

## EMERGING TECHNOLOGIES

# Uncovering the rates of damaged patient bed and stretcher mattresses in Canadian acute care hospitals

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## ABSTRACT

**Background:** Cleaning and disinfection prevent the spread of healthcare-associated infections. Damaged surfaces, such as mattresses, cannot be properly cleaned and may harbour pathogens that pose a risk for cross-contamination. The U.S. Food & Drug Administration has expressed concern that damaged mattresses may be widespread and recommends that mattresses be regularly inspected for damage.

**Methods and materials:** A novel process was developed to assess the integrity of bed and stretcher mattresses throughout a healthcare facility. Between 2014 and 2017, five Mattress Integrity Assessment projects were conducted at Canadian acute care hospitals. All inspected mattresses were categorized based on the presence of damage. Damaged mattresses were either immediately repaired with a medical surface repair patch or tagged for replacement in accordance with a defined protocol. Data was collected, including photographs of damage and repairs.

**Results and discussion:** A total of 2,561 patient mattresses were assessed for damage. 32.5% (833/2,561) were damaged, of which 55.6% (463/833) were repaired and 44.4% (370/833) were recommended to be replaced. Stretcher mattresses had higher damage rates than patient beds.

**Conclusion:** The findings confirm that damaged patient mattresses are widespread in Canadian acute care hospitals, posing a risk for cross-contamination. Staff may be unaware of the potential risks, and frequent inspection is required to ensure mattress damage is repaired or replaced.

## KEYWORDS

Bed; stretcher; mattress; damage; assessment; inspection; repair; patch

## INTRODUCTION

Cleaning and disinfecting patient care areas is essential to preventing healthcare-acquired infections [1-5]. In addition, all furnishings and equipment, such as mattresses, should be regularly inspected to ensure they are safe and properly maintained [6]. Damaged surfaces cannot be properly cleaned and pose a safety risk by harbouring and transmitting pathogens. When the integrity of a mattress cover is compromised, fluids may penetrate the inner core.

In April 2013, the U.S. Food & Drug Administration (FDA) issued a Safety Communication to alert healthcare providers, facility staff, and caregivers that damaged or worn mattress covers can allow blood and body fluids to penetrate inside the mattress, posing a risk for cross-contamination and infection to

patients [7]. There have been cited incidents of patient exposure to body fluids from another patient when fluid leaked upon compression of a contaminated mattress. From 2011 to 2016, the FDA received over 700 reports associated with bed and stretcher mattress covers failing to prevent blood and body fluids from leaking into the mattress [8]. In November 2017, the non-profit organization Emergency Care Research Institute (ECRI) included damaged patient mattress covers in the top ten health technology hazards for 2018 [9].

An outer mattress cover is meant to provide a barrier to the inner core while maintaining a level of moisture vapour permeability to help reduce heat and moisture surrounding the patient (microclimate), thereby reducing the risk of skin breakdown [10]. A wide variety of medical mattresses are

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available on the market, but they are generally either foam-filled (sometimes with a gel layer) or air-filled, with covers made of polyurethane, vinyl, or coated nylon. Medical mattress covers may lose their effectiveness over time and the expected service life varies from manufacturer to manufacturer, ranging anywhere from one to seven years. In addition, the expected life of a mattress cover may differ from that of the mattress itself.

Fluid ingress may occur if mattress covers become worn or damaged. Damage may result from physical causes (punctures, scratches, cuts, or rips in the fabric), chemical causes (frequent cleaning with chemical disinfectants, use of harsh cleaners without rinsing or laundering procedures), or breakdown from aging over time. The medical literature shows that damaged mattresses can be a source of contamination during infection outbreaks and enhanced cleaning and restoration of the mattresses resulted in termination of the outbreaks [11-14].

One study at a hospital in the United States revealed that over 26% of adult patient mattresses had occult damage to the interior of the mattress cover [15]. The FDA has expressed concern that fluid ingress from worn or damaged medical bed mattress covers may be widespread and largely under-recognized by healthcare providers and facility staff.

