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Study of mortality from infectious diseases in Brazil from 2005 to 2010: risks involved in handling corpses

Estudo da mortalidade no Brasil por doenças infecciosas, de 2005 a 2010: riscos envolvidos no manejo de cadáveres

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Abstract *In the wake of disasters, the lack of information on how to handle and dispose of corpses leads the professionals involved in emergency operations to uncertainty about associated risks and safety precautions. The article seeks to establish the risks of the etiologic agents involved in Brazilian mortality due to infectious diseases and identify and discuss the main protection measures for professionals involved in handling of corpses in disaster situations. It involved a survey of deaths by infectious diseases in Brazil between 2005 and 2010, using data from the Mortality Information System. Of the 171,223 deaths analyzed, the pathogens leading to the greatest number of deaths were: HIV, Mycobacterium tuberculosis and Trypanosoma cruzi. 59% belonged to risk class 3 and 40.6% to risk class 2. Eight deaths were caused by risk class 4 pathogens, which represent high risk. The professionals involved in the handling of corpses may be exposed to chronic risks, such as viruses transmitted via blood, gastrointestinal infections and tuberculosis. These findings indicate the importance of investment in the preparation of measures to reduce the risk of infection associated with the handling of corpses.*

Key words Corpse, Disasters, Risk, Exposure to biological agents, Public health

Resumo *Após os desastres, a falta de informações claras sobre como gerenciar a disposição dos cadáveres, resultam em incertezas entre os profissionais envolvidos no atendimento emergencial, de quais são os riscos associados e as medidas de segurança no manejo dos corpos. O artigo objetiva determinar o risco dos agentes etiológicos envolvidos na mortalidade brasileira por doenças infecciosas, identificar e discutir as principais medidas de proteção para os profissionais envolvidos no manejo de cadáveres em situações de desastres. Levantamento dos óbitos por doenças infecciosas, no Brasil, de 2005 a 2010, utilizando-se os dados do Sistema de Informações sobre Mortalidade. Dos 171.223 óbitos analisados, os patógenos causadores de maior número de mortes foram: HIV, M. tuberculosis e T cruzi. Dos agentes, 59% pertencem à classe de risco 3 e 40,6% à classe 2. Oito óbitos identificados foram causados por patógenos da classe 4, que representam alto risco. Os profissionais envolvidos no manejo de corpos podem estar expostos aos riscos crônicos, como os vírus transmitidos pelo sangue, infecções gastrointestinais e tuberculose. Estes resultados demonstram a importância no investimento na elaboração de medidas para reduzir o risco de infecção associada ao manejo de cadáveres.*

Palavras-chave Cadáver, Desastres, Risco, Exposição a agentes biológicos, Saúde pública

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Introduction

The devastating phenomena caused by disasters are part of history. The social groups affected suffer the loss of many lives, economic or environmental losses exceeding its ability to respond, with repercussions on economy, exceeding its (ability to respond) responsiveness¹.

Disasters are the result of combination of exposure to a hazard, vulnerabilities and society's inability to control or deal with consequences. These events have different amplitude in their impacts, however, the social commotion, the possibility of disease occurrence and the impacts on the affected population's mental health are common to all disasters.

The Emergency Events Databases shows that between 1900-2010, the highest number of natural disasters occurred on the Asian continent. However, the highest numbers of deaths were caused by the 7.0 Richter-scale magnitude earthquake that occurred in Haiti (2010), which caused over 222,570 deaths and made 3,700,000 people homeless, and the earthquake followed by tsunami in Indonesia (2004) with 165,708 deaths and 532,898 homeless².

In Brazil, during 1970/2008 there was a rise in the incidence of climactic events involving extreme temperatures and floods, causing the death of more than 6,000 people and damages of 10 billion dollars². A flood, followed by landslides, occurred in 2011, in the mountain region of Rio de Janeiro state, for example, hit 18 municipalities, leading to 918 deaths and 31,399 homeless and displaced people³.

