How You Spend Your Pennies...

Factors Affecting the Efficiency of Human Waste Disposal Systems (Re-usable and Disposable) and their Cost

by M. Rollnick MscEng, Ceng, MIEE, Vector Consultants

How You Spend Your Pennies...

We all need to ‘spend a penny’, one way or another, and for the fit and healthy it’s simple. For the sick or infirm it can be far from simple, involving others, taking time, and costing money — pounds, not just pennies.

This paper considers some of the factors which affect the efficiency of human waste disposal equipment and its costs.

The waste disposal route from the patient used to be simply via the bedpan, possibly the slop hopper, and hence to the drains and the sewers. The system was simple and direct but required soiled pans or urinals to be cleaned by hand under a running tap, and nursing involvement was very high. It was highly unlikely that any disinfection process was used.

The Re-Usable System
Bedpan Washers

The objective of introducing automatic bedpan washers in the 1950’s was to reduce nursing involvement, and the potential risk of cross-infection. Bedpan washers were developed incorporating pumps directing high washing jets onto bedpans to remove soil from pan surfaces.

There was no precise definition of the disinfection conditions required to kill harmful organisms. Hot water cycles were thought to improve disinfection and sometimes piped steam was used.

In the 1970’s, unpublished studies, led to recommendations that bedpan washers must attain and maintain a temperature of a minimum of 80°C for one minute. In 1986 this recommendation was endorsed by a working party of the Central Sterilising Club, and became a national requirement for bedpan washer-disinfectors in the UK.

International Standards now require similar disinfection conditions.

Washer—Disinfector

In 1966 the BSI published BS 2745 (Bedpan and Urine Bottle Washers) but this rapidly became obsolete following the invaluable research by HIRL. Bedpan washers are now generally described as washer-disinfectors, which clearly defines their design objectives. Such equipment usually generates steam for the disinfection cycle using an electrically heated generator.

A complete revision of BS 2745 as a specification for washer-disinfectors, is due to be published in 1991. This requires safety devices to protect the operator and monitor the disinfection cycle to prevent cross infection. Meanwhile, many manufacturers have raised equipment quality and reliability so that the new requirements can be met with minor design adjustments.

From the above it is obvious that the re-usable system machine design has advanced considerably, particularly the control of disinfection and safety, however there are signs that the re-usable system is steadily losing ground to the disposable system and one of the reasons may be lack of attention to fundamental principles.

Perfection Bedpans

Before the introduction of bedpan washers, the stainless steel ‘perfection’ style bedpan was in extensive use. It was stable, fairly comfortable, minimised spillage, and most important, it was almost indestructible. The ‘perfection’ pan (whether stainless steel or polypropylene) was not, however, designed for automatic washing, or for ease of cleaning, and inspection is difficult because of its semi-enclosed shape. An ‘open’ shape is far easier to process.

The vertical sections taken across the width of typical ‘perfection’ and ‘open’ pans illustrate the advantages for cleaning and inspection of the latter (see Fig 1). Despite these obvious disadvantages, the stainless steel ‘perfection’ pan continues to be universally available due to its longevity. Washer-disinfector manufacturers struggle valiantly with a virtually impossible task of cleaning pans of the ‘perfection’ shape.

The ‘perfection’ pan is a key problem which has always limited the effectiveness of the re-usable system. Changing to an ‘open’ design offers a possible solution but how can this be achieved?

Current Nursing Practice - Commode Chair Use

Since the 1970’s the number of beds in the NHS has shrunk at the rate of approximately 5% per annum. To meet growing demand, patient ‘throughput’ has increased accordingly. Earner mobilisation of patients has led to an estimated 75% use of commode chairs for toileting. The remaining 25% involves pan use on the bed, of which 5% are slipper pans. Thus in most situations bedpans are not needed because the patient’s weight can now be supported on the commode chair seat.

The pan, mounted beneath the seat, need only support its own weight plus contents and so its construction can be entirely different and simpler.