Bed and stretcher mattresses are often overlooked as a low-priority asset and are not commonly owned by a consistent department. Facility staff may be unaware of mattress integrity because mattresses are typically covered by bed linens. Great cultural differences exist between facilities and even between departments as it relates to the importance of addressing this problem.

An adhesive patch for the repair of damaged mattress covers was introduced to the healthcare market in 2014. This product is registered with Health Canada and the FDA as a Class 1 medical device, is impervious to fluids, is durable in a healthcare environment, and has been shown to be equivalent to the mattress surface in terms of microbial growth before and after terminal cleaning [14]. The patch is applied by a peel-and-stick method and is manufactured with medical-grade biocompatible materials.

The replacement costs of bed and stretcher mattresses range from a few hundred to thousands of dollars, depending on the mattress type, brand, and composition. Some bed mattresses have replaceable covers but this is uncommon with stretcher mattresses, as they generally do not have zippered openings. The medical device that repairs mattress covers is available in three sizes and costs tens of dollars per patch. Significant cost savings may be realized if damaged mattress covers can be repaired instead of replaced.

The purpose of this study was to determine the extent of damaged patient mattresses in Canadian acute care hospitals.

## METHODS

A novel process was developed to assess the integrity of bed and stretcher mattresses in healthcare facilities. A Mattress Integrity Assessment (MIA) involves proactive inspection of patient bed and stretcher mattresses throughout the facility following defined bedside inspection protocols [16]. Mattresses in all participating clinical areas were assessed for any signs of damage and immediately repaired with the Health Canada and FDA Class 1 medical device according to product guidelines or tagged for

replacement. Following inspection, each bed or stretcher was labelled with a colour-coded sticker for tracking purposes.

**TABLE 1: Mattress inspection categories.**

Colour Code	Mattress Status
Green	Mattress had no visible damage.
Yellow	Mattress had minor damage that was suitable for repair using the Health Canada and FDA registered medical surface repair patch.
Pink	Mattress had damage that was not repairable with the repair patch and required replacement when possible.
Red	Mattress showed signs of fluid ingress or severe damage, requiring immediate removal from service.

As beds and stretchers are often moved throughout a facility, inspection results were recorded for the first location in which the bed or stretcher appeared, and not repeated if the same bed or stretcher was found on another unit. Projects ranged from two to six days in duration and the number of mattresses that could be inspected each day varied depending on the number and types of clinical units involved, preferred inspection times, number of patients on isolation precautions, and number of Assessment Team members.

## Settings

Between December 2014 and June 2017, five MIA projects were conducted at Canadian acute care hospitals in Alberta, Saskatchewan, and Ontario. The hospitals ranged in size from 300 to 1,100 beds. Three were university-affiliated teaching hospitals and all provided a full range of services, including emergency care, medicine, surgery, critical care, maternity, psychiatry, and outpatient services. Three of the projects covered nearly all areas of the hospital and two of the projects were limited in scale, covering only a few pre-selected clinical units.

## Planning

Each project was planned in advance with communication and coordination between manufacturer representatives and hospital management. Assessment Team members included manufacturer and distribution representatives and designated staff as chosen by each facility, which included Facilities and Maintenance, Environmental Services, Infection Control (IPC), or Risk Management. A formal presentation to clinical managers in advance was found helpful to ensure input from all areas and to address any questions or concerns. The project dates and scope were determined and a schedule was developed for the Assessment Team to visit each clinical area. A brief hour-long training was conducted with all members of the Assessment Team prior to project initiation in order to ensure consistency of data collection and tracking.

## Inspection process

Patient bed and stretcher mattresses throughout each clinical area were manually inspected. Occupied mattresses were inspected when possible, as determined by the registered nurse in charge and

depending on patient acuity. Mattresses on which patients were sleeping or too ill to get out of bed were excluded and inspection was attempted at a later time. Linens were removed so that the mattress covers could be visually assessed on the top and sides. Canadian infection control guidelines (Infection Protection and Control Canada) were followed, including hand hygiene and the use of clean gloves with each bed or stretcher. Appropriate personal protective equipment was used to inspect the vacated beds of any patients on contact precautions, with the approval of IPC and the registered nurse in charge. Assessment of each mattress included looking for any potential signs of fluid ingress (staining or warping), physical damage (punctures, scratches, tears, cuts, damaged seams or zippers), chemical damage (bleaching, staining, cracking, delamination), or other abnormalities such as sagging, which may indicate that the inner foam is no longer supportive or that an air bladder has deflated. Any mattress with visible signs of fluid ingress was immediately tagged as “red” according to mattress inspection protocols.

