An Evaluation of Medication Drug Bins as a Potential Source of Nosocomial Pathogens

INTRODUCTION

Infection control in health care institutions is the single most important reason for the prevention of morbidity and mortality associated with nosocomial infections. Hundreds of thousands of American patients suffer the consequences of nosocomial infections each year. Such consequences range from the inconvenience of having to take additional medications for treating an infection to death. Aside from this human cost is the significant economic encumbrance that these infections place on society, including not only an apparent increase in health care resource usage but also the indirect costs associated with the loss of productivity of patients and caregivers.[1]

A facility in which a large number of people having a vulnerable health status and spending a significant amount of time in during the course of the day can be defined as an institutional setting. The time that people spend together in these settings may be continuous for days, weeks, or even months. Child care centers, schools, hospitals, long-term care facilities (including nursing homes and assisted living centers), military installations, and prisons are all examples of institutions. Although they vary greatly in both the population influences and the length of stay of the participants, they all have a common element that being because of confinement, an opportunity of the transmission of infectious agents. Therefore, a variety of infection control practices are important.[2] One third of all nosocomial infections may be preventable, and they are frequently caused by organisms within the institutional environment.

Microorganisms associated with infections manifested in institutional settings include bacteria, viruses, fungi, parasites, and nematodes. Transmission routes may be direct or indirect contact with contaminated fomites or air. One means of reducing nosocomial infections is to identify previously unrecognized fomites and then provide some measure of infection control for those contaminated objects.

Drug bins used to transport and deliver medications to patients by nurses may be an unrecognized fomite and may contribute to the spread of nosocomial infections in an institution. Pharmacy needs to be aware of the possible contamination of drug bins with microorganisms capable of causing nosocomial infection in patients who are compromised.

With this as a basis, a study was initiated in a 300-bed general med/surg hospital to investigate the degree of microbial contamination in dirty drug bins and compare this to the use of bin liners as an adjunct to minimize the potential for nosocomial infection spread.

METHODOLOGY

Fifty-five (55) drug bins used to transport and administer drugs to patients in a 300-bed general med/surg hospital were sampled for bacterial growth.

The drug bins were randomly sampled on medication carts on three active hospital units. Thirty (30) random samples were taken from a general med/surg unit. Fifteen (15) random samples were taken from a MICU unit. Ten (10) random samples were taken from a surgical unit.

Twenty-five (25) bin liners were sampled from a batch of prototype liners provided by Health Care Logistics to the hospital. A similar procedure was used in the sampling of both the drug bins and bin liners.

A hospital lab microbiologist using S/P Brand Culture Swab Collection and Transport System, distributed by Allegiance Healthcare Corporation, Catalog Number C8552-11 moistened with non-bacteriostatic saline wet swabbed both the drug bins and bin liners and streaked both blood agar and EMB (eosin methylene blue) plates.

Plates were incubated at 35˚ C and examined for growth at 24, 48, and 72 hour intervals.

The cultures were identified by standard means and reported and categorized. The blood agar plates were photographed for a visual documentation of the relative amount of bacterial growth.

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RESULTS

Overall, 84% of all the drug bins that were tested were contaminated with bacterial and mold growth as determined by the test swabbing procedures. In contrast only 32% of the bin liners cultured were contaminated with bacteria and mold growth.

Of the 84% of the drug bins that were contaminated 28 bins (50%) showed positive for 1 organism, 14 bins (25%) for 2 organisms and 5 bins (9%) for 3 organisms. Nine bins (16%) showed no growth. [see Table 1 below for organism count in sampled drug bins]

Table 1: Organism count in sampled drug bins

No Organisms	9	16%
1 - Organism	26	47%
2 - Organisms	14	25%
3 - Organisms	6	11%
	55	100%

Of the 32% of the bin liners that were contaminated 6 liners (24%) showed positive for 1 organism, 1 liner (4%) for 2 organisms and 1 liner (4%) for 3 organisms. Seventeen bin liners (68%) showed no growth. [see Table 2 below for organism count in sample bin liners]

Table 2: Organism count in sampled bin liners

No Organisms	17	68%
1 - Organism	6	24%
2 - Organisms	1	4%
3 - Organisms	1	4%
	25	100%

Comparably fewer bin liners were contaminated than drug bins.

