Wastes from Health-Care, Pathogenic Microorganisms, Environmental Factors and Disinfection Processes: conceptual evolution and environmental education

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In the current global and national regulatory rules, there is a consensus that greater awareness is needed about the environmental and human risks involved in managing the Wastes From Health-Care. The discussion of the risks associated with these wastes cannot be analyzed only in the aspect of transmission of infectious diseases. Also involved is the issue of worker health and preservation of the environment, and these issues concerns the Biosafety. In addition, it should be considered the existence of other variables involved in risk factors to human health and the environment related to these residues, given the likely persistence of pathogens in the infectious fractions, and inadequate treatment of biological material, causing to require accountability national and local administrators in managing of Wastes From Health-Care.

Keywords Wastes from Health Care; Risk Factors, Safety Management; Public Health

1. Definition and conceptual evolution of health-care waste

The waste from health-care had different names for several years, the most usual, hospital waste or medical waste, hospital waste septic, which contain pathogens and infectious waste or septic (WHO, 2005, Brazil, 2010; Silva *et al*, 2011).

A first evaluation of the concept attributed to the waste generated in the health services, some evidence shows a relationship with the waste generated in hospitals. Such evidence is based on the assumption that these establishments were represented as single points of generation with significant production of waste, including other units (such as pharmacies, clinics, outpatient clinics, emergency departments), and thus the characteristics of hospital waste deserved a greater emphasis on the sanitary control and as a consequence the intensification of the term "medical waste".

In Brazil, the new terminology on waste from health-care (WHC) is presented together on standards from the National Health Surveillance Agency (ANVISA) of the Ministry of Health and the National Council for the Environment (CONAMA), the Ministry of Environment. With this new terminology, WHC is conceptualized as "waste resulting from activities performed by establishments generators", with the framework of potential generators such as blood banks, clinics, laboratories, pharmacies, clinics and different specialties (dental , veterinary, cosmetic, acupuncture) and centers of teaching and research in health.

The concept of WHC increases the risk assessment and emphasizes the qualitative aspects of the different fractions generated in healthcare facilities, as was previously only directed to fractions contaminated by pathogenic microorganisms. Between 75% and 90% of the waste produced by health-care providers is non-risk or “general” health-care waste, comparable to domestic waste. The remaining 10 a 25% of healthcare waste is regarded as hazardous and may create a variety of health risks (Pruss- Ustun *et al*, 2003).

Currently, with the publication of the National Policy for Solid Waste - Law n. º 12305/2010 (BRAZIL, 2010), and the national standards on management about WHC (ANVISA and CONAMA), has been the standardization of guidelines techniques as the requirement of prior treatment of infective fractions of WHC before its final disposal. However, the management of this waste, in Brazil, is not adopted fully in its implementation steps, by health systems and state and municipal management.

Therefore, when presenting the possibility of inadequate management, exemplified by unfavorable conditions of the handling or disposal of hazardous fractions of WHC, specifically infectious solid waste and part of special (hazardous chemicals and pharmaceuticals), broadens the discussion of the risk factors to human health and the environment.

It should be noted that the risks attributed to WHC in this publication are directed only to infectious fractions generated in the different healthcare facilities as well as the survey does not include liquid wastes from treatment of diseases, is only directed at infectious waste.

2. Survival of pathogenic microorganisms in the environment: evaluation of risks factors attributed to WHC

Extending the evaluation of risks associated with the WHC, Pruss- Ustun *et al* (2003) showed epidemiological evidence regarding concerns about infectious waste generated in hospitals. This work was highlighted that in the United States, an employee cleaning of the hospital contracted staphylococcal infection and endocarditis have been injured with a needle.

In Canada, Japan and the United States, the issues related to fraction of infectious of WHC is directed on the transmission of HIV infection/SIDA and, more frequently, the hepatitis B or C through injuries from needles contaminated with human blood (CDC 2008, Silva, 2009). In these countries, highlight the profile of the exposed workers who handle waste from hospitals.

In Brazil, the inexistence of data on the epidemiological profile of workers who have direct contact with the sharp waste complicates the analysis of the risks attributed to the WHC. Furthermore, we can say that the most exposed to the occurrence of occupational diseases are not properly monitored by the employee agencies, and more, in most situations there is no regular reporting or these organs act in poor shape (Garcia & Zanetti-Ramos, 2004). Given this, there is a greater concern and need to consider the existence of risks when contaminated sharps are disposed without any treatment or inadequately managed.

However, the importance of the qualitative evaluation of risks associated with the WHC produced externally to the point of generation is also put into evidence by studies which demonstrate environmental residence time of some microorganisms in the solid waste. Morel and Bertussi Filho (1997, *apud* Silva, 2009) showed the survivability of Mycobacterium tuberculosis in the mass of solid waste within 180 days. Corroborating this environmental risk assessment, Johnson et al. (2000) document the important transmission of M. tuberculosis in workers at a waste treatment plant health services. In this pioneering account epidemiological, occupational exposure of workers by the pathogen was mainly attributed to the entry of biological treatment plant without prior decontamination.

