CSIRO PUBLISHING

Healthcare Infection, 2014, **19**, 76–80
http://dx.doi.org/10.1071/HI13048

Impact of a linerless, reusable, clinical wastebin system on costs, waste volumes and infection risk in an Australian acute-care hospital

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Abstract. ***Introduction*:** Regular audits of clinical waste (CW) disposal systems and examination of new technologies can lead to cost and waste reductions, and lowering of infection potential. Sydney Adventist hospital, a 360-bed acute-care private facility, noted that their 240 L, clinical waste (CW) bin system posed issues with infection risk, staff injury risk, aesthetics, logistics, space and cost and evaluated a new, linerless, reusable bin system.

***Methods*:** A facility-wide audit was conducted of the current 240 L bin system before a three ward, 3-month staff evaluation of the new, 64 L, linerless, reusable bin system (Clinismart, SteriHealth Ltd, Melbourne, Vic., Australia). Clinical waste volume and mass were compared between systems over a 30-month period as were contractor costs, labour, space requirements and general waste (GW) mass. Staff opinion was sought via a 10-point questionnaire, and infection and injury risks audited.

***Results*:** Inpatient workloads remained static over the study. Staff evaluations showed a strong preference for the new system which was rolled-out to all wards in the facility. Significant decreases were noted in CW mass (53.2% less), CW volume (65.2% less), CW disposal costs (30.9% less) and labour (69.2% less), and the new system was found to be more space-efficient and logistically superior. Waste segregation was markedly enhanced. Infection potential and injury risks noted with the 240 L system were eliminated.

***Conclusion*:** The study found that the use of a smaller, 64 L, linerless, reusable, hospital wastebin system, through its design and operation, has the potential to reduce clinical waste volumes, increase labour efficiencies, decrease costs and minimise infection potential and sharps injury risk, all of which improve the quality of health care.

Received 13 December 2013, accepted 24 February 2014, published online 26 May 2014

Introduction

Taking all reasonable steps to minimise the risk of infection transfer among staff and patients is an important focus for hospital management.[1] Clinical waste (CW) presents a potential infection risk to staff, patients and public so an efficient and hygienic CW disposal system is an important part of successfully minimising this risk and providing quality health care.[2] In addition, in Australia, CW is some tenfold more expensive than general waste[3] and reducing it through correct segregation makes financial sense.[3,4]

In a Greater London study, examination of a random selection of lined waste carts from nine acute hospitals revealed that they were unclean and a source of potentially pathogenic material, posing an infection-control (IC) risk.[5] Observations included: overfilled bins, external soiling on 100% of bins, internal soiling on 60% of bins, *Staphylococcus aureus* and enterococci in or on 60% of bins, Gram-negative species (including *Escherichia coli*, *Enterobacter* spp and *Pseudomonas aeruginosa*) on 60% of bins, and free fluid in 20% of bins. Waste was sometimes not contained by the liner bags, which may at times collapse or come away from the side-wall. A similar study highlighting IC risk found 25% of poorly cleaned CW bin systems were contaminated with potential pathogens.[6]

In the authors' experience, most Australian hospitals use one of two CW bin systems. One is a bin, usually of 50–70 L capacity, that remains in the patient's room and is lined with a disposable plastic liner into which clinical staff place CW. The bag is removed and collected regularly by Hospitality Services (HS) staff and transported to a central

Implications

- Hospitals can follow this example in formulating successful policies on clinical waste disposal procedures.
- Clinical waste cost and volume can be reduced while minimising infection risk.
- Clinical waste cost and volume can be reduced by the use of a new, 64 L, linerless, reusable, clinical wastebin system.

waste-holding area. The other is a larger, plastic bag-lined, 240 L, yellow, mobile garbage bin sited in dirty utility rooms in each clinical unit. In the latter system clinical staff carry patient-derived CW (commonly un-bagged) to the 240 L bins which, when full, are transported internally by hospital staff to a central waste-holding area. In both systems the bags or bins are collected from the central waste-holding area and processed by a CW contractor. Sydney Adventist Hospital (SAH), a 360-bed acute-care private hospital in Sydney, NSW used the 240 L bin system sited in dirty utility rooms.

Regular monitoring of waste-handling systems enables evaluation of costs, volumes, IC and occupational, health and safety (OHS) risks, and logistic efficiencies.[2] Such quality-assurance audits conducted by SAH found that the 240 L system raised the concerns listed in Table 1 and were not compliant with NSW Healthcare Waste guidelines recommending that waste bags should not exceed 55 L, that manual handling of bins should be minimised and that smaller, mobile garbage bins should be used.[2]

With a view to improving quality of care at SAH, management from HS (Hospitality Staff) and Infection Prevention and Control (IPC) departments investigated a new, linerless, reusable, foot-operated bin system in dirty utility rooms. This paper outlines a comparison of the IC and OHS risks, costs and logistics between the large, reusable bin system and the new, smaller, linerless, reusable system.

