Using reusable containers for hospital waste: is there an infection risk?

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Reusable waste containers are used to transport healthcare risk waste (sharps and non-sharps) in many countries, and are becoming increasingly common in South Africa. Initially, there may be a perception of risk of pathogen or disease transmission with their introduction. This paper assessed the international literature on reusable waste container infection risk and found there to be negligible to nil risk of pathogen or disease transfer. The literature confirms that disinfection and microbiological monitoring and validation of reusable waste containers is not indicated, and that washing with hot water and detergent, using visual criteria for cleanliness and due diligence with regard to contractor selection, enable reusable containers to be safely used.

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Introduction

Healthcare risk waste, both sharps and non-sharps, is being transported with increasing frequency in reusable waste containers in many countries to improve user safety, increase sustainability and reduce costs. The author's unpublished survey of healthcare risk waste industry members in Canada, the USA, Australia and New Zealand revealed that an estimated 50% of healthcare risk waste containers (sharps and non-sharps) are reusable waste containers. However, when the concept is initially introduced to a country or region that previously used disposable containers, there are concerns that reusable waste containers may pose a risk of disease or pathogen transmission to handlers, healthcare workers, patients or the hospital environment.

To date, this perception has prompted several authorities in South Africa to require specific levels of disinfection, microbiological monitoring or process validation. In South Africa, the South African National Standard 10229-1:2010, as incorporated under the National Road Traffic Act of 1996, requires that reusable waste containers are disinfected prior to reuse.[1] In addition, the Gauteng Health Care Waste Management Regulations require daily swabs of reusable waste containers for five days prior to the start of the contract, weekly swabs before dispatch, and monthly swabs upon delivery for the first four months of use. Thereafter, on proven adequacy, at half that frequency, cultures of bacteria and fungi by an accredited laboratory are required to confirm "reasonably adequate disinfection", and for the results to be examined quarterly by a competent person.[2] Currently, Eastern Cape bylaws set similar requirements for reusable waste containers.[3]

This paper examines the international literature and guidelines that determine the microbiological risk of using reusable waste containers, and the process, validation or monitoring that may be indicated, if any.

Risk

Risk is the product of probability and consequence,[4] i.e. how frequently an adverse event occurs and how severe the outcome. In general terms, risk can be categorised as occupational, environmental, legal, political, social or economic.[4] Questions that stakeholders legitimately ask regarding reusable waste containers are: "Will I get infected?", "Will antibiotic-resistant pathogens be brought into my hospital?", "Will the use of reusable waste containers impact on the environment?", "Could staff transfer pathogens from reusable waste containers to patients?" and "Is the microbiological monitoring of reusable waste containers a good use of valuable resources?" All of these components need be addressed when assessing the risk of using reusable waste containers.

Decontamination

Although healthcare risk waste (non-sharps) is commonly contained in a bag within reusable waste containers, there is the potential for the internal surfaces of the reusable

waste containers to be contaminated with pathogens. This may occur if the bag collapses in the bin, if waste is inadvertently deposited between the bag and liner, and if the bag is punctured. Also, reusable containers used for sharps are not lined, and could potentially contain pathogens. Therefore, decontamination processes must ensure that any pathogens that might be present must be reduced to a level that eliminates the risk of transfer to the hospital environment, staff or patients.

To ensure a clear understanding of the terminology surrounding decontamination, the following definitions, adapted from Block,[5] are used in this paper:

- "Decontamination" renders an item microbiologically safe for handling and use.
- "Sterilisation" is the removal of vegetative (non-sporing) organisms and spores.
- "Disinfection" is the removal of vegetative pathogens, but not all spores.
- "Cleaning" is the removal of soil, organic matter and debris.

Thus sterilisation, disinfection and cleaning are all forms of decontamination.

It is worth noting that the literature on decontamination procedures relates to hospital surfaces or food-processing surfaces, and care must be taken when extrapolating to other surfaces, such as reusable waste containers.

