Suggested citation: Grimmond T. Using reusable containers for hospital waste – is there an infection risk? South Afr J Epidemiol Infect 2013;28(4):197-201.

Using Reusable Containers for Hospital Waste – Is there an Infection Risk?

Terry Grimmond, FASM, BAgrSc, GrDipAdEd
Director, Grimmond and Associates, Microbiology Consultancy, New Zealand.
E-mail: terry@terrygrimmond.com

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

Keywords: Reusable, waste bins, waste containers, healthcare risk waste, infection risk, sharps, medical waste, clinical waste, monitoring, validation.

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 The author's unpublished survey of HCRW industry members in Canada, USA, Australia and New Zealand (NZ) revealed that an estimated 50% of HCRW containers (sharps and non-sharps) are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

This perception has to date prompted several authorities in South Africa (SA) to require specific levels of disinfection, microbiological monitoring or process validation. In SA, the SA standard SANS 10229-1:2010 as incorporated under the National Road Traffic Act of 1996, requires RWC to be disinfected prior to reuse.[1] In addition, the Gauteng Health Care Waste Management Regulations (2004) require: daily swabs of RWC for five days prior to the start of the contract; weekly swabs before dispatch and monthly swabs at delivery for the first 4 months of use; thereafter, on proven adequacy, at half that frequency; cultures for bacteria and fungi by an accredited laboratory to confirm *`reasonably adequate disinfection'* and for the results to be examined quarterly by a competent person.[2] Eastern Cape bylaws currently set similar requirements for RWC.[3]
This paper examines the international literature and guidelines to determine the microbiological risk of using RWC and what, if any, process validation or monitoring may be indicated.

Risk
Risk is the product of probability and consequence,[4] that is, how frequently does an adverse event occur, and how

severe is the outcome? In general terms, risk can be categorised as occupational, environmental, legal, political, social or economic.[4] Questions that stakeholders legitimately ask regarding RWC are: will I get infected?; will antibiotic-resistant pathogens be brought into my hospital?; will use of RWC impact on the environment?; could staff transfer pathogens from RWC to patients? and; is the microbiological monitoring of RWC a good use of valuable resources?

In assessing the risk of using RWC, all of the above components need be addressed.

Decontamination

Although non-sharp HCRW is commonly contained in a bag within the RWC, there is the potential for the RWC internal surfaces 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 potentially could contain pathogens. Decontamination processes must therefore ensure that any pathogens that might be present must be reduced to a level that eliminates the risk of transfer to 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,

`**Sterilization'** 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 sterilization, disinfection and cleaning are all forms of decontamination.

Of note is 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 RWC.

Prior to the 1970's, health care workers were not clear as to the level of decontamination necessary for medical instruments used on consecutive patients. It was a struggle to weigh up all the risk factors, until Spaulding simplified the decision into just three choices:[6]

1. If it enters sterile tissue, it needs sterilization
2. If it touches mucous membranes, it needs high-level disinfection
3. If it touches only intact skin, it needs 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:[7]

4. Surfaces of mobile medical equipment.
5. High-touch environmental surfaces (including light switches and door handles).
6. Low-touch environmental surfaces (including floors and walls).

With the use of the hierarchy presented in Table 1, decontamination and disinfection decisions for clinical staff and infection prevention practitioners became markedly simpler.

Table 1: Decontamination protocols according to risk level as prescribed by the US Centre for Disease Control and Prevention[7,8]

Risk	Activity	Decontamination Protocol
1. Critical	Enter sterile tissue	Sterilization
2. Semi-critical	Touch mucous membranes	Sterilization 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 (high-touch)	Clean (disinfect if uncertain of contamination with blood, body fluid or presence of multi-resistant organisms)
6. Lowest	Environmental surfaces (low-touch)	Clean

Do RWC pose an infection risk?

Only risk levels 4, 5 and 6 as detailed in Table 1 are relevant, as RWC are not a medical device for use on patients. The questions for risk assessment of RWC corresponding to these levels are:

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

RWC are therefore assessed as having risk level 6, representing the lowest level of risk for infection transfer.

Table 2. Links in the Chain of Infection

1. Presence of a pathogen
2. Sufficient virulence of the pathogen
3. Relatively high concentration of pathogens
4. A mechanism of transmission from environment to host
5. A correct portal of entry
6. A susceptible host.

A further consideration for infection to occur in a patient is that the six links in the CDC- modified `Chain of Infection',[9] as detailed in Table 2, all need to occur.

To assess risk of visually clean RWC, the six links were addressed as follows:

1. Could a pathogen be present? Potentially, but unlikely.
2. Could pathogen be of sufficient virulence? Potentially, but the infectivity of most pathogens decreases with time on dry environmental surfaces.[10]
3. Could pathogen be present in high concentration? Highly unlikely. Cleaning itself can reduce the bioburden by up to five logs[8,9] and the author's unpublished studies show the average bioburden on visually clean RWC is very low, of the order of 1-2 colony forming units per cm^2.
4. Could pathogen be transferred from RWC to patient? Potentially, however: blood-borne pathogens are not transmitted via the airborne route;[7] and with contact precautions RWC should not be touched, however transmission of pathogens is possible via direct contact if lids are contaminated and lifted manually (although use of RWC is commonly after clinical procedure has finished)
5. Could the pathogen enter the host? Potentially if the use of RWC resulted in contaminated hands and then IV lines, wound dressings, etc. were subsequently handled without appropriate hand hygiene.

6. Could the host be susceptible? Potentially, particularly if the patient is immunosuppressed or immunocompromised.

The Chain of Infection assessment, combined with CDC recommended decontamination levels (Table 1), indicate that RWC:

- Pose a negligible to nil risk of pathogen transmission to patients and environments.
- At risk level 6, require cleaning for safe reuse, with no need for disinfection.

