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Transmission of zoonoses through immigration and tourism

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Summary

More than 200 of the documented zoonoses represent a high proportion of the infectious diseases that cause cases of morbidity and mortality and almost 75% are emerging infections. Immigration and tourism are human activities that are included in the broader field of human migration and travel. Travel plays a significant role in the emergence and spread of disease. The migration of humans has provided the route of spread for infectious diseases and zoonoses (for example, plague, yellow fever, monkey pox and severe acute respiratory syndrome). Tourism constitutes a small fraction of overall movements of humans but a point worthy of note is the number of international travellers has increased by more than 1 300% over the last 50 years. In addition, over 80 million people, mostly from developing countries, are legal or illegal immigrants. The consequences of travel extend beyond the traveller to the population visited and the ecosystem. Tourism and immigration may constitute an interface for mixing different genetic and ecological profiles, as well as cultural and social aspects, which is of particular interest in regard to zoonoses. Primary prevention, epidemiological surveillance and health education in the framework of intersectoral and international collaboration remain the cornerstone for response to and control of zoonoses in the context of tourism and immigration.

Keywords

Disease, Health, Immigration, Public health, Tourism, Travel, Zoonosis.

Trasmissione di zoonosi attraverso l'immigrazione e il turismo

Riassunto

Più di 200 zoonosi documentate rappresentano una proporzione elevata di patologie infettive correlate a casi di morbilità e mortalità e circa il 75% sono infezioni emergenti. L'immigrazione e il turismo sono attività umane che rientrano nel più vasto ambito delle migrazioni umane e degli spostamenti. I viaggi rivestono un ruolo importante nella comparsa e diffusione di malattie e i movimenti migratori hanno aperto la strada alla diffusione di malattie infettive e di zoonosi (ad es. peste, febbre gialla, vaiolo della scimmia e sindrome respiratoria acuta). Il turismo rappresenta solo una parte degli spostamenti delle persone, ma è degno di nota il fatto che il numero dei viaggiatori internazionali è aumentato di più del 1300% negli ultimi 50 anni. Inoltre, più di 80 milioni di persone, per lo più provenienti da paesi in via di sviluppo, sono immigrati legali o illegali. Le conseguenze dei viaggi si estendono, oltre al viaggiatore stesso, alla popolazione visitata e all'ecosistema. Il turismo e l'immigrazione possono essere una interfaccia nel mescolare differenti profili genetici ed ecologici – come pure aspetti culturali e sociali – particolarmente interessanti quando si parla di zoonosi. La prevenzione, la sorveglianza epidemiologica e l'educazione sanitaria in una rete di collaborazioni intersettoriali e internazionali, restano fondamentali nel controllo delle zoonosi, in particolare di quelle legate al turismo e all'immigrazione.

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Parole chiave
Immigrazione, Malattia, Salute, Sanità pubblica, Turismo, Viaggio, Zoonosi.

Introduction

Zoonoses are infectious diseases that affect animals. They can be caused by bacteria, viruses or parasites that can also be transmitted to humans. There are actually over 200 known zoonoses that represent a significant proportion of all known pathogens, in particular of the emerging pathogens, as they constitute more than 75% of emerging causes of communicable diseases (1, 6, 9).

Tourism and immigration are human migration activities that involve different time scale characteristics whilst having a considerable social and economic impact and components.

Tourism is the travel of a limited duration for pleasure, leisure or holiday while immigration is migration of a definitely longer duration to settle in a different country or region of the same country. Tourism represents almost 55% of total travel and human movement and migration (4). Nevertheless, the number of international travellers has steadily multiplied by 13 over the past 50 years and has increased by 73% in the last 15 years, raising the total number of international tourist arrivals to over 700 million in 2004. In addition, more people than ever travel to exotic destinations in developing countries (an increase of more than 50% was reported in this specific category between 1993 and 1999). At the same time, over 80 million people, mostly from developing countries, are legal or illegal immigrants (2, 4, 5, 7).

Migration and, more specifically, travel, have a well-known role in the emergence and spread of disease (7). Plague, yellow fever, severe acute respiratory syndrome (SARS), monkey pox, West Nile fever and chikungunya are only few examples of diseases that have spread between countries and continents through travel. This fact is of particular importance in the current era as human movement and migration have dramatically increased, while the time required to cover the same distance has considerably decreased. Today, it is possible to circumnavigate the globe in less than the incubation period of many communicable diseases and zoonoses in particular. Furthermore, increased air travel facilitates the movement of potentially infected people and vectors (2, 4, 5).