### Recording

All inspection findings and interventions were recorded via either a manual spreadsheet or phone-based survey app. Recorded data included the date, location (clinical area/room), mattress type (bed, stretcher, or other), make, model, year (if available), and a description of any damage. Photographs were taken of all damage and before-and-after photos were taken of all repairs. Colour-coded labels were dated and applied to the foot of each bed or stretcher to indicate that it had been inspected and to reflect the inspection findings as intact (green), repaired (yellow), or requiring replacement (pink or red).

### Data analysis

After completion of the inspection process at each site, the findings were tabulated to identify the overall rate of mattress damage, frequency and types of damage, differences among the various clinical areas, and to help identify any mattress damage trends observed by the Assessment Team. Data analysis at each hospital was meant to be specific and relevant to that facility; however, the overall information obtained from these

projects provides a snapshot of the state of patient mattresses in Canadian hospitals.

### Presentation

Following each MIA project, a written report or presentation was provided to hospital management. The reports included an overall summary of the damage, repairs, replacements required, and other relevant observations. Photographs were included to illustrate the types of mattress damage found and all repairs performed with the repair patch. As capital funding for mattress replacement may not be sufficient to cover the total need, any mattresses tagged “red” were identified as the priority for immediate replacement. Staff engagement in the MIA project varied greatly, signaling cultural differences between hospital sites.

### RESULTS

The pooled number of inspected beds and stretchers across the five hospitals was 2,561. Overall, there were 833 damaged mattresses, representing a damage rate of 32.5% (833/2,561). Of the damaged mattresses, 55.6% (463/833) were repaired with a medical device according to product guidelines and specific protocols approved by each hospital. The remaining 44.4% (370/833) were not suitable for repair and were recommended for replacement.

Reasons for not repairing a mattress cover included signs of fluid ingress, damage that was too large to cover with a single patch, more than three to six areas of damage, or if damage was located on a three-dimensional corner where the patch could not be applied properly.

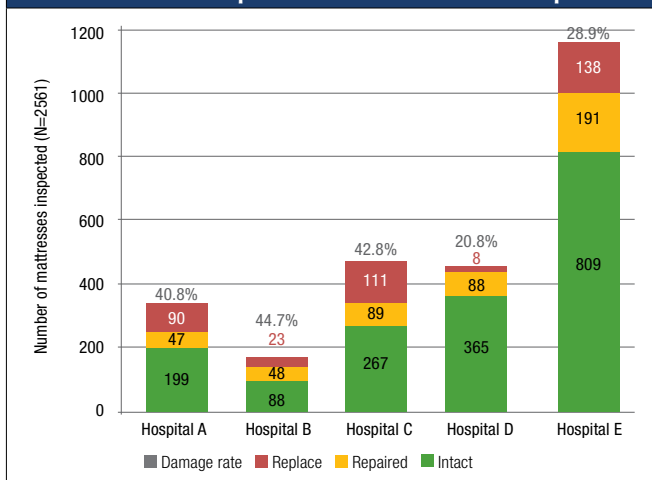
The rates of mattress damage at each hospital ranged from 20.8% to 44.7%, but there was greater variation in the severity of damage. In the hospital with the newest beds, the vast majority of the damage was caught early and was repairable with the repair patch (95.8% repair rate), while beds at another site were older and too damaged to be saved (34.3% repair rate).

Stretchers had the same or higher rates of damage than beds. This is most likely because they generally have thinner mattresses, are frequently moved around the facility, and are cleaned more often than beds. Four out of five hospitals had mattresses that were classified as “red,” posing the highest risk to patients.