Most disasters, except for gradual floods, are unpredictable, sudden and normally violent phenomena, occasioning deaths by traumas, drownings and burns, among others. They cause a sudden presence of corpses, causing stress in the society and representing a social, sanitary, legal and organizational problem, and leads to a collective disposal through mass burials or incineration. The World Health Organization emphasizes there is no evidence that the presence of corpses increases the risk of epidemics⁴.

Disease transmission requires the presence of an agent, exposure to that agent and a susceptible host. To determine the risk involved in the management of dead bodies following disasters is necessary to consider these elements.

Following large disasters, the lack of clear information on how to manage the dead, leads to uncertainty among professionals involved in emergency care. The associated risks; biosafety

principles, including containment principles and precautions; and how to handle bodies safely, are informations unclear. Thus, situations that may represent risk are in the field of biosafety, which establishes principles and strategies based on risk assessment⁵⁻¹².

There are some pathogens in corpses that may represent risks; such as *Mycobacterium tuberculosis*, hepatitis B and C virus, *Vibrio cholerae*, HIV, hemorrhagic fever virus and prions¹³⁻¹⁹. To determine the risk, it is necessary to consider that some victims may be carriers of infections and, therefore, they will require special care. It must be noted, however, that the biological agents involved in the natural putrefaction process are not pathogenic. Besides, the human body is a host of many biological agents, some of them are pathogenic, which mostly do not survive more than 48 hours after death. It is in this time window where there is a greater likelihood of infections acquired by improper handling of corpses. Therefore, we can state that the disaster victims host pathogens that are circulating in the local population, so the risk is similar to handling patients in health care areas^{4,12,20}.

This study aims to analyze the etiologic agents involved in brazilian mortality by infectious diseases, in order to identify the risk and discuss the main protection measures necessary for the professionals involved in corpse handling in disasters.

Methodology

To reach the objectives was carried a research using the Brazilian Health Ministry's Mortality Information System (SIM) data²¹, which uses the Death Declaration standardized nationally. The registration of causes of death is based on the 10th edition's International Classification of Diseases (ICD 2008), implemented since 1996 by WHO.

The ICD-10 presents twelve chapters, one of them is related to infectious and parasitic diseases. It provides codes for classifying diseases. To each state of health, a single category with a corresponding alphanumeric code contains up to four characters, consisting of a letter followed by three numbers. In the studied chapter the coding starts in A00 until B99.

The SIM's data was obtained using the Oracle 10G software.

The study population was represented by the deaths in Brazil due to the infectious diseases

contained in chapter I of the ICD. The study covered the period 2005/2010 (six years).

The inclusion criteria used was the deaths caused by infectious diseases. The exclusions criteria were: deaths from diseases with etiologic agents that could not be identified; deaths from unspecified diseases and deaths from diseases which could have more than one etiologic agent involved.

After this, the etiologic agent was identified to be classified according to the Brazilian Health Ministry's risk group classification²².

For descriptive analysis, the method of absolute frequency distribution was employed. The data was analyzed using the program SPSS 16.0.

All data used in this analysis are public domain and preserve the individuals' identity.

Results

The study found 282,187 deaths from infectious diseases. 110,964 cases (39.322%) are excluded. The Table 1 shows the pathogens responsible for diseases with more than 500 deaths and their risk.

The region with the highest number of reported deaths is the Southeast, with 82,969

cases (48.456%), followed by the Northeast with 37,464 (21.880%) and the South, Center-West and North regions with 25,604 (14.953%), 14,666 cases (8.565%) and 10,520 cases (6.144%), respectively.

Among the pathogens causing diseases with more than 1,000 deaths were:

a) HIV/AIDS – 69,642 deaths: Southeast region (35,112), South region (15,125), Northeast region (10,873), North region (4,346) and Center West (4,186).

b) *Mycobacterium tuberculosis* – 31,435 deaths: Southeast region (13,907), Northeast region (10,612), South region (3,176), North region (2,271) and Center-West region (1,469);

c) *Trypanosoma cruzi* – 29,284 deaths: Southeast region (14,922), Center-West region (6,249), Northeast region (6,079), South region (1,603) and North region (431).

