INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
08–091/ZIP/2009/11–2–217–220
http://www.fspublishers.org

Review Article

Zoonoses

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ABSTRACT

Zoonotic diseases represent one of the leading causes of illness and death from infectious disease. Worldwide, zoonotic diseases have a negative impact on commerce, travel and economies. To survive, a biological pathogen had to be a chronic infection, stay alive in the host for long periods of time, or have a non-human reservoir or waiting for new hosts to infect. For zoonozes, often human is actually an accidental victim and a dead-end host. In recent years, zoonoses and communicable diseases common to man and animals have gained increasing attention worldwide. Human diseases that have their origins in infected animals, such as Bird Flu or tuberculosis, have highlighted the need for a better understanding of animal diseases in terms of their epidemiology, mechanism of transmission to man, diagnosis, prevention and control. In addition, as yet unidentified zoonotic diseases probably exist that pose infectious risks for people. This paper is an effort to develop a tentative inventory of the most common zoonotic diseases for sensitization of the personnel having frequent contact with animals.

Key Words: Zoonoses; Transmission; Infectious; Parasitic; Viral; Bacterial

INTRODUCTION

The diseases and infections, which are naturally transmitted between the vertebrate animals and human beings are called zoonotic diseases and this phenomenon is called zoonosis. Major impacts of zoonoses include illness, monetary loss, adverse effect on morale of personnel, un-favorable publicity and medico-legal implications (Steele, 1980). The major routes of transmission of zoonotic diseases are faeces, urine, saliva, blood, semi-cooked food, milk, aerosole, oral and contact (Schnurrenberger & Hubbert, 1981). There are more than 200 diseases of animals transmissible to people (Pastorel *et al.,* 1999). Examples are Rabies (Fishbein & Robinson, 1991), Tuberculosis (Moda, 1996), Glanders (Blood *et al.,* 2000), Anthrax (Lamarque *et al.,* 1989), etc. Zoonoses may be bacterial, viral, or parasitic, or may involve un-conventional agents (Acha & Szyfres, 2003). Zoonoses, depends upon three points i.e., nature of aetiologic agent, reservoir host and life cycle of the infecting organism (Hubbert *et al.,* 1975).

Dogs and cats are the two most common household pets, which may be a direct or indirect source of human infections (Chomme, 1992). Parasitic infections, such as creeping eruptions, visceral larva migrans, cryptosporidiosis and toxoplasmosis, are diseases associated with contact with dogs and cats (August, 1992). In addition, a number of well known and preventable animal diseases such as rabies, brucellosis, leishmaniasis and echinococcosis continue to occur in many countries especially in the developing world where they mostly affect the poorest segment of the human population. They cause a serious amount of deaths in millions of affected people every year (Acha & Szyfres, 1987). All major zoonotic diseases cause losses of efficient production and quality of food of animal origin, particularly of much-needed proteins and create obstacles to international trade in animals and animal products (Stohr & Melsin, 1997). They are thus, an impediment to overall socioeconomic development. An increase in awareness that some of these diseases may be associated with animals could provide a better plan for the prevention and treatment of common and un-common zoonotic infections (Tan, 1997). This article aims to familiarize people with some common and uncommon bacterial, rickettsial, parasitic and fungal zoonotic infections.

Factors influencing the zoonotic problems. Factors that may influence the zoonoses include: (i) length of time the animal is infective, (ii) length of the incubation period in animals, (iii) stability of the agent, (iv) population density of the animals in the colony, (v) husbandry practices, (vi) maintenance procedures and control of wild rodents and insects, (vii) virulence of the agent and (viii) route of transmission (Schnurrenberger & Hubbert, 1981; Steele, 1981; Benenson, 1990).

Types of Zoonoses

Reverse zoonoses. Infectious diseases of people occasionally transferred to animals and then transferred back to people are termed as 'Reverse Zoonoses' (Steele, 1979). Examples are Tuberculosis (Wolinsky, 1979), Mumps (Steele, 1981), *Streptococcus pyogenes* (Timoney *et al*., 1988), Infectious hepatitis (Steele, 1981), *Corynebacterium diphtheriae* (Brown, 1990), etc.