Component Compatibility

Pans, commode chairs and washer-disinfectors are interdependent and their mutual compatibility is essential. Unless each ward has a clear policy on the range of receptacles to be used, almost any type or shape will be inserted into a commode chair’s rear support or tray, which soon becomes damaged and unusable. Pan surfaces also suffer, particularly polypropylene which becomes roughened and difficult to clean, leading to reprocessing and sometimes the need for hand cleaning.
‘Open’ Pan Design - Effective Processing

A BSI committee, which is drafting a revision of the British Standard for bedpans, BS 2588, has conducted a survey which concluded that few of the pans in use with commode chairs would meet the necessary criteria which are:-

- to have an ‘open’ design to enable effective cleaning and inspection;
- to be capable of fitting into British Standard commode chairs’;
- to have an aperture larger than that in the seat of the commode chair;
- to provide sufficient capacity to satisfy most patient needs; and
- to fit all known bedpan washer-disinfectors conforming to the British Standards.

By meeting the above criteria, the effectiveness of cleaning in washer-disinfectors can be considerably improved, probably by a factor of 10 compared with stainless steel or polypropylene ‘perfection’ bedpans. It should be noted that polypropylene pans are less noisy than stainless pans but they require more thermal energy and longer cycle times to ensure satisfactory disinfection.

The HSSA5 has made the BSI aware of these problems, and there are plans to consider a standard for commode chairs to complete the trio of products specified in British Standards.

Meanwhile, to improve effectiveness of the reusable-system, nursing, engineering and supplies departments must discuss their needs jointly. If necessary they should review their human waste disposal system, consider pan requirements and modify commode chair supports to suit.

The Disposable System

In the mid-1960’s, when washer-disinfectors were becoming established, the first truly integrated human waste disposal system was introduced — the disposable system. The disposable system concepts were revolutionary and presented a very attractive alternative. Here the paper pulp bedpans and polypropylene supports, the paper pulp urinals, and the destructor or macerator, were matched to provide a dedicated design, resulting in an integrated system.

The concept allowed an almost infinite range of receptacle shapes and sizes to be eliminated in one machine. The psychologically unpleasant principle of the communal bedpan or urinal in the reusable system had become unnecessary. Each patient used a new receptacle every time.

The potential advantages offered by this new system were overwhelming, and by the 1970’s and 1980’s the human waste disposal market was shared approximately equally between the disposable and reusable systems. The disposable system is still gaining market share due both to its unique concepts and the deficiencies noted above in the reusable system.

Selecting a Human Waste Disposal System

Despite these very strong conceptual arguments in favour of the disposable system there are additional factors to be considered. Disposable Bedpans: The disposable paper pulp bedpan is supported in a robust ‘open’ design support or carrier. This can become soiled, particularly when used on the bed (now less frequent, as in the reusable-system). When manual cleaning becomes necessary, this is relatively simple due to its ‘open’ shape. Cleaning frequency may be reduced if each patient is allocated a personal pan support.

During the past few months, manufacturers of the disposable system have reacted to the wider use of the commode chair by introducing an approximately circular commode pan. As the commode chair supports the patient the polypropylene carrier is not used which eliminates the need to clean it. The commode chair will still need cleaning and disinfection, in common with commode chairs used with the reusable system.

Disposable Slipper Pans: It is still essential to be able to process pans which support the patient either sitting or supine. Of these, the most difficult to design has been the slipper pan. So far, it has not been possible to produce a disposable slipper pan to support the weight of a patient. However, a specially designed system is now available incorporating a disposable receptacle supported by a re-usable support, using the same concepts as the disposable bedpan and support. The support design has eliminated the problems of cleaning and inspection normally encountered with reusable slipper pans and their internal wedge shape.

The capacity of disposable bedpans and disposable slipper pans is only half that of their re-usable counterparts, but they appear to cope adequately without spillage during handling. It is assumed that this difference in capacity is due to differing design constraints in the two systems.

Misuse and Good Practice

To minimise the risk of blockages, early macerators were dependent upon blade/chamber gap tolerances, requiring regular inspection to ensure efficient maceration and lower maintenance costs.

