures to prevent the availability of such materials to livestock. ii) Exotic/cross breeds are more susceptible to damage under drought conditions than indigenous breeds. Livestock owners will be made aware of how to take proper care of these exotic/cross breeds.

iii) Certain areas will be demarcated for fodder production. Pastures should also be developed for migratory sheep and goat and clean grain made available for pigs and poultry.

(D) Trans-boundary Animal Diseases

TADs are a major cause of economic losses to the livestock industry and are those infectious diseases which could spread fast and have the potential to cause considerable mortality or losses in productivity. TADs have the capability to seriously affect earnings from export of livestock or its products.

A TAD epidemic such as avian influenza (bird flu) or FMD has the same characteristics as other natural disasters—it is often a sudden and unexpected event, has the potential to cause major socio-economic consequences of national dimensions and even threaten food security, may endanger human life, and requires a rapid national level response. Some very important diseases of animal husbandry and public health perspectives include: i) Non-zoonotic diseases – FMD, PPR, RP, CSF, CBPP, etc. ii) Diseases with known zoonotic potential – Anthrax, BSE, Brucellosis, CCHF, Ebola virus, Food-borne diseases, HPAI, JE, Q fever, Rabies, etc.

(E) Miscellaneous Causes **-** India may have remained blissfully unaware of the losses in livestock due to the Bhopal gas tragedy or the consequences of arsenic or other toxic elements that may not only cause acute loss of livestock but are also potentially hazardous for public health as livestock produce is directly related to the human food chain. The impact of major accident hazard units such as nuclear reactors and hazardous waste dumping sites are examples of slow and impending livestock disaster situations.

Role of veterinarians and veterinary service in disasters

During disasters, the role of veterinarians is to ensure high standards of animal health and to reduce mortality among animals. Veterinarians can play a major role in promoting local pre-disaster planning at community level which places a high priority on facilitating livestock and pet evacuation (Heath,

1999). Veterinarians have a role to play in all stages of disaster mitigation and management, but it is during relief efforts that they can play a crucial role in increasing the survivability of animals that are victims and of those that are deployed in rescue teams. Veterinarians can also instruct their clients on first aid for horses and livestock and advice on the contents and appropriate use of first aid kits. The basic needs in a standard kit are listed in table 2.

It is not possible to react effectively and efficiently to a disaster unless the response has been planned well in advance on the basis of a comprehensive risk assessment and unless the measures to be taken by the organizations, institutions and government bodies involved have been co-coordinated and carefully rehearsed. Three operational sectors are essential to be monitored: (i) Animal health, (ii) Hygiene for food processing and sales and (iii) Farm hygiene. These sectors, together with the Veterinary health service personal, are responsible for

a) Disinfection and disinfestations
b) Capture and care of stray animals including housing and feeding
c) Health care of animals
d) Disposal of animal waste and dead carcasses
e) Intervention in the case of epizootics
f) Storage and preservation of food of animal origin
h) Training and up-dating personnel.

Although many natural disasters can be predicted with a great degree of accuracy, salvaging cattle has never been a priority. Nevertheless, disaster management should consider making animal shelters in such areas in safe zones to house cattle. These animal shelters could also have provision for stocking fodder, medicines and drinking water. Endemic disease and chronic conditions like worm infestation or ticks require special attention.

Table 2: Minimum requirements for a standard kit - List of basic needs

Maps, stationery	Medical disaster kit: oxygen airway, intubation set, ventilation bag, suction device, chest tube set, tracheotomy set, etc.
Means for communication and transportation	IV fluids, drugs for shock, tourniquet
Area lighting, flashlights	Dressing/splint kit: compresses, gloves, antiseptics, suture set, splints
Identification devices for area, staff and victims: flags, arm bands, triage, tags	Blood pressure cuff, stethoscope
Stretchers, boards, blankets, Protective devices: gloves, masks, etc.	Scissors, adhesive tape

Prevention and Preparedness of disasters in livestock: National Scenario

Veterinary services in India:

Animal husbandry and veterinary services is a state subject and falls within the purview of the state government. As a consequence each state government and UT has its own department of animal husbandry and veterinary services. Subjects such as animal quarantine, prevention of inter-state transmission of diseases, regulatory measures for quality of biologicals and drugs, import of biologicals, livestock, livestock products and control of diseases of national importance are the responsibilities of the central government.

The Dept. of Animal Husbandry Dairying and Fisheries (DADF) of the Ministry of Agriculture handles the central animal health services. India has about 47,000 registered veterinary practitioners engaged in different activities. More than 70% of the registered veterinary practitioners are in the state government services. The country has 8,720 veterinary hospitals and polyclinics, 17,820 veterinary dispensaries, and 25,433 Veterinary Aid Centres (VACs) and mobile veterinary clinics totaling 51,973 centres. In addition, there are border posts which besides their border duties also work as disease

reporting posts. Thus the total number of disease reporting posts is 52,390. These disease reporting units form the backbone of the disease surveillance system and have an effective coverage.

National Animal Disease Emergency Committee

The central government has a special responsibility for safeguarding against any new disease threatening to enter the country. In the event of an emergency in the livestock sector, the DADF activates its National Animal Disease Emergency Committee (NADEC) to monitor, evaluate and issue necessary guidelines to handle the emergency. At the state level, a similar committee, i.e., the state animal disease emergency committee is activated. The committee holds importance in case of Bird flu outbreaks wherein immediate help and support to the farms, poultry breeders and farmers is provided by the State authority through the emergency responsive system as per exigencies under intimation to the Chairman, NADEC. The freedom from Rinderpest was another achievement through the successful implementation of NADEC. All important stakeholders, including specialists in the subject are members of these committees. The concept is put forth by FAO.

Disease investigation laboratories in India

There are 250 disease investigation laboratories in India for providing disease diagnostics services. Many states have disease investigation laboratories at the district level. Each state has a state-level laboratory which is well equipped and has specialist staff in various disciplines of animal health. Beside the state disease investigation laboratories there is one central and five referral regional disease diagnostics laboratories funded by the DADF. Each state agriculture university/veterinary college also has disease diagnostic facilities. At the national level, the IVRI, and specially its Centre for Animal Disease Research and Diagnostics based at Izatnagar (Bareilly) and the Disease Diagnostic Laboratory of the National Dairy Development Board (NDDB) at Anand, Gujarat, are highly specialized laboratories providing disease

diagnostic services. In order to monitor ingress of exotic diseases, a state-of-the-art laboratory exists at HSADL, Bhopal with BSL-4 standards.

Livestock management during disasters

The following preparations are essential for management of animals during disasters:

i) Development of flood, cyclone and other natural calamity warning systems. In principle, an early warning system (EWS) would make it possible to avoid many adverse economic and human costs that arise due to the destruction of livestock resources every year. Reliable forecasting would also allow state governments to undertake more efficient relief interventions. Other tools that may provide early warning signals include field monitoring and remote sensing systems. Remote sensing, which relies on imagery satellites, is a valuable tool when used in conjunction with field monitoring.

ii) Establishment of fodder banks at the village level for storage of fodder in the form of bales and blocks for feeding animals during drought and other natural calamities is an integral part of disaster mitigation. The fodder bank must be established at a secure highland that may not be easily affected by a natural calamity. A few fodder banks will be developed as closed facilities to prevent them from getting contaminated.

iii) Supply of feed ingredients at nominal cost from the Food Corporation of India: Most grain rations for cattle and sheep provide enough protein to maintain a satisfactory 10–12% level. But when we feed livestock in emergency situations—mostly low-protein materials such as ground ear corn, grain straws or grass straws—a protein supplement is needed. Adequate reserves as per the availability of resources will be developed.

iv) Conservation of monsoon grasses in the form of hay and silage during the flush season greatly help in supplementing shortage of fodder during emergencies such as drought or flood.

v) Development of existing degraded grazing lands by perennial grasses and legumes.

vi) Provision of free movement of animals for grazing from affected states to the unaffected reduces pressure on pastures and also facilitates early rehabilitation of the affected livestock. In emergency situations, the presence of livestock can exacerbate conflict when refugees with animals compete for reduced forage and water resources. To prevent this, what is technically known as emergency destocking programme, will be instituted. This programme provides for the intentional removal of animals from a region before they die.

viii) Treatment and vaccination of animals against contagious diseases in flood affected areas. Routine prophylactic vaccination of livestock in flood-prone area significantly reduces the severity of the post-disaster outbreak of any endemic diseases.

ix) Provision of compensation on account of distressed sale of animals and economic losses to farmers due to death or injury of livestock. A legislation that provides the power to destroy livestock and property, and the process by which compensation is to be paid has to be enacted and implemented by the respective legislative bodies.

Some of the common problems in early warning systems for serious epidemic livestock diseases after disaster include:

- Lack of farmer awareness programmes on high threat epidemic livestock diseases and generally inadequate contact between field veterinary staff and farmers.
- Disease reporting systems which are based primarily on passive reporting of outbreaks rather than active disease surveillance.
- Inadequate training of veterinary and paraveterinary staff in the clinical and gross pathological recognition of epidemic diseases, which may be either unusual or exotic for the country, the implications of delayed

action, and the collection and transportation of appropriate diagnostic specimens.

- Poor coordination of field and laboratory veterinary services.
- Lengthy and over-complicated routine disease reporting chains and failure to institute an emergency reporting system for serious disease outbreaks.
- Failure to establish confirmatory diagnostic capabilities for the target diseases within national laboratories.
- Inadequate liaison with international reference laboratories and failure to send new virus strains from outbreaks to these laboratories on a regular basis for specialized antigenic and epidemiological analysis.
- Lack of an epidemiology unit and expertise to analyze new disease outbreaks, including trace back and trace forward activities.
- Failure to report new disease occurrences to appropriate international organizations, e.g. OIE, within an acceptable time.
- Lack of contingency planning and other emergency preparedness for epidemic diseases.

Existing international disease reporting mechanisms

The Office International des Epizooties (OIE) is the main international animal health organization responsible for international disease reporting. There is a well established system for emergency reporting of important diseases or diseases newly found in a country and a more routine reporting system for other defined diseases. There are a number of other international disease reporting structures, which operate on a regional or global basis either for specific diseases or of a more general nature. These include WHO, European FMD Commission, etc.

Nodal agencies for disaster management in India:

Various departments handle disaster management responses in India as listed under. The livestock disasters are handled by the DADF, MoA. The National Disaster Management Authority (NDMA) has been set up as the apex body for Disaster Management in India, with the Prime Minister as its Chairman. Disaster Management Authorities will be set up at the State and District Levels to be headed by the Chief Ministers and Collectors/Zilla Parishad Chairmen respectively. A National Disaster Mitigation Fund will be administered by NDMA. States and districts will administer mitigation funds. A National Disaster Response Fund will be administerd by NDMA through the National Executive Committee. States and Districts will administer state Disaster Response Fund and Disaster Response Fund respectively.

Table 3: Nodal agencies for disaster management in India

Floods	Ministry of Water Resources, CWC
Cyclones	Indian Meteorological Department
Earthquakes	Indian Meteorological Department
Epidemics	Ministry of Health and Family Welfare
Avian Flu	Ministry of Health, Ministry of Environment, Ministry of Agriculture and Animal Husbandry
Chemical Disasters	Ministry of Environment and Forests
Rail Accidents	Ministry of Railways
Air Accidents	Ministry of Civil Aviation
Fire	Ministry of Home Affairs
Nuclear Incidents	Department of Atomic Energy
Mine Disasters	Department of Mines
Livestock disasters	Department of Animal Husbandry Dairying and Fisheries

Steps for Prevention, Mitigation and Preparedness

DM plans at all levels will include the following important measures:

i) Public awareness about natural disasters that different regions and the country are most likely to experience and their consequences on the livestock sector.

ii) Provisions to establish adequate facilities to predict and warn about the disasters periodically, including forecasting disease outbreaks. This could only be achieved by a well networked surveillance mechanism that proactively monitors emerging infections and epidemics.

iii)Development and implementation of relevant policies, procedures and legislation for management of disasters in the animal husbandry sector. The livestock health infrastructure in India, modeled to provide routine veterinary cover, needs reorganization in view of emerging epidemics/challenges. The existing animal husbandry policies will be revisited and if required, modified to cater to changing realities.

iv) Mobilize the necessary resources, e.g., access to feed, water, health care, sanitation and shelter, which are all short-term measures. In the long term, resettlement programmes, psycho-social, economic and legal needs (e.g., counselling, documentation, insurance) are required to be undertaken.

v)

vi) Another long-term strategy is required to readjust the livestock production system in the country from a biosecurity point of view so that in the event of the entry of any new, dangerous pathogen, the losses could be minimised by segregation.

vii) Initiation of PPP in livestock emergency management, especially in the field of vaccine production, will go a long way in combating animal health emergencies of infectious origin. Similar partnership in feed manufacturing as well as livestock production will minimize the losses due to other livestock emergencies.

viii) Commissioning of risk assessments on high-priority disease threats and subsequent identification of those diseases whose occurrence would constitute a national emergency.

ix) Appointment of drafting teams for the preparation, monitoring and approval of contingency plans. Implementation of simulation exercises to test and modify animal health emergency plans and preparedness are also necessary.

x) Assessment of resource needs and planning for their provision during animal health emergencies.

xi) Central/state governments will develop/ establish an adequate number of R&D and biosafety laboratories in a phased manner for dealing with animal pathogens.

xii) A dedicated establishment, preferably under DADF, may be entrusted with the overall monitoring of the national state of preparedness for animal health emergencies.

xiii) Development of active disease surveillance and epidemiological analysis capabilities and emergency reporting systems.

xiv) A computer-based national grid of surveillance and disease reporting should be developed for timely detection and containment of any emergent epidemic.

xv) An intelligence cell—Central Bureau of Health Intelligence under DGHS should be raised to assist the proposed National Animal Disaster Emergency Planning Committee (NADEPC).

xvi) Immunization of all persons who are likely to handle diseased animals such as anthrax infected cattle and animals.

References: -On request-

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14 Xenotransplantation & Its Applications

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Introduction

Xenotransplantation refers to the procedure in which live cells, tissues, or organs derived a non-human animal are transplanted, implanted, or infused into human patients.

It is in contrast with all transplantations (from other individual of same species), Syngeneic transplantation (Grafts transplanted between two genetically identical individuals of the same species) and Auto transplantation (from one part of the body to another in the same person).

Xenotransplants have been performed in clinical trials or as unconventional therapies for a variety of conditions, or as cosmetic treatments. Human xenotransplantation offers a potential treatment for end-stage organ failure, a significant health problem in different parts of the world. It also raises many novel medical, legal and ethical issues. A continuing concern is that many animals, such as pigs, have a shorter lifespan than humans, meaning that their tissues age at a quicker rate. Disease transmission (xenozoonosis) and permanent alteration to the genetic code of animals are also causes for concern. A few successful cases of xenotransplantation have been published.

Origin and Definition

Xenotransplantation (*xenos*- from the Greek meaning "foreign"), is the transplantation of living cells, tissues or organs from one species to another. Such cells, tissues or organs are called xenografts or xenotransplants.

History

The first description of a xenotransplan-tation is reported in Indian mythology, in a text in Sanskrit from the 12th century BC in which it has been shown that Lord Shiva replaced his son Lord Ganesha's head with elephant's head. Apart from that, first transplantation attempts were made

without any knowledge of the species barrier. The pioneers of xenotransplantation realized xenotransfusions as early as the 16th century, then cell and tissue xenotransplantations in the 19th century. At the same time, and later in the 1960s, organ xenotransplantations were attempted, with disappointing results. Mathieu Jaboulay, Serge Voronoff, Keith Reemtsma, James Hardy, Denton Cooley, Thomas Starzl, Christiaan Barnard and Leonard Bailey were among the pionneers of xenotransplantation.

An American infant girl known as "Baby Fae" with hypoplastic left heart syndrome was the first infant recipient of a xenotransplantation, when she received a baboon heart in 1984 done by Leonard L. Bailey at Loma Linda University Medical Center in Loma Linda, California. Fae died 21 days later due to a humoral-based graft rejection thought to be caused mainly by an ABO blood type mismatch, considered unavoidable due to the rarity of type O baboons.

Following these efforts, baboon-to-human heart, liver, and kidney transplants were attempted, none of which achieved one-year survival of either the graft or the patient. From then on, interest in xenotransplantation diminished, in part because rejection based on preformed antibodies became an insurmountable problem. In addition, the development of haemodialysis, coupled with greater human organ availability as a result of the public's acceptance of the notion of brain death, created a false sense of security about the real need for organ transplants. However, the increase in transplant candidates in this decade, has ultimately led to a resurgence of interest in xenotransplants as a source of organs, especially for children.

Xenotransplantation of human tumor cells into immunocompromised mice is a research technique frequently used in oncology research. It is used to predict the sensitivity of the transplanted tumor to various cancer treatments.

Human organs have been transplanted into animals as a powerful research technique for studying human

biology without harming human patients. This technique has also been proposed as an alternative source of human organs for future transplantation into human patients. For example, researchers from the Ganogen Research Institute transplanted human fetal kidneys into rats which demonstrated life supporting function and growth.

Recent trials concerned above all tissue and cell xenotransplantations. Nowadays, with encapsulation, transgenesis, and cloning, great advances have been made for controling xenograft rejection, but ethical questions linked to the risk of infections have become a major pre-occupation within the scientific community and the general population.

Uses of xenotransplantation

Xenotransplantation could benefit thousands of people by providing an unlimited supply of cells, tissues and organs with many uses:

- Organ transplants – replacing diseased organs, such as hearts, lungs, livers, pancreases and kidneys.
- Cell transplants – replacing damaged or destroyed cells in diseases such as diabetes, Alzheimer's and Parkinson's disease.
- Tissue transplants – skin grafts, cornea transplants or bone transplants.
- Bridging transplants – providing organ function externally to patients with organ failure.

Potential animal organ donors

Being the closest relatives to humans, non-human primates were first considered as a potential organ source for xenotransplantation to humans. Chimpanzees were originally considered the best option since their organs are of similar size, and they have good blood type compatibility with humans, which makes them potential candidates for xenotransfusions. However, since chimpanzees are listed as an endangered species, other potential donors were sought. Baboons are more readily available, but impractical as potential donors. Problems include their smaller body size, the infrequency of blood group

O (the universal donor), their long gestation period, and their typically small number of offspring. In addition, a major problem with the use of nonhuman primates is the increased risk of disease transmission, since they are so closely related to humans.

Currently, Pigs are thought to be the best candidates for organ donation. Since 1980s, a number of research groups have been attempting to genetically engineer domestic pigs so that their organs may be given to humans. The risk of cross-species disease transmission is decreased because of their increased phylogenetic distance from humans. They are readily available, their organs are anatomically comparable in size, and new infectious agents are less likely since they have been in close contact with humans through domestication for many generations. Current experiments in xenotransplantation most often use pigs as the donor, and baboons as human models.

In the field of regenerative medicine pancreatogenesis- or nephrogenesis-disabled pig embryos, unable to form a specific organ, allows experimentation toward the in vivo generation of functional organs from xenogenic pluripotent stem cells in large animals via compensation for an empty developmental niche (blastocyst complementation). Such experiments provide the basis for potential future application of blastocyst complementation to generate transplantable human organs from the patient's own cells, using livestock animals, to increase quality of life for those with end-stage organ failure.

Potential Risks

Xenosis is the infection of humans by agents such as bacteria or viruses that are derived from animals. The infection may or may not result in symptoms of human disease. The possibility of xenosis raises questions about the safety of using xenotransplantation in individuals, but it could also potentially place the general public at risk. The worst-case scenario could be a major new epidemic. This potential threat to public health lies at the heart of the debate about the safety of xenotransplantation. Blood clotting around xenotransplants is

also of concern, and they too must be stopped if the new organ is to live.Another scientific concern is uncertainty whether xenotransplantation will work or whether high levels of immunosuppression will leave patients open to more frequent infectious diseases or cancer.

Rejection

The body's immune system uses several lines of defence against foreign organisms like parasites and bacteria. This would include defence against transplanted tissues, cells and organs that are not normally seen in a human body. Thus, the risk of rejection in xenotransplantation primarily involves the immune system attacking the transplanted tissue and not recognizing it. Scientists have been trying various methods to overcome this phenomenon. Some of these procedures involve trying to alter the patient's immune system to increase its tolerance to transplanted tissues, cells or organs; for example, altering the recipient's immune system and immune cells so that there is no immune response to the foreign transplant or interrupting communications so that no immune response is initiated. Others use genetic engineering to change the cells, tissues and organs of the donating animal, especially by deleting certain animal genes and replacing them with human genes.

Ethics

Xenografts have been a controversial procedure since they were first attempted. Many, strongly oppose killing animals to harvest their organs for human use. Major religions object to the use of genetically modified pig organs for life-saving transplantation. The prohibition of the consumption of pig does pose problems in Jewish and Islamic communities. In general, the use of pig and cow tissue in humans has been met with little resistance, save some religious beliefs and a few philosophical objections. Experimentation without consent doctrines are now followed, which was not the case in the past, which may lead to new religious guidelines to further medical research on pronounced ecumenical guidelines.

Xenogeneic transplantation is a topic for research and clinical trials. However, xenogeneic transplantations are carried out in some countries as unregulated traditional and non-evidence-based treatment. International collaboration and coordination for the prevention and surveillance of infections resulting from xenogeneic transplantation is mandated.

One can conduct an ethical analysis of 'opt in' versus 'opt out' systems for organ donation using the five frameworks of consequentialism/ utilitarianism, autonomy, rights and responsibilities, virtue ethics and multiple perspectives.

Animal-related ethical issues

Xenotransplantation might give rise to a variety of psychosocial problems pertaining to emotional and personal identity issues associated with implantation of organs from nonhuman animals. It also involve the issues of their wellbeing by all the means which being human, we may ignore. These issues should be thoroughly discussed with the potential recipient in advance.

The concept of rights for donor animals is controversial. Nonhuman primates such as baboons have complex social behaviours, and various ethical concerns exist regarding their use. The use of pigs is far less controversial. Various animal rights activists are opposed to the idea of xenotransplantation because they maintain that humans do not have right to breed and use other animals for their own needs. While these issues require considerable debate, the accepted opinion is that animals used for research or clinical xenotransplantation must be treated respectfully and humanely, and they must not be used without institutional approval.

Conclusions

The principal conclusions are as follows : There is a prospect that xenotransplantation may be able to supplement significantly the present inadequate supply of human organs - both to save life and to improve the quality of life; but complex questions of ethics and serious problems of safety need to be resolved;

In view of the potential benefit to patients, whose needs cannot at present be effectively met in other ways, the breeding of pigs to supply organs for xenotransplantation would be ethically justified. There are strong reasons for using pigs rather than higher primates for this purpose;

There is an immediate need to establish an Advisory Committee on Xenotransplantation for the purpose of assessing the potential public health risks from infectious organisms of animals; establishing the essential precautionary measures prior to any clinical human trials; and protecting the interests of the patients who receive xenografts;

Once all the necessary safeguards have been set in place, xenotransplantation may be offered to suitable patients. Strict ethical procedures relating to consent should be followed, and patients unwilling to consent to xenotransplantation should not be disadvantaged in any way. Should xenotransplantation become introduced into clinical practice, its impact on individual patients should be the subject of research.

The Future

In 1969, Sir Peter Medawar, the British scientist who won the Nobel Prize for medicine in 1960 and is considered the father of transplant immunology, stated, "We should solve the problem [of organ transplantation] by using heterografts [xenografts] one day if we try hard enough, and maybe in less than 15 years." In contrast, in 1995, Sir Roy Calne, another great pioneer in organ transplantation, stated that xenotransplantation "is just around the corner, but it may be a very long corner." He has been proved correct.

Although the debate over the risk posed by the infection potential of xenotransplantation is ongoing, the factors driving its development approaches are more pressing than ever. The need for human organs is simply increasing faster than their availability. Validation for the approaches will come with continued improvements in the battle against rejection of xenografts. An interesting approach is that of using retroviral gene therapy to inhibit the production of xenoreactive

antibodies, which are involved in the hyperacute and delayed types of rejection. One study that holds significant promise reported the absence of such antibodies in an animal model when bone marrow was genetically modified to produce the enzyme that actually makes the α-Gal epitope. Production of this epitope thus rendered the animal tolerant.

In the future, cells, instead of whole organs, will be used for a variety of major organ diseases. A recent report describes the xenotransplantation of immortalized human hepatocytes in rats suffering from experimental acute liver failure, and these approaches will continue to be explored in the future. Complementing these approaches will be continued advances in encapsulation technology itself, including agarose/polystyrene sulfonic acid constructs and others, which will broaden the range of cells that can be used for these purposes.

On another front, researchers are trying to modify genetically the pig organ donors themselves, so that they do not present the critical epitopes identified and linked with rejection phenomena. It is believed that a combination of genetic engineering of xenograft tissue to under express or eliminate the expression of such antigens, coupled with tolerance conditioning of the recipient by chimeric or genetically engineered bone marrow, will help overcome these difficulties. The future will continue to see innovations such as modifying xenograft organs by gene therapy approaches to improve the immune characteristics, efficiency and therefore longevity of these organs and their hosts.

Finally, both the US and the UK are proceeding with the establishment of oversight groups and guidelines to monitor and regulate clinical trials, as well as to continue and increase the public debate over the risks posed by the procedure.

References: -On request-

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15 An update on techniques to detect food adulteration

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Food is essential for every organism. The evolution of organism has been remained related to the source, type and utilization of food substances. The scriptures ans science advocates for the pios and balanced food. In Bhagavad Geeta, Sri Krishna says: Yuktahar Viharasya… means "take appropriate food…". There is vast diversity exists in rituals and types of foods. Food accounts for a large part of the family budget. People of India now a day's becoming more aware about the quality of food they consume.

Every consumer wants to get the maximum quantity of a commodity for as low a price as possible. This attitude of the consumers being coupled with the intention of the traders as well as the manufacturer to increase the margin of a profit as high as the variable market demand permits generates a vicious circle where the quality of the commodity gets reduced through addition of baser substances and / or removal of vital elements, and the process is defined as

Adulteration

What Is Food Adulteration?

Any article of food is adulterated if:

- If any inferior or cheaper substance has been substituted wholly or in part,
- If any constituent of the article has been wholly or in part abstracted
- If the article has been prepared, packed or kept under insanitary conditions
- If the article consists in part filthy, rotten, decomposed or diseased animal or vegetable or is infested with insects

- If the article is obtained from diseased animal
- If the article contains any poisonous ingredient
- If the article has unprescribed colouring substance or the colouring substance is in excess of the prescribed limits.

The consumer should be able to detect the adulteration in food. There are many sources of information available in print and in soft form. The method of detection may require simple materials.

Milk

Impure water:

The lactometer reading shall not ordinarily be less than 26.

Water:

- The presence of water can be detected by putting a drop of milk on a polished slanting surface, the drop of pure milk either stops or flows slowly leaving a white trail behind it. Whereas milk adulterated with water will flow immediately without leaving a mark.
- Take 10 ml milk, add 1 ml 10% Acetic acid, filter it and add 2 drops of Diphenyl amine. Dark violet/purple colour indicates addition of water.