Emerging zoonoses. Zoonosis that is newly recognized or newly evolved, or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range is known as emerging zoonosis. Contrary to "lingering" zoonoses, public awareness of "emerging" zoonoses is very high. Emerging zoonotic diseases have potentially serious human health and economic impacts and their current upward trends are likely to continue. The recent emerging zoonoses, for example are Bird Flu (Reddy, 2007), AIDS (Gao *et al.,* 1999), Mad-cow disease (BSE; Steele, 1981) and the Nipah virus (Wong *et al.,* 2002). Some of the "lingering" zoonoses are re-emerging in some regions, although they seem to attract less public awareness. These include brucellosis, dog rabies and parasitic diseases such as cysticercosis/ taeniasis and echinococcosis/ hydatidosis (Murphy, 1998).

Factors influencing emerging zoonoses. Many factors lead to the emergence of zoonotic diseases. Environmental changes, human and animal demography, pathogen changes and changes in farming practice are a few of them. Social and cultural factors such as food habits and religious beliefs play a role too. New animal diseases with an un-known host spectrum are also included in this definition. Natural animal reservoirs represent a more frequent source of new agents of human disease than the sudden appearance of a completely new agent (Meslin, 1992).

Factors explaining the emergence of a zoonotic or potentially zoonotic disease are usually complex, involving mechanisms at the molecular level, such as genetic drift and shift, as it occurs in avian influenza virus (Reddy, 2007) and modification of the immunological status of individuals and populations. Social and ecological conditions influencing population growth and movement, food habits, the environment and many other factors may play a more important role than changes at the molecular level. Viruses especially RNA viruses with their ability to adopt quickly to changing environmental conditions are among the most prominent examples of emerging pathogens (Bell *et al.,* 1988).

Classification of zoonoses. A classification system based on the type of life cycle of the infective organism seems the most useful in planning a preventive medicine program. The following categories are recommended by the World Health Organization Expert Committee on zoonoses (Steele, 1981; 1982):

1. Direct zoonoses. If (i) Infections transmitted from the infected vertebrate host to susceptible vertebrate host either by direct contact, contact with a fomite or mechanical vector and (ii) during transmission, the agent undergoes no developmental and little or no propagative changes, the zoonoses will be termed as direct zoonozes. Examples are Rabies, Brucellosis, Trichionosis, etc. (Richmond *et al*., 2003).

2. Cyclo-zoonoses. If (i) the infection requires more than one vertebrate host species in order to complete the life cycle of the agent and (ii) no invertebrate hosts are required, the zoonoses will be termed as cyclo-zoonozes. Examples are Echinococcosis, Taeniasis, Pentastome Infection, etc. (Schwabe, 1964).

3. Meta-zoonoses. If (i) the infection is transmitted biologically by the invertebrate's vectors, (ii) the agents characteristically multiply or develop or do both in the invertebrate hosts and (iii) they essentially show a pre-patent period (i.e., extrinsic incubation before being transmitted to a suitable vertebrate host), the zoonoses will be termed as meta-zoonozes. Examples are Leishmaniasis, Plague, Schistosomiasis, etc. (Schwabe, 1964).

4. Sapro-zoonoses. If, the infection is transmitted from the inanimate developmental sites or reservoirs such as food, soil and plant to susceptible vertebrate hosts, the zoonoses will be termed as sapro-zoonozes. Examples are larva migrans, some mycotic diseases, etc. (WHO, 1959; 1967).

5. An infection transmitted from the lower vertebrate animals to man is termed as anthroponoses e.g., Plague (Mice/Rat → Man) (Bell *et al.*, 1988) and if vice versa (infections are primarily of human origin), it is termed as zooanthroponoses e.g., Flu (Man↔ Birds) (Arthur, 1966). The infections maintained between man and lower vertebrate animals, which may be transmitted in either direction are called as amphixenoses e.g., Tuberculosis (Cattle ↔ Man) (Telford *et al*., 1991).

Aetiologic Agents Involved in Zoonoses

1. Viral zoonoses. Viral zoonoses are virus infections of animals that can be naturally transmitted to man (Table I), often with devastating effect. Rabies is perhaps the prime example of a zoonotic viral infection, which causes some 60,000 human deaths per year. Rabies is a disease of carnivores and bats, which is mainly transmissible to humans by bites. Almost all persons severely exposed to rabid animals die if not treated. An estimated number of 55,000 persons, mainly children, die of this disease in the world every year (Krebs *et al*., 1993). Other viral zoonoses are avian influenza (Reddy, 2007), crimean-congo haemorrhagic fever (Acha & Szyfres, 2003), Ebola (Leroy *et al.,* 2005) and Rift valley fever (Peters & Linthicum, 1994).