In the scenario of environmental research about pathogenic microorganisms, Pruss- Ustun *et al* (2003) present a study conducted by the Japanese Research Association, in which the infectious dose of the Hepatitis B virus (HBV) or C (HCV) could survive for a week on a drop of blood taken hypodermic needle. Reporting that, in the contamination of healthcare workers, the HIV-1, HBV and HCV are the most important agents involved in occupational infections. Thus, such studies on environmental residence time of important pathogens, contribute significantly to the evaluation of possible routes of transmission of infectious diseases from contact with WHC, focusing mainly on environmental and public health.

Thus, it is important to note that the risk of infection attributed to the WHC should be not only to sharps; see the expanded form of the disease related to these residues, contemplates the different fractions infectious or biologically contaminated materials. From the particularities of the studies presented, some routes of disease transmission by biological agents can be defined and assigned to the survival of these pathogens in the waste mass or the environment assuming also this human predisposition. In addition, the survival of bacteria endowed with high resistance to adverse environmental conditions that occur in solid, lead to the need to know the mechanisms of these different residence biological agents in the environment.

It has different pathogenic microorganisms (bacteria and fungi) isolated in WHC and in the environment, also relating hepatitis viruses A, B and C. Table 1 illustrates some examples of infection that can be caused by exposure to waste from health-care, and usual ways of transmission vehicles. Table 2 shows some of the microorganisms in the WHC, associating them with the survival time in the solid waste.

Table 3.1 identifies the properties of pathogenic microorganisms that matter most for its relationship with the host and the onset of disease. Properties such as infectivity, pathogenicity, virulence, immunogenic power and invasive power are described as fundamental in epidemiology. However, in order to add more specific information about the different pathogens, was also considered the infecting dose presented in Table 3.2.

Table 1 Examples of Infections Caused by Exposure to WHC, Pathogenic Microorganisms and Vehicle Transmission

Type of Infeccion	Pathogenic Microorganism	Vehicle Transmission
	BACTERIA	
Gastroenteric Infections	Salmonella typhi	Feces and or Vomit
Gastroenteric Infections	Shigella SP	Feces and or Vomit
Bacteremia	Enterobacter	Blood
Bacteremia	Klebsiella	Blood
Skin Infections	Streptococcus SP	Secretion
Bacteremia	Staphylococcus aureus	Blood
Respiratory Infections	Mycobacterium tuberculosis	Secretions inhaled, Spittle
	VIRUS	
Inflammation of the liver	Hepatitis A	Feces
Inflammation of the liver	Hepatitis B	Blood and Body fluids
Inflammation of the liver	Hepatitis C	Blood and Body fluids
	FUNGI	
Candidemia	Candida albicans	Blood

Fonte: Pruss- Ustun *et al*, 2003

Table 2 Mean Time Survival of Pathogens in Mass of Solid Waste

Microorganism	Disease	Survival Time (days)
Entamoeba histolytica	Amoebic Dysentery	8 a 12
Leptospira interrogans	Leptospira	15 a 43
Poliovírus	Polio	20 a 170
Larvae	Worms	25 a 40
Salmonella typhi	Typhoid Fever	29 a 70
Mycobacterium tuberculosis	Tuberculosis	150 a 180
Ascaris lumbricoides (eggs)	Ascariasis	2.000 a 2.500

Fonte: Morel e Bertussi Filho (1997) *apud* Silva (2009)

Table 3.1 Properties of Pathogenic Microorganisms that Contribute to Disease Development

PATHOGENIC MICROORGANISM	INFECTIVITY		PATHOGENICITY		VIRULENCE		IMMUNOGENIC POWER		INVASIVE POWER
	(1)	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**	
(I)Escherichia coli	**X**			**X (a)**		**X**	**X**		Intestinal Mucous
(I)Salmonella typhi		**X**	**X**		**X**		**X**		Intestinal Mucous and eventually the bloodstream
(I)Shigella		**X**		**X**	**X**		**X**		Intestinal Mucous
(I)Enterobacter	**X**			**X**	**X**		**X**		Intestinal Mucous
(I)Citrobacter	**X**			**X**	**X**		**X**		Intestinal Mucous
(I)Klebsiella	**X**			**X**	**X**		**X**		Lower respiratory tract
(I)Pseudomonas aeruginosa	**X**		**X**			**X**		**X**	Respiratory tract
(I)Aeromonas SP		**X**		**X**		**X**	**X**		Intestinal Mucous
(I)C. botulinum		**X**		**X**		**X**	**X**		Bloodstream and transported by the body (muscles)
(I)C. tetani	**X**			**X**		**X**		**X**	Peripheral nervous terminations to the central nervous system
(I)C. perfringens		**X**		**X**		**X**	**X**		Intestinal Mucous
(I)Enterococos		**X**	**X**		**X**		**X**		Intestinal Mucous
(I)Staphylococcus aureus		**X**		**X**		**X**		**X**	Bloodstream (septicemia)
(I)Mycobacterium tuberculosis	**X**		**X**			**X**	**X**		System inferior pulmonary
(II)Hepatitis A		**X**	**X**		**X**		**X**		Intestinal Mucous
II)Hepatitis B		**X**		**X**		**X**		**X**	Bloodstream
(II)Hepatitis C		**X**		**X**		**X**	**X**		Bloodstream
(III)Candida albicans	**X**		**X**		**X**		**X**		Discontinuity skin