Coagulase negative staph was the commonest contaminant found with 62% of drug bins contaminated with this organism alone or in combination with other bacteria or mold. Pseudomonas was identified in one drug bin in combination with coagulase-negative staph and penicillium. Other bacteria found include diphtheroids and bacillus in combination with staph coagulase-negative or by itself. Mold growth consisted of alternaria, cladosporium, penicillium and one that was not identified. Again, mold growth was in combination with other organisms or by itself. [see Table 3 below for a breakdown of organisms in the contaminated bins]

Table 3: Breakdown of organisms detected in the contaminated bins

Organism	# of bins	%
Staph/diphth	1	2%
Staph/bac	10	18%
Staph coag-neg	17	31%
Bac	3	5%
Diphth	2	4%
Diphth/bac/staph	1	2%
Mold - un “id”	1	2%
Alternaria	2	4%
Alt/bac/staph	3	5%
Pen/bac/staph	1	2%
Cladosporium	1	2%
Pen/bac	1	2%
Staph/pen/pseudo	1	2%
Diphth/alternaria	1	2%
Bac/pen/clado	1	2%
	46	**84%**

Identification of the representative colonies showed that most of the organisms cultured were associated with normal human skin microflora and environmental contamination. Although most microorganisms identified were generally harmless environmental contaminants, some such as the coagulase-negative staph and pseudomonas are capable of causing serious infections. Patients who are compromised by AIDS or by transplantation or cancer therapy, and patients with an increased susceptibility to infection as a result of diabetes or severe burns are particularly at risk.

In contrast, bacillus was the commonest contaminant found in 9% of contaminated bin liners either alone or in combination with other bacteria or mold. Other bacteria found include diphtheroids, staph coagulase-negative. Mold growth consisted of cladosporium and one that was not identified. Again, mold growth was in combination with other organisms or by itself. [see Table 4 below for a breakdown of organisms in the contaminated bin liners]

Table 4: Breakdown of organisms in contaminated bin liners

Organism	# of bins	%
Staph coag-neg	1	4%
Bac	3	5%
Diphth	1	4%
Diphth/bac	1	4%
Mold - un “id”	1	4%
Staph/bac/clad	1	4%
	8	**32%**

DISCUSSION

The results of this study identify an important problem - that being - a high level of contamination on drug bins circulating in the institution. The presence of nonpathogenic members of the skin and environmental bacteria, in relatively high numbers, indicates this poor degree of cleanliness. Dirty drug bins may be a source of transmission of drug-resistant pathogens and should undoubtedly receive more emphasis in infection control programs. One wonders whether such high levels of contamination are acceptable in the institutional pharmacy setting.

Although there is no direct proof that microorganisms from dirty bins can cause nosocomial infections in patients or pose a threat to health care workers, a strong and obvious relationship can be drawn from the results of this study which suggests that contaminated dirty bins could contribute to the nosocomial infection rate.

The CDC recently stated that contact transmission - direct from body surface to body surface or indirect transmission via contaminated inanimate objects is one of the main sources of microorganism transmission.[3] On environmental surfaces, like drug bins, both the presence of pathogenic microorganisms and their ability to survive on the surface of the bin, can contribute to the risk of infection.

Studies have established the persistence of pathogenic microorganisms and their survival in institutional, commercial, and domestic settings. The potential for infectious disease transmission from the environment is further demonstrated by clinical and laboratory studies showing the transmission of microorganisms from person-to-person and via inanimate surfaces, water, hands, food and household surfaces.