Hydrogen peroxide:

- Take 10 ml milk, add 2 drops of 1% Paraphenyle diamine. Violet color indicates addition of Hydrogen peroxide.

Sodium bicarbonate:

Take 3 ml of the milk in a test tube. Add 10 drops of rosalic acid solution. The rosy colouration indicates the presence of sodium bicarbonate in the milk.

Glucose:

- Take a teaspoonful of the milk in a test tube. Dip a strip of diastix in it for 30 seconds. A change in colouration from blue to green indicates the presence of glucose in the milk.

Sugar:

- Take 3 ml of the milk in a test tube. Add 2 ml of concentrated hydrochloric acid or Muratic acid in it. Heat the test tube after adding 50 mg of resorcinol. The red colouration indicates the use of sugar in the milk.
- The detection may also be made by a different test. Take a teaspoonful of milk in a test tube. Add 1 mg of invertase enzyme. After 5 minutes, dip a strip of diastix in it. Take out the strip after 30 seconds. A change in colour from blue to green indicates the use of sugar in the milk.

Formaldehyde:

- Take 5 ml milk; add 5 ml 5% Ferric chloride and Hydrochloric acid. Light purple colour indicates adulteration of formaldehyde.

Cereal starch:

- Take 3 ml of the milk in a test tube. Add 1 drop of 1% aqueous solution of iodine. The blue of deep blue coloration indicates the presence of cereal starch in the milk.

Urea:

- Take a teaspoonful of milk in a test tube. Add a ½ teaspoon of soybean or arhar powder. Mix up the contents thoroughly by shaking the test tube. After 5 minutes, dip a red litmus paper in it. Remove the paper after half a minute. A change in colour from red to blue, indicates the presence of urea in the milk.
- Take 5 ml of milk in a test tube and add 2 drops of 1% bromothymol blue solution development of blue colour after 10 minutes indicates the presence of urea in milk.
- Take 5 ml milk. Add 5ml 24% acetic acid, filter it. Take 1 ml filtrate; add 1 ml 2% Caustic soda and

0.5 ml Phenol reagent. Violet or green colour indicates presence of urea.

Neutralizer washing soda/baking soda alkaline detergent:

- Take 5 ml of milk in a test tube and 2 drops of bromocresol purple solution. Development of violet colour after 10 minutes indicates the presence of Neutralizer or alkaline detergent in milk.

Boric acid:

- Take 3 ml of milk in a test tube. Add 20 drops of hydrochloric acid and shake the test tube to mix up the contents thoroughly. Dip a yellow paper-strip, and remove the same after 1 minute. A change in the colour from the yellow to red, followed by the change from the red to green, by addition of ammonia-drop solution, indicates that the boric acid is present in the milk (to prepare the yellow paper-strips, dip strips of filter paper in an aqueous solution of the turmeric, and dry it up).

Hydrogenated oil "vegetable ghee":

- Take 3 ml of milk in a test tube. Add 10 drops of hydrochloric acid or Muriatic acid. Mix up one teaspoonful of sugar. After 5 minutes, examine the mixture. The red coloration indicates the presence of Hydrogenated oil "vegetable ghee" in the milk.

Removal of fat:

- The Lactometer reading will go above 26 while the milk apparently remains thick.

Synthetic milk:

a) Test for protein

- The milk can easily be tested by Urease strips (available in the Medical stores) because synthetic milk is devoid of protein.

b) Test for Glucose/ inverted sugar, Sugar syrup

- Milk does not contain glucose /invert sugar, if test for glucose with urease strip found positive. It means milk is adulterated.

Rabri

Blotting paper:

- Take 1 teaspoonful of rabri in a test tube. Add 3 ml of hydrochloric acid or muratic acid and 3 ml of distilled water. Stir the contents with a glass rod. Remove the rod and examine. Presence of finer fibres to the glass rod, will indicate the presence of blotting paper in rabri.

Sweet Card

Hydrogenated oil "vegetable ghee":

- Take 1 teaspoonful of sweet card in the test tube. Add 10 drops of hydrochloric acid or muratic acid. Mix up the contents shaking the test tube gently. After 5 minutes, examine the mixture. The red colouration indicates the use Hydrogenated oil "vegetable ghee" in the sweet card.

Paneer

Starch:

- Boil a small quantity of sample with some water, cool and add a few drops of iodine solution. Formation of blue colour indicates the presences of starch.

Ghee

Hydrogenated oil "vegetable ghee":

- Take 3 ml of ghee in a test tube. Add 10 drops of hydrochloric acid or muratic acid, and 1/4th of teaspoon of sugar. Shake the tube to mix up the contents thoroughly. Examine the test tube after 5 minutes. The red colouration will indicate the presence of Hydrogenated oil "vegetable ghee" in the ghee.
- Take about one tea spoon full of method sample of ghee with equal quantity of concentrated Hydrochloric acid in a stopered test tube and add to it a pinch of sugar. Shake well for one minute and let it stand for five minutes. Appearance of crimson

colour (violet pink) in lower (acid) layer shows presence of Vanaspati or Margarine.

Cottonseed oil (Halfans test):

- Take 5 ml Ghee and add 5 ml Amyl alcohol and 5 ml 1% Sulphur in Carbon disulphide, keep it for 30 min hot water. Crimson colour indicates presence of cottonseed oil in ghee.

[If animal is given cotton seed cake, test also shows positive]

Mashed potatoes, other starches:

- The presence of mashed potatoes and sweet patotatoes in a sample of Ghee can easily be detected by adding a few drops of iodine, when iodine, which is brownish in colour turns to blue then mashed potatoes /sweet potatoes/other starches are presents.The colour disappears on boiling and reappears on cooling.

Butter

Vanaspati or Margraine:

- Take about one tea spoon full of melted sample of butter with equal quantity of concentrated Hydrochloric acid in a stoppered test tube and add to a pinch of sugar.

  Shake well for one minute Appearance of crimson colour is lower (acid) layer shows presence of Vanaspati or Margarine.

Mashed potatoes sweet potatoes and other starches:

- The presence of mashed potatoes and sweet potatoes in a sample of butter can easily be detected by adding a few drops of iodine. When iodine (which is brownish in colour) turns to blue if mashed potatoes/sweet potatoes/other starches are present.

Honey

- A cotton wick dipped in pure honey when lighten with a match stick burns and shows the purity of

honey. If adulterated, the presence of water will not allow the honey to burn. It does, it will produce a cracking sound.

Sugar/ Jaggery:

- Fiehe's Test: Add 5 ml of solvent ether to 5 ml of honey. Shake well and decant the ether layer in a petridish. Evaporate completely by blowing the ether layer. Add 2 to 3 ml. of resorcinol (1 gm of resorcinol resublimed in 5 ml of concentrated HCl.) Appearance of cherry red colour indicates presence of sugar/jaggery.
- Aniline Chloride Test: Take 5 ml of honey in a porcelain dish. Add Aniline Chloride solution (3 ml of Aniline and 7 ml. of 1:3 HCl:water) and stir well. Orange red colour indicates presence of sugar.

Jaggery

Sodium bicarbonate:

- Take 1/4th of a teaspoon of the jaggery in a test tube. Add 3 ml of Muriatic Acid. The presence of Sodium Carbonate effects effervescence.

Oils and Fats

Argemone oil:

- Take about 3 ml of the oil in a test tube. Add 20 drops of nitric acid. Shake carefully. Red to reddish brown colour in lower (acid) layer would indicate the presence of Argemone oil. Or heat the tube for 3 minutes on the flame of a spirit lamp. A red colouration indicates the presence of Argemone oil.

Mineral oil:

- Take 2 ml of the oil sample and add equal quantity of 0.5N alcoholic potash. Heat in boiling water bath(dip in boiling water) for about 15 minute or till it becomes clear and add 10 ml of hot water. Any turbidity shows presence of mineral oil.

Cotton seed oil:

- Take about 3 ml of the oil in a test tube. Add 2 ml of amyl alcohol in it and 1 ml of carbon disulphide and a little amount of sulpher. Plug the mouth of the test tube and heat it on the flame of a spirit lamp for 3 minutes. A red colouration indicates the presence of cotton seed oil in the oil.

Castor oil:

- Take about one ml of the oil. Add 10 ml of acidified petroleum ether and mix well. And a few drops of ammonium molybdate regent. Immediate appearance of white turbidity indicates the presence of castor oil.
- Take about 3 ml of the oil in a test tube. Add 2 ml of petroleum ether. Shake the test tube and mix up the contents thoroughly. Keep the tube immersed in the salt-ice mixture, or in a pot of cold saline water. Examine the test tube after 5 minutes. The appearance of turbidity in the mixture indicates the presence of castor oil. Similar test may also be made to detect adulteration of mustard oil with coconut oil, or Hydrogenated oil "vegetable ghee" (vanaspati).

Cyanide:

- Take 3 ml of the edible oil in a test tube. Add 10 drops of alcoholic potash, and heat the tube on the flame of a spirit lamp. Make an addition of a little amount of each of ferrous sulphate and ferric chloride in the test tube, and shake it to mix up the contents thoroughly. Add 3 ml hydrochloric acid. The blue colouration indicates the presence of hydrocyanic acid, which get produced due to presence of cyanide in edible oil.

Rancidity:

- Take 3 ml of the edible oil in a test tube. Add 3 ml of hydrochloric acid, in it. Close the mouth of the test tube. Mix up the contents thoroughly by shaking. Add 3 ml of 0.1% phloroglucinol solution in it. Shake the test tube vigorously for 2 minutes and keep it aside. Examine the test tube after 30 minutes. A pink or red colouration in acid layer indicates that, the oil sample is rancid.

Processed Food, Sweet or Syrup

Rhodamine B colour:

- If this chemical colour is present in the food, it is very easy to detect. Because it shines very brightly under the sun. Also it can be detected by a more precise method. Take ½ teaspoon of the sample in a test tube. Pour 3 ml of Carbon Tetrachloride and shake the test tube to mix up the contents thoroughly. The mixture turns colourless and addition of a drop of Hydrochloric Acid brings the colour back, when food contains Rhodamine B colour.

Lemonade soda:

Mineral acid

- Pour 2 drops of the lemonade soda on a Metanil yellow paper-strip. A violet coloration indicates the presence of mineral acid in aerated water. The colour impression gets retained even after drying the paper (you can prepare Metanil yellow paper-strips by soaking filter paper-strips in 0.1% aqueous solution, and then drying the paper-strips)

Meat

Adulteration and authenticity of meat products have been making the headlines with horse and pig meat found in UK and Irish beef products and now in

several other countries. The EU Commission initiated an EU-wide program of control measures including random control of processed beef products for foreign DNA as well as analysis of residues of the veterinary drug phenylbutazone ("bute"). Horses that have been treated with the drug phenylbutazone are not allowed to enter the food chain.

Eurofins has been pioneering DNA-based analytical technologies for meat testing using innovative protocols to improve the safety and authenticity of our clients' food products for over 10 years.

Meat species testing:

- Semi-quantitative DNA species testing by means of Real-Time PCR, and confirmation by DNA sequencing
- 1% Threshold Testing according to the method published by the European Union Reference Laboratory for Animal Proteins (EURL-AP) in feeding stuffs
- Qualitative DNA species testing by means of Real-Time PCR
- ELISA tests - screening test that may not be suitable for all matrices and processing levels.

References: -On request-

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16 Community based approach for control of Zoonotic Disease

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The integrated approach of veterinary and human medicine to prevent and control diseases of animal origin forms the basic principle of one health. Zoonoses are fundamental determinants of community health (Stephen et al., 2004). One of the principal causes of the emergence and re-emergence of such diseases is the increased risk of exposure to certain pathogens. This is because of several factors such as animal and human diet changes, increased densities of production animals or wildlife population, human and animal population displacement, increased contacts with wildlife reservoirs due to various outdoor leisure activities, accelerated degradation of natural environment and global warming (Wilcox and Gubler 2005). Moreover, the host defence is also showing increasing breakdown due to immunosuppression and emergence of drug-resistant bacterial strains. Evidently, apart from the prevention and control of the pathogens in animals and humans by movement restrictions, vaccination, improved diagnosis and treatment, raising awareness in the community about the disease and its control measures is very important in the present-day scenario. Community participation is, therefore, widely promoted as an important feature in different projects concerning disease control. However, the definition, applications and expectations of community participation vary considerably among the professionals including veterinarians.

The grassroots involvement of local communities in a zoonotic disease prevention and control programme depends on ensuring that these communities understand the disease in its varied dimensions. The commitment of the community towards the control of disease is possible only through efficient

awareness campaign which will allow better disease reporting and vaccination coverage. Community involvement in health generates in individuals a sense of responsibility for their own health and welfare. Higher the level of self reliance and social awareness, more the individuals will accept responsibility for protecting their animals and themselves from disease hazards transmitted directly or through foods of animal origin or vectors. Community-based zoonotic disease surveillance system may be helpful in making better assessment of the impact of disease in the population as the reliance on official reports alone may lead to gross underestimation of the problem (Mariner 2002). Hence, epidemiological surveys should include the resources such as livestock owners, community animal health workers, para-veterinarians, abattoir workers, etc.

Community Participation

Community is defined as a social group of group of people sharing an environment, interest, belief, resources, preferences, needs, risks, common leadership and a number of other conditions and degree of cohesiveness (McMillan and Chavis 1986). The community involvement in a programme is necessary for the sustainability of a community initiation. It also makes it easy to access the local constraints and opportunities. The extension programmes initiated by the government also require involvement of the community for sustainability. Hence, empowering the community to participate in the health issues is essential for the success of such projects.

Community participation in health development has been identified and adopted as one of the fundamental strategies for accomplishing the priority objectives of the primary health care. According to the declaration of the International Conference in Primary Health Care (1978, Alma-Ata), "Community

participation is the process by which individuals and families assume responsibility for their own health and welfare and for those of the community, and develop the capacity to contribute to their and the community development." Community participation results in involving people to solve their own problems. Moreover, such participation is a basic human right and fundamental principle to democracy.

The participation process in a community includes initiation, preparation, participation and continuation. Community assessment is the most important activity in caring for people in the community (Wilcox, 1994). Knowing the health situation of the people living in the community can lead and help the public health personnel in implementing appropriate and effective interventions to improve the health status of people.

Tools for Community Assessment

There are seven tools that are effectively used for community assessment. These are convenient to use and can help public health personnel understand the community (Chuengsatiansup, 2002).

i. **Community mapping:** Mapping is the only method which helps the public health personnel to rapidly see the whole community. While mapping, they can observe the community surroundings, environment, people's way of life and living situation. It helps them understand the physical and social aspects of the community. Community mapping helps the health personnel not only in getting the picture of the community area but also to learn about the community.

ii. **Kinship mapping:** It is the method to describe the genetic relationship of people in the community and how they care for their relatives. It helps the public health personnel develop a better understanding about their way of living.

iii. **Community organisation structure:** A community structure means the relationship of people in a community. Community organisations should have memberships, same goals of life and management. Knowing the community organisations helps the public health personnel know where to start working with the community.

iv. **Community health system:** Usually public health personnel use their thinking to dominate people in a community without understanding about their way of life and beliefs. The community health system assists in changing the endless beliefs and faith of the community and also helps in understanding the potential in them to tackle various health issues.

v. **Community calendar:** Understanding everyday life of people in the community is a tool to know about the diseases related to people's behaviour and nature of work performed during the period.

vi. **Cultural activity:** It shows the practical relationship and lifestyle of people in the community. If the public health personnel understand it, they will understand the role of the community.

vii. **Life history:** The assessment on the occurrence of a disease in a community can be made by knowing the life history of people. For example, rearing of cattle by feeding the animals on the wet floor under their house, especially in the north-east regions of India, makes the community more prone to TB.

Community Animal Health Workers

The main reason for failure in disease control programme is the inability to instill confidence in the beneficiaries about the value of the campaign. This can be generally overcome by community dialogue. Once a common understanding is reached, an agreement that is termed as 'community contract' (FAO, 2000) can be made where each side clearly states what can be done. The community remembers the broken promises, intended or not, usually long; so the veterinary team may not get a second chance.

As each community is characteristic by unique traditional institutions, customs and experiences, there is no one ideal approach in practice that can be recommended. One general model that has worked well in animal health care in broad spectrum of culture is the community animal health workers. Animal health projects have been relatively successful in many developing countries, which involved community participation as the guiding principle for project design and implementation. These projects worked with local people to describe and analyse the animal health concerns and to identify the solutions. The communities selected people who would work as community-based animal health workers (CAHW). The concept of CAHW probably arose from experiences in the human health sector. CAHW systems have a key role in strengthening the capabilities (epidemiological surveillance, disease control, animal disease reporting systems) of veterinary services in remote areas (Catley 2002). Community-based animal health delivery systems can also assist in animal identification systems, traceability systems, and animal movement control systems. In remote areas of developing countries where infrastructure and enforcement of regulations in weak, CAHWs have an important, but as yet untapped, role to play in raising awareness on the need for these capabilities. They have already proven to be excellent entry-points for human health, relief and conflict management issues in many

areas of Africa. They should be personally accountable during animal health programme and campaign.

Kudumbashree (meaning prosperity of the family) is a women-oriented community based mission launched by the Government of Kerala in 1998 for wiping out absolute poverty from the state through concerted community action under the leadership of Local Self Governments and is today one of the largest women empowering projects in India (Government of Kerala 2007). Women self-help group movement has gathered momentum as a powerful instrument for socio-economic transformation of poor people in India. The attitude of these self-help groups towards livestock raising was high (Anand, 2002). The Kudumbashree workers have been successfully engaged in collection of waste from households on a nominal charge and the improvement of the communities in the disposal of this waste has been successful in certain areas of Ernakulam and Thiruvananthapuram corporation areas in Kerala. Hence, these workers can be mobilised for animal health care activities by training them and making them accountable for the work done by them through regular monitoring by the veterinarians of the area.

Role of Community

Health programmes are unlikely to succeed if community involvement is not an integral part of the structure and execution at local level. Laws, regulations and veterinary policy measures alone will not bring the desired results. Moreover, the individuals and the community must be willing to acquire new knowledge, and to translate it into wholesome habits and constructive behaviour patterns. Human, animal health and veterinary public health (VPH) systems are responsible for providing clear information and explaining the favourable and adverse consequences of various intervention measures being proposed, as well as their relative costs. The core functions of VPH involve diagnosis, surveillance, epidemiology, control, prevention and elimination of zoonoses. VPH activities can improve human

health by reducing exposure to hazards arising from interaction with animals and animal products. Hence, there is an urgent need to expand the links between human and animal medicine.

Community participation plays an integral role in the implementation of VPH programmes. It can be achieved by encouraging the participation of all stakeholders, including women and children in decision-making at the local level so as to increase the ownership accountability and sustainability. The strategies to get community participation in VPH programmes include the use of trained auxiliaries to deliver VPH services locally, involvement of communities in the development and management of VPH programmes, using participatory field research to identify community priorities, evaluating the impact of VPH programmes and making appropriate adjustments, involving NGOs already working in the area in both human and animal health, increasing the outreach to women in rural areas and coordinating with human health services in the region(WHO, 2002).

Evolving Community Participation

Community members should be completely involved as participants in the health programmes in their communities. They have the important advantages of speaking the local dialect, knowing how to reach people, enjoying social acceptance and they also know the local situations or local needs. Both in rural and urban areas, community groups are all important in the planning and implementation of programmes. They provide the resources needed for adapting plans to local conditions, carrying out tasks at little or no cost, and overcoming constraints. They must be informed about their approach and their role in achieving the aims of the programme. By the process of education and by acquiring

experience and knowledge, individuals and communities learn to understand their own situation and be motivated to solve their problems. Community involvement in health generates in individuals a sense of responsibility for their own health and welfare. To be successful, they have to acquire the capacity to evaluate the situations, choose options and determine their contributions. In other words, individuals and families, and the community as a whole, are not obliged to accept the otherwise conventional solutions that may be imposed, but are not suitable.

In the early phases of a control programme, the general public, especially of communities in endemic areas, have to be made aware of the danger to health as well as the economic importance of zoonoses and foodborne diseases. One of the most effective methods has been found to be the discussions in small groups. In such discussions, the health worker (educator) suggests some kind of concrete action, for example, formation of working committees, which may be constituted soon after the discussions. Such committees have proved to be extremely useful in the early phases of several control programmes. The most common teaching aids and media are posters, documents, pictures, slides, films, radio and television programmes. Communicating the health message is very important, and different methods and techniques need to be combined to accomplish the educational purpose. However, the information must be correct, complete and acceptable to the people. The language of the messages must be understandable.

Types of Community Participation

Participation of the community can be sought in different ways that influence its effectiveness (Table 27.1). The organizational principles of national zoonoses control programmes should depend on the epidemiological pattern of the diseases and on the availability and structure of health care

services. They are interrelated with farming practices, habits and levels of urbanization, as well as trade in animals and animal products. It is important that health education and community participation should be included in a zoonoses control project or food hygiene programme from the start and should be closely linked to and coordinated with all changes to it.

Table 27.1: Seven types of community participation

Type of participation Description

Manipulative participation (Co-option)

Community participation is simply a pretence, with people's representatives on official boards who are unelected and have no power.

Passive participation (Compliance)

Communities participate by being told what has been decided or already happened. It involves unilateral announcements by an administration or project management without listening to people's responses. The information belongs only to external professionals.

Participation by consultation

Communities participate by being consulted or by answering questions. External agents define problems and information gathering processes, and so control analysis. Such a consultative process does not concede any share in decision-making, and professionals are under no obligation to take on board people's views.

Participation for material incentives

Communities participate by contributing resources, such as labour, in return for material incentives (e.g. food,

cash). This type of participation is quite common. However, people have no stake in prolonging these practices when the incentives end.

Functional participation (Cooperation)

Community participation is seen by external agencies as a means to achieve project goals. People participate by forming groups to meet predetermined project objectives; they may be involved in decision-making, but only after major decisions have already been made by external agents.

Interactive participation (Co-learning) People participate in joint analysis, development of action plans and formation or strengthening of local institutions. Participation is seen as a right, not just the means to achieve the project goals. The process involves inter-disciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. As groups take control over local decisions and determine how available resources are used, they have a stake in maintaining structures or practices.

Self mobilization (Collective action) People participate by taking initiatives independently of external institutions to change systems. They develop contacts with external institutions for resources and technical advice they need, but retain control over how resources are used. Self-mobilisation can spread if governments and NGOs provide an enabling framework of support. Such self-initiated mobilisation may or may not challenge existing distributions of wealth and power.

Source: Adapted from Pretty (1994) and Cornwall (1996).

Communicable Disease Control

Many studies document the benefits of using a community participatory approach to relief in emergency settings and to development in post-emergency phase for controlling communicable diseases. Community participatory relief programme can deliver aid in a timely manner, ensure that resources reach the most vulnerable and poorest individuals, enhance rather than weaken the existing health structures and empower communities to take more control of their lives

Zoonoses Control Programmes

Planning at local level regarding the control of zoonotic diseases depending on the need of the community and organisation of resources is required for the successful implementation of project. The implementation requires:

1. Selection of the community;
2. Mapping of the risk groups in the community;
3. Identification of risk hotspots;
4. Participatory community risk assessment; and
5. Participatory community risk assessment planning.

The community public health education requirements include:

1. Sensitization of trainers of trainees (public) on all relevant public health matters;
2. Public awareness in schools, religious and political fora;
3. Creating awareness among the decision makes especially village leaders, stakeholders in local government/councils;
4. Retraining of meat inspectors and other service providing cadres involved in meat inspection; and
5. Sensitizing consumers or general public using television and radio programmes.

For implementation of zoonoses control programmes, advocacy is needed to influence the people, policies and systems to bring about widespread changes in the community. Zoonoses control programmes should be included sectorally as well as within the institution in order to sustain the efforts for a longer period of time. This can be achieved by involving various stakeholders and by organising workshops at various levels. For example, community participation has been recognised as a key factor in the effectiveness of rabies prevention and control. Stray dogs in developing countries pose a major threat of rabies, so this segment of the dog population needs to be particularly targeted for rabies control and prevention campaigns. However, such dogs are frequently considered as community or neighbourhood dogs in many developing countries including India. As a result, any drastic dog population control measures often generate resentment among the community. It is, therefore, crucial to build trust between the community and the personnel engaged in the dog population management work. Success can be achieved by educating the school children about rabies, who is turn help in creating further awareness about the disease in their family. They can also assist by reporting rabies suspected dog cases in their community.

Conclusions

The success in the prevention and control of major zoonoses depends on the capability to mobilize the community participation and on coordination and intersectoral approaches, especially between veterinary and public health services. For example, the avian influenza outbreaks in many countries especially Indonesia and Thailand, could be controlled due to active participation of the communities and coordinated efforts of the health and the veterinary sectors and the government authorities. Similarly, rabies control in Kisumu district of

Kenya was initiated in 2010 by the combined effort of veterinary and medical personnel due to alarmingly high cases of dog bite. The programme was started by creating awareness among the village leaders about the need of vaccination against rabies in dogs who in turn motivated the other members of the community. The community members were mobilised to identify households raising dogs and doing door-to-door vaccination. People who refused to vaccinate the dogs were penalised by taking the expense of post-bite vaccination (Omemo 2010).

These and many other examples have shown that community participation is vitally important in order to achieve good results (Deborn et al., 2001). We need to understand the community potential, community perspective on zoonoses and zoonoses mainstreaming. There should be no passing of responsibilities but sharing of responsibilities for control of diseases. The desired level of improvement may not take place unless people want change and intend to make it happen.

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Reproductive management of bovines to improve milk production

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Reproductive inefficiency of dairy cattle causes great frustration for dairy producers. Even under optimal conditions, the reproductive process is less than perfect because of the multiple factors involved in producing a live calf. To manage the complexities of the estrous cycle and the annual reproductive cycle, understanding of many interrelated physiological functions is critical. Furthermore, reproductive efficiency involves successful management of not only the cows but also the people who milk, feed, house, inseminate, and care for them. Although the benefits of improving reproduction are apparent, specific causes of poor reproductive performance are difficult to identify and are not resolved easily. To improve reproductive efficiency, the limiting factors must be identified. In general, detecting estrus is the major limitation to achieving a pregnancy. But once insemination occurs, two sources of pregnancy failure exist, which include, but are not limited to, fertilization failure and embryonic death. To maximize the chances of a renewed pregnancy for every heifer or cow that calves into the herd, a number of important time-dependent components of the estrous cycle must be managed. It is critical to understand each component of the estrous cycle as well as the annual reproductive cycle (calving interval) and determine where limited time and resources might be concentrated best to reach AI-breeding goals. Maximal reproductive efficiency requires management of the calving interval. This consists of three major components: the elective waiting period, the active AI-breeding period, and gestation (including the dry period) plus their various integral parts.

Elective Waiting Period The first component of a calving interval is the traditional rest period or the elective

waiting period (EWP). This period varies from 40 to 70 d on most farms. Part of its duration is based on the physiological need for the reproductive tract of the cow to undergo a healing process or involution. Research indicates that when cows calve without complication, this healing process requires no more than 40 d.