Characteristics of the problem

Zoonoses have the potential to spread through human migration, be it through tourism or immigration, and can be categorised according to the mode of transmission and/or host organism as follows:

- foodborne or waterborne**:** salmonelloses, typhoid fever, brucellosis, amoebiasis etc.
- airborne or droplet-borne: SARS, avian influenza, arthropod vectorborne: malaria, dengue fever, viral haemorrhagic fevers, chikungunya, etc.
- animal hosts/reservoirs: plague, hanta fever, Q fever, rabies, avian influenza, etc.

The mode of transmission and type of host organism/reservoir are factors that are directly related to the potential of the disease to cause outbreaks (epidemic-prone diseases). Epidemic-prone zoonoses are of particular interest with regard to tourism and immigration as human migration has been the main source of epidemics throughout history (7).

Disasters (earthquakes, floods, hurricanes, tsunamis, drought, war, etc.), whether natural or not, as well as the preparedness of the countries to respond to such unexpected events, have a major impact on the spread of disease through travel and migration. Disasters can offer favourable conditions for the occurrence and spread of epidemics as they can potentially enhance the contact with and vulnerability to the respective pathogens as a consequence of the disruption of health and public health systems and of the migration and shelter of individuals.

Travel, in the broad sense, enables contact with 'local' zoonoses as well as an introduction to infectious agents in a setting that is considerably different from an epidemiological point of view. In practice, it provides the

interface for different genetic and immunological backgrounds, pathogens and vectors, cultural and behavioural patterns, environmental and socio-economic aspects to meet and interact. The occurrence of disease and/or of an epidemic in these circumstances, as well as the magnitude of the spread of the disease, relies on factors that define the permissiveness, susceptibility and vulnerability of individuals as well as that of the populations of origin and of destination (7).

Disease may be severe when a pathogen is introduced into a population that was previously naive in regard to exposure. The arrival of European explorers in the Americas at the end of the 15th century introduced diseases like measles, tuberculosis, mumps, influenza and smallpox; these were common in Europe but were unknown on the new continent. The initial epidemics had devastating effects for the previously non-exposed populations of native Americans (smallpox mortality rates reached 30-50% in some regions). Similarly, deaths from infectious diseases by far exceeded deaths related to injuries in military conflicts among European soldiers who were working in the tropics in the 19th century (7).

Nevertheless, the introduction of a pathogen with new or unusual characteristics into a population is not synonymous of the occurrence of disease or, even less, of the occurrence of an epidemic. The duration of survival primarily or exclusively in the human host and the transmission from person to person, in either mode, is of crucial importance in regard to travel-related infections.

A pathogen can be transmitted only if conditions are permissive. Permissiveness is related to a wide variety of factors that range from human behaviour to the environment or to the presence of the relevant vectors/hosts required for the life cycle of the pathogen (7).

Malaria, dengue, chikungunya and schistosomiasis are all examples of diseases that require the presence of their arthropod vector or intermediate host for transmission to continue once introduced in a new region (9).

Tourists who adopt the behavioural patterns prevailing in their destination country might be at increased risk of infection because of different habits in regard to the preparation of food and to clothing or accommodation arrangements (1). On the contrary, the introduction of a travel-related, previously non-existent, foodborne or waterborne disease, such as cholera or typhoid fever, in a country does not generate local transmission or an epidemic unless the health and environmental conditions are permissive.

Susceptibility of a population may vary because of genetic differences. Genetic factors may influence both susceptibility to infection and severity of clinical manifestations. Malaria is an example of a disease that has known susceptibility differences between populations.

Vulnerability is complex and multifactorial, depending on the immunological sequelae, socioeconomic factors, cultural and behavioural patterns. Risk factors, such as gender, age, profession, the consumption of raw/undercooked food, unsafe sex, accessibility to health care services, are known to determine the vulnerability of an individual or population to infectious diseases, not excluding travel-related zoonoses. An outbreak of visceral leishmaniosis with unusually high mortality occurred in southern Sudan in 1994 when a vulnerable malnourished population migrated from a non-endemic to an endemic area (7).

The carriage of pathogens is not the only way in which travel-related infectious diseases occur. Human activities that are directly related to the development of tourism and to immigration contribute significantly to travel-related morbidity.