Studies have shown that the inanimate environment may serve as a reservoir-disseminator of MRSA and nosocomial VRE transmission. Positive cultures have been isolated from infectious patients' rooms and on gloves, gowns, and uniforms of nurses contacting the patients and also in 42% of personnel not in direct contact with patients but through contamination of their gloves by touching contaminated surfaces. [4]

Furthermore, studies have shown that both bacteria and fungi can live for extended periods of time on plastics [5-8] and microorganisms can efficiently be transferred from plastics to human hands.[9] In turn, a number of studies, often associated with the value of handwashing, have indicated that microorganisms can be transferred from person to person or from health care workers to patients.[10-12]

Contamination in dirty drug bins with potentially pathogenic bacteria, especially MRSA, has the potential for transmission to a larger number of health care workers. Theoretically, contaminated drug bins might pose an unsuspected source of transmission of nosocomial pathogens to health care workers and other patients throughout the institution.[13] These bacteria are transmitted to the hands of the health care worker (usually the nurse) and could subsequently be transmitted to other patients in the course of task of administering medications.
Because of the increased risk that dirty bins could present to patients, the use of these containers throughout a hospital without some sort of cleaning protocol should be reviewed.

A wide variety of patients, from neonates to elderly, are present in the institution. Certain groups such as immunocompromised or those at the extremes of life may be more prone to nosocomial infection. Awareness in pharmacy of the potential for a dirty drug bin to be the source of contamination is critical to sound practice.

While the sample size was small and the results of this study need to be confirmed with a larger sample size, clearly the dirty bins harbored significant numbers of bacteria, probably because the difficulty in cleaning them, lack of cleaning or neglect of cleaning.

Therefore some options should be considered to reduce the possibility of transfer of microorganisms from the plastic infectious dirty bins to patients. Two such options are:

1. the initiation of a bin cleaning protocol

   or

2. the use of bin liners

1. The Initiation of a Bin Cleaning Protocol

The cleaning of dirty bins is generally ignored in day to day practice. Through a series of discussions with hospital pharmacists and a small survey conducted at a midwestern state hospital pharmacy meeting, it was determined that no formal bin cleaning protocols exist in pharmacy. Instead, bin cleaning was initiated on either an individual circumstance where a bin was dirty beyond use or when a regulatory body was going to present itself at the institution.

In most cases there is a lack of awareness of a problem with respect to dirty drug bins and spread of nosocomial infections. Changing pharmacist and nurse behaviors is probably the greatest challenge in addressing this problem.

Health benefits from environmental surface disinfection have been demonstrated in several studies. Cleaning studies have indicated that the disinfectant-cleaner routinely used to clean surfaces in patient rooms decreases the microbial load.One can assume that use of a disinfectant-cleaner on drug bins will also decrease the microbial load. Ideally dirty drug bins should be cleaned on a regular basis, perhaps upon patient discharge, irrespective of their appearance. Dirty drug bins should be washed with disinfectants in automatic washing machines - however, this in many institutions turns out to be impractical and unwieldy.

Effective cleaning management requires a correctly constructed, implemented, and monitored cleaning program. A recent study concluded that visual assessment is a poor indicator of cleaning efficacy and that an ACE audit (Audit for Cleaning Efficacy) gives a better assessment of cleaning programs. It recommends that hospital cleaning regimes be designed to ensure that surfaces are cleaned adequately and that efficacy is assessed with use of internal auditing and rapid hygiene testing. It recommends that after cleaning has taken place, measurements (visual, plus adenosine triphosphate [ATP] or microbial) should be obtained to ensure that the cleaning has been carried out correctly or to an appropriate standard. Data from monitoring should be retained and used in trend analysis and compared with benchmark values that have been obtained during the validation of the cleaning program. [14]

Bin cleaning is often dependent on staff motivation and the time they are given to do this task. The result is irregular and inadequate cleaning of bins, which is often a source of dissatisfaction to both pharmacy and nursing personnel that encounter dirty bins. Adding this procedure during the regular cart filling tasks of pharmacy can potentially add cost to the process.