Peri-Parturient Period Parturition in the cow is a process that requires attention, care, and cleanliness. A multitude of calving-related disorders predispose cows to ill health, loss in milk production, and reduced reproductive efficiency. Whatever can be done to reduce one or more of these disorders will result in the reduced incidences of other disorders because of their strong interrelationships. During late gestation, the feto-placental unit is a major nutrient consumer and orchestrates a homeorhetic priority of nutrient utilization. Once parturition occurs, the mammary gland becomes the major nutrient user. As a result, an energy prioritization is manifested that places higher priorities on the use of nutrients for maintenance and for milk secretion than for the onset of estrous cycles and the initiation of a new pregnancy. Cows that consume less DM than their contemporaries have delayed first ovulation and first estrus after parturition, produce less milk, and are less fertile.

Close-up Fresh Period It is no wonder that newly calved or close-up fresh cows have been the focus of new veterinary intervention. It is logical to assume, however, that whatever stimulates Dry matter intake (DMI) and prevents ill health for close-up fresh cows by providing more available nutrients for reproductive processes will prove beneficial to the cow once maintenance, growth, and milk production requirements are satisfied.

Onset of Estrous Cycle A recent review of the factors limiting the onset of estrous cycle in lactating cattle cited a number of events that must occur before cows begin estrous cycles after calving. Because follicular waves begin soon after calving, concentrations of blood FSH are sufficient, but a major

limiting factor to ovulation is the reinitiation of adequate LH secretion in the form of circhoral LH pulses to support final follicular maturation and subsequent ovulation of a dominant follicle. Moreover, the onset of these LH secretory patterns is related to the timing of the postpartum nadir of energy balance. The stimulation of appetite to ensure adequate DMI in normal, healthy cows is essential to provide nutrients for maximizing milk secretion, follicular growth, ovulation, uterine involution, and the initiation of pregnancy. Increased feeding frequency and better feed bunk management to maintain a fresh, adequate supply of feed and multiple sources of clean are critical for stimulating appetite and maximal DMI. However, loss of BCS between parturition and AI may negatively influence conception, because cows with BCS <3 at calving were less likely to be inseminated and loss of BCS between calving and 45 DIM was associated with more days open and delayed intervals to first service. Milk production and DMI of dairy cows are stimulated by increased dietary protein, but, unfortunately, decreased fertility often is associated with excess feeding of ruminally degradable or RUP as assessed by elevated blood or milk concentrations of urea. Concentrations of milk urea N exceeding 19 mg/dl are associated with altered uterine pH and reduced fertility. Therefore more research is needed to determine if various diets and changes in nutritional management can be made to improve fertility rather than merely avoiding reductions in fertility.

Programmed Breeding Programmed breeding is a method to schedule and control the insemination program of lactating cows in the herd. The advantages for programming estrous cycles include: 1) convenience of scheduling labor and tasks; 2) controlling the occurrence of estrus, ovulation, or both; and 3) knowing the stage of the estrous cycle and reproductive status of groups of cows in the herd. There are three programs which are commonly used on dairy farms: 1) Targeted Breeding; 2) Ovsynch; and 3) Presynch + Ovsynch.

Targeted Breeding Program. This program has been promoted by one of the PGF2α manufacturers (Pharmacia & Upjohn) for synchronizing the AI breeding of lactating cows in a herd. Injections of PGF2α are administered 11 to 14 d apart. ***Ovsynch*.** It is described more accurately as an ovulation synchronization program; hence the name, Ovsynch. A 100-µg injection of GnRH is given 7 d before a PGF2α injection, then a second 100-µg injection of GnRH is administered 48 h after PGF2α, with one fixed-time insemination given 0 to 24 h later. A recent study reported no difference in pregnancy rates when 50 versus 100 µg of GnRH were injected at either time. ***Presynch* + *Ovsynch*.** The so-called Presynch procedure entails two injections of PGF2α, given 14 d apart, with the second injection given 12 d before initiating the Ovsynch protocol.

ACTIVE AI-BREEDING PERIOD The duration of this period is a function of the estrus detection rate and the level of individual cow fertility. The percentage of cows detected in estrus depends on the efficiency of detecting estrus in all cows, while the level of cow fertility depends upon a number of factors, including the fertility of the service sire, correct thawing and handling of semen, AI-breeding technique, and timing of insemination.

Detection of Estrus: The greatest limiting factor to successful fertilization is detection of estrus. Approximately 50% of the estrous periods go undetected on the average dairy farm. Two important challenges exist for detecting estrus: accurately recognizing signs of estrus and identifying all possible periods of estrus in breeding heifers and cows.

Signs of Estrus: A cow will not be detected to stand if no other cow is available to mount. Once four or more sexually active animals are in estrus in the same pen, standing and mounting activity normally will be maximized.

Estrus-Detection Aids: Ideal estrus detection system has the following characteristics: 1) continuous surveillance of the cow; 2) accurate and automatic identification of the cow in estrus; 3) operation for the productive lifetime of the cow; 4)

minimal labor requirements; and 5) high accuracy and efficiency (95%) for identifying the appropriate physiological events that correlate with estrus, ovulation, or both.

Assessing Reproductive Efficiency When TAI is performed in cows, then by definition conception rate (**CR**) is equivalent to pregnancy rate (PR), because the EDR is 100%. Therefore, PR = EDR × CR becomes PR = 1 × CR or PR = CR. Pregnancy rate is suggested to be the best measuring stick for success of the AIbreeding program (Stevenson, 2000). For example, If 60% of the cows in the traditional program are submitted for insemination (60% EDR; 40 eligible cows were not inseminated because they were not detected in estrus), with a 40% conception rate, 24% of the cows become pregnant in a 21-d period. With the Ovsynch program, 100% of the cows are inseminated (TAI), and with a similar conception rate, 40% of the cows become pregnant in a 10-d period. Therefore, 16 more pregnancies are achieved at a similar conception rate.

GESTATION AND DRY PERIOD The third component of a calving interval is gestation, including the dry period. The duration of gestation is fairly constant and cannot be shortened significantly without adversely affecting the health or viability of the newborn.

Dry Period Evidence supports the concept that the dry period is a critical component to subsequent performance of dairy cows. Nutrients required during this period include the maintenance and growth of the cow plus that required by the developing feto-placental unit. The diet for the closeup dry period should contain higher energy density with less fiber.

Other Factors Affecting Fertility Preventive Herd Health Practices Appropriate preventive herd health programs should include a vaccination program for cows and replacements, deworming of animals on pasture, mastitis control, hoof care, reproductive visits, and other diagnostic procedures applied to blood and tissue samples resulting from abortions and other unexplained illnesses.

Cow Comfort For maximum comfort and milk yield in dairy cows, they must stand to eat, stand to be milked, and lie down to ruminate and rest. Therefore, tie-stall or free-stall comfort is critical to increased milk yields and acceptable conception rates. During times of heat stress, some environmental modification is essential during late gestation and during lactation to prevent hyperthermia and its harmful effects on cows. During the active AI-breeding period, heat stress reduces uterine blood flow oocyte quality, embryo development, luteal function, and endometrial function; and milk yields and overall reproductive performance. Modifications in free-stall or loose housing should include shade, cooling under shades, forced ventilation with fans, and sprinklers.

Timing of Ovulation and Insemination Once the egg has ovulated, its estimated viable life is <12 h, unless it becomes fertilized. Sperm are not capable of fertilizing the egg immediately upon thawing and deposition into the uterine body of the female because they must travel the uterine horns to the utero-tubal junction, enter the oviduct, and complete a maturation process known as capacitation. In general, normal, motile sperm need about 6 to 10 h to reach the lower portion of the oviduct. The key to proper timing of insemination and maximizing fertilization rates is to inseminate cows at a time to allow ovulation to occur when adequate numbers of motile sperm are present in the oviduct.

Semen Handling Techniques The improper handling of semen results in damaged sperm membranes, cold and heatshocked sperm, or impaired sperm motility. To maintain maximum fertilization rates, recommended semen handling techniques must be followed: 1) when removing straws for thawing, prevent exposure of other straws by keeping them below the frost line of the tank; 2) thaw straws in water at 37°C (95°F) for at least 30 s; and 3) once thawed, prevent cold shock of sperm cells until the semen is deposited in the female.

AI Techniques Actual insemination technique may or may not be a major factor contributing to failure of fertilization. Fewer numbers of motile sperm gain access to the oviduct when semen is placed in the cervix than in the uterus. The target for insemination is the uterine body.

Embryonic Losses Once the eggs are fertilized, the next obstacle is loss of the early embryo that occurs during the cleavage stage of pregnancy. This is a critical period of development when early losses can occur. The next critical stage is around d 15 or 16, when the embryo must be developed sufficiently to override the spontaneous uterine secretion of PGF2α. Additional embryonic losses can occur during the period of 25 to 40 d after insemination. These so-called late embryonic deaths probably occur partly as a result of some failure in the attachment of the developing placenta to the uterine wall. Because of these embryonic and fetal losses, pregnancy diagnosis should be done at least twice. The first should as early as possible to identify non pregnant cows and the second sometime after d 70, because only 3.4% of pregnancies in lactating dairy cows are lost after d 70.

Clinical Mastitis and Abortions Evidence is mounting that cows with mammary infections are predisposed to early pregnancy losses because of disruption of normal luteal maintenance. The mechanism by which mastitis interferes with pregnancy seems related to the secretion of PGF2α.

Male-Related Factors and Sire Usage If a herd bull is used during summer, it is susceptible to heat stress as well as the cows. Even short periods of heat stress (>85°F) cause a marked reduction in semen quality that may last for more than 4 to 5 wk after the end of the heat-stress period.

Future Technologies Significant use of embryo transfer commenced with the introduction of nonsurgical recovery and transfer of embryos in the 1970s. One advantage of using embryo transfer of either fresh or frozen-thawed embryos is the bypassing of the early embryo losses that occur before day of transfer (i.e., d 7). Because of advances in the in

vitro production of embryos as the result of transvaginal ultrasound guided aspiration of oocytes and the discovery of the effects of follicular status on oocyte quality and competence for embryonic development, more transfers of traditionally produced embryos may be expected in the future. Cloning of embryos has increased in recent years. Embryos produced by IVF can be used effectively to estimate the potential fertilizing ability of frozen-thawed semen from dairy bulls. Models developed as alternative progeny-testing schemes based on genetic and economic gains indicate that cloning is highly beneficial for progeny-testing schemes with lower intensity and accuracy of selection. Refinement of molecular biology tools related to increased availability of higher quality embryos has favoured the emergence of screening of potential transgenic-produced cattle and embryo sexing. Other technologies including cell sorting have allowed successful separation of X and Y-bearing sperm.

Summary and Conclusions Components and parts of the calving interval outlined above illustrate the key management steps in maintaining reproductive efficiency in the dairy herd. The close-up dry period nutrition and vaccination programs must be managed well. Maximal DMI ensure that milk yield, onset of estrous cycles, and initiation of pregnancy can occur in a timely manner, if the programmed breeding protocols and good detection of estrus are in place. Use of the Presynch + Ovsynch program is likely to be the most efficient and least costly way to prepare clusters of cows for their best chance to conceive at first AI service. In general, those factors resulting from inadequate detection of estrus or fertilization failure (e.g., semen handling and AI techniques) are resolved more easily than those related to embryonic death. A continuous effort should be focused on reducing various stressors that lower reproductive efficiency.

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Climate change: Impact on Animal Health and Biodiversity

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INTRODUCTION

Global warming is real as evident from the report of the Intergovernmental Panel on Climate Change (IPCC, 2014). The climate change will become worse, and it will not only affect plants or animals but the people will be affected too. The possible effects of climate change on food production are not limited to crops and agricultural production. Climate change will have far-reaching consequences for dairy, meat and wool production, mainly arising from its impact on grassland and rangeland productivity. Heat distress suffered by animals will reduce the rate of animal feed intake and result in poor growth performance. Lack of water and increased frequency of drought in certain countries will lead to a loss of resources. The global warming is causing physical and biological changes throughout the planet and is impacting regional climates, ecosystems, and the organisms in a number of ways. It is a known fact that an animal species can only survive within specific ranges of climatic and environmental factors, if conditions change beyond the tolerance of species, or too fast for evolutionary adaptations, then animals may exhibit ecological responses to these changes. Rapid climate change is a threat of extinction to species that are unable to adapt or have limited habitat. Responses to climate change include (i) adaptation, to reduce the vulnerability of people and ecosystems to climatic changes, and (ii) mitigation, to reduce the magnitude of climate change impact in the long term. However, neither adaptation nor mitigation alone can offset all climate change impacts. Animal's phenology, such as migration, breeding and spring appearance, have changed throughout the world and are linked to seasonal variability. Arctic and marine ecosystems are undergoing physical environmental changes that are affecting

the species that inhabit them. Temperature change and melting sea ice in the arctic is adversely affecting the species of the region, and sea level rise, increased sea temperature and higher pH are among the issues changing the planets marine ecosystems. Spread of pests and disease are occurring as a result of milder temperatures. All of these changes threaten the planets ecological biodiversity and changes projected for the environment will increasingly affect all life on Earth.

CLIMATE CHANGE

Climate Change is occurring as a result of the greenhouse effect, which is the amount of solar radiation that is trapped in Earth's atmosphere, and which regulates the temperature of Earth. The main greenhouse gases are: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Less prevalent but very powerful greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The human activities like industrialization, combustion of fossil fuels and pollution have increased atmospheric concentrations of greenhouse gases. In response, Earth's climate change have changed that includes an increase in land and ocean temperatures, changes in spatial and temporal precipitation patterns, sea level rise, reduction of sea ice, changes in vegetation, seasonal changes, and increases in the frequency and intensity of weather events (IPCC, 2002).

ECOSYSTEMS AND BIODIVERSITY

Animal response to climate change varies greatly between species, but climatic changes lead to disruption of biotic interactions, such as predator/prey interactions, and changes to ecosystem composition and functioning. Climate change can affect individual organisms, populations, species distributions, and ecosystem function and composition both directly and indirectly. While the long term impacts and existing trends still need more research, and may not always link directly to climate change, climatic changes are affecting

all of the physical and biological systems on the planet. In a report IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. With increases of 1.5° C to 2.5° C, approximately 20 to 30 percent of plant and animal species are expected to be at risk of extinction with severe consequences for food security.

Biodiversity describes the richness and complexity of life on Earth. Biodiversity refers to both the number of living species and the number of different genes in those species' gene pools. The composition of most ecosystems is likely to change as species migrate at different rates and are affected differently by climatic changes, and by changes in vegetation and ground cover.

THE EFFECTS OF CLIMATE CHANGE ON LIVESTOCK

The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems, such as rapid population and economic growth, rising demand for food (including livestock) and products, conflict over scarce resources (land tenure, water, biofuels, etc). For rural communities, losing livestock assets could trigger a collapse into chronic poverty and have a lasting effect on livelihoods. The direct effects of climate change will include, for example, higher temperatures and changing rainfall patterns, which could translate into the increased spread of existing vector-borne diseases and macro-parasites, accompanied by the emergence and circulation of new diseases. In some areas, climate change could also generate new transmission models. These effects will be evident in both developed and developing countries, but the pressure will be greatest on developing countries because of their lack of resources, knowledge, veterinary and extension services, and research technology development. Some of the indirect effects will be brought about by, for example, changes in feed resources linked to the

carrying capacity of rangelands, the buffering abilities of ecosystems, intensified desertification processes, increased scarcity of water resources, decreased grain production. Other indirect effects will be linked to the expected shortage of feed arising from the increasingly competitive demands of food, feed and fuel production, and land use systems. Some of the direct and indirect impacts of climate change on livestock and livestock systems are as follows.

Factor	Impacts
Water	Water scarcity is increasing at an accelerated pace and affects between 1 and 2 billion people. Climate change will have a substantial effect on global water availability in the future. Not only will this affect livestock drinking water sources, but it will also have a bearing on livestock feed production systems and pasture yield.
Feeds	**Land use and systems changes** As climate changes and becomes more variable, niches for different species alter. This may modify animal diets and compromise the ability of smallholders to manage feed deficits. Changes in the primary productivity of crops, forage and rangeland Effects will depend significantly on location, system and species. In C_4 species, a rise in temperature to 30-35° C may increase the productivity of crops, fodder and pastures. In C_3 plants, rising temperature has a similar effect, but increases in CO_2 levels will have a positive impact on the productivity of these crops. For food-feed crops, harvest indexes will change, as will the availability of energy that can be metabolized for dry season feeding. In semi-arid rangelands where the growing season is likely to contract, productivity is expected to decrease. **Changes in species composition** As temperature and CO_2 levels change, optimal growth ranges for different species also change; species alter their competition dynamics, and the

	composition of mixed grasslands changes. For example, higher CO_2 levels will affect the proportion of browse species. They are expected to expand as a result of increased growth and competition between each other. Legume species will also benefit from CO_2 increases and in tropical grasslands the mix between legumes and grasses could be altered. **Quality of plant material** Rising temperatures increase lignifications of plant tissues and thus reduce the digestibility and the rates of degradation of plant species. The resultant reduction in livestock production may have an effect on the food security and incomes of smallholders. Interactions between primary productivity and quality of grasslands will require modifications in the management of grazing systems to attain production objectives.
Biodiversity (genetics and breeding)	A 2.5° C rise in global temperature would determine major losses: between 20 and 30 per cent of all plant and animal species assessed could face a high risk of extinction. Ecosystems and species display a wide range of vulnerabilities to climate change, depending on the imminence of exposure to ecosystem-specific critical thresholds, but assessments of the effects of CO_2 fertilization and other processes are inconclusive. Local and rare breeds could be lost as a result of the impact of climate change and disease epidemics. Biodiversity loss has global health implications and many of the anticipated health risks driven by climate change will be attributable to a loss of genetic diversity.
Livestock and human health	Vector-borne diseases could be affected by: (i) the expansion of vector populations into cooler areas (in higher altitude areas: malaria and livestock tick-borne diseases) or into more temperate zones (such as bluetongue disease in northern Europe); and

	(ii) changes in rainfall pattern during wetter years, which could also lead to expanding vector populations and large-scale outbreaks of disease (e.g. Rift Valley fever virus in East Africa). Temperature and humidity variations could have a significant effect on helminth infections. Trypano-tolerance, an adaptive trait which has developed over the course of millennia in sub-humid zones of West Africa, could be lost, thus leading to a greater risk of disease in the future. Changes in crop and livestock practices could produce effects on the distribution and impact of malaria in many systems, and schistosomiasis and lymphatic filariasis in irrigated systems. Heat-related mortality and morbidity could increase.

MEETING THE CHALLENGE: ADAPTATION & MITIGATION STRATEGIES

Livestock can play an important role in both mitigation and adaptation. Mitigation measures could include technical and management options in order to reduce green house gas emissions from livestock, accompanied by the integration of livestock into broader environmental services. In general, livestock is more resistant to climate change than crops because of its mobility and access to feed. Following are the suggestions given by several agencies like FAO, to increase adaptation in the livestock sector.

Production adjustments: Changes in livestock practices could include: (i) diversification, intensification and/or integration of pasture management, livestock and crop production; (ii) changing land use and irrigation; (iii) altering the timing of operations; (iv) conservation of nature and ecosystems; (v) modifying stock routings and distances; (vi) introducing mixed livestock farming systems, such as stall-fed systems and pasture grazing.

Breeding strategies: Many local breeds are already adapted to harsh living conditions. Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases. Such measures could include: (i) identifying and strengthening local breeds that have adapted to local climatic stress and feed sources and (ii) improving local genetics through cross-breeding with heat and disease tolerant breeds. If climate change is faster than natural selection, the risk to the survival and adaptation of the new breed is greater.

Market responses*:* The agriculture market could be enhanced by, for example, the promotion of interregional trade and credit schemes.

Institutional and policy changes: Removing or introducing subsidies, insurance systems, income diversification practices and establishing livestock early warning systems and other forecasting and crisis-preparedness systems – could benefit adaptation efforts.

Science and technology development: Working towards a better understanding of the impacts of climate change on livestock, developing new breeds and genetic types, improving animal health and enhancing water and soil management would support adaptation measures in the long term.

Capacity building for livestock keepers*:* There is a need to improve the capacity of livestock producers and herders to understand and deal with climate change increasing their awareness of global changes. In addition, training in agroecological technologies and practices for the production and conservation of fodder improves the supply of animal feed and reduces malnutrition and mortality in herds.

Livestock management systems*:* Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies.

These could include (i) provision of shade and water to reduce heat stress from increased temperature. Given current high energy prices, providing natural (low cost) shade instead of high cost air conditioning is more suitable for rural poor producers; (ii) reduction of livestock numbers – a lower number of more productive animals leads to more efficient production and lower green house gas emissions from livestock production; (iii) changes in livestock/herd composition (selection of large animals rather than small); (iv) improved management of water resources through the introduction of simple techniques for localized irrigation (e.g. drip and sprinkler irrigation), accompanied by infrastructure to harvest and store rainwater, such as tanks connected to the roofs of houses and small surface and underground dams.

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Role of Veterinarians in control of Emerging Zoonoses

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One Health is a new dimension in viewing health. It takes into account health and well being of man, animals and nature or "Health for all" concept. The importance of this dimension is exposed when individuals cannot derive a solution especially in cases of disease threats or zoonoses. Today world recognizes health not only as the physical, the mental and the social wellbeing (as per WHO) but also as spiritual, emotional, vocational, political dimensions. These symbolize "One Health" in which a huge range of factors to which other sectors besides health must contribute if all people are indeed to attain a level of health that will permit them to lead a socially and economically productive life. Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature. There is a growing need to improve human and animal health services to protect global health and food security. It is observed that the limited resources for human and animal health service have failed to produce the desired effect, but collectively by adopting interdisciplinary or intersectoral strategies (One Health approaches) we can face challenging situations to achieve a paradigm shift in health service provision. For this there has to be convincing arguments that the costs of a major shift will generate substantial net benefits.

Health threats

Health threats at the human–animal–ecosystem interface have increased over the past decades, as pathogens continue to evolve and adapt to new hosts and environments, imposing a burden on human and animal health systems. The increase in health threats to humans and animals is driven by multiple, inter-related global factors generally related to human behavior

and environmental changes and also reflects the complexities of the ecosystems in which humans and animals coexist. Because reducing these risks cannot be achieved by one sector alone, there is increasing convergence towards a One Health approach that incorporates a cross-sectoral, multidisciplinary mode of addressing these threats and reducing health risks. Today's highly mobile, interdependent and interconnected world provides myriad opportunities for the rapid spread of infectious diseases, and radio nuclear and toxic threats, which is why updated and expanded regulations are necessary.

Magnitude of Health threats

Leaders within healthcare organizations of all shapes and sizes face a wave of challenges including globalization, the explosion of information technologies, concerns around environmental impacts, changing demographics, increased regulatory scrutiny, pending healthcare reform and, most recently, a global economic recession. Some of the major health threats faced in today's world are

- Unsafe water, poor sanitation and hygiene can kill an estimated 1.7 million people annually, particularly as a result of diarrhoeal disease
- Emerging zoonoses like Avian Influenza and Vector-borne diseases including malaria, dengue and leishmaniasis are always a threat in developing world. For example Malaria kills over 1.2 million people annually, mostly African children under the age of five. Poorly designed irrigation and water systems, inadequate housing, poor waste disposal and water storage, deforestation and loss of biodiversity.
- Urban air pollution generated by vehicles, industries and energy production kills approximately 800000 people annually. Indoor smoke from solid fuels kills an estimated 1.6 million people annually due to respiratory diseases.
- Road traffic injuries are responsible for 1.2 million deaths annually; low- and middle-income countries bear 90 per cent of the death and injury toll. Degradation of the built

urban and rural environment, particularly for pedestrians and cyclists, has been cited as a key risk factor.

- Toxic exposure like lead (Pb) can kill more than 230 000 people per year and causes cognitive effects in one third of all children globally; more than 97% of those affected live in the developing world. Similarly, common people are exposed to residues of pesticides and other heavy metals in the environment which can lead to health hazards like cancer.
- Climate change impacts including more extreme weather events, changed patterns of disease and effects on agricultural production are estimated to cause over 150 000 deaths annually.
- Unintentional poisonings kill 355 000 people globally each year in developing countries, where two-thirds of these deaths occur, such poisonings are associated strongly with excessive exposure to, and inappropriate use of, toxic chemicals and pesticides present in occupational and/or domestic environments

KEY CHALLENGES

Emerging and communicable diseases

Many zoonotic diseases are emerging as a result of environmental factors, including climate change, deforestation, alterations of wildlife habi-tat, and other land use change; human population growth; movement of human beings and animals across borders; and increased production of food animals. Infectious diseases account for 14 million deaths per year, around 25 per cent of the world total. They are the world's leading killers of children and young adults. Six major diseases currently cause 90 per cent of the deaths from communicable diseases: AIDS, malaria, tuberculosis, pneumonia, diarrhoeal diseases, and measles.

Poverty and population growth

The global human population is estimated to reach 7 billion within the next few years and will increase its need for land, food and energy. As global populations expand and shift,

the healthcare sector is coming under increasing pressure. The scope and emphasis of a One Health program are necessarily influenced by the changing characteristics of human and animal population it serves. The increased rate of population growth, loss of biodiversity, changes in population density and urban-rural movement requires a One Health dimensions to solve the new problems thus created. Despite undoubted health advances in many areas, poor health continues to be a constraint on development efforts. According to the World Bank estimates 970 million people were living below the '$1-a-day' poverty line in 2004, and 2,550 million (40 per cent of the world population) below the '$2-a-day' line (Chen and Ravallion, 2007). Characteristics of extreme poverty include very low income and lack of access to the basic necessities of health and life – food, shelter, water and other living requirements. High density of population contributes to the spread of communicable diseases, so population pressure not only drains food resources and leads to widespread malnutrition, but also sets the stage for epidemics. Population pressure, malnutrition and infection - thus constantly reinforce one another. Thus a decrease in the number of young people in relation to the old appears imminent. The vicious circle of population pressure explains the effect of population on health. This involves Population pressure >>> Food Shortage>>> Malnutrition>>> Infection >>> High child mortality>>> High birth rate.

Health Inequalities

Global Health status accurately reflects the quality of life, or Human Development Index of our communities. In both the developed and developing world, many of the most compelling challenges derive from disparities or inequalities in the disease burden between advantaged or wealthy communities (or nations) and disadvantaged or poor communities. Health inequities are avoidable inequalities in health between groups of people within countries and between countries. Social and economic status and their effects on people's lives determine their risk of illness and

the actions taken to prevent them becoming ill or treat illness when it occurs. In Bolivia, babies born to women with no education have infant mortality greater than 100 per 1000 live births, while the infant mortality rate of babies born to mothers with at least secondary education is under 40 per 1000. Although economic benefits have been gained in the past 25 years, it is unequally distributed among rich and poor countries. Gender biases in power, resources, entitlements, norms and values damage the health of millions of girls and women.