In many countries, including Brazil, infectious agents are categorized by risk groups based on their relative risk. Figure 1 presents the number of deaths caused by infectious diseases, according to the risk group of the etiologic agent.

There are no deaths from diseases caused by risk group 1 agents. There is variation between mortality from diseases whose etiological agents

Table 1. Pathogens responsible for diseases with more than 500 deaths, from 2005 to 2010, related to the risk.

Pathogen	2005 - 2010		Risk classification
	N	%	
Human Immunodeficiency Virus	69,642	40.673	3
<i>Mycobacterium tuberculosis</i>	31,435	18.359	3
<i>Trypanosoma cruzi</i>	29,284	17.102	2
Hepatitis C vírus	10,782	6.297	2
Group A Beta-Haemolytic Streptococcus	4,771	2.786	2
Hepatitis B vírus	3,314	1.935	2
<i>Neisseria meningitidis</i>	2,651	1.548	2
Dengue vírus	2,232	1.303	2
<i>Leptospira interrogans</i>	2,106	1.229	2
<i>Schistosoma mansoni</i>	2,047	1.195	2
<i>Leishmania infantum</i>	1,536	0.897	2
<i>Mycobacterium leprae</i>	1,452	0.848	2
Varicela zoster vírus	1,264	0.738	2
<i>Clostridium tetani</i>	803	0.468	2
<i>Treponema pallidum</i>	616	0.359	2
<i>Taenia solium</i>	576	0.336	2
<i>Entamoeba histolytica</i>	563	0.328	2
<i>Cryptococcus neoformans</i>	539	0.314	2
<i>Toxoplasma gondii</i>	512	0.299	2
Total	166,125	97.022	
Total deaths (all diseases)	171,223	100	

Source: Brasil, 2012; 2010.

belong to the risk group 2 (n: 69,591) and 3 (n: 101,624), with the predominance of deaths by risk group 3 agents.

Among the risk group 2 pathogens in that caused the highest number of deaths are the agents for Chagas disease (17.102%), Hepatitis C (6.297%), erysipelas (2.786%), Hepatitis B (1.935%), meningococcal meningitis (1.548%), dengue (1.303%), leishmaniasis (1.229%) and schistosomiasis (1.195%).

From the analysis of the distribution of deaths and risk group of the agent involved in the infection, shown in Figure 1, there is an increase in deaths from 2008 through 2010.

The states that presented the highest number of death caused by risk group 2 agents were São Paulo (25.394%), Minas Gerais (14.920%), Bahia (8.131%), Rio de Janeiro (7.006%) and Goiás (6.890%) (Figure 2).

The largest numbers of deaths due to diseases caused by risk group 3 agents were observed in the states of São Paulo (25.031%), Rio de Janeiro (14.774%) and Rio Grande do Sul (10.192%). Another important factor is the state of Pará with 0% of deaths (Figure 3).

In this group are HIV/AIDS (40.673%), *Mycobacterium tuberculosis* (18.459%) and other lower incidence but high epidemiological relevance, such as hantavirus (0.116%) and *Histoplasma capsulatum* (0.128%).

Among the arboviruses belonging to risk group 3, which constitute a public health prob-

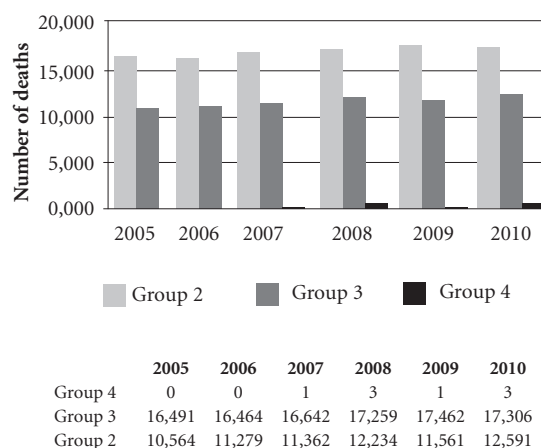


Figure 1. Deaths caused by infectious diseases, according to the risk group of the etiologic agent.