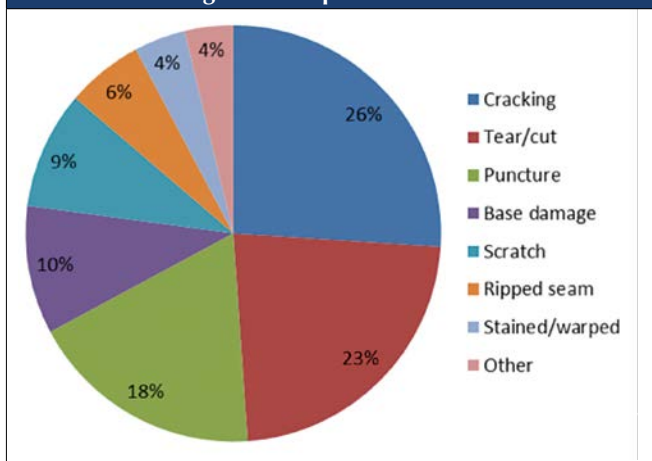
**TABLE 2: Damaged bed and stretcher mattresses by site.**

	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Combined
<b>Beds:</b>						
Number	817	349	264	94	246	<b>1,770</b>
Intact	626	198	160	52	203	<b>1,239</b>
Damaged	191	149	104	42	43	<b>529</b>
Damage rate	23.4%	42.7%	39.4%	44.7%	17.5%	<b>29.9%</b>
<b>Stretchers:</b>						
Number	321	118	72	65	215	<b>791</b>
Intact	182	67	39	36	162	<b>486</b>
Damaged	138	51	33	29	53	<b>304</b>
Damage rate	43.0%	43.2%	45.8%	44.6%	24.7%	<b>38.4%</b>

**FIGURE 1: Status of patient mattresses in five hospitals.**



**FIGURE 2: Damage rates of patient beds vs stretchers.**



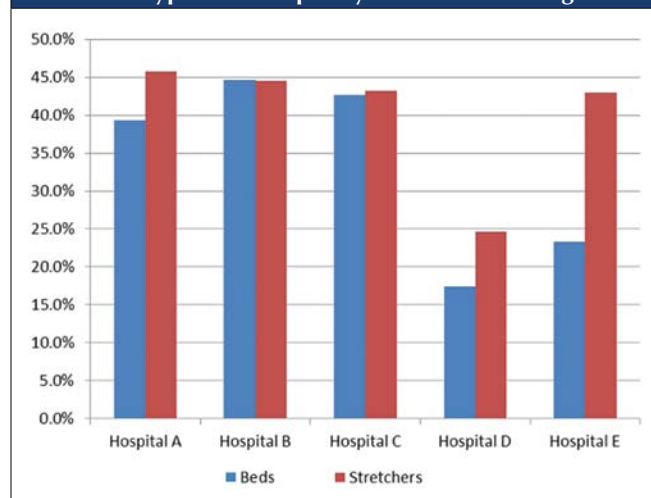
**Types of damage**

Beds and stretchers are physically damaged from everyday use, transportation through hallways and elevators, contact with sharp objects, or by placing equipment on top of the mattress. Tears and rips are generally ragged in nature, while cuts are clean-edged from a sharp object. Punctures are small holes in the mattress cover that may be the result of hazardous sharp objects such as syringes or catheters or innocuous objects such as jewellery or pens. Scratches involve partial depth damage to the mattress cover, usually as a result of dragging equipment across the surface. Combined, all types of physical damage represented approximately 68% of damage, while 32% of damage appeared to be from chemical causes.

Cracking of the mattress cover occurs from repeated and prolonged contact with chemical disinfectants, especially if the linens are replaced before the mattress cover is fully dry. Cracking may begin in a small area, such as a fold in the mattress cover at the pivot point when the head of the bed is raised. Once cracking starts, it may become extensive and eventually progress to the point of destruction of the polyurethane cover (delamination).

Two of the hospitals had extensive cracking damage, with more than 80 inpatient beds combined showing severe delamination and obvious signs of fluid ingress and contamination. Nearly 15% (122/833) of mattresses had more than one type of damage.