Health care challenges

Health Challenges like Water scarcity, climate change, increasing incidence of drought and famine, malnourishment, disease, rapidly rising costs for food and energy. The extinction of endangered animal species and explosion of human population are also the major challenges faced today, for which approaches like One Health is needed. India is home to the greatest burden of maternal, newborn and child deaths in the world. Infant mortality rate declined from 83 per 1000 live births in 1990 to 44 per 1000 live births in 2011 and maternal mortality ratio reduced from 570 per 100,000 live births in 1990 to 212 in 2007–2009.

However, both remain high in comparison to other BRICS countries. Animals and human beings often share exposure risks from noninfectious disease threats, such as air and water quality problems, pesticides, lead, and carbon monoxide. The triple burden of disease (communicable diseases, non-communicable diseases and other new infections) and the fact that people can afford more and more expensive care and treatment results in an increase of health expenditures that confronts countries with real challenges on the ways to reduce or freeze health expenditures rather than utilizing the country's resources on the disease prevention programmes.

Climate change and global health

Effects of climate change on human health can be expected to be mediated through complex interactions of physical, ecological, and social factors. These effects will undoubtedly have a greater impact on societies or individuals with scarce resources, where technologies are lacking, and

where infrastructure and institutions (such as the health sector) are least able to adapt. For this reason, a better understanding of the role of socio-economic and technological factors in shaping and mitigating these impacts is essential. Potential risks to human health from climate change would arise from increased exposures to thermal extremes (cardiovascular and respiratory mortality) and from increases in weather disasters (including deaths and injuries associated with floods). Other risks may arise because of the changing dynamics of disease vectors (such as malaria and dengue fever), the seasonality and incidence of various food-related and waterborne infections, the yields of agricultural crops, the range of plant and livestock, pests and pathogens, the salination of coastal lands and freshwater supplies resulting from rising sea-levels, the climatically related production of photochemical air pollutants, and the risk of conflict over depleted natural resources. The global environment is rapidly changing, and animals and human beings are exposed to shared environmental health risks. Environmental disasters such as Hurricane Katrina wreak havoc on both human and animal populations. Now humankind became increasingly aware of the need for a more collective approach such as One Health approach to tackle certain urgent environmental problems.

Food insecurity

We face a global situation where an estimated 925 million people go hungry. The effects of food price increases are likely to deepen the vulnerability of those who spend between 50% and 80% of their family budget on food, mostly basic staples. Chronic and acute child malnutrition, low birth weights, and suboptimal breastfeeding are estimated to cause the deaths of 3.5 million mothers and young children every year. Furthermore, one in three children under the age of 5 years born in developing countries suffers from stunting due to chronic under nutrition. Efforts to respond to food insecurity, food safety and food trade challenges have addressed all four dimensions of food security namely, availability, access, utilisation and stability. Rising prices present a great opportunity for farmers to respond to growing demand. But

farmers need inputs and cash to do this. Increases in extreme weather events will damage crops and disrupt farming. Sea level rise and flooding of coastal lands will lead to salination or contamination of fresh water and agricultural lands, and the loss of nursery areas for fishing. Drought and changing patterns of plant and livestock diseases and pest infestations, reduction of income from animal production, decreased crop yields, lessened forest productivity, and changes in aquatic populations will all affect food production and security. The regions which are already suffering from food insecurity and malnutrition are most likely to be adversely affected.

Water and sanitation challenges

Good health depends on continuous supply of safe and pure water. WHO estimates that the total global economic losses associated with inadequate water supply and sanitation are US$ 260 billion/year. The quality of water, whether used for drinking, domestic purposes, food production or recreational purposes has an important impact on health. Provision of public health infrastructure has been key to economic, social, and industrial development, and remains a challenge in many parts of the world. In 2002, 21% of people living in developing countries did not have sustained access to an improved water source, and 51% did not have access to improved sanitation. Water of poor quality can cause disease outbreaks and it can contribute to background rates of disease manifesting themselves on different time scales. Initiatives to manage the safety of water do not only support public health, but often promote socioeconomic development and well-being as well. Millions of people are exposed to dangerous levels of biological contaminants and chemical pollutants in their drinking-water due to inadequate management of urban, industrial or agricultural wastewater. WHO estimates that more than 200 million people are affected by schistosomiasis and around 800 million more are at risk of infection. In addition, dangerously high concentrations of chemical hazards, such as arsenic and fluoride, originating from natural sources affect millions and cause conditions such as cancer and fluorosis. The main health effects of lack of access to clean water and sanitation are diarrhoeal and other diseases caused by biological or chemical contaminants.

Wars and terrorism

Terrorism, defined as use systematic violence, threat of violence or terror against individuals, groups or Governments to achieve a political objective is currently a global distribution and growing interest for international public health problem. The terrorism related violence affects the public health and the health care services in an important way and in different scopes, among them, increase mortality, morbidity and disability, generates a context of fear and anxiety that makes the psychopathological diseases very frequent, seriously alters the operation of the health care services and produces important social, political and economic damages. Terrorist attack may also disrupt public water system and sanitary system. Hence it is imperative for to develop preparedness and response plans in this context. There is a broad scope for the tools that One health offers, particularly in areas such as the epidemiological surveillance of terrorist attacks and its impact on morbidity and mortality planning, execution and evaluation of programmes of prevention, preparedness and emergency response of the health system to terrorism, intervention in mental health programs or programs of social intervention, among many others.

The need for One Health

The increased health threats resulted in global issues of environmental sustainability and have equally affected the health of humans and animals that are closely interconnected. The health and sustainability consequences of global change are economically, socially, medically, and environmentally costly, and as such, their control can be considered a global public good. The complexities and breadth of such threats demand interdisciplinary solutions that address the connections between human and animal health, as well as the underlying environmental drivers that impact health. Increasingly, there is a push in the global community to move from reductionist, reactionist approaches to more holistic, preventive approaches that rely on systems thinking. One Health concept is a growing global strategy that is being adopted by a diversity of organizations and policy makers in response to the need for integrated approaches. This approach can be relevant to a wide range of global development

goals. If knowingly or unknowingly nature is not used (disuse) or is overused (abuse) it would deteriorate. Healthy environment and healthy animals ensure healthy life for mankind.

Contributions from One Health Approach

In global health there has been significant progress towards achieving the Millennium Development Goals but many challenges remain. There have been reductions in child mortality and gains in the treatment and prevention of HIV/AIDS, tuberculosis, malaria, poliomyelitis and neglected tropical diseases. The value of an activity or its impact may be reflected by market prices, e.g. health treatment expenditures or production losses avoided. But often, One Health risk mitigation activities result in nonmarket outcomes such as avoidance of human distress or death, feelings of consumer confidence, improved animal welfare or conservation of an animal species, which do not have a market value but nevertheless can be measured using one of the many approaches available in economic theory, such as contingent valuation. A change from a traditional sectoral approach of health management to a holistic One Health approach needs to compare the marginal benefits against the marginal costs of such a change. The final outcome of One Health initiatives is the avoidance or reduction of health threats in humans and animals and translated into values using established economic quantification methods. There is a financial gain for animal and public health services to combine their resources to either attain a critical mass that allows the establishment of some minimal infrastructure and service provision or to enhance the delivery of services by sharing cost-structures. Such cost-sharing initiatives serve to reduce the investment required in individual programmes, thus increasing the efficiency of a programme.

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Understanding of basics of Reproductive Ultrasonography and its applications in Animals

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Ultrasound techniques are becoming increasingly important in animal reproduction, offering both a mean of diagnosis and a useful therapeutic tool and thus help to maximize the reproductive efficiency. For this reasons, understanding the use of ultrasound technology is critical in contemporary animal sciences, since ultrasound examinations are now a routine component of diagnostic workups in reproduction. Ultrasonography has several advantages over other imaging modalities. It is non-invasive, free from radiation hazards, provides instant diagnosis and determines shape, size, location and internal consistency of structures. Further repetitive examinations can be done and it is well tolerated by the animals. Practical applications of reproductive ultrasound include follicular dynamics and ovulatory status for timed AI, treatment efficacy in problematic animals, early assessment of pregnancy, and identification of animals carrying twins, detection of ovarian and uterine pathology and determination of fetal age, viability and sex. Each of these applications presents opportunities for improving reproductive efficiency of an animal.

Principles of Ultrasonography

Ultrasound is defined as any sound frequency above the normal hearing range of the human ear; i.e. greater than 20,000 Hz. Briefly, ultrasonography utilizes high frequency sound waves to produce cross sectional images of the tissues and internal organs. The sound waves are produced by vibrations of specialized crystals (piezo-electrical crystals) housed in the ultrasound transducer. Vibrations of the crystals are produced by pulses of electric current. A proportion of sound waves reflected back to the transducer is converted to electric current and displayed as an echo on the ultrasound viewing screen. The

transducer, therefore, acts as both the sender and receiver of echoes. The echoes are evident on the viewing screen as varying shades of gray (black to white). The absolute value of the acoustic impedance of any tissue is relatively unimportant, because it is the magnitude of the difference in acoustic impedance at tissue interface that determine the amount of reflection of the beam.

Most ultrasound scanners used in bovine reproduction currently are B-mode (brightness modality) real-time scanners. In B-mode ultrasonography, the image is a two-dimensional display of dots (pixels). The brightness of the dots is proportional to the amplitude of the reflected echoes returning to the transducer. Real-time refers to the ability to image movements (e.g. fetal heart beat or motion) as it occurs. Dynamics of some reproductive structures or events (i.e. ovulation) could be studied by video tape recordings of real-time ultrasound examinations. Ultrasound scanners are equipped with transducers of varying frequencies. The most commonly used frequencies in bovine reproduction are 3.5, 5.0 and 7.5 MHz. The higher the frequency of the transmitted sound waves, the better the image resolution, but the shallower the depth of penetration.

There are two types of scanners; linear array and sector. Linear array transducers have piezo-electric crystals arranged in rows and as such the image produced by linear array transducer appears rectangular. Sector transducers, on the other hand, have only a few such crystals and the image produced is pie-shaped corresponding to the field of scan. Mechanical sector scanners offer multi frequency capability in a variety of scan head design with 3.0, 5.0 and 7.5 MHz crystals in a single scan head. Because of the versatility of these machines, they are also more expensive than linear- array systems. Recent ultrasound scanners have a wider frequency range and accept a full line of single and dual frequency probes. Digital image port for computer image storage is also available. Battery-powered portable ultrasound scanners are also currently available.

Doppler ultrasonography which detects turbulence within blood vessels and direction of flow is also a useful diagnostic tool in bovine reproduction. The Doppler phenomenon is the change in sound frequency of a moving object as perceived by a stationary observer. Doppler ultrasound machines detect frequency change and, therefore, movement which is converted to an audible signal. The major considerations in selecting an ultrasound scanner are price, resolution quality, portability, serviceability and technical support. Other factors include memory capabilities, remote control, transducer and cable design (I or T), single or dual frequency probe and above all, the use for which the machine would be put. For routine bovine reproductive ultrasonography (early pregnancy diagnosis, pathology of the ovaries and uterus, fetal sexing etc a 5 MHz linear rectal transducer seem to be the most versatile and effective. However, a 7.5 MHz linear transducer is recommended for follicular dynamics studies. For transvaginal oocyte recoveries, a convex-linear transducer gives better results.

Techniques

For transrectal or transcutaneous ultrasound scanning in cattle, no sedation is indicated as the procedure is totally non-invasive and well tolerated. Adequate restraint is however required and the scanner should be placed at a sensible distance from the cow/bull on the side opposite the operator‘s rectalling arm. All precautions that apply to palpation per rectum are applicable to transrectal scanning. All faeces from the rectum should be evacuated prior to introduction of the transducer. It is often advantageous to carry out a preliminary exploration of the topography of the reproductive tract before commencing the ultrasonographic examination. The transducer face is lubricated with a suitable coupling medium and is usually covered by a lubricated plastic sleeve before insertion in a cupped, lubricated hand through the anal opening. It is then progressed cranially along the rectal floor to overlie the reproductive tract. The transducer face must be pressed firmly

against the rectal mucosa in order to effect ultrasound transmission through the rectal wall into abdominal viscera. The probe is moved across the reproductive tract in a thorough and systemic manner.

Basal requirements

To make an accurate diagnosis via an ultrasonographic examination, ambient lighting is imperative. A darkroom is ideal for viewing the monitor and helps the human eye recognize as many shades of gray as possible. When examinations are carried out in lighted conditions, some type of hood must be draped over the monitor to facilitate effective gray-shade delineation. Interposition of any contaminating faeces will prevent ultrasound transmission and produce poor imaging and artefactual interference. The ultrasound screen and the human eye should be at similar level for accurate interpretation of ultrasound images.

Interpretation of ultrasound images

Interpretation of ultrasonography of the reproductive tract requires a thorough understanding of the composition of the images and an awareness of the possible artefacts which can occur and lead to a misdiagnosis. As sound waves pass through the tissues and surrounding areas they may be modified in a number of ways. Sound waves passing through body structures will encounter tissue interfaces and the returning echoes will be of varying strengths and so produce a variety of images. The ultrasonic characteristic of a tissue depends on its ability to reflect sound waves. Liquids do not reflect sound waves (i.e. are non echogenic or anechoic) and are represented on the viewing screen as black. The ultrasonic images of liquid containing portions of structures such as ovarian follicles, embryonic vesicles appear black. A dense tissue (e.g. bone) reflects a large proportion of the transmitted sound waves (i.e. echogenic) and is represented on the viewing screen as light gray or white. Various tissues and contents of the reproductive tract appear on the screen in varying shades of gray depending upon their echogenicity. Some common

artifacts include; distant enhancement (occurs when the incident sound beam strikes the far wall of a fluid-filled structure; e.g follicle, embryonic vesicle), refraction artifacts, specular reflection, reverberation artifacts, acoustic shadowing. The use of ultrasonography has allowed accurate monitoring of ovarian follicular development in heifers and postpartum cows on a daily basis in a non-invasive manner. This has contributed immensely to the understanding of follicular dynamics during the estrous cycle, early gestation and the postpartum period. In the areas of pregnancy diagnosis, fetal sex determination, folliculocenteses, amnio and allantocentesis, reproductive tract pathology, monitoring of normal and abnormal postpartum interval, diagnosis and evaluation of treatment of ovarian cysts, mammary ultrasonography, male reproduction.

Ultrasonography has proved to be a useful clinical and research tool. Ultrasonography is quite helpful for individuals who are inexperienced in palpation per rectum as palpation skills are acquired quickly while at the same time making accurate diagnosis via ultrasonography. One of the greatest constraints limiting the widespread use of ultrasonography in bovine reproduction is the high cost of the ultrasound machine. It is hoped that with the availability of several types of scanners and improvements in the quality of scanners, the price may be affordable to a large number of veterinarians and research scientists and this will enhance its application in clinical as well as research studies of bovine reproduction. It must be emphasized that the use of ultrasonography requires some skills. Such skills are usually obtained during university training or through attendance at continuous professional development courses organized for such purposes. Furthermore, experience can be gained through the use of the ultrasound scanner repeatedly.

Applications ultrasonography in animals:

The ability of ultrasound to distinguish fluid from soft tissue and differentiate between soft tissues based on their composition makes it better than radiography for examining

soft tissue structures. Ultrasound therefore provides a non-invasive alternative to many radiographic contrast procedures, though the two techniques should still be considered as complimentary. Ultrasound may also often provide information that was previously only available through exploratory laparotomy. Further applications of ultrasound include identifying pregnancy and foetal number determination. Ultrasound also permits foetal sexing.

As a pregnancy diagnosis method, transrectal ultrasonography is accurate and rapid, and the outcome of the test is known immediately at the time the test is conducted. The rate of embryonic mortality and the efficacy of strategies to rebreed cows at various stages post breeding also play a role in determining the advantages and disadvantages of the timing of pregnancy diagnosis and resynchronisation.

Assessment of normal ovarian structure

Follicles

The ultrasonographic anatomy of the ovaries of the cow has been described in detail. Antral follicles of various sizes appear as non-echogenic structures, which can be distinguished from blood vessels in cross-section by the elongated appearance of the latter . A linear relationship has been shown between follicle diameter measured by *in vivo* ultrasonography and follicle diameter determined after slaughter. Correlation coefficients of 0.7–0.9 for various sizes of follicular structures have been recorded between *invivo* ultrasonography and post-mortem slicing of excised ovaries. In goats, have reported that transrectal ultrasonography is a reliable method for studying follicular dynamics.

Ovulation

Determination of ovulation by ultrasound examination has been reported . In this, the ovaries of 8 heifers were examined in one investigation by ultrasonography every 4th hour during and after oestrus. Ovulation was depicted by the absence of a preovulatory follicle that was present at a previous examination and subsequently confirmed by the development

of corpus luteum at the same spot. The usefulness of ultrasonography performed at 2-hourly intervals for detecting the onset of ovulation has also been demonstrated.

Corpora lutea

The ultrasonic characteristics of corpora lutea (CL) have been described. Generally, a CL is identified ultrasonically from the third day after ovulation. A developing CL appears on the ultrasound image as a poorly defined, irregular, greyish-black structure with echogenic spots all within the ovary; a mid-cycle CL is a well-defined granular, greyish echogenic structure with a demarcation line visible between it and the ovarian stroma; in a regressing CL the demarcation line is faint, owing to the slight difference in echogenicity between the tissues.

In small ruminants such as goats, where we cannot examine ovarian structure through palpation per rectum, ultrasound is the best method for monitoring ovarian activity as mentioned.

Pregnancy diagnosis

Early pregnancy diagnosis can improve reproductive performance by decreasing the interval between successive artificial insemination services and coupling a non-pregnancy diagnosis with an aggressive strategy to rapidly rebreed the animal.

Pregnancy diagnosis in cattle can be achieved by ultrasonography. In this the foetus appears as an echogenic structure inside a non-echogenic structure. To compensate for embryonic mortality, cows diagnosed pregnant early post breeding must undergo one or more subsequent pregnancy examinations to identify and rebreed cows that experience embryonic mortality. This applies to all methods for early pregnancy diagnosis including transrectal palpation conducted before the rate of embryonic mortality decreases. Thus, dairy managers who have implemented early pregnancy diagnoses must consider the timing and frequency of subsequent

pregnancy examinations to maintain the reproductive performance of the herd.

Determination of foetal number and viability

The ability to identify multiple foetuses with real-time ultrasonography is a clear advantage over other techniques. Cows carrying twin foetuses can be accurately identified using transrectal ultrasonography by 40–55 days post artificial insemination. Determination of foetal viability is a clear advantage of ultrasound over other methods of pregnancy diagnosis. The heart contractility can be seen between the ribs during examination.

Foetal sex determination

Foetal sex determination has several implications in the animal breeding industry. The gender of foetuses can be detected by visualisation of the location of the genital tubercle or the scrotum and mammary glands. The most appropriate time of ultrasonographic sex determination is 55–60 days of gestation and the technique can be accurate even under farm conditions. Foetuses at 48–119 days of age have been successfully sexed. The procedure is reliable and the accuracy has ranged from 92 to 100%.

In production dairy systems, determination of foetal sex is useful when combined with a management decision or strategy that justifies the expense of foetal sexing. In other words, a dairy producer who pays for information regarding foetal sex must economically justify the usefulness of that information. Fulfilling sales contract obligations regarding the sex of a calf carried by a pregnant cow to be sold is one scenario that may justify this expense. It should be emphasized however, that ultrasonic identification of the genital tubercle or the scrotum and mammary glands for sexing purposes requires considerable experience.

Determination of foetal age

Estimation of foetal age, monitoring of foetal growth across time and diagnosis of pregnancy disorders can be performed by ultrasonographic foetometry. Biparietal diameter

of the skull and length of the long bones, can be used to estimate gestational age. Growth curves of foetal structures based on ultrasonographic foetometry have been reported. In this, the sonographic foetometry of foetuses in 19 pregnant heifers have been described in detail. A total of 485 examinations were carried out from 2 to 10 months of pregnancy. The organs evaluated included eyeball, metacarpal diaphysis, os ilium and os ischii and scrotum. Ultrasonographic foetometry has been shown to provide a precise estimation of gestational age and prediction of calving dates. This investigation concluded with the assertion that the accuracy and precision of the prediction of calving date were sufficient to be of benefit in the management of cows in late pregnancy and at calving.

Interventional technique

Ultrasound-guided transvaginal oocyte aspiration is helpful in obtaining ova from clinically infertile but otherwise valuable cows for *in vitro* fertilization. In this way, the genetic potential of such donor cows can be propagated.

Guided needle placement

All types of transducer can be used to guide needle placement. The needle can be directed through a channel in the transducer itself, via an attachable biopsy guide or by free hand. When passed across the beam, the shaft and tip are clearly visible allowing the path of the needle to be determined and precise placement of the tip for the removal of material or the introduction of a diagnostic or therapeutic agent. Ultrasound-guided interventional techniques are used commercially in cattle to facilitate follicular aspiration and embryo transfer. This technology has also been applied in mares, goats and buffalo. Routinely performed diagnostic sampling techniques, including fluid aspiration, fine needle aspirates and core biopsies are common components of clinical diagnostic workups in many species.

Therapeutic ultrasound

In a trial for using ultrasound for therapeutic purpose, Sasaki and his coworkers fabricated a prototype 3.25-MHz split-focus therapeutic transducer combined with a small 6.5-MHz imaging ultrasonic probe for transrectal treatment of prostate cancer, evaluating the feasibility of using split-focus high-intensity focused ultrasound (HIFU) to ablate localized tumour tissue without injuring the surrounding organs. They established a localised tumour model by inoculating VX2 tumour into rabbit livers. The localized VX2 tumours of nine rabbits were transdermally treated with split-focus ablation at a peak intensity in water of 6 kW/cm^2 for 4 s (6 shots) under the guidance of ultrasonic B-mode imaging. Necropsy a day after treatment found the surface of the livers and gastrointestinal tracts to be grossly normal. The VX2 tumours were completely coagulated and were surrounded by ablated liver tissue. The six shots of split-focus HIFU destroyed the VX2 tumours without injuring the liver surfaces or the surrounding organs. These results suggest that split-focus HIFU ablation could be an effective treatment of localized tumours.

How safe is diagnostic ultrasonography?

As discussed above, the benefits of ultrasound as a diagnostic imaging procedure in animal reproduction are numerous. Importantly, routine examinations have been shown to have no harmful biological effects. Ultrasound is considered a safe procedure for the animal, the operator and nearby personnel, allowing it to be performed in any location without the need for specific safety precautions. It is non-invasive and therefore well tolerated in animals, making serial examinations, such as to monitor progression of the condition, response to treatment or to practice scanning techniques, possible.

Ultrasound is a wave form of non-ionizing energy. It has no relation to X-rays, which damage tissues because of their ionizing effect on living cells. The low intensity of pulsed ultrasound used for diagnostic purposes and in the Doppler devices designed for foetal monitoring produces no significant heating. However, other Doppler devices do use intensities that

may produce significant heating and are not suitable for foetal monitoring. Another bioeffect of ultrasound is cavitation, which is a complex phenomenon in which gas-filled bubbles enlarge in an ultrasound field. At high intensities these bubbles may collapse suddenly, causing large but localized increases in temperature, thermal decomposition of water and release of free radicals. This phenomenon has been termed transient cavitation. Diagnostic ultrasound contrast agents have been developed for enhancing the echogenicity. However, bio effects of contrast-aided diagnostic ultrasound happen on a microscopic scale and their importance in the clinical setting needs more investigation.

Compared with other diagnostic aids as X-rays, ultrasound is considered very safe, with no harmful bio effects. However, the question of long-term biologic effects of diagnostic levels of ultrasound cannot yet be answered and require more investigation.

Conclusions:

The impact of real-time ultrasound on the study of animal reproduction has been dramatic, and development of portable ultrasound machines has given clinicians an added tool for diagnostic reproductive management. Ultrasound is commonly used to monitor uterine anatomy, involution and pathology. In addition, it has been used to detect pregnancy, study embryonic mortality, monitor foetal development, and determine foetal sex. Recent advances in ultrasound technology in both hardware and software have resulted in the production of superior images and the widespread use of ultrasound.

Compared with other diagnostic aids such as X-rays, ultrasound is considered very safe and has no harmful bio effects. Another advantage of ultrasound is its real-time nature in examination, allowing studies of moving structures.

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21 Risk Assessment and Strategies to prevent Antibiotic Resistance

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Introduction

Antibiotics have been critical to fight against many diseases and infections. Their discovery was one of the leading causes for the dramatic rise of average life expectancy in the 20th century and their significance to public health would be impossible to overstate. Antibiotics are defined as any compound which either kills or severely impedes the growth of bacteria. Upon the introduction of penicillin into general clinical practice in 1944, formerly deadly illnesses such as Strep throat and tuberculosis became instantly curable. Almost as soon as antibiotics were introduced into clinical circulation, cases where their ability to effectively stop infection were observed. As the use of antibiotics became more widespread, the prevalence of antibiotic resistant bacteria increased. In a recent study in Atlanta, 25% of bacterial pneumonia cases were shown to be resistant to penicillin, while a further 25% of cases were resistant to more than one antibiotic. Resistance development has resulted in perpetual research and development in the search of new antibiotics in order to maintain a pool of effective drugs at all times. While the development of resistant strains is inevitable, the speed and scale of development has been exacerbated by the practices through which we use and disseminate antibiotics.

The introduction of every antimicrobial agent into clinical practice has been followed by the detection in the laboratory of strains of microorganisms that are resistant, i.e. able to multiply in the presence of drug concentrations higher than the concentrations in animals receiving therapeutic doses. Such resistance may either be a characteristic associated with the entire species or emerge in strains of a normally susceptible species through mutation or gene transfer. Resistance genes

encode various mechanisms which allow microorganisms to resist the inhibitory effects of specific antimicrobials. These mechanisms offer resistance to other antimicrobials of the same class and sometimes to several different antimicrobial classes.

Types of resistance

1. **Natural Resistance:** Inherently or genetically resistant due to lake of penetration of drug into bacterial cell, absence of metabolic pathway or target site or rapid inactivation of drug in bacterial cell.
2. **Acquired resistance:** Resistance against drug to which bacteria was previously sensitive. It is due to inappropriate use of antimicrobials. It is done by mutation or gene transfer.

Development and acquisition of resistance

Many infectious diseases remains the leading cause of death in the world as previously controlled infections are becoming increasingly common in animals with diseases where the immune system is compromised. The microbes responsible for these infections are often antibiotic resistant pathogens. The ability for the pathogens to grow despite the presence of antibiotics, through the development of antibiotic resistance, has rendered victims as vulnerable as patients from the pre-antibiotic era. Modern uses of antibiotics have caused a huge increase in the number of resistance bacteria. In fact within eight to twelve years, after wide spread use, strains resistant to multiple drugs become widespread. How do bacteria become resistant to antibiotics and what are the biochemical mechanisms that they use? Several mechanisms have been developed by bacteria in order to deal with antibiotics but all require either the modification of existing genetic material or the acquisition of new genetic material.