Table 1. Adverse issues noted with system A (240 L bins)
HS, hospitality staff; IC, infection control; OHS, occupational health and safety

Concern	Issue
Space	The bins required a large floor space area in: (1) the dirty utility rooms, (2) the bin store room, and (3) the waste storage area.
Logistics	HS staff on average changed the bins in each ward on a daily basis, and as only one bin should be handled by one person at a time, this task required many return trips to wards. This in turn resulted in high HS staff hours to complete and increased traffic of cumbersome bins in public areas.
OHS	(1) To reduce trips to wards, staff wheeled two bins at a time in a push-and-pull arrangement resulting in strain risk to HS staff and potential impact with other staff, visitors and patients. (2) Staff, in reaching into the bin to expel air and tie off the liners, or reposition collapsed liners were exposed to potentially infectious material and improperly disposed sharps.
IC	Bins were considered a potential IC risk to patients and staff through: (1) absence of foot-operated opening mechanism requiring staff to lift lid manually, (2) arrival of visually-scratched and sometimes externally-soiled bins, and (3) a liner collapsing into the bin placing staff at risk by their attempts to reach inside and pull the liner up and over the rim, or making it impossible for the liner to be tied off before transport.
Segregation	The largeness of the bins tempts staff to dispose of waste other than CW into the bin. In one audit, 80–85% of contents were general waste.
Aesthetics	Transportation to and from wards of unsightly 'obviously waste' bins in public areas.

Methods

A hospital-wide audit of the 240 L bin system, system A, was conducted by IC and HS staff with regard to IC, OHS, space and logistics. The smaller, 64 L, linerless, foot-operated system (Clinismart, SteriHealth Ltd, Melbourne, Vic., Australia), system B, was introduced and, in accord with SAH CW bin-placement policy, was placed in each of the dirty utility rooms in three wards of SAH in August 2010 and rolled-out in three stages over the next year to all hospital wards. In system B, patient CW (bagged or un-bagged) is carried manually or on the procedure cart to the dirty utility room for disposal. The lockable, reusable bins, manufactured from scratch-resistant and puncture-resistant ABS polymer are set slightly off the floor on a wheeled frame with a pedal-operated lid (Fig. 1). The bins are transported in multiples in a vendor-supplied purpose-designed transporter to and from wards by HS staff as can be seen in Fig. 2, and transported to and from the facility in purpose-built transporters (Fig. 3). The bins are collected, and robotically decanted, cleaned and decontaminated offsite by the vendor before being returned for reuse. Staff of SAH were trained in the correct handling of system B bins by the vendor initially and by SAH educators subsequently.

The clinical waste-disposal efficiency of system B was monitored by comparing volumes produced, number of bins used, correctness of waste segregation, labour required, and costs. Quantitation at 30 months (after full roll-out) was carried out to ensure consistency of change. Staff opinion on system B was assessed by a 10-point questionnaire completed by HS and clinical staff on the three participating wards. In addition, during the initial trial period the contents of bins on each of the three wards were monitored for incorrect disposal of sharps.

Data on Inpatient Days (ID) (overnight plus day stay) were obtained from SAH. Data on CW weights and volumes and on general waste (GW) weights were obtained from the waste contractor invoices. Data on HS staff hours to transport bins to and from wards ('bin workload') were obtained from the SAH HS Manager. Bin fill volumes were assumed to be 'three-quarters full' (SAH change-out policy) in both systems. Apart from correct system usage (bin opening, closure, and mounting), no change in CW definition or education content

Fig. 1. Relative sizes of system A and system B. Note foot-operated mechanism in system B.

Fig. 2. System B: internal transport trolley.

Fig. 3. System B: dedicated road transporter.

was made during the trial. As in previous training sessions, correct CW segregation was included in the education. At roll-out, smaller, yellow bags for disposing of individual patient CW were logistically required by 2 of the 15 wards in the hospital. WinPepi v2.78 (JH Abramson, Hebrew University, Jerusalem, Israel) was used to calculate probability (significance set at $\leq$0.05), relative-risk and 95% confidence limits.

Results

Adverse issues noted during the audit of system A are listed in Table 1.