Since macerators are invariably top-loaders, it is sometimes too convenient for staff to dispose of the wrong items and materials unless they are instructed otherwise. Some occasional abuse may be tolerated, but continual misuse will cause breakdowns. The risk of breakdown can be minimised by addressing the following factors:-

- ward staff must be trained to appreciate that the macerator can only accept human waste, paper pulp items and toilet paper;
the disposal unit must be capable of consistently reducing the disposable pulp receptacle and contents to a flowing suspension.

**General Comparisons**

**Ward Loading**

One of the first steps in the selection of equipment for any particular site is to decide how busy the sluice-room is likely to be. That is, the maximum number of beds per ward, the type of patient, and their degree of dependence or ambulance.

A very busy, high throughput ward may need to process up to 240 receptacles per-day, which, spread over 2.5 hours, is a rate of only 10 items per hour. But it is important to be able to dispose of human waste fast, at busy times, to avoid an accumulation or backlog of filled receptacles. This is (at least) unpleasant and (at worst) a possible infection hazard to sluice room personnel.

For example, in some 25 bedded wards there will be 20 filled receptacles within the half-hour after breakfast, requiring, ideally, a disposal rate of 40 items per hour. This is beyond the capability of most washer-disinfectors, but macerators would be operating well within their capacity.

Washer-disinfectors generally tend to provide capacity for processing on an or two urinals with a cycle time of about three to four minutes (i.e. a processing rate of about 20 items per hour), provided that the equipment is well maintained.

Larger capacity washer-disinfectors are available to process more receptacles but cycle times are usually proportionately longer and the processing rate is similar to standard capacity machines. Even if they are able to cope with heavy loads at peak times, they can waste energy during the rest of the day when loading is light.

One alternative is a 'twin' washer-disinfector combining two identical machines. Here it is possible to double the throughput rate of receptacles when busy, and save energy under light loading. The key disadvantage is of course a doubling of capital cost and space, and if physically in the same housing, maintenance access may be more restricted.

Washer-disinfectors with stored energy generators can provide cycle times as low as two minutes on a continuous basis (with adequate maintenance), processing some 40 items per hour. These use similar electrical energy to machines with conventional steam generators. In hard water areas, effective water treatment is essential.

The average macerator (given a suitably designed drainage system) can process some 90 items per hour (based on three items per cycle) on a continuous basis, without the need for special maintenance or water treatment plant.

**Space Requirements**

The average space taken up by the equipment, either macerator or washer-disinfector, is approximately 0.5 cu m. In the extreme of the very busiest orthopaedic ward (using 240 disposables per day), an additional 0.375 cu m of storage space will be required for disposables for each day's use. If delivery of stocks is weekly, the storage space required would be five times machine volume, or ten times if it is deemed necessary to maintain a 'buffer' stock of a further one week's supply.

An average orthopaedic ward of some 25 patients may use about 125 disposables per day, so that the required storage space in the above example can be halved in many cases. Storage accommodation for disposables has to be provided either in the sluice room or in a central stores which requires an efficient hospital distribution system.

**Water Treatment**

The washer-disinfector depends upon a steam disinfection cycle; steam usually being generated within the machine. In hard water areas treatment is vital in order to protect the steam generator which may be at 100°C (or even 115°C in pressurised, stored energy steam generators). These temperatures will produce heavy scale deposits unless suitable water treatment is provided.

If the disinfection process is followed by any wash cycle, water stored in intercepting tanks must be maintained below 20°C or above 55°C to avoid the risk of legionellae.

Domestic hot water is not always treated or, where treatment is provided, some systems vary and are unreliable, so it is advisable for each machine to be provided with its own water treatment unit.

The macerator is unaffected by hard water problems, since it uses cold water only, to facilitate maceration and to form and convey a slurry through the drains to the sewers.

**Infection Control/Monitoring**

Despite more stringent controls and a better understanding of infection control, human waste disposal equipment must be checked periodically. In the case of washer-disinfectors it has been stated 'that these are at a disadvantage in comparison with macerators because they depend upon' performance monitoring.