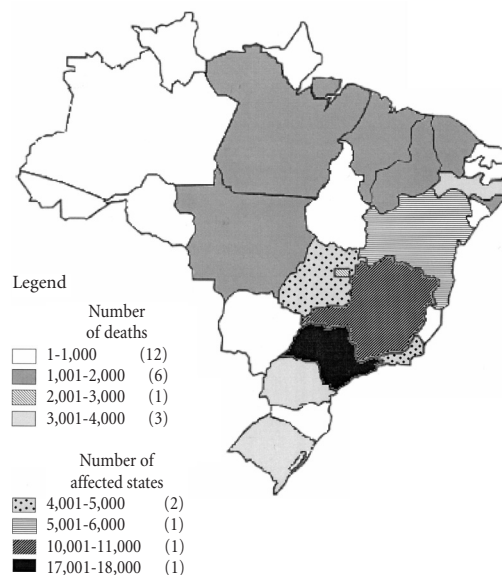


Figure 2. Deaths in Brazil from diseases whose etiologic agents belong to risk class 2, from 2005 to 2010.

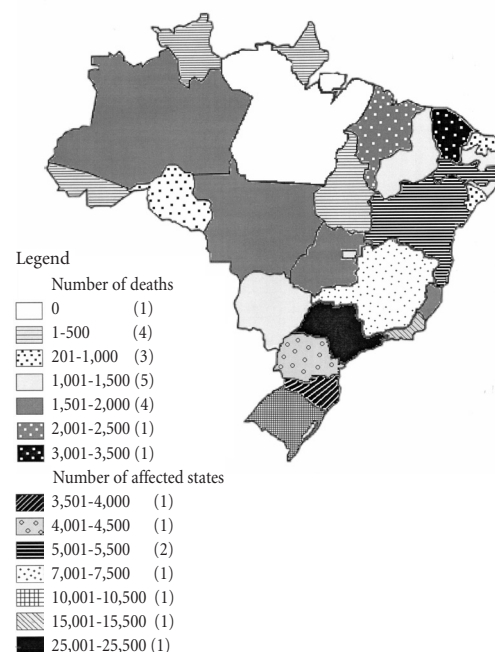


Figure 3. Deaths in Brazil from diseases whose etiologic agents belong to risk class 3, from 2005 to 2010.

lem, due to the morbidity and/or mortality, we identified: *Yellow Fever virus* (37 deaths), *VEE* (01), *Chikungunya virus* (03) and *West Nile virus* (01). It also identified 8 deaths caused by group 4 agents: 07 for *Junin virus* (71.428% in the Northeast) and 01 for *Crimean Congo hemorrhagic fever virus* (Southeast) (Figure 4).

Discussion

The Southeast region presented the highest number of notifications (48.456%), because it has the highest population density. There is a vertical increase in the magnitude of deaths coverage in the north-south direction. The under-notification rates for deaths in the North and Northeast region is due to the fact these regions have the most precarious development indicators in Brazil²³. However, it is important to point out as limitation of this study the possibility of errors in the diagnosis of diseases and errors related to the quality of information, in the record of the underlying death cause, contained in the Death Declaration.

The Northeast region had the highest number of deaths caused by *Leishmania infantum*, *Schistosoma mansoni* and *M. leprae*; that are representative of the socioeconomic conditions. This region has the lowest average total home earnings (nominal) *per capita*²⁴.

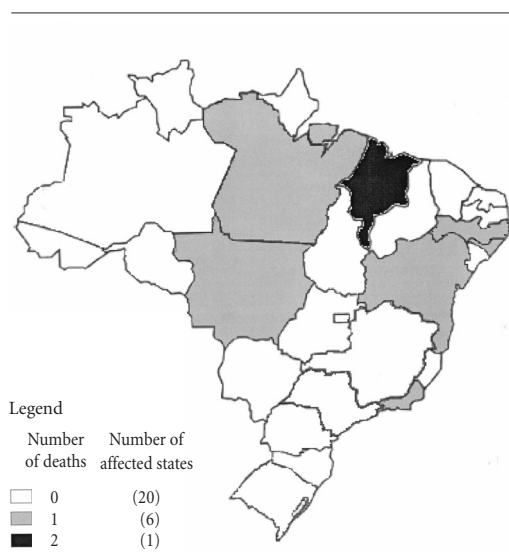


Figure 4. Deaths in Brazil from diseases whose etiologic agents belong to risk class 4, from 2005 to 2010.

