XAVIER UNIVERSITY

Hospital Mattresses: Significant Contributors to Hospital Acquired Infections

Edmond A. Hooker, MD. DrPH

Epidemiologist

Professor, Department of Health Administration

Xavier University | Cincinnati, Ohio

Emergency Physician

USACS | Mercy Health, Cincinnati

Conflict of Interest

I am a medical advisor to Trinity Guardian, the manufacturer of the launderable bed barrier.

Objectives

At the end of the presentation, participants will be able to:

- Explain why modern mattresses require a multi-step process in order to be effectively cleaned and disinfected.
- Explain how hospitals can overcome the challenges of cleaning modern mattresses that are now made of polyurethane, which is soft and porous.
- Discuss how to identify and mitigate mattress damage in hospitals.
- Describe best practices in mattress cleaning, disinfection, and maintenance.

Introduction

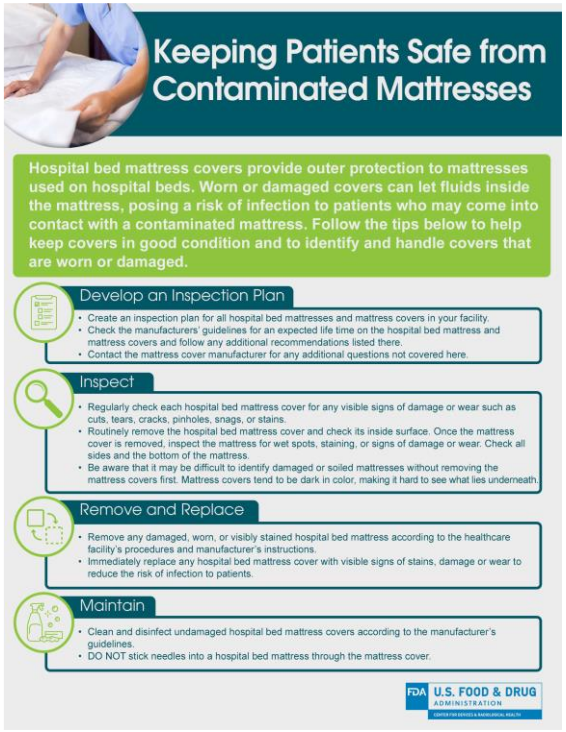
Hospital beds are high-tech reprocessable **Class II medical** devices.

The surface of the mattress (cover) is manufactured using polyurethane-coated fabric to ensure moisture-vapor transmission, in order to prevent pressure ulcers.

Due to multidrug-resistant organisms, healthcare organizations have used increasingly harsh chemicals to clean these mattresses. None of these chemicals are actually approved for use on polyurethane-coated fabric.

XAVIER UNIVERSITY

HOSPITAL BEDS ARE A HUGE PATIENT SAFETY ISSUE



Keeping Patients Safe from Contaminated Mattresses

Hospital bed mattress covers provide outer protection to mattresses used on hospital beds. Worn or damaged covers can let fluids inside the mattress, posing a risk of infection to patients who may come into contact with a contaminated mattress. Follow the tips below to help keep covers in good condition and to identify and handle covers that are worn or damaged.

Develop an Inspection Plan

- Create an inspection plan for all hospital bed mattresses and mattress covers in your facility.
- Check the manufacturers' guidelines for an expected life time on the hospital bed mattress and mattress covers and follow any additional recommendations listed there.
- Contact the mattress cover manufacturer for any additional questions not covered here.

Inspect

- Regularly check each hospital bed mattress cover for any visible signs of damage or wear such as cuts, tears, cracks, pinholes, snags, or stains.
- Routinely remove the hospital bed mattress cover and check its inside surface. Once the mattress cover is removed, inspect the mattress for wet spots, staining, or signs of damage or wear. Check all sides and the bottom of the mattress.
- Be aware that it may be difficult to identify damaged or soiled mattresses without removing the mattress covers first. Mattress covers tend to be dark in color, making it hard to see what lies underneath.

Remove and Replace

- Remove any damaged, worn, or visibly stained hospital bed mattress according to the healthcare facility's procedures and manufacturer's instructions.
- Immediately replace any hospital bed mattress cover with visible signs of stains, damage or wear to reduce the risk of infection to patients.