In a formal bin cleaning protocol, the task of cleaning should be undertaken by a designated and fully informed pharmacy staff person whom should take all necessary precautions. Those responsible for the cleaning should be provided with some protective clothing, such as gowns, gloves and goggles. It should be noted that repeated washing of bins will decrease their lifespan and potentially make them more susceptible to microbial growth. Bins will be in need of regular and on-going replacement.

Overall, though bin cleaning is an option that would be an effective intervention to minimize spread of nosocomial infections potentially caused by dirty drug bins - bin cleaning is costly, time-consuming and potentially harmful to personnel performing the cleaning and to the integrity of the bins over time.

2. The Use of Bin Liners

Bin liners on the other hand are a useful and practical alternative. The use of bin liners as an intervention to minimize the spread of nosocomial infections is a second option. They improve patient care by providing a more consistent, convenient and cost-effective method of maintaining clean patient medication drawers and medical storage bins.

A bin liner is a lightweight polystyrene plastic tray with dimensions slightly less than that of a drug bin that fits into the drug bin covering and shielding its inside surface. This shielding of the inside surface of the drug bin protects the drug bin itself from dirt and residue that can harbor potentially dangerous microorganisms.

A bin liner replacement program can easily be implemented as a procedure during the regular cart filling tasks of pharmacy. Bin liners can be replaced on a regular basis upon discharge of a patient with the new liner being assigned to a newly admitted patient. Whenever a bin liner becomes soiled it can be disposed of and replaced with another clean liner. This could be accomplished both in the pharmacy and up on the nursing unit. No cleaning is required. When compared to a bin cleaning protocol the bin liner replacement program is clearly easier to implement and maintain.

Though exhibiting a lower contamination rate bin liners only minimize microbial growth but do not eliminate it. Bin liners are subjected to the same conditions that the bin is. The difference is that - once dirty - the bin liner can be easily and quickly replaced with a new and clean bin liner whereas a dirty bin needs to be put through a cleaning process.

Study Limitations

The bin liners cultured in this study showed a contamination rate of 32% in comparison to the 84% contamination rate of the dirty bins. It should be noted here that the bin liners used in this study were prototypes and not units from a fully manufactured batch. As such, handling precautions were not initiated to package these prototypes in plastic bags of 25 as the production of sales batches will be packaged. Also, these prototypes were subjected to excessive handling from the manufacturer to distributor and on to the study site (hospital) where the study was conducted. In this process they may have been contaminated.

Although the dirty bins cultured in this study were not contaminated with lifethreatening nosocomial pathogens, 84% of the dirty bins were contaminated. No overt attempt in this study was made to culture bins of patients with prescribed contact precautions for MRSA or VRE. Though none of these serious pathogens showed up in this study the potential exists for contamination of these organisms in dirty bins.

CLOSING

This study makes no attempt to assess the risk of acquiring an infection from a dirty drug bin. No follow up was included to assess if any patient infection resulted from this contamination. The study, however, sought to discover if there is a potential source from which an infection could develop and suggest ways in which this source can be minimized. This study suggests that regular cleaning of bins or use of bin liners between patients should be considered.

Additional studies are needed to determine the identification and transmissibility of nosocomial pathogens through use of dirty drug bins. In further studies, more defined criteria should be set for the numbers of colony forming units that constitute a clean bin versus a dirty bin. Studies should also be initiated to determine the effectiveness of a bin cleaning protocol.