The etiologic agents are classified according to their risk, in order to relate them to biosafety recommendations. This classification is based on the interaction of criteria like: individual, community and environment risk; mode of transmission; pathogenicity; genetic alteration; endemicity; infective dose; availability prophylaxis and effective treatment. The consequences of the infections reflect the complexity of these interactions.

The risk associated with new agents of high lethality, which may turn into pandemic events, is a growing concern. *Sabia virus*, *Oropouche virus* and zoonotic strains of Hantavirus isolated in São Paulo, are among the most relevant pathogens.

Another factor for risk assessment is related to infections that could have been treated effectively with antibiotics, such as: *M. tuberculosis* and *Staphylococcus aureus*, which have become resistant.

The classification categorizes biological agents into 4 groups, increasing by degree of containment and complexity of protection level.

The pathogens classified as risk group 1 cause a low or practically nonexistent individual risk.

The risk group 2 agents can cause human disease and might be a hazard to employees. Effective prophylaxis and treatment are often available, and the risk of dissemination is limited. *Trypanosoma cruzi* is one of these agents of importance related to number of deaths in Brazil (n: 29,284), despite the national program for the control be one of the greatest successes of the public health system. This number is due to the disease's long latency period; 3,5 million individuals are still chronically infected²⁵.

We highlight the importance of the deaths (18) caused by transmissible spongiform encephalopathies, combination of deaths caused by prions and Creutzfeldt-Jakob disease. Brazil currently ranks these agents as belonging to risk group 2. These occurrences are important due to the fact these agents with no genetic material (DNA and RNA), composed only of protein (PrPsc), produce diseases in humans and animals and are resistant to most chemical or disinfection methods routinely practiced in Brazilian hospitals and laboratories.

Risk group 3 agents can cause severe or lethal human diseases represents a serious hazard to directly exposed people, because of the potential for aerosol transmission and risk of dissemination.

Deaths from HIV/AIDS present an growth of 3% a year starting in 2005. Tuberculosis appeared

as the second most important cause of death, with steady number of deaths per year. Together, they represent 99.461% of the group 3 agents and rose the total quantity of deaths caused by these pathogens. These diseases are still a public health problem in several of Brazil's regions, despite the considerable proportion (13%) of health care resources, which continues to be spent on disease control²⁵.

HIV/AIDS deaths have decrease in the Southeast region, although it is the region with the highest number of notifications (48.480%). North, Northeast and South regions present an upward trend and the Center-West region is the most stable.

Tuberculosis, on the other hand, is a high-morbidity endemic disease that manifests higher death risks among the adult population. Sequels of injuries take years to develop, often in a subclinical manner. There are great regional differences in tuberculosis mortality, with higher levels in states with a greater prevalence of HIV/AIDS, such as Rio de Janeiro and São Paulo, and in states with limited access to health care services, like states in the Amazon region. It was observed that there is subnotification of deaths from diseases with compulsory notification, including the arboviruses in the North region states: Acre, Roraima, Rondonia, Amapá and a total absence of events in Pará revealing a deficiency in the regional system of epidemiological surveillance. It is relevant, since there are some types of viruses, such as the arbovirus that despite they have a wide geographical distributed in Brazil, they predominate in the tropics, where there are favorable ecological conditions. A great number of different types of arboviruses were identified in the Brazilian Amazon and they have been proved to be pathogenic, although the virulence of most of these viruses is still unknown²⁶.

Group 4 agents has epidemiological relevance and represents a high risk, due to degree of dissemination, transmissibility, lethality or causative of emerging diseases whose transmission mechanism is unknown. Until now there are no effective treatment and prevent measures, demonstrating the relevance of the eight deaths caused by agents of this group.