The development of the tourism industry is frequently associated with various levels of urbanisation activities of what were previously rural areas, such as road construction, deforestation and increased trade, ultimately creating close and unprecedented contact with wild flora and fauna and, potentially, with the reservoirs or hosts of unknown pathogens (1). Certain forms of tourism, such as ecotourism or wildlife tourism, that has been developed

by several countries constitutes a non-negligible source of income for many developing countries, such as Tanzania and Kenya (1).

In a broader perspective, human activities, otherwise related to various aspects of economic development, including construction, opening of roads, urbanisation, introduction of technology, new farming methods etc., are all associated with human migration and potentially immigration, as well as with ecological and wildlife habitat changes, and consequently have a considerable influence on the emergence and spread of disease (7).

Travel-related morbidity and mortality

Health problems are frequent in travellers. Between 22% and 64% of travellers to the developing world report mild problems, most of which are related to self-limited illness, such as diarrhoea, respiratory infections and skin problems. Of these, 8% of the population (that exceeds 50 million) require medical care during or after travel. According to different studies, non-communicable diseases are the first cause of travel-related mortality with accidents and exacerbation of pre-existing disease (cardiovascular events) being the first cause of death while abroad. Malaria remains the most frequent cause of death related to an infectious disease whereas diarrhoea is the most frequent illness suffered by tourists (2, 3).

The risk of travel-related infectious diseases and death depends on a multitude of factors that include the countries of origin and destination (with regard to the level of development and consequent public health infrastructures and endemicity of disease), the length and conditions of stay, the season and climate, the purpose of travel, prevailing behavioural patterns and activities that define potential exposure, means of transportation, as well as the health characteristics of the host, i.e. pre-existing diseases, previously acquired immunity, compliance with prophylactic measures, etc. (2).

All of these factors are necessary to formulate a reliable risk assessment for the individual traveller, define the probability of exposure to specific disease pathogens and of eventual disease occurrence following this exposure.

The incidence of selected zoonoses per 100 000 travellers per month of stay has been estimated as follows (4):

- diarrhoea: 30 000-80 000
- enterotoxigenic (ETEC) *Escherichia coli*: 10 000
- malaria in West Africa (without the use of appropriate malaria prophylaxis): 2 000-3 000
- dengue fever: 200
- typhoid fever in India, North and north-west Africa: 30
- typhoid fever (overall): 3
- Japanese encephalitis: 0.1.

In 2006, the Geosentinel Surveillance Network published comparative morbidity data collected between June 1996 and August 2004, by destination from 17 353 patients with travel-related illness after travel to the developing world (3). The 30 geosentinel sites are specialised tropical or travel medicine clinics on six continents that collect clinician-based surveillance data on travel-related diseases from a broad sample of destinations. Of ill travellers, 55% had had pre-travel counselling and 67% had a diagnosis that fell into 4 of 21 major syndrome categories, namely: acute diarrhoea, systemic febrile illness, dermatological disorders and chronic diarrhoea. The young and mostly male (52%) patients (average age: 33; range: 26-45) had travelled for an average of 23 days (range: 14-60) in one or several regions of the developing world; sub-Saharan Africa was the most popular destination (almost 25%) followed by South-Central and South-East Asia (almost 14% of patients had a travel history to either region). Tourism was the main purpose of travel (59%) followed by visits to friends and relatives (15%) and business (14%). Of the patients, 64% had visited the clinic within the first month of their return, whereas 11% had required hospital admission. Significant differences in proportionate morbidity were observed among regions ($p<0.01$): the systemic febrile illness was more frequent among

patients who returned from sub-Saharan Africa, acute diarrhoea among those returning from South-Central Asia and dermatological disorders were less common among patients returning from sub-Saharan Africa or South-Central Asia. Malaria was the most frequent cause of systemic febrile illness overall (352/1 000 patients or 59% of cases where a pathogen was reported), the predominant cause of the same syndrome in those returning from sub-Saharan Africa 622/1 000 and within the first three causes of systemic febrile illness in all regions. Dengue was the second most frequent cause of systemic febrile illness overall (104/1 000), being the first cause in all regions except for sub-Saharan Africa. Patients returning from sub-Saharan Africa were the only travellers to present with rickettsial infections, whereas typhoid fever was a considerable cause of systemic febrile illness among ill travellers to South-Central Asia (141/1 000) (3).