Prior to the 1970s, healthcare workers were unclear as to the level of necessary decontamination for medical instruments used on consecutive patients. It was difficult to weigh up all of the risk factors, until Spaulding simplified the decision into just three choices:[6]

- If the medical instruments enter sterile tissue, they need sterilisation.
- If they touch mucous membranes, they need high-level disinfection.
- If they touch intact skin only, they need intermediate or low-level disinfection.

However Spaulding's classification relates to medical devices used on patients, and it was never intended to be applied to environmental surfaces, such as hospital floors, walls, tables and beds. The question of how to handle environmental surfaces was resolved in 1991 when the US Centers for Disease Control and Prevention (CDC) added three environmental categories, namely:[7]

- Surfaces of mobile medical equipment.
- High-touch environmental surfaces, including light switches and door handles.
- Low-touch environmental surfaces, including floors and walls.

With the use of the hierarchy presented in Table I, decontamination and disinfection decisions for clinical staff and infection prevention practitioners became markedly simpler.

Table I: Decontamination protocols pertaining to environmental surfaces according to risk level, as prescribed by the US Centers for Disease Control and Prevention[7,8]

Level	Risk	Activity	Decontamination protocol
1	Critical	Enter sterile tissue	Sterilisation
2	Semi-critical	Touch mucous membranes	Sterilisation or high-level disinfection
3	Non-critical	Touch intact skin	Intermediate to low-level disinfection
4	Low	Medical equipment handles	Intermediate to low-level disinfection
5	Lower	Environmental surfaces (touched often)	Clean, and disinfect if there is uncertainty with regard to contamination with blood, body fluid or the presence of multi-resistant organisms
6	Lowest	Environmental surfaces (touched seldom)	Clean

Do reusable waste containers pose an infection risk?

Only risk levels 4, 5 and 6, as detailed in Table I are relevant as reusable waste containers are not a medical device for use on patients.

Questions with regard to the risk assessment of reusable waste containers corresponding to these levels are:

- Is it a mobile medical equipment item that is touched by staff who then touch patients? (No)
- Is it an environmental surface that is frequently touched? (No)
- Is it an environmental surface that is infrequently touched? (Yes)

Therefore, reusable waste containers can be assessed as having a risk level 6, which represents the lowest level of risk for infection transfer.

Consideration should also be given to the six links in the CDC-modified "chain of infection".[9] All six links (Table II) would have to occur for infection to result in a patient.

Table II: The six links in the modified Centers for Disease Control and Prevention "chain of infection"

- The presence of a pathogen
- Sufficient virulence of the pathogen
- Relatively high concentration of the pathogen
- Mechanism of transmission from the environment to the host
- The correct portal of entry
- A susceptible host.

To assess the risk of visually clean reusable waste containers, the six links were addressed as follows:

- Could a pathogen be present? (Potentially, but unlikely).
- Could the pathogen be of sufficient virulence? (Potentially,

but the infectivity of most pathogens decreases with time on dry environmental surfaces).[10]
- Could the pathogen be present in high concentrations? (Highly unlikely. Cleaning itself can reduce the bioburden by up to five logs,[8,9] and the author's unpublished studies show that the average bioburden on visually clean reusable waste containers is very low, of the order of 1-2 colony-forming units/cm^2).
- Could the pathogen be transferred from the reusable waste containers to the patient? (Potentially. However, blood-borne pathogens are not transmitted via the airborne route,[7] and with contact precautions in place, it is unlikely that reusable waste containers would be touched by the healthcare workers depositing waste or sharps. However, the transmission of pathogens is possible via direct contact if the lids are contaminated and lifted manually, although the use of reusable waste containers commonly occurs after the clinical procedures have been completed).
- Could the pathogen enter the host? (Potentially, if the reusable waste containers result in contaminated hands, and then if intravenous lines and wound dressings, for example, are subsequently handled without appropriate hand hygiene).
- Could the host be susceptible? (Potentially, particularly if the patient is immunosuppressed or immunocompromised).

The "chain of infection" assessment, combined with the prescribed levels of decontamination (Table I), indicate that reusable waste containers:
- Pose a negligible to nil risk of pathogen transmission to patients and environments.
- At risk level 6, require thorough cleaning for safe reuse, with no need for disinfection.