Corpses and disasters

The sudden presence of a greater number of corpses in areas affected by disaster can cause fear in the population over disease outbreaks; however, the deaths are normally caused by traumas,

burns, among others. There is few evidence that corpses may constitute a risk in areas that are not endemic for specific diseases. However, the human body hosts biological agents, some of which are pathogenic, so disaster victims host pathogens that are circulating in the population. Thus, the risk associated with corpse handling is similar to the healthcare service. In order to determine the risks it is necessary to have an adequate understanding of the epidemiological structure of the microbial agents, including infection sources and their means of transmission. These factors are determinant in preventing and reducing contamination risk while working. If we consider the infection a result of a multifactor interaction, it is possible to characterize the risks that corpses represent after a natural disaster.

Some infections are transmitted from one person to another, whether sick or carrier; however, the disease severity does not necessarily imply in risk to other person. A patient with a mild infection can disseminate the agent to more people than if he has in a serious condition, showing enough symptoms that could justify his hospitalization or isolation. There are carriers, who eliminate infectious agents, but do not present signs of disease, and there are those who are convalescing and continue eliminating the agent of the infection. These people pose a risk to others, because they cannot always be recognized as carriers, which makes them a potential source of infection.

The professionals are responsible for seeking information about the risks they can be exposed to in the region where the disaster occurred, considering the endemic zone of diseases or the complexity that exists in the location where certain cases are more frequent. Then they be able to identify the precautions.

The scientific evidence based on examination of diseases, that could represent a risk to public health in the presence of corpses, suggests that a set of specific criteria is needed: a large number of corpses carrying disease in endemic areas; a wide dissemination of the disease in the area; a long survival time of the etiologic agent in the human or animal body or in the environment after the host's death; and the necessary environmental conditions for the propagation of diseases²⁷. These criteria often need to be simultaneous to constitute a risk to public health. Removing any of these criteria may result in a significant risk reduction.

The agents associated with disease transmission via corpse manipulation include the

blood-borne viruses (HIV, HBV, HCV, HTLV-1), gastroenteric pathogens (*Salmonella*, *Shigella*, *Campylobacter enteritis*, *V. cholerae*, *E. coli*, rotavirus, norovirus, HAV and enteric adenoviruses), parasites (*Giardia*, *Cryptosporidium*) and air transmission agents (*Mycobacterium tuberculosis*)^{4,6,12,28,29}. However, we must consider that, although some diseases are contagious, their etiologic agents cannot survive more than 48 hours in corpses^{6,12}. This is the period of greatest likelihood of infections. But there are some agents, including blood-transmitted viruses (e.g. Sabia virus, Ebola virus, Marburg virus and CCHF virus) and enteric pathogens (e.g. *V. cholerae*), which can remain viable for some time in the body. In this case, the risk of transmission from corpses is possible, and specific precautions are needed^{12,28-30}.

In catastrophes there is a higher risk of percutaneous injuries involving perforating or cutting materials during the handling of rubble, hardware, woodwork and even bone and teeth fragments from mutilated bodies, which may cause the transmission of diseases by blood. Among the major pathogens responsible for the contamination of professionals during percutaneous accidents are HIV, HBV and HCV^{7,31,32}.

This study found that 40.643% of the deaths was caused by HIV. As the virus may be present in corpses at the same incidence percentage, HIV represents a high risk for professionals involved in disasters. In addition, we must consider that HIV remains viable in the blood and in the pleural and pericardial fluids up to 16 days post-mortem, if the body is stored at low temperatures (2°C)^{4,19,29}. The HIV has been isolated in bone fragments, spleen, brain, bone medulla and lymph nodes 6 days after post-mortem^{4,19,29,33-37} and detected, in 2006, after 6 days among the tsunami corpses in Indonesia⁴. It is important to note that the corpses infected by HIV are often coinfecting with other agents³⁸.

The risk of chronification of the HBV, in Brazil, varies between 5-10% and for the HCV, between 60-90%³⁹. This percentage is considered high for professionals exposed to blood.