All resistance was acquired through spontaneous mutation. Development of resistance through this method is called primary resistance. Errors in DNA synthesis during

replication and occasional failures in the DNA repair systems result in a spontaneous mutation frequency for an individual base pair. However, the spontaneous mutation rate to acquire a mutation that causes resistance is often even lower since multiple mutations must take place before primary antibiotic resistance can be acquired. In *E. coli*, it has been estimated that primary streptomycin resistance is acquired at a rate of approximately 10 when exposed to high concentrations of streptomycin. While this is an extremely rare event, the very fast growth rate of bacteria means that it doesn't take long before resistance is developed in a population. Once the resistance genes are acquired, the genes can be transferred directly to all the bacteria's progeny. This is known as vertical gene transfer.

Mechanism of resistance

1. *Reduced drug accumulation:* by decreasing drug permeability and/or increasing active efflux (pumping out) of the drugs across the cell surface
2. *Drug inactivation or modification:* e.g., enzymatic deactivation of *Penicillin* in some penicillin-resistant bacteria through the production of β-lactamases.
3. *Alteration of target site:* e.g., alteration of PBP — the binding target site of penicillins — in MRSA and other penicillin-resistant bacteria.
4. *Alteration of metabolic pathway:* e.g., some sulfonamide-resistant bacteria do not require para-aminobenzoic acid (PABA), an important precursor for the synthesis of folic acid and nucleic acids in bacteria inhibited by sulfonamides. Instead, like mammalian cells, they turn to utilizing preformed folic acid.

Consequences of resistance

The antimicrobial resistance has an impact on the cost of animal and human health care worldwide. Ineffective therapy due to antimicrobial resistance is associated with increased animal and human suffering, lossof productivity and often death (WHO, 2001). Resistant strains of bacteria are found around the world. Organisms that are resistant to one drug are more likely to become resistant to others. The bacteria *Streptococcus pneumonia* has become resistant to penicillin and now demonstrates some resistance to several other antibacterials. Resistant pathogens are expensive to control and extremely difficult to eradicate.Ineffective therapy can seriously affect the progress and outcome of disease. It has significant impact the cost of treating disease.Limited clinical effectiveness of readily available cheap antimicrobials in many regions which results in difficult to choice and to use more effective but more expensive drugs to treat.Resistant animal pathogens in food products may cause infections in humans that are difficultto treat. Loss of public confidence in the safety of food which affects the demand for products, with potentially serious economic effects on the farming sector

Table 1: Reports of resistance developed in bacteria from India

Bacteria	Resistance to	Reference
Most Gram negative bacteria (Enterobacteriacease, pseudomonas spp.)	Penicillin G, Oxacillin, macrolides, Lincosamides, streptogramins, streptogramin, glycopeptides, bacitracin	Giguere *et al.*, 2006
Proteus vulgaris	*Ampicillin, cephalosporin, Polymyxin*	
Proteus mirabilis	Tetracycline, polymyxins	
Serratia marcescens	Ampicillin, Amoxicillin-clavulanate, cephalosporin I, polymyxins	
Enterobacter spp.	Ampicillin, Amoxicillin-clavulanate, cephalosporin I, cefoxitin	

Haemophilus spp.	Streptomycin, kanamycin, macrolides	
Campylobacter jejuni and Campylobacter coli	Cephalosporin I, Trimethoprim	
Enterococcus spp.	Oxacillin, Cephalosporin, aminoglycosides, sulphonamide, trimethoprim	
Listeria monocytogens	Oxacillin, Cephalosporin, lincosamides	
Bacillus anthracis	Cephalosporins, sulphonamide, trimethoprim	
Anaerobes (including Clostridium spp.)	Aminoglycosides	
Streptococcus pneumoniae	Penicillin, cotrimoxazole, tetracycline, erythromycin, ciprofloxacin	Goyal*et al.*, 2007 Chawala*et al.*, 2010
S.pyogenes	Penicillin, erythromycin, trimethoprim	Capoor*et al.*, 2009 Bergmann *et al.*, 2012
Staphylococcus aureus	Clindamycin, Vancomycin	Gupta *et al.*, 2009 Thati*et al.*, 2011
E. Coli	Ampicillin, tetracycline, co-trimazole, trimethoprime, carbenicillin	Sukumaran*et al.*, 2012
Salmonella spp.	Nalidixic acid, ciprofloxacin, ampicillin, chloramphenicol, ampicillin and trimethoprim	Rowe *et al.*, 1997 Nagshetty*et al.*, 2010
K. pneumoniae	Ceftizoxime , cefotaxime, carbenicillin	Sikarwar&Batra, 2011 Nagaraj *et al.*, 2012
Shigella spp.	Newer gen. fluoroquinolones, 3rd gen. Cephalosporins	Bhattacharya *et al.*, 2012
Pseudomonas spp.	Ciprofloxacin, ceftazidime, cefepime, gentamicin, amikacin	Chaudhary *et al.*, 2013

Practices responsible for failure of antimicrobials in disease state:

- The microorganisms have developed resistance to drug.
- Mixed infection & narrow spectrum drug
- Penetration of drug into site infection is not proper due to pus, debris, exudates etc.
- The host defense mechanism is impaired
- Late administration of antimicrobial drug
- Use of expired drug
- The owner or attendant of animal does not comply with therapeutic regimen
- Improper nursing and feeding
- Improper diagnosis (Viral not Bacterial infection)
- Improper selection of drug (Causative organisms are not sensitive to drug).
- Improper route of administration with inadequate duration of treatment
- Interaction of drug with other administered drugs.

Management of the Resistance Problem

How can we select antibiotics?

- Select an antibacterial based on indication
- The diagnosis may be masked if therapy is started before cultures are obtained.
- Antibacterials may be used immediately if disease is severe
- Requires clinical judgment and detailed knowledge of pharmacological and microbiological factors.
- Antibacterials : empirical therapy, definitive therapy, and prophylactic therapy.
- Empirical therapy: infecting organism has not been identified - Combination therapy/broad-spectrum agent
- Infecting microorganism is identified : Narrow-spectrum AB
- Initiation of optimal empiric antibacterial therapy: knowledge of most likely infecting organisms and their antibacterial susceptibilities.
- Simple and rapid laboratory tests may permit more rational selection of initial antibacterial therapy.
- Blood should be taken prior to the institution of drug therapy.

- *For definitive therapy, Use* specific & narrow-spectrum antibacterial once an organism has been identified & its susceptibility is known.

Successful Antimicrobial Therapy depends on:

- Prefer drug requires administration at long interval
- For less severe infections prefer an oral administration in small animals
- For severe infection→ parenteral administration
- Always use antimicrobial agent in proper dose
- Proper duration of time
- For definitive therapy, recommend a narrow-spectrum drug
- Keep the broad spectrum drug reserve for life threatening infection
- Prefer bactericidal over bacteriostatic drug with less toxicity
- Do not combine antimicrobials without valid cause
- Do not use antimicrobial indiscriminately
- Avoid overuse of newer agent if olderis effective
- Use drug manufactured by reliable pharmaceutical firm.
- Do not use antimicrobials to treat slight, self-limiting or unbeatable infections.

How can we fight back?

- Don't use antibacterial in minor or self limiting viral infections
- Farmers should not use antibacterials of previous prescription
- Record of vaccinations must be generated.
- Develop and implement guidelines, protocols and drug utilization reviews to ensure that use of antibacterialdrug is optimized
- Ensure surveillance for changes in the occurrence and pattern of antimicrobial resistance in different bacteria.
- Maintain good hygiene and infection control measures – particularly hand washing.
- Strict infection control measures should be monitor in hospitals
- Educate farmers: help them to understand about cost of unnecessary use of antibacterials
- Communicate with farmers about progression of disease after initiation of therapy

- Use laboratory tests to support your diagnosis & select theright antibacterial.
- Emphasise good animal husbandry practices (adequate and clean quarters)
- Work with governments to move away from using antibacterials as growthpromoters.
- Collaborate in monitoring of antibacterial use and resistant pattern with institutes
- Educate the public and health professionals about the antibacterial resistance
- Coordinate the development and implementation of regional programs to optimize antibacterial use and to prevent the spread of resistant organisms.
- Develop the rapid affordable systems for diagnosis and susceptibility testing.
- Ensure that antibacterials remain available through prescription only, rather than as over-the-counter medications.

Table 1: Type, mode and spectrum of activity of different antimicrobial agents

Group of antimicrobials	Type of action	Mode of action	Spectrum of activity
Penicillins	Bactericidal	Inhibition of cell wall synthesis	Narrow
Cephalosporins	Bactericidal		Broad
Carbapenems	Bactericidal		Broad
Polypeptide Antibacterials	Bactericidal		Narrow
Quinolones	Bactericidal	Inhibits DNA synthesis	Broad
Metronidazole	Bactericidal		Narrow
Rifamycins	Bactericidal	Inhibitions of RNA transcription	Narrow
Aminoglycosides	Bacteriostatic/ Bactericidal	Inhibition of protein synthesis	Narrow
Lincosamides	Bacteriostatic		Narrow
Macrolides	Bacteriostatic		Narrow
Tetracyclines	Bacteriostatic		Broad
Chloramphenicol	Bacteriostatic		Broad
Sulfonamides	Bacteriostatic	Competitive inhibition	Broad

Table 2: Spectrum of activity of commonly used antimicrobials

G+ve activity	G-ve activity	Anaerobic activity
Penicillins	Fluoroquinolones	Penicillins
Macrolides	Aminoglycosides	Metronidazole
Cephalosporins	Cephalosporins	Cephalosporins
Sulpha + TMP	Sulpha + TMP	Sulpha + TMP
OTC	OTC	OTC
Imipenem	Imipenem	Imipenem
Chloramphenicol	Chloramphenicol	Chloramphenicol
Rifampin		Clindamycin

Table 2: Last-resort antibacterials

Drug	Why last resort?
1) Meropenem and other carbapenem	Potency & lack of resistance
2) Vancomycin	Anti-MRSA
3) Co-trimoxazole	Powerfull
4) Piperacillin/Tazobactam	Broad coverage
5) Levofloxacin	Broad spectrum& PO
6) Linezolid	Anti-MRSA
7) Cefepime	Broad spectrum
8) Polymyxin B (Colistin)	Potent
9) Tigecycline	Anti-MRSA
10) Aztreonam	Anti-pseudomonal

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22

Staining Techniques: Routine & Rapid tool in Microbial Disease Diagnosis

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Simple staining

Staining is an important technique in microbiology, which enables us to visualize the microorganisms to have the idea of shape and size. Simple staining procedure includes staining of the bacterial smears with a single stain. For example staining using methylene blue or the staining of blood smears from animals with stains to visualize the presence of microorganisms.

- In simple staining basic stains are used to stain the negatively charged particles. Usually the bacterial cell wall components and nucleic acids carry a negative charge which strongly attract the basic stain with the positively charged chromogen.
- The morphology and arrangement of the bacteria are visualized by simple staining. The basic stains commonly used for simple staining are methylene blue, crystal violet and carbol fuchsin.

Procedure:

1. Take a glass slide clean with alcohol and cotton, dry it
2. Make a thin smear from culture/broth/blood and heat fix over the flame.
3. Place the slide on staining rack and flood with the stain (Methylene blue/Crystal violet/safranin) allow for 30 sec to 1 min
4. Wash the stain under the tap water in a slanting position
5. Air dry, observe under the oil immersion microscope

Differential staining:

These stains show differences among different types of bacteria and therefore are useful in their differential identification. These procedures involve more than one dye. Gram's and acid fast stains belong to this category.

- Differential staining uses atleast three reagents.
    - The first reagent is called primary stain, the second reagent is called a decolourizer and the third one is called counter stain.
    - The primary stain imparts colour to all the cells. The decolourizer is used to establish a colour contrast. The counter stain stains the cells that are decolourised.

Preparation of Smears

- Bacteria differ a slightly in refractive index from the surrounding medium. Hence, it is difficult to see unstained bacteria in ordinary microscope. So staining is the primary requirement to see the bacteria in the light microscope.
- Smear can be prepared from fluid materials like culture, urine, sputum, pus etc by taking a loopful of the material in an inoculating loop and spread it thinly on a clean glass slide. The smear is then allowed air dry.
- The smear can also be dried by holding it high over a bunsen flame.
- The dried smear is then fixed by passing it through the flame slowly three times with the smear upwards.
- Alternatively the fixing can also be done by heating through the slide. In this method the slide is held with the smear on top in the top of the Bunsen flame for a few seconds so that the slide becomes hot.
- The slides are then marked on one end with a diamond or grease pencil on the side having the smear. In slides with a ground matt surface at one end ordinary graphite pencil can be used to mark the slide.
- For preparation of smears from material like cultures on agar first a loopful of water or saline is placed on the slide and then with a sterilized loop a minute quantity of material is taken from the culture and put on the water placed on the slide and emulsified. Then a thin smear is prepared.

Gram's staining

- Gram's staining is a differential staining method. This method was developed by Christian Gram.
- Based on this staining bacteria are grouped into two categories, gram positive and gram negative.
    - In this staining method four different reagents namely

- primary stain,
- mordant,
- decolorizer and
- counterstain.

- The *primary stain* normally used in Gram's staining is crystal violet.
- The *mordant* used is Gram's iodine. The iodine in Gram's iodine combine with violet and forms a complex. The crystal violet iodine complex binds to magnesium RNA components in the cell. The resultant magnesium - RNA – crystal violet – iodine complex is bigger and difficult to remove from the cell.
- The *decolourising* agent used is ethyl alcohol (95%) which functions as a lipid solvent and dehydrating agent.
- Safranin or dilute carbol fuchsin is used as the *counter stain.*

Materials Required

- Primary stain – Crystal violet
- Mordant – Gram's iodine
- Decolorizer – 95% ethanol
- Counter stain – Safranin
- Glass slide with smear
- Immersion oil
- Blotting paper
- Microscope

Procedure:

1. Keep the slide over a staining rack and flood the smear with crystal violet and allow it to react for 1-2 minutes.
2. Wash the smear with running tap water.
3. Flood the smear with Gram's iodine and allow to react for one minute.
4. Wash the smear with running tap water.
5. Decolorize the smear using 95% ethanol for 10 seconds.
6. Wash the smear with running tap water.
7. Counter stain with safranin for 1-2 minutes.
8. Wash the smear with running tap water.

9. Blot dry and focus the smear under low power, high dry and oil immersion.

Inference:

- Gram positive bateria stain deep violet.
- Gram negative bacteria stain red.
- By microscopic observation we can describe the staining, morphology and arrangement.

Acid Fast Staining (Ziehl- Neelsen's Staining)

Principle

- Acid fast staining is an important differential staining technique.
- The primary stain referred to as acid fast stain binds strongly to only bacteria having waxy material on the cell wall. This method is used to identify organisms under the genus Mycobacterium.
- The important pathogenic species under this genus are *M.tuberculosis, M.bovis, M.avium,M.partuberculosis and M.leprae.* In this method strong carbol fuchsin is used as the primary stain, acid alcohol mixture is used as decoloriser and methylene is used as counter stain.
- The acid fast organisms retain the colour of the primary stain i.e., red, where as the non acid fast organisms take the color of methylene blue.
- The acid fastness is due to presence of waxes (mycolic acid) in the cell wall of the organisms.
- The acid fast organisms can withstand the decolorising action of acid alcohol mixture where as the non acid fast organisms cannot.

Procedure

- Flood the smear with carbol fuchsin and heat the stain using spirit lamp for 5 minutes. Donot allow the stain to evaporate. When fumes start emanate the stain stop heating. Once fumes subside start heating again. The

purpose is to keep the stain under hot condition. Never allow the stain to dry over the smear.
- Wash the smear in running tap water after cooling.
- Decolorize with acid alcohol (until the smear appears colourless).
- Wash the smear in running tap water.
- Counter stain with methylene blue for two minutes.
- Wash the smear in running tap water.
- Blot dry and focus under oil immersion.

Inference:

If positive, acid fast (red) organisms are obseved in the blue background. We can describe staining character and morphology.

Staining Of Bacterial Capsule

Principle

- The capsule is gelatinous in nature. Because of this it is difficult to stain the capsule, hence special staining methods are used.
- The bacterial capsule is demonstrated by negative staining method. In negative staining the object is not stained but the background is stained. Hence object appears as colourless particle in a dark background.
- Normally the objects that are difficult to stain or that won't take any stain are stained are stained by negative staining method.
- One of the best reagents to produce dark background is the India ink used for drawing. Since the bacterial capsules are gelatinous nature they won't take any stain. In a black background the capsules appear as halos.
- The organisms are stained by simple stain like crystal violet.

Procedure

- Place a drop of 6% glucose solution at one corner of the slide.

- Add a drop of bacterial culture to the glucose solution on the slide and mix well.
- Add a drop of India ink to the mixture and mix well again.
- Using another slide prepare a thin smear.
- Air dry the smear thoroughly and then fix for 15 seconds in methanol.
- Drain away the methanol and remove the residual methanol by passing the slide through a gentle flame.
- Stain the smear with crystal violet for two minutes
- Pour off the stain and wash the smear in running tap water.
- Air dry and examine under oil immersion.

Inference

If capsules are present they appear as unstained areas in the dark back ground. Inside the capsule the stained bacterium is seen.

Staining Of Bacterial Spore

Principle

- Certain genera under gram positive bacteria form spore during adverse conditions. These spores are referred to as endospores when they remain within the cell.
- The spores may either bulge the bacteria or not. Depending up on the position of the spore inside the cell, they are referred as terminal, subterminal or central.
- Spores are special structures consisting of a very thick cell wall, nucleic acid and a few ribosomes.
- The spore wall is rich in dipicolinic acid. Under favourabe condition a spore may germinate into a vegetative bacterium.
- The process by which spores are formed with in the cell is called sporogenesis.
- The process by which a spore turns in to a vegetative bacterium is called germination.

- Spores are stained by special staining methods.
- The primary stain used is malachite green. Since spores have an impermeable coat the primary stain has to be applied as hot stain. The decolorizer used tap water.
- Tap water can not remove the stain that has entered the spore. Safranin is used as counter stain. In this method the spores appear as green colour dots inside cells which are stained pink.

Procedure

- Prepare a smear from the suspected culture in a glass slide. Air dry it and fix with heat.
- Allow the water to boil in beaker and place the smear over the beaker on a staining rack.
- When water droplets are noticed below the slide, flood the smear with Schaeffer and Fulton stain solution A and allow to react for one minute.
- Wash the smear in cold tap water after cooling.
- Counter stain the smear with Schaeffer and Fulton solution B for 30 seconds.
- Wash the smear with tape water, blot dry and view under oil immersion.

Inference

If spores are present they are stained green and the vegetative part of the bacteria are stained red. We can describe the location of the spore - terminal, subterminal or central and whether it is bulging the bacterium or not.

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Role of Mass Media in Creating One Health Awareness

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One health recognizes that the health of people is connected to the health of animals and the environment. The goal of one health is to encourage the collaborative efforts of multiple disciplines-working locally, nationally, and globally-to achieve the best health for people, animals, and our environment. A one health approach is important because 6 out of every 10 infectious diseases in humans are spread from animals. There are many examples that show how the health of people is related to the health of animals and the environment. For instance, some diseases can be shared between animals and people. These diseases are known as zoonotic diseases. Examples includes: Rabies, Salmonella infection, West Nile virus fever, Q Fever (Coxiella burnetti) etc. One health is not a new concept, but it has become more important in recent years. This is because many factors have changed interactions between people, animals, and our environment. These changes have led to the emergence and reemergence of many diseases.

In the rapidly evolving world of social media, social networks, mobile applications and citizen science, online communities can develop organically and separately from larger or more established organizations. The mass media are intensively employed in public health. These media are employed at all levels of public health with the hope that it leads to the learning of correct health information and knowledge, the changing of health attitudes and values and the establishment of new health behavior. Media is one of the most powerful instruments of communication. It can help to promote the right things on right time and gives a real as well as strong aspects of the world about what is right or wrong also it also express that how can we store and distributes the views. Media refers so many links such as mass media broadcast media, print

media and the web media. We know that television and radio are considered broadcast media while newspapers, magazines and journals are formatted as print media and internet news are called as the web media. The media is an important source of information through its news segments, entertainment and allows for exchange of ideas, suggestions and views for related matters. The term media is derived from medium, which means carrier. Media denotes a links specifically designed to reach large viewers.

Mass media have long been a tool for promoting public health being widely used to expose high proportions of large populations to messages through routine uses of existing media, such as television, radio, and newspapers. Communication campaigns involving diverse topics and target audiences have been conducted for decades. Some reasons why information campaigns fail' is an early landmark in the literature. Exposure to such messages is, therefore, generally passive. Mass media are frequently competing with factors, such as pervasive product marketing, powerful social norms, and behaviours driven by addiction or habit. Mass media campaigns have generally aimed primarily to change knowledge, awareness and attitudes, contributing to the goal of changing behaviour. There has not normally been a high expectation that such campaigns on their own would change people's behaviour. Theory suggests that, as with other preventive health efforts, mass media campaigns are most likely to reduce unhealthy attitudes if their messages are reinforced by other efforts. Reinforcing factors may include law enforcement efforts, grassroots activities, and other media messages. Mass media campaigns have usually been one element of broader health promotion programmes with mutually reinforcing components as mentioned below:

1. Mobilizing and supporting local agencies and professionals who have direct access to individuals within the target population.

2. Bringing together partnerships of public, voluntary and private sector bodies and professional organizations.
3. Informing and educating the public, but also setting the agenda for public debate about the health topic, thereby modifying the climate of opinion surrounding it.
4. Encouraging local and national policy changes so as to create a supportive environment within which people are more able to change their behavior.

Content and delivery of mass media

Several aspects of mass media campaigns may influence their effectiveness. These can be categorized into variables related to message content and to message delivery.

1. Message content

One important aspect of message content involves the themes used to motivate the desired behavior change. Some common motivational themes in mass media campaigns to prevent unhealthy behaviors include: fear of legal consequences, promotion of positive social norms, fear of harm to self, others, or property and stigmatizing unhealthy behaviors as irresponsible and dangerous.

2. Message delivery

A mass media campaign cannot be effective unless the target audience is exposed to, attends to, and comprehends its message. Two important aspects of message delivery are control over message placement and production quality. Control over message placement helps to ensure that the intended audience is exposed to the messages with sufficient frequency to exceed some threshold for effectiveness. It also allows for the optimal timing and placement of those messages.

3. Message pretesting

Pretesting of campaign themes and messages is also thought to be important for a successful outcome. Pretesting can help to assess which themes or concepts are most relevant to the target audience. It can also help to ensure that the target

audience will attend to and comprehend the specific messages presented.

Use the mass media

Media can be an effective tool in one health promotion, given the appropriate circumstances and conditions.

1. To wide exposure of message. Mass media offer the widest possible exposure, although this may be at some cost. Cost–benefit considerations are at the core of media selection.
2. To time frame deliver of message. Mass media offer the best opportunity for reaching either large numbers of people or specific target groups within a short timeframe.
3. To promote public discussion to facilitate the educational process. Media messages can be emotional and thought provoking. Because of the possible breadth of coverage, they can be targeted at many different levels, stimulating discussion and thereby expanding the impact of a message.
4. To create awareness. By their very nature, the media are awareness-creating tools.
5. To accompanying back-up of awareness campaign. Regardless of whether media alone are sufficient to influence health behaviour, it is clear that the success of media will be improved with the support of back-up programmes and services.
6. To conduct long-term follow-up. Most changes in health behaviour require constant reinforcement. Media programmes are most effective where the opportunity exists for long-term follow-up.
7. To utilize generous budget. Paid advertising, especially on television, can be very expensive. Even media with limited reach, such as pamphlets and posters, can be expensive depending on the quality and quantity. For media to be considered as a strategy in health

promotion, careful consideration of costs and benefits needs to be undertaken.

Media strategies for promoting one health

Mass media should follow the five inviolable principles of journalism like truth and accuracy, independence, farness and impartiality and humanity and accountability. Scientists can play a key role in promotion of one health through the media. Identification of appropriate content and designing for the stake holders is an important task. This need to be done based on SWOT analysis of the targeted audience/readers. Print, electronic and web media are regularly publishing/broad casting/telecasting programmes on public health issues. Scientists can regularly provide the content in the form of news articles, features, success stories and illustration. It should take in to account the timeliness, reliability and relevancy and the season.

Representatives of local self governments, women self help group members, NGOs and progressive leaders/farmers/opinion leaders need to provide with awareness programme based on the severity of the issues. Scientific content should be administered among the policy makers for funding and technical support. Media awareness should consider the geographical peculiarities before devising appropriate programmes. Only mass media approach can solve one health issues very effectively in the Country. Mass media campaigns clearly can be an effective tool for one health promotion whether the effort is on a national or local scale.

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24 Post mortem Disease diagnosis of Important infectious Diseases

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Early disease diagnosis is one of the challenging factors for veterinarians since this is the only way to undertake effective preventive measures to reduce the economic loss of farmers. Due to various reasons incidence of infectious diseases are on the rise for the last one decade. Emerging, reemerging or neglected diseases, all come under this category. Proper recording of prevalence data in specific areas is important in disease diagnosis.

The art of disease diagnosis starts from anamnesis. Animal Owner can give important information on the duration of illness, symptoms, vaccinations done and feed given, whether grazing is allowed or not and chances of disease introduction from other areas. In case of poultry, mortality pattern and age itself may give clue about the disease. Ailing animals if any should be subjected for detailed clinical examination and clinical pathological data provide valuable information about the etiological diagnosis.

Postmortem examination

Postmortem (PM) examination is the systematic and scientific examination of tissues and organs of a carcass to determine the cause of death, the extent of lesions or the nature of illness. The dead animals/ birds should be subjected to detailed PM examination in systematic manner to arrive at a PM diagnosis. It is mandatory to collect representative samples of tissues from all organs for histopathological studies and contents of viscera if suspected for poisoning. Microbiological, virological and parasitological examinations are supportive in arriving at the final or confirmative diagnosis.

Diagnostic Autopsy

The importance of autopsy is paramount to identity the etiology to provide a rational basis for the prevention and treatment of diseases. Lesions are the end results of a disease process involving several mechanisms. There are several diseases where pathegnomonic lesions are manifested. Such diseases are diagnosed in the autopsy table itself, without further laboratory examinations. After detailed examination of the carcass the pathologist has to summarise the lesions encountered and assess the importance of the lesions, when the diagnosis is given. For example, the lesions encountered in a cow were summarized as cardiac dilatation, ascites, and catarrhal enteritis, congestion of liver, hydatid cyst (10cm) in spleen and suppurative bronchopneumonia of apical and cardiac lobes of both lungs. Here the PM diagnosis will be suppurative bronchopneumonia. On laboratory investigation, the cultural examination revealed presence of *Corynebacteriumspp.* Therefore the etio-pathological diagnosis will be *Corynebacterium* suppurative bronchopneumonia

Exercise: Conduct and autopsy examination of the animal and record the findings

The techniques of autopsy

The way of doing postmortem examination is very important. This has to be accomplished in three stages. External examination, Internal examination and Examination of organs.