What is the theoretical probability of reusable waste containers causing infection?

To answer the question as to what the theoretical probability of reusable waste containers causing infection would be, probability needs be determined in respect of each of the six "chain of infection" links, and all six probabilities multiplied together to calculate the "probability of infection".[11]

The author has detailed his conservative estimation of the "worst case" probabilities for reusable waste container risk of infection in Table III.

Multiplying these probabilities provides an overall probability of reusable waste containers being associated with infection of one in 400 million (extremely low).

Have reusable waste containers ever transmitted disease to a patient?

Two case studies in the world literature report on microbiological sampling of reusable waste containers. However, neither confirmed pathogen nor disease transmission.[12,14] Both papers found that unclean reusable waste containers could harbour potential pathogens. However, Neely et al state: "There is no direct proof that microorganisms from the infectious waste boxes caused nosocomial infections in patients".[12] Both articles are valuable in that they remind readers that not all reusable waste containers providers are equal. Due diligence is essential in selecting a reliable provider with a suitably engineered, safe product, and a high standard of documentation, service, cleanliness and regulatory compliance. Ensuring that reusable waste containers are delivered "visually clean", i.e. free of soil, waste items, blood or other potentially infectious material and fluid, further reduces the risk calculated in Table III.

To further examine the question, the author considered epidemiological evidence from the waste industry and from the international literature. The following was determined:
- In an unpublished survey of industry members in the USA, Australia, New Zealand and Canada on the use of reusable waste containers and total handled healthcare risk waste, the author conservatively estimated that 800-million reusable waste containers were processed in these countries in the past 20 years.
- Assuming a conservative 10-fold greater number to allow for reusable waste container processing in all other countries, the estimated total number of processed reusable waste containers may well approach eight billion.
- There are no published reports of disease transmission from reusable waste containers.

Given the above, the incidence of disease from a reusable

Table III: Calculation of disease transmission probability using reusable waste containers

Link	Probability	Comment
Pathogen present	1:40	*"Worst case":* Poorly cleaned reusable waste containers
Pathogen present in high numbers	1:100 000	Average bioburden reduction with cleaning is four logs.[8,9,13] The addition of heat and disinfection (commonly used) adds a minimum of one log of further reduction[8]
Pathogen virulent	1:1	*"Worst case":* All pathogens are virulent
An available means of transfer to the host	1:10	The incidence is undocumented, but the "worst case conjecture" would be via air and contact transfer
Correct entry into the host	1:10	The incidence is undocumented, but the probability estimate is based on "worst case conjecture" of a pathogen being deposited on an area of the patient that is vulnerable to entry, as well as specific and relevant to that pathogen's pathogensesis
A susceptible host	1:1	*"Worst case":* The host is susceptible

waste container is less than one in eight billion reusable waste containers uses. To put this incidence in perspective, the annual risk of road accident deaths in South Africa is one in 3 635 inhabitants.[15]

The frequency of use of large, open-top containers for sharps in operating theatres, and the absence of any reported incident of disease transmission from the bins to vulnerable surgical patients, is added epidemiological evidence that reusable waste containers do not pose an infection risk.

Do we need to microbiologically monitor reusable waste containers?

Based on the presented evidence and the CDC recommendations,[7] it is clearly unnecessary to microbiologically monitor the containers. Any such monitoring would be a non-judicious use of resources.

Reusable container infection risk needs be compared with that pertaining to cleaning hospital crockery and cutlery. The knives, forks, spoons and cups that patients put in their mouths are washed in hospital dishwashers with hot water and detergent, yet these utensils are not swabbed, nor microbiologically validated. They are inspected for cleanliness, and if soiled, put back in for a second wash or washed by hand. If crockery and cutlery (items that touch mucous membranes and thus could be categorised as semi-critical items with a level 2 risk of transmission, according to Spaulding), are not microbiologically monitored, then the microbiological monitoring of reusable waste containers, which carry the lowest level of risk (level 6), is unwarranted and cannot be justified.

In the USA where reusable waste containers have been used for more than 20 years without a reported incident of disease transmission, the Occupational Safety and Health Administration states[16] that "disinfection of these containers is not necessary to ensure their safety for their intended use. It may be possible to achieve their proper decontamination by means of a soap and water wash".