Parasite-induced diarrhoea was more frequent in all regions (354/1 000) except in ill travellers returning from South-East Asia where bacterial causes (*Campylobacter*) predominated (369/1 000).

Overall, insect bites were the most common dermatological disorder (187/1 000) followed by cutaneous larva migrans (129/1 000), allergies (113/1 000) and skin abscesses (97/1 000).

Recent data confirm that the destination is of prime importance for the definition of travel-related morbidity, that malaria remains the leading cause of travel-related disease among febrile travellers overall, dengue is a non-negligible contributor to travel-related febrile illness and is most common in all regions except in sub-Saharan Africa and parasites prevail everywhere in cases of travellers with acute diarrhoea returning from South-East Asia.

Although incidence data are needed to be able to formulate sound risk assessments, proportionate morbidity that is specific to the region is very important for individual case management after the return of the ill traveller and provides a reliable estimate of the region-specific risk of disease.

Management and response – conclusions

The management and response to migration and travel-related infectious diseases includes primary prevention, early identification and case management, including treatment, secondary prevention of cases and epidemiological surveillance.

With regard to travel-related zoonoses, primary prevention is mainly focused on the animal and human health interface through the collaboration of the two competent sectors in the country of destination (5). The existing infrastructure of the public health sector in both the country of origin and in that of destination are factors that define the outcome after the introduction of a travel-related zoonosis and the extent and effectiveness of primary and secondary prevention and permissiveness, as described earlier. In addition, health education and increased awareness of tourists and immigrants play an important role with regard to both primary and secondary prevention (1).

Early identification of cases followed by effective and appropriate control measures and the early application of treatment contribute to the containment of disease and assist in limiting sequelae and reducing the impact on health (5). Malaria-related deaths are associated with both the lack of anti-malaria preventive treatment and the delay in considering and confirming diagnosis.

Finally, the epidemiological surveillance of zoonoses, including travel-associated disease, offers a unique tool for the assessment of existing control and prevention measures, both in the animal and human sectors (1). The efficient implementation of epidemic intelligence procedures, in conjunction with action-oriented surveillance systems, offer the advantage of providing information at an early stage.

As applicable in all unexpected events of public health importance, management and

response to travel-related zoonoses rely on overall public health preparedness in the countries of origin and of destination. Furthermore, the international community has, for centuries, used international regulations to limit and control the spread of disease between countries. The revised *International Health Regulations* adopted in 2005 reshaped the rules and procedures for the management of public health events of international concern (8). The management of travel-related zoonoses will inevitably benefit from the application of this legally binding text that requires countries to have the capacity to detect, identify, respond to and communicate on all unexpected public health events that have a potentially international impact.

References

1. Chomel B.B., Belotto A. & Meslin F.-X. 2007. Wildlife, exotic pets and emerging zoonoses. *Emerg Infect Dis*, **13** (1), 6-11.
2. Hill D.R. 2006. The burden of illness in international travelers. *N Engl Med*, **354** (2), 115-118.
3. Freedman D.O., Weld L.H., Kozarsky P.E., Fisk T., Robins R., von Sonnenburg F., Keystone J.S., Pandey P. & Cetron M.S. 2006. Spectrum of disease and relation to place of exposure among ill returned travelers. *N Engl Med*, **354** (2), 119-130.
4. Keystone J.S., Kozarsky P.E.., Freedman D.O., Nothdurft H.D. & Connor B.A. 2003. Epidemiology: morbidity and mortality in travelers in travel medicine, 1st Ed. Mosby, St Louis, 510 pp.
5. Murphy F.A. 1998. Emerging zoonoses. *Emerg Infect Dis*, **4** (3), 429-435.
6. Pappaioanou M., Gomez T. & Drenzek C. 2004. New and emerging zoonoses. *Emerg Infect Dis*, **10** (11) (www.cdc.gov/ncidod/EID/vol10no11/04-0797_05.htm accessed on 7 September 2008).
7. Wilson M.E. 1995. Travel and the emergence of infectious diseases. *Emerg Infect Dis*, **1** (2), 39-46.
8. World Health Organization (WHO) 2005. International health regulations. WHO, Geneva, 74 pp (www.who.int/csr/ihr/en/ and www.who.int/csr/ihr/IHR_2005_en.pdf accessed on 7 September 2008).
9. World Health Organization (WHO) 2008. Zoonoses and veterinary public health. WHO, Geneva (www.who.int/zoonoses/en/ accessed on 7 September 2008).