1. External examination

a) Whole body: examination of the whole carcass body is necessary to assess the overall condition of the animal. The following points have to be noted

1. Position of the carcass
2. General condition

3. Presence of rigor mortis
4. Evidence for dislocation/fracture
5. Signs of post mortem changes

b) Examination of the skin for ectoparasite infestation, lesions of pox, swelling, eruption, injuries etc.
c) Examination of the visible mucous membrane for pallor, congestion, icterus, cyanosis etc.
d) Examination of the natural orifices for discharge, prolapse etc.
e) Examination of the extremities such as horn, hoof, tail etc for wounds, necrosis or gangrene
f) Examination of specific organs such as mammary gland in females, prepuce, penis and testicles in males, navel and umbilicus in newborn animals.

Internal examination: Depending on the size and species of the animal veterinarian has to choose the best way of collecting details by doing detailed internal examination of the carcass.

A) Large animals

Place the ruminant on its left side for easy access to abomasum, duodenum and intestines. Monogastric animals (horse, elephant etc.) are usually placed on their right side. Abduct the limbs by cutting through the fascia and muscles. Make an incision on the median line from the chin to the anus taking care to encircle the udder, genitalia, umbilicus or any operation wound. Reflect the skin and expose the sub coetaneous tissue and superficial lymph nodes. Dissect the superficial lymph nodes udder, penis and the umbilicus. Open the abdominal cavity by making a longitudinal cut from the xiphoid cartilage to the pubis and transverse cut from the pubis to the flank and along the posterior border of the last rib. Gain access to the abdominal cavity. Slip of the omentum and pull out the intestine and stomach compartments. Apply pairs of ligatures at the junction between the esophagus and stomach and the second around the rectum. Remove the whole mass of

stomach and intestine in one piece. Remove the liver and spleen after dissecting off their respective omental attachments to the abdominal cavity. Remove adrenal and kidneys, along with the uterus, bladder and reproductive organs in one piece, by separating their attachments and cutting around the respective orifices. Pairs of ligatures may be put on either sides of their desired site of cutting.

The thoracic cavity may be approached by severing the diaphragm along its margin with the ribs, examine the lower jaw above the symphysis and make a ventral incision big enough to grasp free end of the tongue. Pull out on the tongue, adjoining connective tissue, larynx, trachea and esophagus. Dissect the structures up to their entrance at the thoracic cavity. Hold these structures from within thoracic cavity and deflect them backwards. Remove all organs in the chest cavity, heart, lungs lymph nodes (mediastinal/ bronchial) in one piece.

Examination of organs

All parts of an organ should be examined thoroughly. The identification of lesions requires keen observation, knowledge about the basic anatomy and an investigative outlook. The important task is to differentiate lesion from post mortem changes.

The following are the land marks for observations

1. Location and orientation
2. Presence of anomalies and malformations
3. Relative size and shape
4. Presence of abnormal fluid in body cavity
5. Odor emanating from the organs
6. Nature of contents in a hollow organ

- Pericardium: Cut the pericardium with a pair of sharp pointed scissors and observe for nature of exudates, quantity of fluid in the pericardial and thickness of the membranes.

- Heart: Excise the heart through its anterior roots above the valves. Expose the cavities by marginal cuts by the side of the septa. Look for the nature of the blood clot, thickness of the myocardium, volume of the cardiac chambers, hemorrhage on the epicardium, thickness of the coronary vessels etc. Acute myocardial necrosis in calf is typical in FMD in calves. Diffuse mineralization is seen in the aorta in Johne's disease.
- Lungs: Cut along the course of the primary, secondary, or territory bronchi. Make multiple slices of the organ or through any suspected lesion. Observe the course of the airways for froth, blood, aspirated materials, parasites etc. The lung parenchyma may contain froth, blood worms or even nodules or abscesses. Necro suppurative and fibrinous broncho pneumonia is seen Contagious bovine pleura pneumonia in cattle.
- Liver: Slice the organ at different places with a sharp knife to reveal the interior lesions such as cysts, nodules, abscesses, blood clots or even infarcts. Multiple abscesses in liver indicate infection with *Arcanobacterium pyogenes* or *Fusobacterium necrophorum*.
- Kidney: Incise and stripe of the capsule see if the capsule is adhered to the cortical surface of any thickening of the membranes. Bisect the kidney and examine the cut surfaces for infarcts, hemorrhage or cysts. Multifocal non suppurative interstitial nephritis is seen in Leptospirosis and some cases of Theileriosis.
- Spleen: Cut in to slice and examine the cut surfaces for the lesion of hematoma, nodules etc. Multifocal suppurative splenitis with necrosis is predominant lesion in case of bacterial embolism especially in *Arcanobacterium* and *Fusobacterium spp*.
- Stomach: Cut open longitudinally on the greater curvature, evacuate the contents and spread on a plain surface with a pair of bowel scissors and wash with water. Both serosa

and mucosa have to be examined for hemorrhage, erosions, ulceration, nodules or worms. Erosive omasitis with ruminal ulcers can be an indication of Rinderpest or Malignant catarrhal fever.

- Intestine: Cut open longitudinally, spread on a plain surface with the mucus surface facing up wards and need to be examined for hemorrhage, erosions, ulceration, nodules or worms. Necrotising entero-typhlo-colitis with necrosis of Payers patches may be due to Rinderpest or Salmonellosis.
- Lymph nodes: Cut longitudinally and examine the sagital surface for hemorrhage or exudates. Transverses cuts or sections through lesions are also possible. Hemorrhagic berry like lymphnodes are characteristic lesion in Classical swine fever.
- Spinal cord: Make several transverse incisions at intervals of 2-3 cm and examine the cut surfaces for discoloration, thickening or modularity.
- Bones: Saw the bone longitudinally and split in to two halves for examination or cut transversally at several places to see the marrow.
- Muscle: Make several incisions and expose the interior to see accumulation of gas, exudates, hemorrhage, parasitic cysts etc.

PM diagnosis

Infectious diseases always create havoc in animals just as in the case of man. In chronic diseases with emaciation, examination of bone marrow and serous atrophy of fat are significant. Animals died of Rinderpest shows punched out erosions in esophagus, hemorrhagic or ulcerative lesions in omasum, abomasum and large intestine. The payer's patches may be enlarged with necrotic patches. Hemorrhagic lesions (Zebra markings or tiger strippings) of longitudinal folds in the terminal end of large intestine and rectum are also remarkable in rinderpest. Erosions and ulcers on the feet, tongue, palate,

gum and pillars of the rumen give indications of FMD and there can be myocardial necrosis in the heart of young animals.

Salmonellosis is a bacterial disease of all domestic animals caused by many species of salmonellae and characterized clinically by one or more of major syndromes like high fever, septicemia, acute enteritis, and chronic enteritis. The postmortem examination shows severe lesions suggestive of acute gastroenteritis and necrotic hepatitis. The cultural studies on fecal samples and tissue collected during postmortem examination ca confirm presence of *Salmonella spp*. Subcutaneous echymotic hemorrhage over the throat and ribs, heavy swollen lungs with frothy blood in the airways with antero-ventral consolidation and pleurisy in chronic cases are the characteristic lesions in Pasteurellosis. When cattle die of endometritis leaving inflamed lymph nodes, mammary gland lesions and aborted fetus showing subcutaneous edema, hepatomegaly with bronze discoloration, fibrinous pleurisy and focal pneumonia, it is always better to proceed for laboratory diagnosis of Brucellosis. Liver and kidney lesions are highly significant in Leptospirosis in dog carcasses with icteric mucous membrane. Yellowish brown to grayish discoloration, pale and friable liver, multiple petecheal and echymotic hemorrhage in hepatic duct system are generally met with in dogs died of leptospirosis. Enlarged, pale, swollen kidney with capsular adhesion to the renal cortex, sub capsular and cortical echymotic hemorrhage, grey mottling of the capsular surface and focal to multifocal grayish to white discoloration are some of the gross lesions in kidney in such cases. Diffuse interstitial nephritis is a general histopathological finding.

Fungal diseases are common in animals and birds. Aspergillosis is such a kind of disease in animals and birds in which lungs show characteristic lesions. It gets adhered to the thoracic wall by yellowish fibrinous material with circular raised yellow fibrinous nodules on the thoracic wall. Lungs show consolidation at the area of adhesions. The cytological

examination of smear made from fibrinous materials reveal the presence of branched fungal hyphae with Leishman- Giemsa stain and special stains for fungal hyphae such as Grocott-Gomori's stain and Periodic Acid Schiff on the tissue sections.

PM diagnosis in wild animals

PM examination gives clues about the mode of death and provides valuable evidence needed for initiating legal action against the accused. It is also an important tool for monitoring health in both wild and captive animals including elephants. A proper diagnosis of the cause of death provides information required for planning preventive remedial measures. However the fact remains that in large number of mortality, postmortem reports are either inconclusive or defective and the data on prevalence of diseases in wild animals is almost non-existent. A properly conducted postmortem helps in bridging the gap. The significance of wildlife diseases came to importance since the awareness of conservation gained momentum. There are reports of emerging diseases like Ebola, Congo hemorrhagic fever, Kyssanur forest disease etc the source of which are supposed to be wild animals.

The significance of data and information obtained from a systematic postmortem examination can never be underestimated and form the most valuable tools for disease diagnosis. Tuberculosis is an ancient disease in man and animals that continues to be an increasingly important public health problem worldwide. Incidence of TB in elephants has become alarming in Kerala for the last one decade. With the emergence of HIV infection, the emergence of multidrug resistant tuberculosis appears to be alarming. The socio religious tradition of respect and reverence to elephants along with proven tuberculosis environment impose serious threat to the human health. Recent reports point to the question whether elephants are prey to human tuberculosis by *Mycobacterium*

tuberculosis. More than 35% cases of tuberculosis in elephants are in temple elephants. Non occurrence of tuberculosis in elephants in close contact and mahouts nursing and attending to infected animals for long years gives a little relief that it is not communicable. The gross lesions in elephants include emaciated carcass with prominent bones, baggy pant like skin on the hind limbs and prominent buccal and frontal depressions with serosanguineous trunk discharge. The lesions confined to the lungs are commonly frank abscesses with creamy pus, cavitations of the lungs, miliary nodules studding the whole parenchyma and diaphragm and diaphragmatic adhesion of lungs, grayish white nodules of varying size with hard consistency, diffused consolidation, congestion and focal haemorrhages. Histopathological picture shows typical granuloma with central caseation and calcification, mononuclear cell infiltration and fibrous tissue encapsulation and occasional giant cells. Diffuse and multifocal infiltration of mononuclear cells can be seen amidst thick stroma of fibrous tissue. Varying degree of edema of alveoli and bullous emphysema were also characteristic. Impression smears taken from the deeper and compact part of nodules in such cases reveal acid fast bacilli. Herpes viral infection is another important disease in elephants which shows massive hemorrhages in all the organs with predominant epicardial and endocardial hemorrhages.

Even though many diseases were eradicated, TB and FMD are still in the top list of the most prevalent diseases in the country. As mentioned here there are very specific lesions related to specific diseases identifiable during PM examination. As the environment changes, micro organisms also change their morphological and physiological characters. Therefore it has become mandatory to confirm the PM diagnosis by laboratory methods making use of molecular, immunohistochemical and serological tests to arrive at etiological diagnosis.

Carcass disposal & disinfection

Once the PM is over, the materials are to be collected and prepared for sending to accredited laboratories. It is always relevant to seek the support from High Security Animal Disease Laboratory in case of highly zoonotic and emerging infectious diseases. The significant part of PM examination in infectious disease is the disposal of the carcass. The next procedure is disinfection of the place and disposal of the carcass. The best way is incineration at 985-1050^{0}C without releasing any suspended particles in the atmosphere. The floor should be cleaned with hot water and detergents. Another method is to burn or bury the carcass and disposables used by the handlers. The handler has to dispose all the body coverings and gloves along with the carcass. Wash hands with soap and disinfectant and finally with hot water. Floor or starch can be used for deodorization. The instruments have to be cleaned thoroughly with hot water and detergent and then sterilized by autoclaving. Strict measures have to be followed during all the stages of post mortem examination in order to prevent contamination of the environment.

Sporicidal fumigants

Formaldehyde or paraformaldehyde can be used for fumigation of the room after the PM examination of carcasses suspected for infection with spore forming organisms. Care has to be taken by using PPE including full face respirator fitted with chemical filter. Four liters of 10% formalin has to be boiled for area up to 25-30 m3 for four hours and leaving over night, at room temperature less than 150c.

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25 Nutritional management of livestock during disaster

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According to the United Nations "A disaster is an event that is concentrated in space and time and that subject a society to severe danger and such serious losses of human life or major material damage that leads to break down of local social structure and the society is unable to perform any or some of its key functions. India is the worst-affected country of disaster in the South Asian region. Drought, floods, earthquakes and cyclones devastate the country with grim regularity with worst affected are the poor and marginalized sections of the India. Unfortunately, poverty is most widespread in areas that are more vulnerable to natural disasters - the flood-prone regions of North Bihar, East Uttar Pradesh, North Bengal and North-Eastern region etc. Small, marginal and landless farmers own 70% of the total livestock which produce 62% of total milk production in India. These are the most affected population during natural disasters. Natural disasters cause scarcity of feeds, fodders and scenario becomes again worse due to inaccessibility and transportation difficulties of feeds and fodders.

Natural disasters in India Floods

Nearly 75% of the total rainfall is concentrated over a short monsoon season of four months (June-September). As a result the rivers witness a heavy discharge during these months, leading to widespread floods. The most flood-prone areas are the Brahmaputra and Gangetic basins in the Indo-Gangetic plains. The other flood-prone areas are the north-west region with the rivers Narmada and Tapti, Central India and the Deccan region with rivers like the Mahanadi, Krishna and Kauveri. While the area liable to floods is 40 million hectares, the average area affected by floods

annually is about 8 million hectares. The annual average cropped area affected is approximately 3.7 million hectares.

Table 1. Average annual loss due to Floods

Sr. No.	Items	Loss
1.	Area affected	7.35 million hec.
2.	Population affected	40.97 million
3.	Human lives lost	1793 number
4.	Cattle lost	85599 number
5.	Houses damaged	1452904 number
6.	Houses damaged	370.61 crore
7.	Crop area damaged	3.73 million hectare
8.	Crop damaged	1095.13 crore
9.	Public Utilities damaged	1186.47 crore
	Total Losses	2706.24 crore

Source: Central Water Commission, Ministry of Water Resources, Government of India.

Drought

The heavy deliberation of rainfall within a span of three months in most areas causes heavy run-off and heavy flooding. On the other hand dry conditions prevailing during the rest of the year, particularly in the arid and semi-arid regions, renders 68% of the total landmass at risk to drought. The drought impacted 56% of the land mass and threatened the livelihoods of 300 million people across 18 states.

Cyclones

The states most exposed to cyclone-related hazards, including strong winds, floods and storm surges, are West Bengal, Orissa, Andhra Pradesh and Tamil Nadu along the Bay of Bengal. Along the Arabian Sea on the west coast, the Gujarat and Maharashtra coasts are most vulnerable. On an average, about five to six tropical cyclones form in the Bay of Bengal and Arabian Sea every year, of which two to three may be severe. Cyclones are most deadly when crossing the coastal areas of Andhra Pradesh, Orissa, West Bengal and Bangladesh, mainly because of the serious storm surge problem in this area.

The impact of these cyclones is confined to the coastal districts, the maximum destruction being within 100 km from the centre of the cyclone and on either side of the storm track.]

Earthquakes

Fifty-six per cent of India is prone to seismic activity. During the International Decade of Natural Disaster Reduction (IDNDR), India suffered the adverse impact of several earthquakes, north-eastern states, the Kutch region of Gujarat and Uttaranchal are the most vulnerable regions.

Tsunami

One of the most devastating disasters of the 21st century was the Asian tsunami that wreaked havoc in 11 countries on December 26, 2004. A tsunami is a series of ocean waves generated by sudden disturbances in the sea floor, landslides, or volcanic activity. In the ocean, the tsunami wave may only be a few inches high (typically 30-60 cm) but as they race onto shallow water regions their speed diminishes which results in increase in the height of the wave. Typical speeds in the open ocean are of the order of 600 to 800 km/hr.

Difficulties and actions for disaster management in livestock:

1. Animal reactions when under duress.

Disasters that stimulate nervous reactions, such as flash flood, wildfire and tornadoes, animal owners may see a behavioural pattern from their livestock that they are both unprepared and unable to handle. This is one reason why emergency disaster management directors limit how much time owners can have to address livestock. This delay may imperil the residents and secondarily first responders. The local emergency system may have an organized predetermined group of volunteers who are trained, equipped and coordinated to move into disaster areas to deal with livestock evacuation.

2. Access and transportation difficulties.

Traditionally, livestock producers have the equipment, resources, experience and practice to move livestock under a variety of conditions. Newer rural residents may lack livestock movement equipment, or enough equipment to handle their livestock population. This often stems from an operational philosophy. Producers expect the need to move large animals between forage sites and then off site to a market on a regular basis. Animal evacuation from a disaster area must occur in a coordinated manner under the direction of the incident command team to allow success without impeding handling of the disaster and while protecting public safety.

3. ***Equipment and facility design risks.***

Any livestock handler will tell you that when stress and an emergency combine while moving livestock is when you will find every hole in the fence, every sharp edge on the equipment and every loose board on the trailer. Having properly designed and effectively maintained equipment and facilities are critical during disasters. Remember, you will be handling agitated livestock with an extremely limited time frame.

4. ***Losing focus on the disaster event.***

The large amounts of stimuli and tension generated during disasters affect both humans and animals. Because people get so focused on 1 to 3 objectives they often fail to look around and notice the other things that are going on around them. Emergency responders get better at avoiding this problem with experience and training. Usually they follow a response guideline that reminds them to take in all the other factors. Although it's not desirable for livestock owners to face so many disasters that they also develop this broad focus, there is one key approach that helps enhance safety in tense situations—teamwork. Take help and designate one person to keep watching for additional oncoming hazards.

Feeding management strategies during natural disaster

We have to use different approaches by taking into consideration following two objectives,

1)Primary objective: Feeding and management of livestock for their survival.

2)Secondary objective: Ensuring minimum level of production and growth especially during later phases of flood.

Water management

Animals can survive for many days without food but cannot survive for more than 3 to 4 days without water. In draught scenario is again worsened by unavailability of clean safe drinking water due to contamination by different natural and spoiled sources. So one should take into consideration following

Points intended for water management

1. Providing clean and safe water to the livestock
2. Priority should be given to lactating and pregnant animals over nonproductive stocks,
3. Water should be provided in small quantity and more frequently.
4. Salt intake of the animal should be restricted.

Priority of feeding and watering

The priority of animals with different feeds and fodders should be in descending order as first suckling animals, then suckling with mother, producing and working animals, sick and old animals, and at last adult non producing animals.

Feeds and feeding technologies to be used during disaster

1. Concentrate mixture supplement

Concentrate mixture as high energy sources have capacity to balance the ration. It is easy to procure less bulk material like concentrate from unaffected area which permits easy transportation and distribution among farmers.

2. Treatment of Straws

After harvesting the grain from the crop, the left portion is known as straw. Paddy straw constitutes the basal roughage of cattle and buffaloes in India. To minimize spoilage in the heavy rainfall areas of flood it can be stored on wooden or bamboo platform raised over the ground. The straws soaked in flood water may be fed when fresh after receding of flood water. However, to prevent its spoilage due to growth of moulds and fungi, it should be processed and preserved properly. The following methods can be used for the preservation and improvement of flood soaked straws.

a) *Preservation*: Common salt can be mixed at a rate of 0.5 to 1.0% in soaked straw after squeezing the water. This prevents substantially the growth of moulds and fungi, and helps in the preservation of soaked straw for sometimes.

b) *Sun drying:* In bright sun light soaked straw should be spread in thin layer and turned out with rakes. The drying can be done on dry ground or abandoned roads of flood affected areas and collected for storage when moisture content reduces to less than 15 %.

c) *Ensiling:* Straw can be ensiled with other ingredients in *kuchha* or *pucca* silos, depending upon the availability of other ingredients. Straw may be either ensiled with (a) chaffed green fodder; (tree leaves/grasses/aquatic plants) and molasses with urea or (b) poultry litter, a little green fodders and molasses, (c) pig excreta, green fodders and molasses etc.

d) *Urea treatment*: It is a very simple and effective technique to improve the utilization of poor quality roughages. Feeding of urea treated straw can meet the maintenance requirement without any concentrate supplement. Around 4.0 kg farm grade urea can be dissolved in 35-50 L water and this solution should sprinkle over 100kg straw. Tightly pack the urea treated straw with plastic sheets and kept for 7 days in summer and 15 days in winter and fed

to animals by incorporating in animal's diet gradually. It can be fed to animals @ 1 % of whole ration.

e) 3. Sugarcane crop residue

Around 383 MMT of sugarcane bagasse produced annually in India. It contains CP < 3%, CF >45%, Total ash 4%, Digestibility 30%. The palatability and nutritional value of bagasse for the livestock (cattle and buffaloes) are much better than the rice hull.

f)

Feed formulations tried during the droughts of 1972-73 in Maharashtra

g)

The cattle relief camps were set up around the sugarcane factories located in the drought affected zones. Large scale feeding of bagasse, molasses in combination with urea and mineral supplements was adopted. The feed formulations developed through experimentation were tried on nearly 40,000 cattle without any detrimental effects.

Ingredients	Adult non producing		Growing animals	
	I	I I	I	I I
Bagasse kg	2.0	3.0	2.0	3.0
Molasses kg	0.4	0.5	0.8	0.8
Sugarcane tops chopped(kg)	8.0	nil	3.0	--
Urea (g)	22	25	40	40
Common salt (g)	30	30	20	20
Mineral mix (g)	50	50	25	25
Vitamin A (IU)	--	8000	--	8000

4. Compressed Complete Feed Block (CCFB)

CCFB has decreased bulk density (65Kg Vs 400Kg/m3) as compare to normally stacked feeds makes its handling, storage and transportation easy and economical having potential as a part of feed bank. CCFB can be made for

different types of animals such as maintenance, growth and lactation to economize the purpose.

5. UMMB and UMLD

Compact blocks of UMMB can easily be stored, transported and distributed. The aim of UMLD is survival of animal by using low cost and simple method of feeding. Revival feeding after restricted feeding showed improved nutrient intake and body weight gain.

Composition of UMMB and UMLD

UMMB		***UMLD***	
Ingredient	***%***	***Ingredient***	***%***
Molasses	38	Molasses	84
Urea	10	Concentrate	10
Portland Cement	10	Urea	3
Wheat bran	40	Mineral Mixture	2
Salt	1	Phosphoric Acid	2
Mineral Mixture	1	Vitablend AD3	0.02
Vitablend AD3	1g/qt		

6. Forest by products

Besides common fodder, shrubs and herbs like pipal, neem, saura, tara, mango, kathal, etc. other non-toxic tree leaves may also be fed to farm animals to supply part of their nutritional requirements. The availability of digestible protein for most of the green tree leaves is limited to 1-2% and energy equivalent to 10-15% of total digestible nutrients, on fresh basis containing about 15% dry matter. They are potential sources of much needed carotene, the source of Vit. A activity.

7. Aquatic plants

Several types of aquatic plants are available in river, pond and other water logging areas may be used for the feeding of farm animals. Although the palatability of most of the aquatic plants

is not good but the voluntary intake often exceeds 1 kg dry matter per 100 kg body weight in cattle and buffaloes. Besides supplying protein and energy they are rich sources of carotenes. So far the common aquatic plants tested for the feeding of farm animals are water hyacinth, aquatic spinach, stalks and leaves of lotus plant (Nymphacae sp. and Neumbiull sp.), hydrilla, pistia, aquatic weeds and jugaIi paddy etc. They are available readily at moat of the places during floods.

8. Unconventional cakes and seeds

The utilisation of deoiled salseed meal, treated neem seed cake, nahar seed meal, tapioca waste, extracted tea leaves have already been tested. These feeds may be incorporated to supply about 10-30% dry matter requirement of farm animals. These unconventional feeds can also be used for the feeding of simple stomached pig and poultry during scarcity of costlier conventional feeds replacing limited proportion of conventional ingredients.

9. Fruit factory waste

The waste materials like pine apple wastes, orange peel, tomato pomace are found to be abundantly available which are wasted due to lack of proper utilization as animal feed. These can form a part of the diet of livestock after processing through ensiling.

10. Animal organic wastes

The north eastern region has a large potential of animal organic wastes contributed by excreta of farm animals and poultry, waste materials from slaughter houses, dead animal carcasses etc. The animal excreta are richer in crude protein content. But their use is limited due to the presence of pathogenic micro-organisms and ova of different parasites. So these can only be used through suitable methods. The recent proliferation of gobar gas plants and its projected expansion would be capable of utilizing huge quantity of animal organic wastes and other carbon wastes for the production of biogas. The residual slurry available regularly after 3-5 weeks of anaerobic fermentation has been found to be a moderately good source of microbial

protein (Kamra and Pathak, 1980). The feeding of digested slurry in the diets of ruminants and pigs has already been demonstrated as a potential source of feed at Indian Veterinary Research Institute (Pathak *et al.* 1981).

Feeds not to be fed exclusively during such calamities

In the scarcity conditions animals do not get enough feeds for eating and they mostly pass through under fed conditions due to non-availability and scarce supply of feed-stuffs. At the end of such scarcity period, animals usually develop craving for food and uncontrolled eating behaviour. Thus, it is desired to be careful in feeding the farm animals after the flood water has receded.

1. ***Nitrate Poisoning***

Newly growing grasses contain high concentration of nitrite and nitrate and they should be fed in small quantity mixed with dry roughages like paddy straw and wheat straw.

2. ***HCN Poisoning***

It may result when sorghum its crosses are used at too immature stage or are severely stressed as by drought. New tree leaves contain high level of hydrocyanic acid. Due to its softness animals eat larger quantity and occasionally suffer from toxicity. Such tree leaves should not be fed as a sole ration and should be incorporated in straws for partial supply of nutrients.

Requirements of a Relief Camp

The estimated amounts of various feed stuffs required for the feeding of 1000 heads of cattle and buffaloes for one month period have been worked out for guidance:

(A) Ration based on unconventional feeds and fodders etc.

The estimated requirement of feed stuff for a relief camp housing 40% adult male, 40% adult female and 20% young stock has been given below:

Paddy straw/wheat straw/Bagasse	40 ton
Molasses	1 ton
Rice Polish	6 tons
Wheat bran	6 tons
Oil cakes	5 tons
Damaged grains/cheap concentrate or grains	4 tons
Mineral mixture	0.4 tons
Common salt	0.2 tons
Any green fodder/aquatic weeds/tree leaves	30 tons

Feed and fodder bank

Creation of feed and fodder bank is a basic requisite for predisaster management. It includes,

1. Pasture improvement
2. Application of fodder conservation techniques
3. Management of stocking rates Promotion of seeds that flourish from the first irrigation
4. Introduction of drought-resistant and water logging tolerant plants varieties,
5. Crop residues from major cereals like rice & wheat straws, Coarse cereals, legumes, haulms, left after removing grains, grasses from periphery of forest area wastelands and farmlands may be harvested and stored as hay,
6. Gramin Feed and Fodder Bhandaran Yojna: Ministry of Agriculture and Cooperation.