(I) Bacteria; (II) Virus e (III) Fungi (1) Low; (2) High (a) Pathogenic Strains
Fonte: Silva, 2009

Table 3.2 Properties of Pathogenic Microorganisms that Contribute to Disease Development

PATHOGENIC MICROORGANISM	INFECTIVE DOSE
(I) Escherichia coli	106 - 108 (UFC) (*) ([a])
(I) Salmonella typhi	106 - 108 organisms ([a])
(I)Shigella	Personal Contact: 102 organisms
(I)C. botulinum	The lethal dose for man is one hundredth of a milligram ([a])
(I)C. perfringens	Food poisoning: 108 - 109 organisms
(I) Staphylococcus aureus	Food poisoning: amount less than 1µg of enterotoxin
(I) Mycobacterium tuberculosis	1 a 2 bacillus (tuberculosis-infection)
(II) Hepatitis B	Amount of 0,00004 ml (whole blood) for transmission by contaminated blood

Fonte: Pruss- Ustun *et al*, 2003, WHO, 2005, Silva, 2009
(I) Bacterias, (II) Virus (*) Unity Formation of Colony (UFC)
(a) Transmission of agents in food

3. Chemical agents commonly used in disinfection and sterilization of health-Care waste: assessing the effectiveness in the use of sodium hypochlorite (NaClO)

The different technical positions about the hazardous and risks associated with the WHC, the absence of evidence showing that these residues have the potential to infect people who are engaged in health services (Silva, 2009; Silva et al, 2011), and obligation about management of infectious waste arising from patient care, have been adopting mandatory guidelines for on-site treatment of waste materials or biological health facilities, in order to reduce or eliminate the microbial load, and thus minimize the risk of infection associated these materials (ANVISA, 2004, CDC, 2008).

When employing the term on-site treatment, some definitions are established by national and international standards. In Brazil, ANVISA (2004) defines as a treatment, the physical process or other processes that may be validated to reduce or eliminate the microbial load on equipment compatible with the inactivation of the agent, and also defines the traditional method to be applied to services health, steam sterilization - Autoclaving.

In the United States, the Center for Disease Control (CDC, 2008) highlights distinct concepts associated with the terms "sterilization" and "disinfection". The definition of the term "sterilization" is a process that destroys or eliminates all forms of microbial life, using physical or chemical methods outside of the generating unit, and of the methods has the autoclaving, and in the which refers to "disinfect", conceptualized as a process to eliminate most or all pathogenic microorganisms, except bacterial spores on inanimate objects, and even recommends the use of disinfectants in solutions or combined with other agents, among which has to chemical disinfection by sodium hypochlorite (NaClO) (solution volume between 5.25% -6.15%).

Among the techniques of biological waste treatment (Group A1) used in most clinical and laboratory practice, besides the common method of sterilization (autoclaving) has the chemical disinfection by the addition of hydrogen peroxide, sodium hypochlorite, acids, alcohols , quaternary ammonium compounds or incineration, after compression or grinding waste, if necessary (CDC, 2008, PAHO 2010).

Decontamination of biological samples by NaClO and contaminated surfaces, routines clinical laboratories and health services, is also recommended by national and international standards (ANVISA, 2004, CDC, 2008, PAHO, 2010), and some authors emphasize the high inactivation of microorganisms by chemical disinfection with NaClO 2-12% compared to sterilization by autoclaving (Rutala & Weber, 2001 apud CDC, 2008). On the other hand, some studies highlight the inefficiency of treatment 1% sodium hypochlorite for biological samples (syringes contaminated with pathogenic bacteria in the presence of blood) (Chitnis et al, 2002), besides the chemical and physical properties such as the release of NaClO chlorine gas when in contact with some kind of acid or acid solution, its use for a limited time and restrictions on its reuse for long periods (BRAZIL, 2010).

In Brazil, recent studies on decontamination of biological samples proved the effectiveness of the chemical disinfection by sodium hypochlorite (NaClO) 2% in the elimination of strains of Mycobacterium tuberculosis clinical isolates from patients with tuberculosis compared the efficacy of the method sterilization classic - Autoclaving (Silva, 2009). However, despite the effectiveness of the disinfection process NaClO 2% of the strains in the elimination of the biological agent compared to Autoclaving, it should be noted that there are limitations in the study as the use of a small number of fractions infectious of WHC (sputum samples) and also consider the adequacy of procedures from routine laboratory diagnostic investigation unit in the city of Salvador, Bahia, Brazil.

Thus, it is recommended the need to consider that the results of that survey also highlighted the responsibility of managers of healthcare services in the definition of technology choices for the treatment of WHC, considering the quality assurance processes (disinfection or sterilization) can eliminate or reduce pathogenic microorganisms.

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