The crucial steam disinfection cycle depends upon the control and monitoring of the temperature relationship which is one of the easiest parameters to measure, and one of the most reliable. Periodic checks must be made on the integrity of the instrumentation, using an independent digital thermometer, thermocouples and timer (or a chart recorder).

The risk of infection of maintenance personnel is low since, invariably, all washer-disinfector moving parts are protected, being external to the chamber (where receptacles are emptied and cleaned).

The equivalent periodic check on macerators involves the assessment of door seal and lock integrity. To prevent the ejection of aerosols from the machine, the lid must be a tight seal with no freedom of movement during operational cycles. This is simply checked by attempting to lift the lid and pass paper through the seal. Macerator design is relatively simple, with fewer components compared with the washer-disinfector, but rotating blades are the most vulnerable moving part. Although unlikely, it is possible for solid foreign objects to be placed inadvertently in the chamber and the resulting impact with blades can cause damage. Since blades are in constant
contact with potentially infected matter, the chamber and blades will, in this instance, need chemical disinfection before maintenance. The procedures for disinfection of hospital equipment prior to maintenance are described in HN(87)227. Other components are external to the chamber and hence are safe to maintain without disinfection.

**Equipment Standards**

When manufacturers of washer-disinfectors were under pressure to improve their microbiological safety, tests on macerators concluded that the process of macerating bedpans and their contents also introduced bacteriological hazards. If splashing occurred when the machine was pressurised, or still running as the door was being opened, the contents could be dispersed in the sluice room in the form of an aerosol. These hazards were readily addressed and virtually eliminated. The manufacturers improved locking devices and lid seals to maintain a firm seal, and in some designs the chamber is subjected to a vacuum through critical stages of the cycle. There is no British Standard covering macerators and their safety, but discussions are taking place within the HSSA to assess the best approach towards producing a Standard.

**Drain Design**

The main source of concern regarding the disposable system has always been the risk of blockage. In the past, some building contractors have taken advantage of the opportunity offered by maceration to reduce pipe diameter to 2 ins with a reduction in installation costs. Where pipe runs are long and possibly of plastic material, it is essential to ensure that pipe gradients are adequate with sufficient supports to prevent sagging. Drain layout should be correctly designed with gradual bends. Blockages in washer-disinfectors are rare because the majority in use in the NHS are front-loading machines (and perhaps less liable to abuse), and toilet paper is the only recommended waste product added to each human waste discharge. However, when any bulky items such as incontinence products find their way through the machine, the resulting blockage to the drainage system will be time-consuming and expensive to clear.

**Labour Costs**

The amount of time which is spent by nursing and engineering staff in dealing specifically with human waste disposal tasks is difficult to separate accurately from their many duties. A Regional Health Authority, and some members of the Industry, are sponsoring a work study exercise, comparing nursing involvement in the two systems. Great care has been taken to select the most appropriate ward and to ensure a fair assessment. The assessment of engineering involvement can be very sensitive to water quality and treatment (for washer-disinfectors) and drain and sewage design (for macerators) so it will be essential to note and possibly even correct site conditions before beginning such an exercise.

**Costs**

From the above, many operational factors have a bearing on revenue expenditure. In both systems, this is directly related to equipment usage, that is receptacles processed per day. This varies widely from ward to ward so that, without reference to equipment usage, it would be misleading to compare reusable and disposable systems financially. Space limitations do not allow the inclusion of detailed financial data here, but this will be addressed in a separate publication which compares expenditure in both systems with various equipment usage rates.

**Summary**

Both reusable and disposable systems have their merits and problems. The disposable system, being fully integrated, appears to be steadily gaining market share compared with the reusable system. Since its introduction, the success of the reusable system has been limited by the use of pans not designed for automatic processing. Where the ‘perfection’ pan has been superseded by ‘open’ shaped receptacles and those used in commode chairs, cleaning effectiveness can be improved by a factor of 10.

For this and other reasons, nursing involvement in the reusable system can be high while the ‘perfection’ pan is in use. A work study exercise to compare nursing involvement in reusable and disposable systems is under way.