2. Bacterial zoonoses (Table I). Every year millions of people get sick, because of foodborne zoonoses caused by different types of pathogenic bacteria such as Salmonellosis (Visser, 1991), Campylobacteriosis (Benenson, 1990) etc. Other bacterial zoonoses are: anthrax (Braderic & Punda-Polic, 1992), brucellosis (Young, 1989), *E. coli* (Griffin & Tauxe, 1991), leptospirosis (Heath & Johnson, 1994), plague (WHO, 1993), shigellosis (Keusch & Bennish, 1991) and tularaemia (Acha *et al*., 2003).

3. Ricketssial zoonoses (Table I). Rickettsiae are extremely small sized obligate intracellular prokaryotes, which multiply by binary fission. Rickettssial diseases are primarily transmitted by arthropods. The major reservoirs of infection are humans, rats, mice and small mammals (Ross, 1983). The main sources of human infection are affected domestic animals and their products. Human patients can

Table I. Some important Zoonotic diseases

Animal species	Type	Disease	Mode of transmission	Reference
Dogs	**Bacterial**	Anthrax Bacillus anthracis	Spore inhalation and Ingestion	Hunter *et al*., 1989
		Tuberculosis Mycobacterium bovis	Inhalation, ingestion and through break in skin	Evans *et al*., 2007
		Glanders Burkholderias mallei	Contact with infected horses	Acha *et al*., 2003
		Brucellosis Brucella spp	Milk and carcass of infected animals	Acha *et al*., 2003
		Salmonellosis Salmonella spp non-typhoidal	Ingestion Food of animal origin	Acha *et al*., 2003
		Plague Yersinia pestis	Rat Flea bite	Acha *et al*., 2003
	Viral	Rabies Rabies virus	Infected dogs, and other mammals bite	Beran, 1991
	Rickettsial	Rocky Mountain Spotted Fever *Rickettsia rickettsii*	Tick bite	Acha *et al*., 2003
		Ehrlichiosis Ehrlichia canis	Tick bite	Radostitis *et al*., 2007
	Parasitic	Toxoplasma gondii	Ingestion of oocysts of cat faeces	Radostitis *et al*., 2007
		Dipylidium canimum	Faeco-oral	Radostitis *et al*., 2007
		Dirofilaria immitis, Dirofilaria tenuis	mosquitoes	Radostitis *et al*., 2007
		Echinococcus granulosus	inghestion	Radostitis *et al*., 2007
		Leishmania spp	Sand flies	Radostitis *et al*., 2007
	Fungal	Sporothrix schenckii	Cutaneous lesion infected with spore	Acha *et al*., 2003
		Microsporum spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
		Trichophyton spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
Buffaloes	**Bacterial**	Anthrax Bacillus anthracis	Spore inhalation and Ingestion	Hunter *et al*., 1989
		Tuberculosis *Mycobacterium bovis*	Sputum, raw milk urine and vaginal discharge.	Evans *et al*., 2007
		Glanders *Burkholderias mallei*	Contact with infected horses	Acha *et al*., 2003
		Brucellosis Brucella spp	Milk and carcass of infected animals	Acha *et al*., 2003
		Salmonellosis Salmonella spp non-typhoidal	Ingestion Food of animal origin	Acha *et al*., 2003
		Plague Yersinia pestis	Fleas bite	Acha *et al*., 2003
	Viral	Rabies Rabies virus	Bite	Beran, 1991
		Vesicular stomatitis virus	Insect or contact	Radostitis *et al*., 2007
		Japanese B encephalitis	Mosquitoes	Acha *et al*., 2003
		Rift Valley Fever	Mosquitoes	Acha *et al*., 2003
	Rickettsial	Q-Fever Coxiella burnetii	Inhalation and ingestion	Acha *et al*., 2003
	Parasitic	Toxoplasma gondii	Ingestion of oocysts of cat faeces	Radostitis *et al*., 2007
		Dirofilaria immitis, Dirofilaria tenuis	mosquitoes	Radostitis *et al*., 2007
		Fasciola hepatica	Ingestion Snail	Radostitis *et al*., 2007
		Campylobacter fetus	Handling of Infected aborted animal fetus and foetal membranes	Radostitis *et al*., 2007
		Echinococcus granulosus	Ingestion	Radostitis *et al*., 2007
		Leishmania spp	Sand flies	Radostitis *et al*., 2007
	Fungal	Sporothrix schenckii	Cutaneous lesion infected with spore	Acha *et al*., 2003
		Microsporum spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
		Trichophyton spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