Lynne Sehulster, senior author of the 2003 CDC guidelines,[7] states (personal communication, 2008, April 23): "There is no epidemiological or anecdotal evidence to support decontamination strategies over and beyond simple cleaning. The notion of a microbiological challenge test to confirm decontamination is a scientifically unjustified practice, given that a waste container is, in my assessment, a piece of equipment best described as an environmental surface".

More than 100 hospitals in Kwazulu-Natal, including government and private, have used reusable waste containers for healthcare risk waste (sharps and non-sharps) since 2006, without a reported incident of pathogen or disease transmission.

The author is informed that having assessed the above information, both the Gauteng and Eastern Cape provinces are removing their requirement for the microbiological monitoring of reusable waste containers.

In the USA, New Zealand, Canada and Australia, there are no outcome nor process "standards" for the processing of reusable waste containers, nor is microbiological sampling or "cleanliness quality kit" use recommended. No doubt this is a reflection of the non-involvement in infection transmission by reusable waste containers. All of the above jurisdictions require that reusable waste containers are decontaminated and rendered visibly clean, a criterion that matches risk, and one that has stood the test of time. Notwithstanding the above, it is advisable for hospital decision-makers to conduct due diligence, including factory visits, to ensure that the reusable waste containers contractor is a reliable provider with a suitably engineered safe product and a high standard of documentation, service, cleanliness and regulatory compliance. Adherence to these requirements is considered to be more than adequate in eliminating any risk of infection from reusable waste containers.

The benefits of reusable waste container use

Reusable waste containers may also reduce sharps injury risk to healthcare workers.[17,18] Studies on the impact of safety-engineered reusable containers for sharps indicate that the adoption of the same reusable containers for sharps may have reduced container-associated sharps injury by more than 80% in the KwaZulu-Natal hospitals to which earlier reference was made in this manuscript.

The use of reusable waste containers can significantly reduce the volume of waste that is sent to landfill. In overseas studies, the same reusable containers for sharps utilised by the KwaZulu-Natal hospitals resulted in a 28% reduction in landfill waste[19] and an 85% reduction in greenhouse gas emissions,[20] when compared with the use of disposable containers for sharps. In data obtained from South African providers of reusable waste containers for sharps, the author calculates that in the six years since their adoption in South Africa, 1.14-million disposable containers for sharps have been eliminated from landfills. The same reusable waste containers have also been associated with reduced waste stream costs.[20]

The adoption of reusable waste containers by hospitals complies with the legislative requirements of the National Environmental Management Act No 107 of 1998,[21] and the National Waste Management Strategy of 2012.[22] These Acts require that generators of waste must minimise the amount of waste generated, with the ultimate aim of diverting waste from landfill.

Conclusion

It is concluded that:

- The risk of pathogen or infectious disease transmission from reusable waste containers is negligible to nil.

- Cleaning, using visual criteria and due diligence in the selection of a reusable waste container contractor, should ensure the risk-free use of reusable waste containers.
- Disinfection and microbiological validation and monitoring of reusable waste containers are not indicated.
- The use of reusable waste containers for the disposal of sharps can significantly reduce sharps injuries, landfill waste and costs.
- Hospitals that use reusable waste containers comply with national sustainability legislature.

Conflict of interest

The author is a consultant on microbiological risk to clients. The latter includes waste industry members who supply reusable healthcare risk waste containers. Industry members did not fund, initiate, contribute to, sight or review this article.