**FIGURE 3: Types and frequency of mattress damage.**



**DISCUSSION**

Five MIA projects confirmed that damaged mattresses are common in Canadian acute care hospitals, as over 32% of those inspected had visible damage. Damaged surfaces cannot be properly cleaned and pose a risk of harbouring and transferring pathogens to subsequent occupants. Any patient with diarrhea or incontinence would be lying on a source of contamination, and any damage to the mattress underneath may become a reservoir.

Stretchers, which are most commonly used in the Operating Room (OR) and the Emergency Department (ED), had higher rates of damage than beds. Stretchers from the OR are used to transport surgical patients to and from other departments, and this movement could potentially increase the risk of transferring pathogens from one area of the hospital to another. Patients coming into the ED may be very ill or harbour as-yet undiagnosed infections and the ED stretcher may be their first significant point of contact upon admission.

There are several reasons why damaged mattresses are so prevalent. With competing capital wish lists, beds are often a low priority compared to new technologies. Mattresses are often kept in use far beyond the recommended lifespan because there is simply not enough money to keep replacing them.

Mattresses are usually covered by linens and, once covered, they may be “out of sight, out of mind.” Cleaning checklists often list bed rails, bed controls, and bathrooms as the priority, but may not list the mattress even though the mattress has one of the highest touch points in the patient environment [17].

The National Health Service in the United Kingdom has made six- to twelve-month mattress inspections mandatory [18-20]. Hospitals in the United States are cited for damaged surfaces and even penalized for any preventable healthcare-acquired infections [21], yet scheduled mattress inspections are rarely performed in the U.S. or Canada. Unfortunately, damage begets damage. When staff see damaged soft surfaces as commonplace, it becomes the



norm and contributes to a culture of apathy. Terminal cleaners often see damage when they are cleaning the mattress but do not report it because they either see it as normal or find it too time-consuming to fill out a maintenance requisition. Front-line staff believe it is up to maintenance staff to track and repair equipment and maintenance staff do not see the damage unless someone tells them – and the vicious cycle continues.

Throughout the MIA process, there were notable differences in occupational cultures between hospitals, clinical units, and individuals. Some people were passionate about addressing this problem, while others were not, but the majority of staff was simply not aware that damaged mattresses pose an infection risk to patients.

Implementing a mattress inspection and repair program is critical to patient safety and reducing the infection risk that damaged mattresses pose. Senior management needs to be committed and assist in engaging three key stakeholder groups, identified as Damage Monitors, Damage Fixers, and Damage Champions. The Damage Monitors consist of all staff that come into contact with bed and stretcher mattresses daily, such as Porterage, Environmental Services, Nursing, and Physicians. This group's key responsibility is to look out for damaged mattresses and to report them immediately upon discovery. The Damage Fixers consist of a subset of individuals who have been trained in the mattress assessment process described above and decide when a mattress can be repaired or when it needs to be replaced. These individuals must have access to the adhesive patch and replacement mattresses to complete the assessment in a timely manner, and to reduce the likelihood of damaged mattresses circulating undetected. The Damage Fixers may be individuals from Facilities or Maintenance; however, they could be from another department, such as Nursing. Finally, the Damage Champion may be an individual from Infection Prevention and Control or Risk Management who takes ownership of this program to ensure that it operates successfully and that there is an effective communication channel between Damage Monitors and Damage Fixers. Communication may include a dedicated phone line or email address, or may be part of an existing facilities reporting software. Damage Monitors would also conduct routine bed and stretcher mattress integrity audits to ensure the program is running smoothly.

## CONCLUSION

MIA projects at five hospitals suggest that one in three Canadian patients is lying on a damaged mattress. Damaged mattresses cannot be properly cleaned and pose a risk of cross-contamination and potential infection. More education is required to increase clinician and staff awareness that damaged mattresses are not acceptable and need to be repaired or replaced. MIA projects may be helpful to find and address mattress damage and repair minor damage before it becomes extensive. Operationalizing a stretcher and bed mattress surveillance program in healthcare facilities is critical to resolving this problem and enhancing patient safety.

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