	Other	Bovine Spongy form encephalopathy BSE	Ingestion	Radostitis *et al*., 2007
Horses	**Bacterial**	Tetanus Clostridium tetani	Wound infected with spores.	Radostitis *et al*., 2007
		Anthrax Bacillus anthracis	Spore inhalation and Ingestion	Hunter *et al*., 1989
		Tuberculosis Mycobacterium bovis	Sputum, raw milk urine and vaginal discharge.	Evans *et al*., 2007
		Glanders Burkholderias mallei	Contact with infected horses	Radostitis *et al*., 2007
		Brucellosis Brucella spp	Milk and carcass of infected animals	Radostitis *et al*., 2007
		Salmonellosis Salmonella spp non-typhoidal	Ingestion	Radostitis *et al*., 2007
		Plague Yersinia pestis	Fleas bite	Radostitis *et al*., 2007
	Viral	Vesicular Stomatitis Virus	Bite	Radostitis *et al*., 2007
		Rabies virus	Insect or contact	Radostitis *et al*., 2007
		Eastern encephalitis Western encephalitis Venezuelan encephalitis	Mosquitoes	Acha *et al*., 2003
		California encephalitis	Mosquitoes	Acha *et al*., 2003
	Fungal	Sporothrix schenckii	Cutaneous lesion infected with spore	Acha *et al*., 2003
		Microsporum spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
		Trichophyton spp	Carrier animal direct contact and infected inanimate object	Radostitis *et al*., 2007
Sheep and goats	**Bacterial**	Anthrax Bacillus anthracis	Spore inhalation and Ingestion	Hunter *et al*., 1989
		Tuberculosis Mycobacterium bovis	Sputum, raw milk urine and vaginal discharge.	Evans *et al*., 2007
		Glanders Burkholderia mallei	Contact with infected horses	Radostitis *et al*., 2007
		Brucellosis Brucella spp	Milk and carcass of infected animals	Radostitis *et al*., 2007
		Salmonellosis Salmonella spp non-typhoidal	Ingestion	Radostitis *et al*., 2007
	Viral	Rabies Rabies virus	Bite	Beran, 1991
		Vesicular Stomatitis Virus	Insect or contact	Radostitis *et al*., 2007
		Bovine pustular stomatitis virus orf, contagious ecthyma	Abrasion infected while handling disease animals.	Acha *et al*., 2003
	Rickettsial	Q-Fever Coxiella burnetii	Inhalation and ingestion	Acha *et al*., 2003
	Parasitic	Toxoplasma gondii	Ingestion of oocysts of cat faeces	Radostitis *et al*., 2007
		Fasciola hepatica	Ingestion Snail	Radostitis *et al*., 2007

develop a chronic illness characterized by endocarditis and hepatitis (Steele, 1980).

4. Parasitic zoonoses (Table I). Parasitism is the major health problem both for animals and humans, which constitutes major part of the zoonoses. Some of the examples of parasitic zoonoses include cysticercosis, echinococcosis, toxoplasmosis, etc. (Steele, 1980; 1982).

5. Fungal zoonoses (Table I). Fungus is the main source of the most of the skin problems and mostly occurs due to direct contact.

In most developing countries, zoonotic diseases are among those diseases that contribute significantly to an already overly burdened public health system. In industrialized nations, zoonotic diseases are of particular

concern for at-risk groups such as the elderly, children, childbearing women and immuno-compromised individuals. Many different determinants contribute to the emergence of new zoonotic agents and it is rare that these factors act singly. Among the forces that shape their emergence are human demographics and behavior; technology, industry and agriculture; economic development and land use; international travel, commerce and military expeditions; microbial adaptation and change; and breakdown of public health measures (Yamada, 2004). Indeed, social and environmental changes are accelerating, in both the developed and developing worlds. The developed world has the greatest travel and transport, providing particular risks for rapid spread. Ecological change is greatest in the developing world and biodiversity is greatest in the tropics, which makes these regions potentially productive breeding grounds for new pathogens.