Conclusion

Management of disaster to date has been reactionary rather than proactive and preventative and not sufficient to meet the challenge. Along with disease and epidemic management feeding technology applications like Conc. mix, urea treatment, UMLD, UMMB, CCFB are some of the alternatives to meet the challenges. Unconventional feeds and wastes also have capacity to mitigate the challenge. In this regard, integration of work among veterinarians with state and central local bodies is necessary.

References: -On request-

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Essentials of Biosecurity in Broiler Production

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Broilers are chicken (*Gallus gallus domesticus*) bred and raised specifically for meat production. Chickens are one of the most common and widespread domestic animals, and although the global population has decreased from more than 24 billion in 2003 to 19 billion in 2011, there are more chickens in the world than any other species of bird. Most commercial broilers bred for meat reach slaughter weight at between 5 to 7 weeks of age, although slower growing strains reach slaughter weight at approximately 14 weeks of age. Because of this young age, much of their behaviour and physiology is that of an immature bird. Broilers and egg laying hen are the same species and share many characteristics, however, due to the rapid growth and selection for enlarged breast muscles, broilers are susceptible to different welfare concerns, particularly skeletal.

Broiler production is quite different from egg production. The birds, their nutritional requirement, housing and environmental requirements, management, processing and marketing of final products are all different from their counterpart egg production. However, the basic principles of poultry production can be utilized for efficient production of meat from poultry also. Some of the specific requirements of efficient broiler production are given below. The birds required for broiler production should have fast growth rate, high feed efficiency, early feathering, good body conformation and low mortality. Under Indian conditions, performance of the leading stock of broiler birds should be as follows:

Average body weight at eight weeks	1.8 to 1.9 Kg
Feed required to produce one kg live weight	about 2.0 kg
Mortality	About 2 percent

Broiler production was not known in India till 1962 when hybrid broiler bird was imported and introduced. Presently, this industry is progressing at much faster pace than layers. This is because broiler meat demand and price have gone up considerably. Higher and quick return and lesser risk attached with broiler farming than layers are also responsible for quick growth which is evident in the following table.

Growth of poultry production in India vis-à-vis world

	Chicken population (million)		Poultry meat (million tones)	
Year	1975	2011	1975	2011
India	141.0	550	1.03	3.20
World	6021.6	19000	2.10	8.20

Looking at the present market trend, Indian markets have demand for smaller broiler of 900 to 1000 gm of weight. This weight may be attained at six weeks of age with present birds. The broiler industry, which has increased markedly in size during the past two decades represent a considerable investment in housing, installations, breeding stocks and commercial flocks.

Commercially available meat-type chicken in India

Breed	**Weight at six weeks (g)**	**Weight at seven weeks (g)**	**Food conversion ratio**	**Livability (%)**
B-77	1300	1600	2.3	98-99
CARIBRO-91	1650	2100	1.94-2.2	97-98
CARIBRO Multicoloured	1600	2000	1.9-2.1	97-98
CARIBRO Naked necked	1650	2000	1.9-2.0	97-98
Vanraja	1500	1800	2.1-2.25	97

Because of the geographical concentration of broiler industry in specific regions, large integrated operations are extremely vulnerable to outbreak of disease. Proper investment in biosecurity and preventive measures is required to optimize performance, productivity and economic advantage. Biosecurity programs are an integral, cost-effective component of broiler production.

Vaccination schedule for broilers:

Age	**Name of disease**	**Name of Vaccine**	**Route**
Day old chick	Marek's disease MD,	HVT strain (live)	Sub-cutaneous
3-7 days	Infectious bursal disease	IBD Lukert Strain + IBD Killed Vaccine	Intraocular Intramuscular
8-10 days	Ranikhet disease	La Sota N.D. Killed	Drinking water Intramuscular
14-18 days Intraocular	Infectious bursal disease	IBD intermediate	Drinking water
28-30 days	Ranikhet disease	La Sota	I.O/ D.W.

Pullet and breeder farms should be operated on an all-in-all-out basis. No other poultry, exotic or local bird species should be permitted on farms. Only authorized personnel should visit farms. Contractors and company employees should not make unauthorized visits to other farms, come in contact with free-living birds, or attend avian exhibitions or shows. It is advisable for hired labor to reside on the farm, but their residences should be situated outside the perimeter fence surrounding live bird housing.

Procedures relating to biosecurity, including scheduling visits to farms by flock supervisors, decontamination of personnel, and use of showers and protective clothing, should all be in writing. Each level of management should ensure that subordinates are aware of current biosecurity precautions. Specific activities that may be associated with the introduction

or dissemination of disease include feed delivery, vaccination, genetic selection, movement of flocks from pullet to breeder farms, egg collection and depletion of flocks at the end of the breeding cycle. The procedures should be planned to optimize biosecurity.

Broiler farms should be filled on an all-in-all-out basis. A minimum of 10-12 days should be allowed between successive flocks. No other poultry or swine should be housed on the same farm. Broiler should be operated on a limited-access basis with no outside visitors or unauthorized personnel entering the facility. Flock should be inspected by an experienced supervisor at least weekly to ensure freedom from obvious clinical abnormalities. In the event of disease signs or an increase in mortality above the accepted range for age, type of flock or season, live and dead birds should be submitted to a diagnostic laboratory for evaluation.

Special precautions are required at the time of flock depletion. All equipment, including forklifts and vehicles used to transport birds, coops should be completely decontaminated by washing and disinfection before being moved to another farm. Catching crews should follow predetermined biosecurity procedures, including decontamination after completing the catching program.

Following are the suggested Biosecurity procedures for Broiler farm

Owner/Veterinarian/flock supervisor/catching crew

1. Wash and clean vehicle thoroughly, inside and out, each week.
2. Use clean coverall for each visit. Coveralls to be available at every farm.
3. Use new hairnet for each farm.
4. While entering the premise
   - Vehicle should be parked at least 100 feet from broiler house.
   - Put on clean coveralls, hairnet, dust mask, and rubber boots.
   - Approved disinfectant should be applied at recommended rate.

- Completely wash outside and inside of boots.
- Wash hands with alcohol solution.
- Disinfection of any equipment and vaccine containers before entering broiler house.

5. While exiting the broiler farm
   - Hairnet and mask should be left on the farm.
   - Thorough disinfection of any equipment taken into poultry house before placing in vehicle.
   - Boots should be removed and washed in disinfectant inside and out.
   - Outer clothing should be removed and put in container designated for soiled clothings.
   - Dump water and clean interior and exterior of bucket with brush.
   - Wash hands with alcohol solution.
   - Spray sides of shoes and floorboard of vehicle with disinfectant before placing shoes on floorboard.

Egg vehicle/litter vehicle drivers

- Drivers should wash and disinfect rubber boots on entry and exit from each farm visited.
- Wash hands with alcohol solution.
- Driver should enter egg-storage room only.
- Drivers should use footbath if entering through main gate.
- Drivers should spray soles of shoes and floorboard of vehicle with disinfectant after every stop.
- Driver should wash and disinfect floor of egg truck weekly.

Feed delivery

- Hands should be washed with alcohol solution.
- Driver should not enter houses under any circumstances.
- Persons should spray soles of shoes and floorboard of vehicle with disinfectant after every delivery.

References: -On request-

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An overview of bypass nutrients and their role on improved and sustainable productivity of dairy animals

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Improvement in the productivity of dairy animals in India is possible only if the early lactating high yielding and genetically improved cows and buffaloes were fed according to the nutrient requirement with high energy diet. In tropical countries, the majority of livestock subsist on poor quality native grasses, crop residues and agro-industrial byproducts. Milk yield and optimum reproductive performance are the most important factors in determining profitability of dairy animals and high milk production is always more important for high profitability than the low feeding cost. In early lactating cows and buffaloes, the energy intake through ration doesn't meet the requirement for higher milk production, resulting in a Negative Energy Balance (NEB), which is closely related to reproductive performance Therefore, minimizing the extent and duration of NEB could be beneficial for reproduction besides getting the best productive performance from cows (Tyagi *et al*., 2010).

Deleterious effect of NEB on productive performance of early lactating animals would be reduced by supplementation of protected fat in the ration through enhancing energy intake. Earlier, supplementation of protected fat was considered only as energy source during the transition period leading to improvement in reproductive performance but later it was demonstrated that the effect was also due to Fatty Acids (FA) which act as a precursor of progesterone synthesis via cholesterol and prostaglandins pathway (Stapleset *et.al*., 1998). Protected protein feeding to lactating animals leads to proportionate increase in the supply of amino acids to the host

ruminant for productive/ reproductive purpose, with an overall increase in the efficiency of protein and energy utilization. A series of trials have been conducted on cattle and buffaloes on feeding of protected protein, to see its effect on growth and milk production. The average growth rate and milk production was increased by 15-25 and 10-15%, respectively (Guru *et al*., 2006; Ghorbani *et al.*, 2007; Foda *et al*., 2009). Various studies showed that, formaldehyde treatment was efficient and cheaper method to protect the protein source from highly degradable cakes in the rumen (Walli, 2005; Shelke *et al*., 2012) and its feeding significantly increased daily milk yield and protein, fat, SNF, total solids content of milk (Shelke *et al*., 2011). The technology of feeding formaldehyde treated cakes has been adopted in India by some milk producers and protected protein feed is now being manufactured exclusively by some commercial feed factories, including National Dairy Development Board, Anand, Gujarat (India).

Protected nutrient technology:

Protected nutrient technology is one such approach, involving feed management through passive rumen manipulation, by which the dietary nutrients (fat and protein) are protected from hydrolysis, allowing these nutrients to bypass rumen and get digested and then absorbed from the lower tract. The protected nutrients mainly include protected fat and protein and it is also called as bypass nutrients. The other protected nutrients are protected starch, chelated minerals and vitamins. Here, we can discuss only protected fat and protein and its impact of feeding on the performance of cows and buffaloes.Protected protein: Highly degradable proteinous oil cakes when ingested by ruminants, result in large scale ammonia production, much of it gets wasted as urea excreted through urine. Even the animal has to spent energy to convert ammonia into urea in liver. In order to increase the efficiency of protein utilization from the highly degradable cakes, these proteins need to be protected from excessive ruminal degradation and can be used as protected protein, so that the

amino acids from these protein feeds are absorbed intact from the intestines of the animal for tissue protein synthesis as well as for the process of gluconeogenesis in liver (Walli, 2005).Appropriate technological methods such as physical, chemical or combinations of both, for the proteinous feeds and their by-products can be employed before their inclusion in the rations of livestock for improving productivity. Among the various processing methods, dry roasting and extrusion cooking technologies can be used to improve the digestibility and utilization of proteinous and other feeds by ruminants. Chemical treatments have also been used for the protection of proteins and for this formaldehyde treatment has been the most effective and feasible technology for manufacture of bypass protein.

Sources of protected protein:

The protein degradability data (in rumen) obtained by several groups of workers on large number of feed stuffs in India and other countries has revealed that only a few feeds are good sources of naturally occurring protected protein (having lower protein degradability), viz., maize gluten meal, cottonseed cake, fish meal, coconut cake and maize grain. Feeds like linseed cake, deoiled rice bran, soybean meal and Leucocaenea leaf meal are of medium protein degradability, while Mustard Cake (MC) and Groundnut Cake (GNC) are highly degradable cakes (Walli, 2005 and Shelke et al., 2011). Negi et al. (1989) found that 50 to 70% of total N in tree forages may be present as protected protein. However, these forages contain 16-53% of total N in the form of acid detergent insoluble nitrogen. This is because of the presence of tannins, particularly the condensed tannins which bind the proteins irreversibly and if fed to animals, are capable of corroding the epithelial lining of the gastrointestinal tract. So, tree forages could be used as a source of protected protein only after devising a method for their tannin detoxification, using either some chemical, biological or biotechnological approach. While the proteins of lower protein degradability do not need

any protection, highly degradable cakes like MC, GNC and sunflower seed cake need protection against attack of ruminal proteolytic enzymes, for improving their utilization by ruminants.

Methods of protein protection:

Among the several methods which allow the escape of dietary protein from ruminal degradation, much of the work was carried out on heat treatment of highly degradable cakes. The problem with 'heat treatment' is that it may not be cost effective and moreover, it can also over-protect the protein (Sengar and Mudgal, 1982). Walli (2005) have fine-tuned the heat treatment of GNC and soybean cake and found that heating at 150°C for 2 h as the optimum temperature time combination. Walli and Sirohi (2004)observed that the roasting of soybean at 130°C for 30 min protected its protein from ruminal degradation. Formaldehyde treatment has been used by several workers in India to reduce the protein degradability of high degradable cakes and also to study the impact of its feeding on the productive performance of dairy. The technology for manufacture of formaldehyde treated mustard cake has been commercialized by the National Dairy Development Board, Anand and the treated cake is available in the market as a commercial product.

Performance of cows and buffaloes fed on protected protein: In India, dairy animals by and large, do not get their required dietary energy through the normal feed which the animals are offered, as the feed is mostly devoid of energy rich grains. Success achieved in terms of increase in milk yield (volume) through the feeding of protected protein in low yielders is essentially due to the supply of more energy to these energy deficient animals, through the same feed, as the extra amino acids supplied through protected protein feeding are converted to glucose in liver. Thus, essentially the feeding of protected protein increases the efficiency of protein and energy utilization within the ruminant system. Numbers of studies have been conducted on feeding of naturally occurring

protected protein like cottonseed cake and maize gluten-meal to lactating ruminants, in India with most of these experiments yielding positive results. Walli and Sirohi (2004) also reported 15% increase in milk yield on feeding of formaldehyde protected mustard cake to crossbred cows. Garg et al. (2003) while comparing naturally protected protein (30% UDP) and processed (formaldehyde treated) sunflower seed meal supplement (optimal-bypass with 75% UDP) in crossbred cows, found a significant increase in milk Similarly, Shelke *et al.* (2011) concluded that supplementation of protected nutrients (protected fat at 2.5% of DM intake and formaldehyde protected cakes) to lactating Murrah buffaloes significantly increased milk yield and milk fat.

Protected fat

Sources of fatty acids:

The main sources of Short Chain Fatty Acids (SCFA) are cottonseed oil and palm oil. All the sources of fat contain adequate quantity of Long Chain Fatty Acids (LCFA). The main sources of linolenic acid (C18:3n3) are flaxseed, hemp, canola, soybean, nuts and dark green forages. Ryegrass silage contains as much as 60% of linolenic acid as a percentage of total fatty acids which would encourage high forage systems to increase dietary linolenic acid content. Omega-3 fatty acids are found also in cold water and salt water fish (salmon, trout, mackerel, sardines). The main sources of linoleic acid (C18:2n6) are sunflower seed, safflower, hemp, soybean, nuts, pumpkin seeds, sesame seeds and flaxseed. Gamma-linolenic acid (C18:3n6) is found in evening primrose oil, grape seeds and borage. Dihomo-gamma-linolenic acid (C20:3n6) is found in maternal milk while arachidonic acid (C20:4n6) occurs mainly in meat and animal products. Oleic acid (C18:1) is found in olive, almond, avocado, peanut, pecan, cashew, macadamia nut and butter. Omega 7 in the form of palmitoleic acid (C16:1) is found in tropical oils (coconut, palm).

Methods of fat protection: The protected fat can be obtained by various methods such as encapsulation technique and calcium

salt formation of fatty acids. Calcium salts of fatty acids were produced at NDRI, Karnal by double decomposition method from edible oils and non-edible oils and other products such as acid oil (a byproduct of vegetable oil refining). The calcium salts were prepared by a method described below:

Soybean oil acid oil was heated in a metal container; an aqueous solution of sodium hydroxide was added and again heated to cause saponification, sodium salts so formed were dissolved in excess water. Calcium chloride dissolved in water was then added slowly to the water soluble sodium soaps with stirring causing immediate precipitation of calcium salts. Excess water was removed by squeezing the soaps through cheese cloth. The soap was allowed to air dry and then lumps were broken before being mixed with other concentrate ingredients (Mishra et al., 2004).

Sugumar and Balakrishnan (2008) also concluded that calcium soaps of sunflower acid oil was selected as the potential protected fat to be used as concentrated energy source in the rations of dairy cows. Calcium salts are being manufactured commercially from palm fatty acids by single stage fusion technique which is more economically viable and environment friendly. These types of protected fats are commercially available in the market.

Productive performance of cows and buffaloes fed on protected fat: Adding protected fat to dairy rations can positively affect efficiency of dairy cows through a combination of caloric and non-caloric effects. Caloric effects are attributable to higher energy content and energetic efficiency of lipids as compared to carbohydrates or proteins with the overall benefit being increased milk production and the persistency of lactation. The non-caloric effects include improved reproductive performance and altered fatty acid profile of milk. Feeding Ca soaps of fatty acids to high producing lactating cows resulted in higher milk and milk fat production (Sklan et al., 1991). Thakur and Shelke (2010) reported an improvement of 12.4% in milk yield of buffaloes fed 4% Ca salts of fatty

acids. Tyagi et al. (2009a) reported that protected fat supplementation at 2.5% of DMI for 90 days postpartum increased the milk production and its persistency up to 120 days after cessation of protected fat feeding.

Fat supplementation prepartum: Pregnancy rate was increased by 19% on supplementation of safflower seeds at 0.68 kg day-1 (4.7% fat in the diet) with similar energy and protein content to the late-gestation heifers (Lammoglia et al., 1996). Bellows et al. (2001) also reported supplementation of safflower seeds, soybeans, or sunflower seeds (4.7, 3.8 and 5.1% fat in diet, respectively) for the last 65 day before calving to first-calf heifers increased the pregnancy rates by 94, 90 and 91%, respectively compared to controls (79%) receiving diets with equivalent energy (2.4% fat). However, in another study it was observed that supplementation of sunflower seeds (6.5% fat in diet) during last 68 day before calving did not improve subsequent pregnancy rate compared to control diet (2.2% fat). The contradictory results of both studies were due to mainly forage availability. In second study, 71% more forage availability and greater nutrient quality was reported. The samples of forages were analyzed for protein and fat; protein ranged from 18 to 34% and fat was from 2 to 3.5% depending on forage species. The major fatty acid in the forages was linolenic. This would be the reason for no improvement observed in pregnancy rate of second study, higher quality of forage would meet the nutritional-reproduction response in these heifers and this tended to mask any carryover effect resulting from supplemental fat fed in the gestation diet. Tyagi et al. (2009b)reported that protected fat supplementation at 2.5% of DMI 30 days pre partum, increased the calf birth weight and decreased the incidence of retention of foetal membranes.

Fat supplementation postpartum:

Freshly calved cows were supplemented with rice bran (5.2% fat in the diet) up to 50 day showed higher pregnancy rate than that of cows receiving a control diet containing 3% fat

in the diet (De Fries et al., 1998). Wehrman et al. (1991) reported that 18% increased in cycling of cows by supplementation with 1.36 kg of whole cottonseed (5.5% fat in diet) 30 day before the breeding season compared to a control diet without added fat. Supplementation of 75% of whole cottonseed to heifers before breeding improved estrus activities and conception rate (Barje et al., 2007).

Feeding bypass fat at the rate of 100-150 g day-1 to high yielders during the transition period (10 days before and 90 days after calving) could help improving their milk production and reproduction efficiency (Garg et al., 2008). National Dairy Development Board of India has standardized the production process of bypass fat supplement on a pilot scale, conducted feeding trials and different methods of manufacturing and economics thereof, for commercial production. Now, bypass fat supplement using palm fatty acid distillate would be produced commercially by setting up a bypass fat plant.

Conclusion:

In developing countries like India, supplementation of protected fat and protein is beneficial to medium and high yielding cows and buffaloes but the cost effectiveness of the same needs to be kept in mind. As about the feeding of protected protein, the results of some farm studies and field studies have indicated the usefulness and cost effectiveness of its feeding to cows and buffaloes yielding around 5-8 L of milk.

In addition, milk fat yield and percentage of unsaturated fatty acids in milk fat was increased, resulting improve nutritive value of milk from a human health point of view.

References: -On request-

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28 Early warning system for livestock and zoonotic diseases

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Early warning of outbreaks and the capacity for prediction of spread to new areas is an essential pre-requisite for the effective containment and control of epidemic animal diseases, including zoonoses. As experienced throughout much of the globe, weaknesses of disease surveillance systems and the inability to control major diseases at their source have contributed to the spread across geographical borders of diseases confined to livestock, such as foot-and-mouth disease, as well as diseases with a zoonotic potential, e.g. BSE and avian influenza.

Early Warning and Response is based on the concept that dealing with a disease epidemic in its early stages is easier and more economical than having to deal with it once it is widespread. From a public health perspective, early warning of outbreaks with a known zoonotic potential will enable control measures that can prevent human morbidity and mortality. Also, new previously unknown human infectious diseases have emerged and will continue to emerge from the animal reservoir.

Several initiatives, at national and regional level have already been developed in the field of early warning. At the international level FAO, OIE and WHO have each developed Early Warning and Response Systems that systematically collect, verify, analyse and respond to information from a variety of sources, including unofficial media reports and informal networks. In addition, the OIE and WHO mandates include official notification of disease or infection outbreaks to

the international community within conditions determined by their Member Countries. FAO has a broad mandate to disseminate information, including all agricultural statistics, to Member Countries.

The Global Early Warning and Response System for Major Animal Diseases, including Zoonoses (GLEWS), build on the added value of combining the alert and response mechanisms of the different organizations, enhancing the Early Warning and Response capacity for the benefit of the international community. Through sharing of information on disease alerts, unjustified duplication of efforts will be avoided and the verification processes of the three organizations will be combined and coordinated. For zoonotic events, alerts of animal outbreaks can provide direct early warning so that human surveillance could be enhanced and preventive action taken. Similarly, there may be cases where human surveillance is more sensitive and alerts of human cases precede known animal occurrence of disease. On the other hand, sharing assessments of an ongoing outbreak will enable a joint and comprehensive analysis of the event and its possible consequences. Joint dissemination will furthermore allow harmonized communication by the three organizations regarding disease control strategies.

Regarding the joint response to disease emergencies, the three organizations will be able to respond to a larger number and cover a wider range of outbreaks or exceptional epidemiological events with the provision of a wider range of expertise. This will improve international preparedness for epidemics and provide rapid, efficient and coordinated assistance to countries experiencing them. GLEWS is based on

the notion that infection does not recognize geographical nor species borders. For its zoonotic component it takes a stand in the shift in paradigm from independence to interdependence of agencies and professions involved in zoonotic control.

1. Existing Early Warning and Response Systems within the three Organizations

2.1 Legal framework of existing Early Warning and Response Systems 2.1.1 The International Health Regulations

The revised International Health Regulations adopted by the World Health Assembly in 2005 (IHR (2005)) are an international legal instrument that will come into force on 15 June 2007, replacing the current IHR. The purpose and scope of the IHR (2005) are to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade. IHR(2005) is legally binding on all WHO Member States who have not rejected them and on all non-Member States of WHO that have agreed to be bound by them.

The IHR (2005) require States to notify WHO of all events that may constitute a public health emergency of international concern and to respond to requests for verification of information regarding such events. National IHR Focal Points will provide to and receive information from WHO on a 24 hour a day basis, seven days a week. This will enable WHO to ensure appropriate technical collaboration for effective protection of such emergencies and, under certain defined

circumstances, inform other States of the public health risks that merit action on their part.

The IHR (2005) require WHO to cooperate with other competent intergovernmental organizations or international bodies in the implementation of the Regulations, including FAO and OIE.

2.2 Existing Early Warning Systems

OIE has set up an animal health information search and verification system for non-official information from various sources on the existence of outbreaks of diseases or exceptional epidemiological events that have not yet been officially notified to the OIE. It then relies on the capacity of its Member Countries and on their capabilities to verify the outbreak information. OIE operates an early warning system to warn the International Community of exceptional epidemiological events in its Member Countries. This alert system is aimed at the decision makers, enabling them to take any necessary protective measures as quickly as possible.

FAO, through its special EMPRES priority programme established in 1994, developed an early warning and response system. The system benefits from the official information furnished by the OIE and combines other sources of information such as those generated by technical projects, consultancy missions or personal contacts and provides an analysis of the situation through bulletins, electronic messages and reports for better disease containment and control. In addition, FAO has also developed information search and verification systems of information from various sources (so-called data mining).

WHO systematically gathers official reports and rumors of suspected outbreaks from a wide range of formal and informal sources. Reports of suspected outbreaks are received from ministries of health, national institutes of public health, WHO Regional and Country offices, WHO collaborating centres, civilian and military laboratories, academic institutes, and nongovernmental organizations (NGOs). With the advent of modern communication technologies, many initial outbreak reports now originate in the electronic media and electronic discussion groups.

2.3 Existing Response systems

The Global Framework for Transboundary Animal Diseases (GF-TADs) launched by **FAO** and **OIE** initiates and supports strategic regional and national cooperation for the control of TADs. The Framework is designed to empower countries and regional alliances in the fight against TADs, to provide capacity building and to assist in the establishment of programmes for the targeted control of certain TADs based on their regional priorities. It contributes to the strengthening of national disease reporting structures and mechanisms to fulfil international animal health monitoring functions effectively. The GLEWS initiative is a major contributor to this Framework.

The Technical Cooperation Programme (TCP) is an instrument that enables **FAO** to respond rapidly to urgent needs for technical and emergency assistance in member countries and to contribute to their capacity building. The programme

does not operate in isolation, but is closely associated with other normative and field activities of the organization.

In addition, **FAO** has launched the Emergency Centre for Transboundary Animal Diseases Operations (ECTAD) within its EMPRES programme in November 2004, to operate as the corporate centre for the design and delivery of FAOís services as the Chief Veterinary Officer of the organization. ECTAD is primary aim is to implement a clear, simple chain of command between AGAH/EMPRES and the field to deal efficiently with the emergency at hand and to ensure an integrated approach of the relevant groups and services involved in the response.

WHO offers assistance to affected countries in the form of technical advice, supplies and by mounting coordinated international investigations The Global Outbreak Alert and Response Network (GOARN) is building on new and existing partnerships of national and international institutions and networks, to deal with the global threats of epidemic-prone and emerging diseases in humans and to prepare for rapid deployment and coordination of international resources in response to an outbreak of international importance. GOARN aims at ensuring appropriate technical support to affected human populations quickly, assessing risks of rapidly emerging epidemic disease threats and sustaining containment and control of outbreaks by contributing to national outbreak preparedness.

OIE has emergency funds that can be rapidly mobilized for sending experts from OIE Reference Laboratories to assess

the epidemiological situation in a country and define the actions required.

2.4 Existing systems for dissemination

OIE disseminates official information about animal diseases including zoonoses in the three OIE official languages. The dissemination of emergency messages and follow-up reports (as per the OIE Early Warning System) is done using different tools: faxes, electronic distribution lists and the OIE website. Also, Animal Health Information, from the OIE six-monthly and annual monitoring system is disseminated using the OIE website and in hardcopy (World Animal Health publication).

FAO disseminates bulletins, reports, descriptive and analytical early warning and emergency messages. The tools used to disseminate information are: FAO/AGAH/EMPRES web site and electronic distribution lists. The EMPRES bulletin is also distributed in hardcopy. Concerning HPAI, a specific bulletin FAO AIDE News is issued every month or when appropriate.