HBV and HCV transmission is similar to HIV. However, HBV unlike HIV is capable of surviving in stains of dried blood or other dry body fluids for 7 days. HBV is highly infectious agent and transmission can occur after exposure to extremely low volumes of infected blood; but the occupational risk of HBV is low, largely due to preexposure vaccination. In contrast, HCV, less infectious than HBV, has a higher occupa-

tional risk due to the inexistence of prophylactic measures^{36,37,40}.

The resurgence of tuberculosis, especially in HIV positive patients and the emergence and growth of the number of cases of extensively drug-resistant strains reinforce the importance of this disease for professional involved in the management of dead bodies^{6,19,36,41-43}. The risk of contamination with *M. tuberculosis* among professionals who handle corpses is real^{5,17,36,42-46}. Kantor et al.⁴⁷ report that the risk of acquiring the disease during the necropsy of people with tuberculosis is amplified by 17.8%. Wilkins et al.⁴⁸ confirmed this risk, reporting that 25% of students (negative Mantoux reactions) who participated in a necropsy of an immunocompromised patient in Australia developed tuberculosis. Garg et al.⁴⁶ demonstrated that 60% of the tuberculosis cases found during autopsy are unexpected. This data demonstrates the importance of adopting a precaution measures for the handling of bodies in disaster situations in countries where the tuberculosis incidence rate is high. This study detected tuberculosis as the second cause of deaths (18.459%).

The *Koch bacillus* can remain viable for long periods in corpses. Studies show the existence of infectious *bacilli* 24 to 48 hours after the embalming of an infected corpse^{13,19,42}.

M. tuberculosis transmission can occur through exposure to expelled fluids and/or air, through the respiratory tract during the putrefaction process or when residual air from the lungs is eliminated during corpse handling. Exposure may occur from gurgling at the nose and mouth of the cadaver due to fluid buildup in the chest cavity and putrefaction of tissues and organs. The risk is amplified when many bodies are stored in temporary locations, since the aerosol *bacilli* can remain viable for a long time^{5,19,29,45,49}. This risk can be reduced by placing a protective mask over the corpse's air passages, when moving the body, and through adequate ventilation of the environment^{4-6,29,37,50}.

Infection from skin and mucous membranes occurs through direct contact with lesioned skin or contaminated objects. That mainly occur with methicillin-resistant *Staphylococcus aureus* and Group A *Streptococcus pyogenes*³⁷.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a nosocomial pathogen, which is disseminated among the population. Due to this prevalence, whether as a commensal or a pathogen, professionals who handle corpses are exposed a risk. Also Group A *S. pyogenes* represents

a risk for the workers, because it can survive in corpses, and be transmitted by direct contact or as a result of inoculation.

Corpses usually eliminate fecal matter and may expose people who handle them to normal microorganisms present in the gastrointestinal tract²⁹. This exposure can occur through the fecal-oral via through direct contact or contact with contaminated objects or equipment, such as stretchers and vehicles used for transportation and storage. The most worrying biological agent in this case is Hepatitis A virus, while *Shigella*, *Salmonella typhi*, *Helicobacter pylori* and *Cryptosporidium* represent a lower risk¹². Thus, the gastrointestinal microorganisms do not survive long in the environment and represent a low infection risk⁶.

Simple measures can reduce the infection risk associated with corpse handling, such as standard precautions for handling blood and body fluids and contact precautions. These practices include the use of gloves. The special gloves, as cut resistant or specific for chemicals, must be established during risk assessment. Avoid the manipulation of personal objects while wearing contaminated gloves. Protective clothing is recommended, like coveralls, made by polyethylene. Wearing closed shoes or boots is compulsory. Disposable filter masks (N95) must be used for respiratory protection from aerosolization risk. If there is a risk of splashes of chemicals, blood or any fluids, the use of protective goggles is recommended.

Upon arrival at the disaster area, the professionals must assess the ground, to observe the elevations, in order to anticipate the risk of an avalanche or a falling stone that could cause injury to the individuals who are working in the lower parts of the terrain. In these cases, protection for the head must be used.