To conclude, it cannot be predicted, which zoonotic pathogens are likely to emerge next or cause the biggest problem. Given the obvious link between human health and pathogens that circulate in domestic animals and wildlife, we must be alert to pathogen flow in any of these areas.

REFERENCES

Acha, P.N. and B. Szyfres, 1987. *Zoonoses and Communicable Diseases Man and Animals*. Pan American Health Organization, Scientific and Technical Publications, Washington, DC

Acha, P.N. and B. Szyfres, 2003. *Zoonoses and Communicable Diseases Man and Animals*, 3rd edition, Vol. (1 & 2). Pan American Health Organization, Scientific and Tech. Publications, Washington, DC

Arthur, D.R., 1966. Zooanthroponoses. *Nature*, 212: 1024

August, J.R., 1992. Zoonotic complications of bite and scratch wounds. *Proc. 10th ACVIM Forum*, pp: 665–667.

Bell, J.C., S.R. Palmer and J.M. Payne, 1988. *The Zoonoses: Infections Transmitted from Animals to Man*. Edward Arnold Press, London

Benenson, A.S., 1990. *Control of Communicable Diseases in Man*, 15th edition. American Public Health Association, Washington, DC

Blood, D.C., C.C. Gay, O.M. Radostits and K.W. Hincncliff, 2000. *Veterinary Medicine*, 9th edition. W.B. Saunders Publishing Company Limited, NY

Braderic, N and V. Punda-Polic, 1992. Cutaneous anthrax due to Pencillin resistant Bacillus anthracis transmitted by an insect bite. *Lancet*, 340: 306–307

Brown, E., 1990. Other Corynebacteria. *In:* Mandell, G.L., R.G. Douglas and Jr. J.E. Benett (eds.), *Principles and Practice of Infectious Diseases,* 3rd edition. Chuchill Livingstone, Inc. New York

Chomme, B.B., 1992. Zoonoses of house pets other than dogs, cats and birds. *The Pediatric Infectious Disease J.,* 11: 479–487

Fishbein, D.B. and L.E. Robinson, 1991. *Rabies. N. Engl. J. Med*., 329: 1632–1638

Gao, F., E. Bailes, D.L. Robertson, Y. Chen, C.M. Rodenburg and S.F. Michael, 1999. Origin of HIV-1 in the chimpanzee Pan troglodytes troglodytes. *Nature*, 397: 436–441

Griffin, P.M. and R.V. Tauxe, 1991. The epidemiology of infections caused by Escherichia coli O157: H7, other enterohaemorrhagic *E. coli* and the associated hemolytic uremic syndrome. *Epidemiol. Rev.*, 13: 60

Heath, S.E. and R. Johnson, 1994. Leptospirosis. *J. American Vet. Med. Assoc.*, 205: 1518

Hubbert, W.T., W.F. McCulloch and P.R. Schnurrenberger, 1975. *Diseases Transmitted From Animals to Man.* Charles C. Thomas Publishers, Springfield, IL

Keusch, G.T. and M.L Bennish, 1991. Shigellosis. *In*: Evans, A.S., P.S. Brachman (eds.), *Bacterial Infections of Humans*, 2nd edition. Plenum Medical Book Co, New York

Krebs, J.W., T.W. Strine and J.E. Childs, 1993. Rabies surveillance in the United states during 1992. *J. American Vet. Med. Assoc.,* 203: 1718–1731

Lamarque D, C. Haessler, R. Champion., D. Granga., Bendina, P. Steinmetz., A. Guelina and Y. Maurice, 1989. Anthrax in Chad: a zoonosis that still exists today. *Med. Trop.*, 49: 245–251

Leroy, E.M., B. Kumulungui, X. Pourrut, P. Rouquet, A. Hassanin, P. Yaba, A. Délicat, J.T. Paweska, J.P. Gonzalez and R. Swanepoel, 2005. Fruit bats as reservoirs of Ebola virus. *Nature*, 438: 575-576

Meslin, F.X., 1992. Surveillance and control of emerging zoonoses. *World Health Stat Q.*, 45: 200–207

Moda, G., 1996. The zoonotic importance of *Mycobacterium bovis*. Tuberculosis and Lung Diseases, 77: 103–108