When selecting a human waste disposal system for any site, it is vital that all disciplines discuss and decide objectives. The equipment usage, space, site conditions, availability and quality of supplies (eg water, electricity), the costs of maintenance, nursing time and other expenditure must be considered.

The disposable system is capable of high process rates (more than double that of the fastest reusable system). Its capital cost is currently about £1,000 less than an average reusable system, but in the busiest wards, revenue costs may be higher. In such wards the space for disposable receptacle storage can be as much as five to ten times machine volume.

The design of macerators is generally simpler (having less components) than washer-disinfectors. Monitoring and maintenance involvement are likewise expected to be lower, particularly in hospitals with modern drainage systems. Human waste disposal equipment is constantly processing potentially infected matter and special vigilence is essential, with frequent checks to ensure that infection control standards are maintained.

The British Standards for reusable pans, commode chairs and washer disinfectors must be completed as soon as possible to improve their compatibility and processing effectiveness of the reusable system. The Standards for macerators are also under consideration.

**Author’s Comments**

Manufacturers are continually improving product standards. To ensure fair and meaningful comparisons, competing systems must be assessed under ‘like for like’ conditions. Product age is particularly relevant.
The user will ultimately benefit from this healthy competition, but could wrongly assume that the latest standards apply to all equipment in use. The percentage incorporating the very latest advances will initially be low and it follows that the majority may not have such high standards. Therefore, extra care is generally needed to minimise cross infection and other hazards, particularly with older equipment.

With constantly changing standards and designs, any paper can only be valid at the time of going to print. Where up to date product information is needed, the potential user can always contact the manufacturer, or ask Vector Consultants for an unbiased opinion.

Based upon the above discussion, detailed cost comparisons against equipment usage, will be analysed in a separate paper.

Notes and References
(1) Disinfection is a process which kills or inactivates organisms but not usually bacterial spores. It may also be associated with the removal of organisms. It does not necessarily eliminate all organisms, but reduces them to a safe level. Disinfection is usually associated with those items that are not intentionally invasive, but are in contact with mucous membranes, damaged skin, infected lesions, blood and other body fluids. (Defined by the Hospital Infection Research Laboratory (HIRL), Dudley Road Hospital, Birmingham).

(2) Dr K. Rodgers (Microbiologist) at the Birmingham Children's Hospital and the HIRL.

(3) Central Sterilising Club — Publication No. 1 'Washer—Disinfector Machines' available from the HIRL.

(4) Standard committee not yet convened.

(5) Standard being drafted.


(7) A box of 150 disposable pans measures 85 x 36 X 55 cms = 0.168 cu m.

A box of 100 disposable urinals measures 86 x 26 X 92 cms = 0.206 cu m.

A box of 250 disposable receptacles = 0.374 cu m.

Stored Energy Generators — where steam is generated and stored in a small pressure cooker-like vessel, providing a virtually constant steam supply for disinfection purposes.

(8) Legionellae (Control of) in Health Care Premises (code of practice) ISBN 0 1 1 321208 9.

(9) 'To dispose or re-use? — an Evaluation of Sluice-Room Equipment' 8. Hickman Hospital Engineering, February 1989.


(11) 'Microbiological assessment of a bedpan disposal unit’ J. F. Archer MD Consultant Microbiologist May 1989 (National Medical Laboratories).


(13) Vector Consultants are specialists in human waste disposal (HWD) systems. The consultancy provides unbiased advice to healthcare buyers on the suitability of HWD systems for new sites. It is currently involved in a Regional Health Authority product evaluation exercise comparing disposable and re-usable human waste disposal systems. Its speciality is troubleshooting on existing sites, where solutions can sometimes be relatively simple and inexpensive.

Maurice Rollnick, who formed Vector Consultants three years ago, is the instigator and a Founder Member of the HSSA (Healthcare Sanitary Systems Association - an association of manufacturers of human waste disposal equipment and accessories) and represents its members on British Standards Institution Committees.

For more information contact Vector Consultants at 'Coniston’ Eastfield Road, Ross-on-Wye, Herefordshire HR9 5JY. Telephone: (0989) 62852. Fax: (0989) 67081.