What is the theoretical probability of RWC causing infection?

To answer this question, a probability needs be placed on each of the six Chain of Infection links, and all six probabilities multiplied together to calculate a "probability of infection".[11]

In Table 3, the author has conservatively estimated the "worst case" probabilities for RWC risk of infection. Multiplying these probabilities gives an overall probability of RWC being associated with infection as an extremely low 1 in 400 million.

Have RWC ever transmitted disease to a patient?

Two case-studies in the world literature report on microbiological sampling of RWC however neither confirmed pathogen or disease transmission.[12,14] Both papers found that unclean RWC could harbour potential pathogens, however Neely et al. states `*…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 RWC providers are equal. Due diligence is essential in selecting a reliable provider with a suitably engineered, safe product and high standards of documentation, service, cleanliness and regulatory compliance. Ensuring that RWC are delivered 'visually clean', that is, free of soil, waste items, blood or other potentially infectious material, and fluids, would further reduce the risk calculated in Table 2.

To further examine the question the author examined epidemiological evidence from the waste industry and from international literature and determined the following:

- In an unpublished survey of industry members in USA, Australia, New Zealand and Canada regarding use of RWC and total HCRW handled, the author conservatively estimates that some 800 million RWC have been processed in these countries in the past 20 years.
- Assuming a conservative tenfold greater number to allow for RWC processing in all other countries, the estimated total number of RWC processed may well approach 8 billion.
- There are no published reports of disease transmission from RWC.

Given the above, the incidence of disease from an RWC is less than 1 in 8 billion RWC uses. To put this incidence in perspective, the annual risk of road accident death in SA is 1 in 3,635 inhabitants.[15]

The frequency of use of large open-top sharps containers 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 RWC do not pose an infection risk.

Do we need to microbiologically monitor RWC?

Based on the evidence presented here 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 the cleaning of hospital crockery and cutlery. The knives, forks, spoons and cups that patients put in their

Table 3. Calculation of disease transmission probability using reusable waste containers

Link	Probability	Comment
Pathogen present	1 : 40	'Worst case' – poorly clean RWC[12]
Pathogen present in high numbers	1 : 100,000	Average bioburden reduction with cleaning is 4 Logs;[8,9,13] Addition of heat/disinfection (commonly used) adds a minimum of 1 log further reduction.[8]
Pathogen virulent	1 : 1	'Worst case' – all pathogens virulent
An available means of transfer to host	1 : 10	Incidence undocumented but 'Worst case conjecture' – via air and contact transfer.
Correct entry into host	1 : 10	Incidence undocumented but 'Worst case' estimate – deposited on uncovered wound, etc.
Susceptible host	1 : 1	'Worst case' – all hosts susceptible

mouths are washed in hospital dishwashers with hot water and detergent, yet these utensils are not swabbed or microbiologically validated. They are inspected for cleanliness and, if soiled, put back in for a second wash or washed by hand. If we do not microbiologically monitor crockery and cutlery (items that touch mucous membranes and thus could be categorized as semi-critical items with a level 2 risk of transmission according to Spaulding), then the microbiological monitoring of RWC, which carry the lowest level of risk (level 6), is unwarranted and cannot be justified.

In the USA where RWC have been used for more than 20 years without a reported incident of disease transmission, the Occupational Safety and Health Administration state[16] *`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): *`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".*

In Kwazulu-Natal (KZN) more than 100 hospitals, including government and private, have used RWC for sharp and non-sharp HCRW since 2006 without a reported incident of pathogen or disease transmission.

The author is informed that after assessing the above information, both Gauteng and Eastern Cape Provinces are removing their requirement for microbiological monitoring of RWC.

In USA, NZ, Canada and Australia there are no outcome or process 'standards' for the processing of RWC, nor is microbiological sampling or 'cleanliness quality kit" use recommended, and no doubt this is a reflection of RWC non-involvement in infection transmission. All the above jurisdictions require RWC to be 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 the RWC contractor is a reliable provider with a suitably engineered, safe product and high standards of documentation, service, cleanliness and regulatory compliance. Adherence to these requirements is considered more than adequate for the elimination of any risk of infection from RWC.

Benefits of RWC use.

Reusable waste containers may also reduce HCW sharps injury (SI) risk. [17,18] These studies on the impact of a safety-engineered reusable sharps container indicate that in the KZN hospitals cited above, the adoption of the same reusable sharps containers may have reduced container-associated SI by more than 80%.

The use of RWC can significantly reduce the volume of waste landfilled. In overseas studies the same reusable sharps container used in the KZN hospitals resulted in a 28% reduction in landfilled waste[19] and an 85% reduction in greenhouse gas emissions[20] when compared with the use of disposable sharps containers. In data obtained from SA providers of RWC for sharps, the author calculates that in the 6 years since their adoption in SA, some 1.14 million disposable sharps containers have been eliminated from landfills. The same RWC has also been associated with reduced waste-stream costs.[20]

The adoption of RWC by hospitals is in compliance 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 require that generators of waste must minimize the amounts of waste generated with the ultimate aim of diverting waste from landfill.

Conclusions

It is concluded that:

- The risk of pathogen or infectious disease transmission from RWC is negligible to nil.
- Thorough cleaning using visual criteria, and due diligence in selecting RWC contractors, will ensure risk-free use of RWC.
- Disinfection and microbiological validation and monitoring of RWC are not indicated.
- Use of RWC for sharps disposal can significantly reduce SI, landfilled waste and costs.
- Hospitals adopting RWC are in compliance with national sustainability legislature.

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