Quantitative outcomes

Changes in ID, CW mass, CW volume, bin workload and costs between the system A and system B are shown in Table 2. Although patient inpatient days and a workforce of approximately 1300 full-time equivalent (FTE) staff remained fairly constant over the 3 years of the study, CW volume and mass decreased by 65.2% and 53.2% respectively and GW mass decreased by 33.7%. Bin transport labour workload fell by 69.2%. Contractor CW disposal costs decreased by 30.9% to 27.4% of total SAH waste-disposal costs. Approximately 5000 large, plastic bags lining the 240 L bins were eliminated per year. Available space in soiled utility rooms was increased markedly; so too in the waste-storage area where the bins were stacked in a purpose-built transporter (Fig. 3).

Table 2. System comparison of CW mass and volume, bin workloads and costs per month

CL, confidence limits; CW, clinical waste; ID, inpatient day; GW, general waste; Q2, quarter 2; Q1, quarter 1; NS, not significant; *P*, probability; RR, relative risk

	System A (Q2 2010)	System B (Q1 2013)	Change (%)	Significance
Inpatient days per month	12 919	13 025	0.8	NS
CW volume (L per month)	86 784	30 490		
CW L per ID	6.72	2.34	–65.2	$P<0.001$ RR = 0.35; 95% CL = 0.28–0.45
CW mass per month (kg)	7636	3603		
CW kg per ID	0.59	0.28	–53.2	$P=0.037$ RR = 0.48; 95% CL = 0.23–0.97
GW mass per month (kg)	7734	5173		
GW mass per ID (kg)	0.60	0.40	–33.7	$P<0.001$ RR = 0.76; 95% CL = 0.75–0.77
Bin transport to wards (bins per day)	11.1	7.0		
Bin transport workload (hrs per day)	3.25	1.00	–69.2	$P<0.001$ RR = 0.31; 95% CL = 0.24–0.39
CW disposal costs per month	$8094	$5595	–30.9	$P<0.001$ RR = 0.78; 95% CL = 0.77–0.79

Sharps risk

Despite specific education, improperly disposed sharps were historically an issue with 240 L bins as they posed a risk to staff repositioning or tying off liner bags. In the first week of system B adoption, improper sharps disposal was detected daily in one of the roll-out wards (e.g. Vacutainer needle, lancet, micropin). One week after re-education, no improperly disposed sharps were detected. In the year previous to the trial, one staff member sustained a sharps injury (SI) from a sharp retained in a 240 L bin liner. In the 30 months since system B commenced, no SI from CW bin-handling were reported.

Qualitative outcomes

Three HS staff and 37 clinical staff completed staff-opinion surveys. On ease of use, 98% of staff preferred system B; on ease of changing bins, 100% preferred system B; and 89% preferred system B for ease of waste segregation. Overall, 84% of staff preferred system B over system A. All of the concerns noted during audits of system A were resolved with system B.

Infection risk

System B was deemed to be superior to system A in terms of cleanliness and hygiene due to system B bins being visually cleaner. Being linerless, system B bins did not require staff to lean inside CW bins to re-position or tie-off liners (a potential IC risk). Also, by having a foot-pedal, system B eliminated manual lifting of lids.

Discussion

The linerless system B was assessed by IC staff as having a lower potential infection risk compared with the potential risk of system A. An important outcome of the implementation of system B was a decrease in incorrectly disposed-of sharps, which in turn reduced the staff sharp-injury risk. System B bins are designed to be used in patient's rooms or dirty utility rooms; SAH chose to place them in dirty utility rooms in most wards for space and aesthetic reasons, and in selected patient's rooms in Endoscopy and ICU because of increased CW volumes in these areas.

The smaller, linerless wastebin system, in reducing CW costs, volumes and space, proved to be very acceptable to ward and hospitality staff. Replacing the larger, 240 L bags met NSW Health recommendations that waste bags should not exceed 55 L.[3] Staff appreciated not having to lean inside large CW bins, fix liners, tie-off liners, move heavy bins or lift lids with their hands. Staff also commented favourably on system B's foot-operated lid, ease of use, inducement to segregate CW, ease of bin exchange and ease of transport. Whereas the 240 L bins required many trips per day to and from wards, system B bins were transported in one trip by use of the purpose-designed transporter and thus markedly reduced transport labour. Another advantage of system B bins was that they were of the same design family as the reusable sharps containers used at SAH and thus both could be transported at the same time on the transporter. Being smaller, system B bins were exchanged and washed more often than the 240 L bins and this was manifested in their visual cleanliness, noted by staff.