Murphy, F.A., 1998. *Emerging Zoonoses*, Vol. 4, p: 3. University of California, Davis, California, USA

Pastorel, P.P., J. Blancou, P. Vannier and C. Verschueren, 1999. *Veterinary Vaccinology*, 2nd edition. Elsevier Publication, New York

Peters, C.J. and K.J. Linthicum, 1994. Rift Valley fever. *In*: Beran, G.W. (ed.), *Handbook Series of Zoonoses, Section B: Viral Zoonoses*, 2nd edition, pp: 125–138. Boca Raton, Florida: CRC Press

Reddy, M.R., 2007. *Bird Flu. Health, Safety and Contingency Guidelines.* SBS Publishers and Distributors (Pvt) Ltd., New Delhi

Richmond, J.Y., H. Krauss, A. Weber, M. Appel, B. Enders, A.V. Graevenitz, H.D. Isenberg, H.G. Schiefer, W. Slenczka and H. Zahner, 2003. *Zoonoses, Infectious Diseases Transmissible from Animals to Humans,* 3rd edition. ASM Press. American Society for Microbiology, Washington DC., USA

Ross, F.C., 1983. *Introductory Microbiology*. Charles E. Merril Publishing Co. Ohio, USA

Schnurrenberger, P.R. and W.T. Hubbert, 1981. *An Outline of the Zoonoses*, pp: 1–157. Iowa State University Press, Ames

Schwabe, C.V., 1964. *Veterinary Medicine and Human Health*. Williams and Wilkins Publications, Baltimore

Steele, J.H., 1979. *Handbook Series in Zoonoses, Section A: Bacterial, Rickettsial and Mycotic Diseases*, (Vol. I). CRC Press, Boca Raton

Steele, J.H., 1980. *Handbook Series in Zoonoses, Section A: Bacterial, Rickettsial and Mycotic Diseases,* (Vol. II). CRC Press, Boca Raton

Steele, J.H., 1981. *Handbook Series in Zoonoses, Section B: Viral Zoonoses*, (Vol. I & II). CRC Press, Boca Raton

Steele, J.H., 1982. *Handbook Series in Zoonoses, Section B: Parasitic Zoonoses*, (Vol. I, II & III). CRC Press, Boca Raton

Stohr, K. and F.X. Melsin, 1997. The role of veterinary public health in the prevention of zoonosis. *Archives of Virology Supplement*, 13: 207–218

Tan, J.S., 1997. Human zoonotic infections transmitted by dogs and cats. *Arch. Internal Medicine*, 157: 1933–43

Telford, S.R., R.J. Pollack and A. Spielman, 1991. Emerging vector-borne infections. *Infectious Disease Clinics of North America*, 5: 7–17

Timoney, J.F., J.H. Gillispie, F.W. Scott and J.E. Barlough, 1988. *Hogan and Burner's Microbiology and Infectious Diseases of Dometic Animals*, 8th edition. Comstock Pub. Co. Ithaca, USA

Visser, I.J.R., 1991. Cutaneous salmonellosis in veterinarians. *Vet. Rec.*, 129: 364

WHO, 1959. *Joint WHO/FAO Expert Committee on Zoonoses*, 2nd Report. World Health Organization, Technical Report Series No. 169, Geneva

WHO, 1967. *Joint WHO/FAO Expert Committee on Zoonoses*, 3rd Report. World Health Organization, Technical Report Series No. 378, Geneva

WHO, 1993. Human plague in 1991. *Wkly. Epidemiol. Rec.*, 68: 21–23

Wolinsky, E., 1979. Non-tuberculous mycobacteria and associated diseases. *American Rev. Resp. Dis*., 119: 107–159

Wong, K.T., W.J. Shieh., S.R. Zaki and C.T. Tan, 2002. Nipah virus infection, an emerging paramyxoviral zoonosis. *Springer Semin. Immunopathol*., 24: 215–228

Yamada, A., 2004. Zoonoses. *Uirusu*, 54: 17–22

Young, E.J., 1989. Clinical manifestations of human brucellosis. *In*: Young, E.J., M.J. Corbel (eds.), *Brucellosis: Clinical and Laboratory Aspects*. CRC Press, Boca Raton

(Received 01 April 2008; Accepted 31 October 2008)