WHO disseminates information through a restricted e-mail list, the WHO web site and information bulletin. The Weekly Epidemiology Record is available in hard copy and electronically. INFOSAN has been developed by WHO in cooperation with FAO to promote the exchange of information on food safety and to improve collaboration among food safety authorities at national and international levels.

3 GLEWS: A joint FAO/OIE/WHO initiative to enhance Early Warning and Response at international level

3.1 Project background and rationale

The GLEWS initiative started with the voluntary participation of representatives of FAO, OIE and WHO, who share the common objective to enhance the Early Warning and Response capacity for the benefit of the international community. Mutual benefit through collaboration has been identified throughout the Early Warning and Response process.

Early Warning

The three organizations use complementary and partly overlapping sources of information to identify infectious disease events. Through sharing of information on disease alerts, the capacity for early warning of the three organizations could be enhanced while avoiding unjustified duplication of efforts. In some instances the geographical coverage of disease alerts could be improved, e.g. through the use of FAO/AGAH animal health information for non OIE countries. For zoonotic events, alerts of animal outbreaks provide direct early warning so that human surveillance could be enhanced and preventive action taken. Similarly, there may be cases where human surveillance is more sensitive and alerts of human cases precede known animal occurrence of disease.

There is also added value in combining and coordinating the verification processes. One source of information is often not sufficient to verify or deny the

presence of a disease in a country that did not spontaneously report it. A rumour might be denied by an official institution, although the epidemiological context tends to demonstrate the contrary. Each disease event tracked has therefore to be verified in light of the current and most updated epidemiological knowledge. Socioeconomics and demographic data on livestock also represent a valuable source of information in this exercise. Joint dissemination of risk assessment would also benefit from the different information sources providing a comprehensive analysis of the event and its possible consequences in its specific context.

Response

Sharing assessments of ongoing outbreak undertaken by either of the organizations, e.g. based on reports from local representation or field missions, would be of value to all three organizations. Furthermore, the organizations would, in accordance with their different mandates, bring together different pieces of information from different sources that would enable a joint assessment of the outbreak. Immediate notifications to the OIE would provide initial details of the outbreak and any immediate control measures taken. FAO would bring the integration of other data and information, e.g. on animal production systems, factors affecting movements of livestock etc, crucial for the assessment of the risk of further spread. Joint analysis and assessment by the three organizations would also benefit from the different specific competencies and resources of the three different organizations and may form the basis for a joint infection control strategy. Joint dissemination would enable

harmonized communications by the three organizations regarding disease control strategies.

Table: List of diseases of common interest.

Zoonotic	
1. Anthrax	10. New World Screwworm
2. Bovine Spongiform Encephalopathy (BSE)	11. Nipah Virus
3. Brucellosis (*B. melitensis*)	12. Old World Screwworm
4. Crimean Congo Hemorrhagic Fever	13. Q Fever
5. Ebola Virus	14. Rabies
6. Food borne diseases	15. Rift Valley Fever* (RVF)
7. Highly Pathogenic Avian Influenza (HPAI)	16. Sheep Pox*/Goat Pox
8. Japanese Encephalitis	17. Tularemia
9. Marburg Hemorrhagic Fever	18. Venezuelan Equine Encephalomyelitis
	19. West Nile Virus
Non zoonotic	
1. African Swine Fever (ASF)	
2. Classical Swine Fever (CSF)	
3. Contagious Bovine Pleuropneumonia (CBPP)*	
4. Foot and Mouth Disease (FMD)*	
5. Peste des Petits Ruminants (PPR)	
6. Rinderpest, Stomatitis/Enteritis	

*diseases for which trend analyses and forecasting will be emphasized

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29 Global Health challenges and food security

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Introduction

Food and Agriculture Organization (FAO) defines food security as "it exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." So, along with availability, access is also critical to prevent food insecurity.

According to one of the estimate it is revealed that global human population will reach nearly 10 billion people by 2050 (FAO, 2009a). Providing adequate and nutritious food for such a large population highlights the importance of the world's agriculture system. Food and Agricultural Organization of the United Nations projects that food production will have to increase by 70 percent over the same time frame. Projected increases in income globally will increase demands for not only more food but for better quality food, leading to an increased intake of animal protein (Masuda and Goldsmith, 2010). The demand for more high-quality foods will have to be met by increases derived from plant and animal production systems.

Food security consists of complex problems that involve addressing malnutrition, optimizing food safety and managing global environmental change. Food insecurity is caused by multiple reasons *viz*., population growth, increased purchasing power, changing dietary preferences, severe weather events and the integration of food systems into global financial systems. Rising global food prices, changing diets, natural disasters, severe weather events and global economic issues have reinforced the access to food, which would allow everyone in the world to lead active and healthy lives. The global food network consists of a variety of activities that link

farms to tables including the production, processing, transportation and preparation of food. By linking local, national and global food systems together, the network provides tremendous food benefits: availability, variety and pricing.

Global Climate Change

Global environmental change means, both natural and anthropogenic in origin, under way in the earth system from ecosystems to climate change. Animal agriculture affects this change through the landscapes it consumes and the biogeochemical cycles it affects, and is also affected by these changes, in some cases significantly, and must adapt to them in order to provide the quantity and affordability of animal protein expected by society. This adaptation, in turn, has important implications for sustainable production.

Approximately 17 billion food animals globally occupy 30 percent of the ice-free land surface of Earth, resulting in about 72 percent of deforestation worldwide and consuming 32 percent of freshwater globally (Nepstad *et al*., 2011). Currently, food animals contribute 14.5 percent of global greenhouse gas (GHG) emissions, according to the FAO (Gerber *et al.*, 2013). Enteric fermentation from ruminants is the second largest global source of methane (Makkar and Vercoe, 2007). Land degradation from overgrazing rangelands has long been noted across many different socioeconomic and environmental conditions, leading to soil erosion and soil nutrient loss, reduced feed stocks, and habitat changes, among other impacts (Jun Li *et al*., 2007). The goal of reducing animal agriculture's ecological footprint in the face of increasing production has progressively gained more attention (Chicago Council on Global Affairs, 2013). How this goal might be achieved will vary by the type of production system; systems vary from high to low input (intensive to extensive) in terms of the amount of capital and technological input needed, output per unit area, and time required to manage animals.Thorough

analysis is necessary before viewing any production system as more or less sustainable, given the many environmental (ecosystem) services, species types, and social and livelihood implications. Generally, however, intensive systems for feed and animal production tend to produce fewer emissions and use less land per unit of production

Animal Health and Disease

Challenges to the health and well-being of animals and humans are presented by animal disease pathogens. Understanding and developing effective measures to control animal infectious diseases are sometimes problematic mainly due to the lack of direct and continuous monitoring of the animal status as would otherwise occur with humans. The majority of these pathogens also have the ability to have a long period of carrier status in host animals (i.e., animals show no clinical signs but are able to transmit pathogens). For example, the *Salmonella enterica* may develop carrier status in an animal host, and such carriers typically excrete high levels of bacteria during recovery from enteric or systemic disease without showing clinical signs. The carrier state may exist for the lifetime of the animal host with bacterial species such as S. enterica serovar Dublin. Therefore, preventive measures are critically important components of the first line of defense. The delivery of effective vaccine strategies for the control of major animal pathogens will be especially important, and finding new and better vaccines able to deliver long-lasting and durable protective immunity will be needed to be effective against multiple strains or variants.

One main goal of animal health is in food provision and food safety. During the last four decades, there have been several emerging and new health events that have received public attention. Most of these health events were linked to animal diseases or originated in animal products, including avian influenza, bovine spongiform encephalopathy, West Nile fever, sudden acute respiratory syndrome, HIV/AIDS, and Ebola virus. Because of the extensive involvement of animals

and their products in these events, animal scientists and animal production sectors have been involved in measures to minimize the spread and impact of these diseases. The public health sector, particularly within central government or international agencies, has maintained the lead in the effort to control or eradicate these diseases. Nevertheless, the prevention effort requires major involvement of animal health officers and others in related industries because the roots of most of these diseases extend to animal populations, particularly to food-producing animals.

Organization for Animal Health (OIE), the Codex Alimentarius, and the International Plant Protection Convention (IPPC) as the basis for recommended standards (Zepeda *et al.*, 2001). It has become clear that the health status of animals and their products plays a major role in import and export regulations. This type of requirement for trade has placed pressure on the animal health structure both nationally and internationally. Animal scientists, particularly veterinary professionals, throughout the world are faced with having to fulfill a crucial role in protecting their country's animal health status, providing sound surveillance information on the occurrence of diseases within their territories, and conducting scientifically valid risk analyses to establish justified import requirements. Population-based approaches for disease management require scientifically sound research prior to application of available options.

Animal diseases are severely affecting the production of food animals and disrupting regional and international trade in animals and animal products. Such diseases as hand, foot, and mouth disease, African swine fever, blue tongue, and classical swine fever are eminent transboundary animal diseases. These diseases are infamous for their ability to severely affect, and indeed disrupt, regional and international trade in animals and animal products. They are also notorious for the enormous financial damage and ethical violations caused when

introduced into countries that are free from these diseases. The burden of these diseases involving the loss of animals and biological diversity and the lowering of production efficiency is generally much less well known or is underestimated. Declines in biodiversity have been identified as potentially increasing infectious disease transmission among ecological populations in certain cases. Furthermore, these diseases threaten food security and the livelihoods of smallholders and prevent animal husbandry sectors from developing their economic potential (Kelly *et al*., 2013).

Emerging and re-emerging animal diseases that were considered under control are threatening trade and the disruption of animal protein distribution. The appearance of the porcine epidemic diarrhoea (PED) virus, for example, in North America presents significant challenges for producers and animal health officers.

Human Health and Disease

The World Health Organization (WHO) has recognized that the worldwide upswing in resistance to antibiotics is based on a combination of factors that includes "overuse in many parts of the world by both human and animals, particularly for minor infections, and misuse due to lack of access to appropriate treatment" (WHO, 2001). According to the U.S. Centers for Disease Control and Prevention (CDC), antibiotic use in people is a primary factor, and the most acute problem is in hospitals. And the most resistant organisms in hospitals are emerging because of "poor antimicrobial stewardship among humans". Antibiotics are among the most commonly prescribed drugs used in human medicine; however, CDC estimates that up to 50 percent of all antibiotics prescribed are not needed or are not optimally effective as prescribed.

Animal Health

During the last few decades, various regions of the world were infected with serious zoonotic diseases such as immunodeficiency viruses, SARS, MERS, and reemerging diseases such as tuberculosis, undulant fever and Rift Valley fever. Furthermore, there were 2.4 billion human illnesses and 2.2 million deaths per year from foodborne illness, and more than 1.7 million deaths from HIV/AIDS in 2011. Global outbreaks of influenza, for example, have occurred periodically in the human population. The viruses of the outbreaks in the 20th century were avian in origin and arose through mutational events. In particular, recent evidence of direct bird-to-human transmission has increased global concerns over the pandemic potential of these viruses (Dinh *et al.*, 2006). Escherichia coli O157:H7 is another major public health concern in North America and other parts of the world. The feces of animals, particularly cattle, are considered the primary source of these bacteria, and major routes of human infection include consumption of food and water contaminated with feces and, to a lesser extent, contact with live animals. Human infections are often asymptomatic or result in uncomplicated diarrhea, but may progress to bloody diarrhea, kidney disease, and death.

Food Safety

Food safety concerns pertinent to foods of animal origin often relate to Salmonella, parasite infections, antibiotic residues, Listeria, Campylobacter, Staphylococcus, and Clostridium. According to a National Animal Health Monitoring System fact sheet that detailed results of a Salmonella prevalence study, only 38 percent of sampled farms with finishing hogs had samples that were positive when tested for Salmonella (USAPHIS, 1997). Of the 38 percent of Salmonella-positive farms, the level of bacterial shedding in finishing hogs was low at an estimated 6 percent. In another study, 9.6 percent of uncooked or unprocessed samples

obtained from retail stores were contaminated with Salmonella. Although proper handling and cooking will prevent the consumer from becoming infected, it is of primary importance that animal science researchers work to identify means to reduce foodborne pathogens.

Antimicrobials

Antimicrobials and improvement in vaccine efficiency have saved millions of human lives. Over the course of the 20th century, deaths from infectious diseases declined markedly and contributed to a 29-year increase in life expectancy (CDC, 1999). They also play an important role in modern agriculture and in enhancing food security by preventing disease and improving food safety for humans. Antimicrobials are also used in animal agriculture to alter the animal's gut microflora and decrease the level of pathological bacteria present for production purposes. This aids feed conversion and hastens growth. Prudent and judicious use of antimicrobials is an important piece of the sustainability challenge. Animal agriculture, however, is at risk now of losing this progress through bacterial resistance. The CDC and WHO have identified antibiotic resistance as one of the greatest threats to human health worldwide. Resistance is now spreading to the point where there is a rise in so-called superbugs.

Animal Welfare

Concerns about animal welfare increasingly shape the acceptability and adoption of food animal production technologies. Although concerns about animal welfare are not new, it was not until the 1960s that significant public concern about animal welfare associated with the intensification of animal agriculture began to be apparent. These concerns centered mainly on confinement rearing and led to an influential British government committee report that stated that

both the physical and mental states of animals were important for welfare and recommended that all farm animals should be provided at least sufficient space to "stand up, lie down, turn around, groom themselves and stretch their limbs," referred to as the "Five Freedoms" (Brambell, 1965). Over time, this list of freedoms was expanded to include freedom from fear, distress, discomfort, pain, injury, disease, hunger, and thirst as well as freedom to express normal behaviors via provision of appropriate facilities and social companions. These Five Freedoms have been accepted by legislative and standards-setting bodies in many countries as ethical principles that underlie the care and treatment of farm animals. They also form the basis for a joint statement by the American Veterinary Medical Association (AVMA) and the Federation of Veterinarians of Europe (FVE) describing the roles of veterinarians with respect to animal welfare.

As public interest in and concern about animal welfare increases globally, emphasis on regulation, voluntary standards setting, and the development of animal welfare labeling programs continues to increase. Many countries now have regulations, codes of practice, or standards covering animal transport and humane slaughter, and an increasing number also have standards covering the breeding, housing and management of farm animals.

Conclusion:

Global health and food security is a trans-boundary and broad area of discussion and any effective decision needs integrated approach of all stake holders for it successful implementation and further planning process.

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30 Zoonotic brucellosis-prevalence, occurrence and transmission

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Brucellosis is an ancient disease and is one of world's major zoonoses accounting for enormous economic losses and significant human morbidity in endemic areas.Clinical conditions similar to brucellosis have been described since the time of Hippocrates in 450 BC. In the 19th century J. A. Marston was the first to describe brucellosis as Mediterranean gastric remittent fever in 1861 from his base in Malta. Sir David Bruce described the cause of the disease in 1887 and reported numerous small coccal organisms in stained sections of spleen from a fatally infected soldier. He isolated and identified the organism in culture from spleen tissue of British soldiers stationed at Malta and named it *Micrococcus melitensis* (Bruce 1887). Later, it was renamed *Brucella melitensis* in his honor. The relationship between contagious bovine brucellosis and human brucellosis was confirmed by Meyer and Shaw in 1920. In India, the presence of brucellosis was first established early in the previous century and since then reported from almost all states.

Occurrence and transmission

Animal brucellosis is endemic worldwide and bovine brucellosis, caused by *B. abortus*, remains the most widespread form in animals. Brucellosis causes considerable economic losses through reduced productivity, abortions and weak offspring of livestock, which is a major hurdle for trade and export. Human brucellosis is mainly caused by *B. melitensis*, *B. abortus*, *B. suis* and *B. canis*. Although *B. ovis* is widespread in sheep, it has not been identified in humans. *B. melitensis* is the principal cause of human brucellosis worldwide and may account for up to

90% of all brucellosis cases with *B. melitensis* type 1 predominating in India. The infective dose of *B. melitensis* is very low (10 organisms). Human brucellosis is traditionally described as a disease of variable manifestations. It is a severely debilitating disease manifesting numerous complications that require prolonged treatment with a combination of antibiotics leading to considerable medical expenses in addition to loss of income due to loss of working hours.

Consumption of unpasteurized milk and their products especially soft cheese, yoghurts and ice-cream, undercooked traditional delicacies such as liver and spleen are mainly responsible for human brucellosis. Camel milk is considered to be the most important source of infection in Middle East countries and Mongolia. Though rare, occasionally human-to-human transmission takes place through tissue transplantation or sexual contact. Also, contact with vaginal discharge, urine, feces and blood of infected animals through broken skin and mucous membrane of conjunctiva and inhalation of the organism can cause the disease. The disease is an occupational hazard for livestock owners, abattoir workers, dairy workers, shepherds, farmers, veterinarians and laboratory workers. Brucellosis is one of the most common laboratory acquired infections. With the increase in global tourism, brucellosis is emerging as a common imported disease in the developed world.

Among non-human animals, the predominant route of exposure for smooth strains of Brucella is through ingestion or inhalation of organisms that are present in fetal fluids or other birth products; herds are typically exposed following the introduction of an infected animal that subsequently gives birth or aborts a fetus, whereupon pasture or water become contaminated by excretions. Transient disease (e.g. abortions) can also develop following administration of a

live Brucella vaccine, particularly the *B. abortus* vaccine strain. Among dogs and sheep, transmission of rough strains of Brucella may be more common via the venereal route, although supporting data are limited. Among dogs, the urine of males and vaginal secretions of females are the main sources of infection via the venereal, oral, nasal, or conjunctival routes.The greatest impact of brucellosis is evident in breeding facilities, where chronic infections can become established and leave considerable effect on breeding success. Unlike other rough strains, *B. canis* is capable of causing human illness; however, *B. canis* associated illness is of decreased severity and frequency, compared with illness caused by the smooth Brucella strains.

B. suis was among the earliest agents investigated and developed as a bioterrorism weapon in the United States offensive bioterrorism program in the 1950s. The zoonotic pathogens *B. abortus, B. melitensis* and *B. suis* have been identified as Category B bioterrorism agents because they are easily capable of causing considerable morbidity and low numbers of deaths if used in a mass event. These three *Brucella* spp. are also designated as select agents by the US Government. They are under joint regulation between the CDC and the USDA as pathogens capable of causing substantial morbidity and death rates among domestic animals, with resultant effects on food supply. Therefore, any research or other work with these pathogens and any interstate transportation of isolates must be registered with these regulating agencies and be accompanied by the appropriate permits.

An estimated 500,000 human infections per year still occur worldwide. The reported incidence in endemic areas varies from <1/100,000 population in UK, USA and Australia, to >20-30/100,000 in southern European countries such as Greece and Spain and up to >70/100,000 in Middle Eastern countries like Kuwait and Saudi Arabia.

Worldwide prevalence

Brucellosis is major health problem in Mediterranean, Middle East, India, Latin America, Africa, parts of Mexico and parts of Asia. Syria has the highest annual incidence worldwide, reaching an alarming 1603 cases per million per year. Rate of human infection is high in Peru, Kuwait and Saudi Arabia as compared to sub-Saharan Africa, where the rate is relatively low which may be due to under reporting and low levels of surveillance.

Only 17 countries claim to be free of brucellosis. Though it has been eradicated from almost all of Europe, reports still indicate presence of human brucellosis in Greece, Spain and Turkey. Brucellosis-free status has been granted by the European Union (EU) to Sweden, Denmark, Finland, Germany, the UK (excluding Northern Ireland), Austria, Netherlands, Belgium, and Luxembourg (European Commission 2005). Norway and Switzerland are also considered brucellosis-free countries. France is an example of successful eradication. An increase in annual number of reported cases in Turkey has been observed, exceeding 15000 cases in 2004 (OIE, 2005) whereas situation in Iran is improving with the annual incidence falling from 1000 cases to 238.6 cases per million in 2003 (OIE, 2005). Iraq shows high endemicity with the annual incidence of 278.4 cases per million of population (OIE, 2005). Serological evidence of brucellosis was reported in chicken using conventional and non-conventional serological tests.

In US, the disease is usually present in Hispanic populations due to illegal importation of unpasteurized dairy products from neighboring Mexico, where the disease is endemic. The incidence is approximately 200 per year or 0.04 per 100,000. Patients in the United States are primarily found in Texas, California, Virginia, and Florida.

The occurrence of bovine brucellosis has been reported by 93 countries. The concept of host restriction of different

Brucella species is gradually eluding as reports from Brazil and Columbia show that *B. suis* biovar 1 has become established in cattle, thus, becoming a more important reservoir than pigs. *B. suis* has the widest host range, with established host-pathogen relationships in reindeer and hares in addition to swine. However, almost all *Brucella* spp can infect mammalian species other than their preferred host; for example, both *B. melitensis* and *B. suis* are capable of colonizing bovine udders and, therefore, contaminating cows' milk.

Prevalence in India

The true incidence of human brucellosis in India is not known. It has been estimated that the true incidence may be 25 times higher than the reported incidence due to misdiagnosis and underreporting. One study showed a seroprevalence of 1.6% by SAT and confirmed by isolating *B. melitensis* in 43 of the 93 children referred to the microbiology laboratory of the Patil Medical College in Bijapur, Karnataka during a period of 13 years. Most of them were shepherds and had the habit of consuming fresh goat milk. They also reported brucellosis in 495 adults with a prevalence rate of 1.8% by testing blood samples of 26,948 adults in Bijapur during a period of 16 years from 1988 to 2004 and isolated *B. melitensis* from 191 cases. Mathur (1964) reported 8.5% seroprevalence of brucellosis among dairy personnel in contact with infected animals and isolated Brucella from 7 cases. In Gujarat, 8.5% prevalence of Brucella agglutinins was recorded in human cases. In Haryana, 34% prevalence of human brucellosis was recorded among veterinarians, attendants and compounders in contact with animals. Thakur and Thapliyal (2002) observed a prevalence rate of 4.97% in samples obtained from persons exposed to animals with a markedly higher prevalence of 17.39% among field veterinarians. Another scientist found that 24 (8.2%) veterinary workers showed

Brucella specific antibodies in significant titres. High seroprevalence rate was also noted in specific risk groups such as abattoir workers. Mudaliar *et al*. (2003) showed the presence of Brucella antibodies in 5.33 % of animal handlers of which 4.51 % were dairy farm workers and 14.63 % were veterinary doctors. Rana *et al*. (1985) showed a seropositivity of 27.7 % among veterinarians in Delhi. Agasthya *et al*. (2007) reported brucellosis in high risk group individuals with disease prevalence at 41.23 % in veterinary inspectors, 30.92 % in veterinary assistants, 12.37 % in veterinary officers, 6.18 % in veterinary supervisors, 6.18 % in group- D workers, 2.06 % in shepherds and 1.03 % in butchers.

Economic impact

The impact of the disease on national economy due to brucellosis in cattle and buffalo was to the tune of Rs 240 million every year. This amounts to more than half % of total value of all meat and milk products produced in the country. The annual loss due to human brucellosis was estimated to be 30 million man-days. Earlier to this, the economic loss due to brucellosis among bovines was estimated at Rs 311.47 million (Mathur and Sharma 1974). Kunen (1994) estimated that the losses due to brucellosis cost India at least Rs 350 million annually in terms of food animals and man-days of labour lost. Human brucellosis causing physical incapacity and loss of 3 million man days of labour annually and it is estimated that 5 lakhs new human cases are affected annually in the world.

Prevention and control

Prevention of human brucellosis is dependent primarily on eradication or control of animal brucellosis by vaccination or culling, practice of hygienic measures by those at occupational risk and pasteurization or proper

heating of milk produce before consumption. Control of animal brucellosis is dependent on two main principles:

(a) *Prevention of exposure of animals* to infection by preventing free grazing and movement along with frequent mixing of flocks of sheep and goats, unrestricted trade, use of local cattle yards and fairs for trading, sending dry animals back to villages for maintenance, use of semen from unscreened bulls for artificial insemination and poor farm hygiene which contribute to the high prevalence and wide distribution of brucellosis in animals in India.

(b) *Elimination of infected animals from the herd*. Detection of truly infected animals assumes paramount importance in any brucellosis control programme. The campaign is easy to operate with high success in small farms with control over movement of animals. A test and slaughter of infected animals or extensive vaccination with approved vaccine, depending on the situation, may be used. This requires a quick, cheap and reasonably sensitive screening test besides a good confirmatory test. In cattle, RBPT is used as screen test followed by testing positive sera with CFT for confirmation. The milk ring test (MRT) could be used for identifying infected dairy herd with good results followed by sero-testing individual animals. Its major drawbacks are that this cannot be used on dry animals and its efficacy is doubtful in sheep and goats.

Mass immunization in cattle: At present, mass immunization with recommended doses of approved vaccines is the only way to bring down the incidence of brucellosis in areas with high prevalence. For cattle, B. abortus S-19, a live attenuated vaccine, given at the age of 3 to 6 months (in certain cases up to 8 months) is recommended. In spite of certain drawbacks, it is used 80% of cases with satisfactory results. When used routinely to attain coverage of population, there is a gradual decline in incidence leading to herd immunity. Where eradication is

the aim, vaccination should be stopped once the incidence falls below 0.2% and the infected animals must be eliminated.

Control in sheep and goat: The epidemiology and planning for prevention and control of brucellosis in sheep and goats are similar to that of cattle with minor adjustments. A live attenuated Brucella vaccine based on a smooth variant of *B. melitensis* Rev-1 appears to be highly effective and is widely used to vaccinate small ruminants in parts of the world where *B. melitensis* is enzootic. Immunization of young recently weaned rams (weaner rams) with the *B. melitensis* Rev-1 vaccine is also recommended for control of *B. ovis* in some countries. Like the strain 19 vaccine, this vaccine, too, causes abortions in pregnant animals and short-term shedding of the Rev-1 strain in milk leading to human infections with *B. melitensis* Rev-1. The probability of success in flocks where contact with other flocks is frequent remains poor. Under such circumstances, all the animals coming in contact should be tested.

Control in swine: In swine, control of brucellosis poses difficulty because there is neither a satisfactory test to identify infected individual animal nor a satisfactory vaccine. It is, therefore, advisable to slaughter the herd.

Control in wild animals: Control of brucellosis in wildlife animals has proved more challenging, which has been much complicated by the movement to protect animal biodiversity. In USA, brucellosis control in elk and bison in the Greater Yellowstone Area currently calls for surveillance and removal of seropositive animals from some populations as well as management actions to limit contact between bison and cattle in selected locations. Because transmission is increased among populations that access elk in winter feeding areas, some authorities have proposed discontinuation of winter feeding programs. Experimental vaccination did not prove effective in feral

swine or elk (Olsen *et al*. 2006) with variable results in bison. A bigger challenge for brucellosis control in wildlife and feral domestic animals, even an effective vaccine is developed, could be effective vaccine delivery systems for these animals.

Although advances in vaccine safety have been made, even the current animal vaccines possess certain drawbacks such as these are capable of causing both abortion among pregnant vaccinates and persistent infection among vaccinates with the vaccine strain. Thus, development of new vaccine(s) or improvements in existing vaccines, including expansion for use in more animal species, and efficacy against more of the pathogenic *Brucella* spp. are needed.

References: -On request-

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