The smaller bin resulted in superior CW segregation. Faced with the large, 240 L bin it was difficult for staff to avoid a mentality of 'big bin, everything in' and with system B it was evident that the use of a smaller bin made staff more conscious of what they put in. Fig. 4 shows the marked reduction in CW volume and mass before and after adoption of system B. The two wards requiring smaller patient CW bags at roll-out did so because their large yellow bags on preset procedure and emergency trolleys were unable to be easily deposited into system B smaller bins. It was evident that the use of smaller CW bags reduced CW volumes in these two wards. However, their use in only 2 of 15 wards is unlikely to have greatly impacted the overall results.

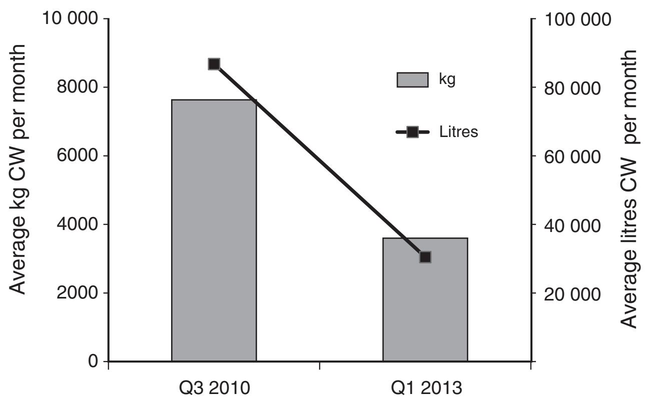

Fig. 4. Average monthly clinical waste (CW) mass and volume before and 30 months after adoption of system B. Q, quarter.

With system B the volume of CW was reduced by two-thirds and mass by just over half (Fig. 4). The difference is due to the GW, which is lighter, being correctly segregated. The marked increase in correct segregation with system B is in direct contrast to the less than 10% change in CW segregation seen with education alone.[4] Of note, though, was that the marked decrease in CW volumes was not reflected in a GW increase (GW mass decreased 34% over the 3 years due to SAH recycling strategies). There are few recent papers on CW management in the Australian literature; however, data in a NSW Auditor-General's report in 2002[3] shows that, with system B, SAH 2013 CW weights per FTE were half that of a similar-sized government hospital in the report. Although the cost per litre of CW removed was higher with system B, the system's efficiencies resulted in an overall CW disposal cost reduction of 30.9% bringing it down to 27.4% of SAH total waste disposal costs, markedly less than the 60–68% stated in other studies.[3,5] Not included in SAH CW costs were the savings in HS staff hours transporting the bins to and from wards. Comments in evaluation questionnaires indicated system B was highly regarded by SAH staff because of CW volume and cost reductions, increased handling efficiencies and safety, and because 5000 fewer large plastic bags were being landfilled. In reducing cost, risk, waste volumes and handling, system B meets the NSW Healthcare Waste Policy Directive which requires new systems be examined to, '...optimise waste-collection process, reduce handling and transportation, and to promote safe work practices'.[3]

With the continued waste disposal improvements resulting from this initiative, the use of the smaller, reusable bin system has diversified into cytotoxic waste, and this application is also seeing promising results.

Strengths of the study were the time-frame over which it was conducted, the accuracy and completeness of monthly weight and cost data, the comparative detailed audits, and the involvement of frontline staff in formal evaluations. Limitations of the study were that bin volume calculations were based on an assumed three-quarter fill level and the 'Hawthorne improvement effect' of a new CW system (with associated education) could not be ascertained. However, as the results were sustained almost 3 years after system B introduction, it is unlikely any such effect contributed greatly to the results. Further limitations were that the impact of smaller patient CW bags in 2 of 15 wards could not be separated from the overall impact of system B, that improper sharps disposal was ascertained on one ward only, and that infection control risks were visually assessed (microbiological monitoring was not conducted).

Conclusion

The study found that the use of a smaller, 64 L, linerless, reusable, hospital wastebin system, through its design and operation, has the potential to reduce waste volumes, increase labour efficiencies, decrease costs and minimise infection-risk potential, all of which improve the quality of health care and meet NSW Healthcare Waste Guidelines.

Conflict of interest

Two authors (FD and DM) declare no conflict of interest. TG is a consultant to the waste and healthcare industries internationally. All authors declare no commercial entity influenced the intent, study methodology or manuscript content of this project.

Funding

No specific funding was received from any source for this project.

Acknowledgements

The authors thank SAH for their facilities and resources, SteriHealth Limited for their assistance in supplying invoice data on weights and costs, and Caleb McGuire of SteriHealth Limited for his valuable assistance in implementing system B. We also thank the staff at SAH for their valuable evaluation and comparison of the systems.

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