Declarations

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References

1. National Road Traffic Act 93 of 1996: Incorporation of standard specifications into the national road traffic regulations [homepage on the Internet]. c2013. Available from: https://application.ecoimpact.co.za/admin/upload/PDFs/INCORP_STANDARDS_GNR1249.htm
2. Gauteng health care management regulations 2004. Department of Agriculture Conservation and Environment [homepage on the Internet]. 2004. c2013. Available from: http://www.gdard.gpg.gov.za/Services/Documents/CertifiedHCWMRegulationsSTAMPED.pdf
3. Buffalo City environmental health bylaws [homepage on the Internet]. 2010. c2013. Available from: http://www.buffalocity.gov.za/municipality/bylaws/bylaws_noise_enviro_health.pdf
4. Reinhart PA, Gordon JG, editors. Infectious and medical waste management. Michigan: Lewis Publishers, 1991; p. 7.
5. Block S. Definition of terms. In: Block S, editor. Sterilization, disinfection and preservation. 5th ed. Philadelphia: Lippincott, Williams and Wilkin, 2001; p. 19-28.
6. Spaulding EH. Chemical disinfection of medical and surgical material. In: Lawrence CA, Block SS, editors. Disinfection, sterilization and preservation. Philadelphia: Lea & Febiger, 1968; p. 517-531.
7. Sehulster L, Chinn RYW. Guideline for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention [homepage on the Internet] 2003. c2013. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm
8. Rutala WA, Weber DJ, the Healthcare Infection Control Practices Advisory Committee. Guidelines for disinfection and sterilization in health-care facilities. Centers for Disease Control and Prevention [homepage on the Internet]. 2008. c2013. Available from: http://www.cdc.gov/hicpac/pdf/guidelines/disinfection_nov_2008.pdf
9. Favero MS, Bond WW. Chemical disinfection of medical and surgical materials. In: Block SS, editor. Disinfection, sterilization and preservation. 5th ed. Philadelphia: Lippincott Williams & Wilkins, 2001; p. 896.
10. Assar KS, Block SS. Chemical disinfection of medical and surgical materials. In: Block SS, editor. Disinfection, sterilization and preservation. 5th ed. Philadelphia: Lippincott Williams & Wilkins, 2001; p. 1221-1235.
11. Rutala W, Mayhall C. Medical waste. Infect Control Hosp Epidemiol. 1992;13(1):38-48.
12. Neely AN, Maley MP, Taylor GL. Investigation of single-use versus reusable infectious waste containers as potential sources of microbial contamination. Am J Infect Control. 2003;31(1):13-17.
13. ASTM E 2314 standard test method for determination of effectiveness of cleaning processes for reusable medical instruments using a microbiologic method (simulated use test). West Conshohocken: American Society for Testing and Materials International; 2008.
14. Runner J. Bacterial and viral contamination of reusable sharps containers in a community hospital setting. Am J Infect Control. 2007;35(8):527-530.
15. Annual Report, 2010- 2011. Road Traffic Management Corporation [homepage on the Internet]. c2013. Available from: http://www.rtmc.co.za/images/docs/RTMC%20AR%202010%20-%202011.pdf
16. Bloodborne pathogens. United States Department of Labor [homepage on the Internet]. c2013. Available from: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051
17. Grimmond T, Rings T, Taylor C, et al. Sharps injury reduction using Sharpsmart: a reusable sharps management system. J Hosp Infect. 2003;54(3):332-238.
18. Grimmond T, Bylund S, Anglea C, at al. Sharps injury reduction using a sharps container with enhanced engineering: a 28 hospital nonrandomized intervention and cohort study. Am J Infect Control. 2010;38(10):799-805.
19. Grimmond T, Himes E, Skinner D. 28% waste reduction with Sharpsmart safety device: a 5 year, 103 hospital study [homepage on the Internet]. 2009. c2013. Available from: http://www.cleanmed.org/2009/downloads/posters/28%20Percent%20Waste%20Reduction%20with%20Sharpsmart%20Safety%20Device_a%205%20year%20103%20Hospital%20Study.pdf
20. Grimmond T, Reiner S. Impact on carbon footprint: an LCA of disposable vs reusable sharps containers in a large US hospital. Waste Manag Res. 2012;30(6):639-642.
21. South Africa National Environmental Management Act No. 107 of 1998 [homepage on the Internet]. c2013. Available from: http://www.wipo.int/wipolex/en/details.jsp?id=8126
22. South Africa National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). Department of Environmental Affairs [homepage on the Internet]j. c2013. Available from: http://cer.org.za/wp-content/uploads/2012/06/National-Waste-Management-Strategy-as-implemented.pdf