All disposable protective equipment must be disposed in bags identified with the hazard symbol. Wash hands after handling corpses and before eating. All equipment, including clothes, stretchers and vehicles used for transportation, must be washed and decontaminated.

Transport bags body hinder the ventilation, increasing the decomposition rate, especially in hot climates^{6,12,37,51}.

The professionals must be immunized against Hepatitis B. The vaccine leads to immunity in 90 to 95%^{19,37}. The BCG vaccine is recommended for protecting against tuberculosis, with a reactive or weak reactive tuberculin test and without immunosuppression⁵². In addition, a three-dose of the Td vaccine is recommended in order to reach an

adequate level of protection against tetanus and diphtheria in people who were not vaccinated in the past. Individuals who were vaccinated in childhood and who received their last dose for over 10 years, require only one dose of the vaccine⁵³.

Conclusion

Natural disasters and outbreaks of infectious diseases represent global challenges for reaching the Millenium Development Goals.

Natural disasters have been occurring continually in the world, sometimes leading to a displacement of people, which aggravates the factors that favor transmission of diseases. It is importante for policy makers, health authorities and professionals involved in emergency care, to understand the mechanisms involved in the dissemination of diseases, to realize that corpses in disaster situations are not a source of epidemics, and that disease outbreaks may be a secondary result of the increased local risk factors for disease occurrence. The same happens with victims of warfare. In both cases, it is probable that the survivors are the source of disease outbreaks. The rapid implementation of control measures, early warning and surveillance, must be a priority, especially in the absence of epidemiological surveillance data from pre-disaster. It is essential, in these areas, to intensify disease surveillance mechanisms and compulsory notification in the health units where victims are cared for, since exotic pathogens can be imported or can emerge and re-emerge in the region affected by the disaster.

Nonetheless, the professionals involved in emergency care can be exposed to chronic risks, such as blood-transmitted viruses, gastrointestinal infections and tuberculosis. The risk to this group can be estimated based on the identification of deaths, existing epidemics and the prevalence of endemic diseases in the local population and the probability of exposure and transmission.

In natural environments, there is a variety of biological risk agents, which can be occasional infection sources, such as: infection via ingestion of pathogens in water or contaminated food (gastroenteritis, cholera); infection via inhalation (histoplasmosis, cryptococcosis and tuberculosis); percutaneous infection by inoculation (tetanus, deep micosis), penetration (leptospirosis, schistosomiasis) or vector bites (arboviruses, malaria, trypanosomiasis and leishmaniasis).

Geographical location and local environmental conditions, influenced by light, humidity, altitude, heat, fauna, vegetation, pollution and degree of human interference, among others, also modify the risk, increasing or reducing agent susceptibility according to the interaction of the various epidemiological factors. Too the affected population's living conditions must be evaluated, with special attention to the availability of potable water and sanitation, as well as the age distribution, nutritional state and vaccine coverage of the people affected, and how much access they have to health care. When monitoring the incidence of infectious diseases and documenting their impact in these conditions, it is possible to better quantify the outbreak risk that follows natural catastrophes.

Since the HIV epidemic, the emergence of multi-drug resistant bacterial strains (such as *Staphylococcus aureus* resistant to meticillin and *Enterococcus sp.* resistant to vancomycin), the reemergence of tuberculosis in the global population, the dispersion of Extensively Drug-Resistant Tuberculosis (XDR-TB) and the higher risk

of acquisition of blood-transmissible biological agents (HIV and viral B and C Hepatitis, for example), disasters require the professionals involved to be trained in implementing biosafety measures in terms of procedures, identification and protective equipment use, in order to prevent accidental exposure.

Every country must prepare itself by implementing a response plan to disasters; training health care professionals and those involved in emergency care in the identification, diagnosis and treatment of diseases and in the establishment of the necessary protection and containment measures. In these situations, simple hygiene and sanitation measures, such as the action of washing hands, and the supply of potable water, shelters and adequate sanitary facilities are important for the prevention and control of infectious diseases. Thus, when preparing for the inevitable, medical response staff and the professionals involved in emergency care will be better able to alleviate the suffering which occurs after natural disasters.

Collaborations

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