Ample infection control data in the literature demonstrate the cost-benefit of departments that have aggressively pursued interventions to decrease nosocomial infections.[15] In comparison with other widely accepted preventive medical interventions, infection control is recognized as very cost-effective. Reducing nosocomial infections is a proven method to decrease unreimbursed resource utilization and improve patient care and safety.[16]

The prevention of pain and suffering of patients and improvements in quality patient care are obvious additional benefits to the institution and its reputation, which are difficult to quantify. Charges such as laboratory/microbiologic costs, antibiotic costs, pharmacy costs, IV costs related to the delivery of antibiotics, and increased length of stay caused by nosocomial infections can be quantified. On the basis of the potential for these additional costs, the use of bin liners as a cost-effective strategy for the reduction of nosocomial infections and improvement of patient care in the institution makes sense.

Bin liners dramatically reduce the bacterial contamination of drug bins. The results of this initial study should highlight their value in an institutional setting.Bin liners employed as a strategy to reduce nosocomial infections in the institution help improve compliance because they are convenient, quick to use,and low cost in comparison to a bin cleaning program. Consequently, use of these products as part of an infection control program/strategy for pharmacy can have a significant impact on both health outcomes and health care costs.

Although it is recognized that not all nosocomial infections are potentially preventable, more could be prevented with an active intervention-based infection control program. The continued emergence and control difficulties with multidrugresistant pathogens, such as methicillin-resistant S aureus, vancomycin-resistant enterococci, and extended spectrum beta-lactamase producing gram negative bacilli, are major problems in acute care and long-term care facilities alike.

Quality of care and patient safety is the objective of every health care professional. Infection control interventions contribute to both patient safety and quality of care. The use of bin liners as an infection control intervention is pharmacy's contribution.

DEFINITIONS

Alternaria - a genus of fungi; most common species found in a variety of habitats and ubiquitous agents of decay; as decomposers of foodstuffs contribute to spoilage of 20-40% of agricultural output; some alternaria species are gaining prominence as emerging human pathogens, particularly in immunocompromised patients; have been found associated with infections of the cornea, oral and sinus cavities, respiratory tract, nails and skin.

Bacillus - aerobic rod-shaped spore-producing bacterium; often occurring in chainlike formations; a variety of bacterium; a microscopic, rod-shaped vegetable organism; a class of bacteria which are rod-shaped. Belonging to this class are: E. coli, Salmonella, Shigella, Klebsiella, Enterobacter, Clostridia; of these, Bacillus Calmett-Guérin is administered for vaccination against tuberculosis; bacteria causing tetanus, diphtheria, pertussis, and tuberculosis are also rodshaped.

Cladosporium - a genus of fungi having greenish conidiophores with oval or round spores; some species cause superficial fungal infections of the skin of the palms.

Diphtheroid - pseudodiphtheria; false diphtheria; one of a group of local infections, suggesting diphtheria, with occasional symptoms of toxemia, caused by various microorganisms other than the diphtheria bacillus.

Fomite - An inanimate object which, when contaminated with a viable pathogen (bacterium, virus, etc.) can transfer the pathogen to a host; any inanimate object (as a towel or money or clothing or dishes or books or toys etc.) that can transmit infectious organisms from one person to another

Mold - a fungus that produces a superficial growth on various kinds of damp or decaying organic matter

Pathogen - any disease-producing agent especially a virus or bacterium or other microorganism; any disease-causing agent, such as a virus or bacterium; Definition: Organism which can cause disease in another organism.

Penicillium - a saprophytic mold, a genus of the fungi of the class ascomycetes, order aspergillales; they form blue molds which grow on fruits, bread, cheese, etc. Occasionally in man they produce infections of the external ear, skin, or respiratory passageways; common allergens.

Pseudomonas - a genus of small, motile, gram-negative bacilli with polar flagella. Most are saprophytic living in soil and decomposing organic matter; sometimes pathogenic (aeruginosa) in man causing urinary tract or ear infections.

Staphylococcus - spherical gram-positive parasitic bacteria that tend to form irregular colonies; some cause boils or septicemia or infections; Definition: Staphylococcus is a genus of spherical, facultatively anaerobic, Grampositive bacteria in the family Micrococcaceae; they cause a wide range of skin and systemic infections.

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