Maintain

- Clean and disinfect undamaged hospital bed mattress covers according to the manufacturer's guidelines.
- DO NOT stick needles into a hospital bed mattress through the mattress cover.

FDA U.S. FOOD & DRUG ADMINISTRATION

FDA has Issued Two Safety Advisories in Last 10 Years

TOP 10

ECRI Institute

2019 Top 10 Health Technology Hazards

Executive Brief

A Report from Health Devices

"Clean" Mattresses Can Ooze Body Fluids onto Patients

AMA AMERICAN MEDICAL ASSOCIATION

2023 AMA National Conference Resolution

Resolution 428 be adopted as amended.

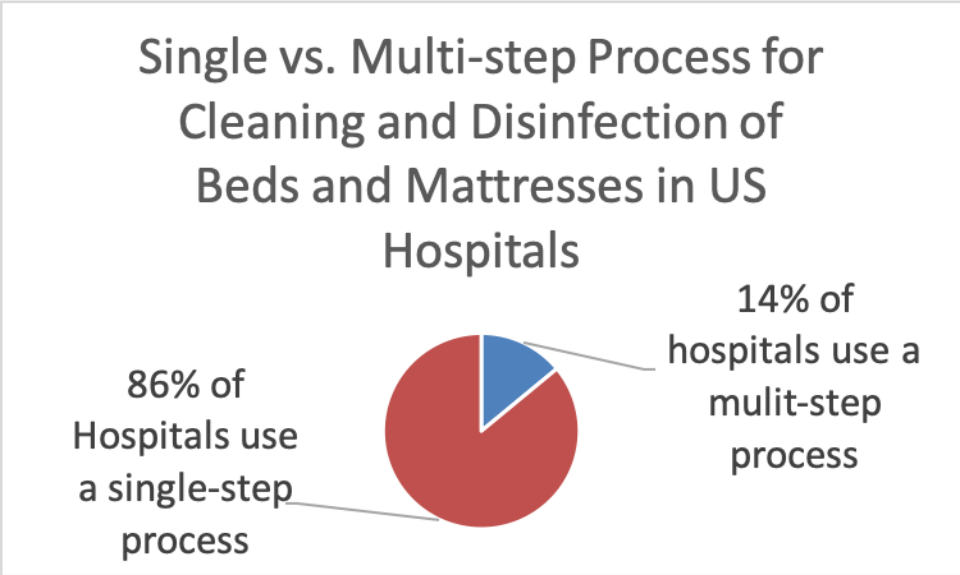
RESOLVED, That our American Medical Association work with the accrediting bodies and interested stakeholders to make sure all possible appropriate care and maintenance measures be undertaken to mitigate infection related to hospital bed and mattress use (Directive to Take Action).

Your Reference Committee heard testimony in support of this resolution. It was noted that not all hospitals are following proper mattress care recommendations from manufacturers and regulatory agencies, which results in an increased spread of infections. Amendments were offered to encourage our AMA to collaborate with other health care organizations in addressing appropriate care and maintenance measures. Your Reference Committee agrees and recommends that Resolution 428 be adopted as amended.

Manual Reprocessing of the Hospital Bed does not work

- In almost all healthcare facilities, the bed and mattress are reprocessed using a manual single-step process
- This results in the mattress remaining contaminated, causes mattress failure, rust bed frames, and causes healthcare acquired infections

Most Hospitals only use one-step process in USA



Based on a sample of at 2019 APIC conference.

Hooker, E. A. (2021). Disinfecting hospital beds and mattresses: A time for change. *AJIC*, *49*(10), 1341.

1-step process violates MIFUs

- FDA changed reprocessing guidelines in 2015 and required all bed manufacturers to document a process by which their product could be reprocessed (cleaned and disinfected)
- New Instructions for Use for major manufactures (MIFUs) are 5-6 steps
- 1-step process violates MIFU and is therefore against Joint Commission standards

XAVIER UNIVERSITY

2015 FDA REPROCESSING GUIDANCE- KEY DEFINITIONS

- **Cleaning** is physical removal of soil both visible and non-visible, allows for subsequent disinfection step
- **Disinfection** is process to kill micro-organisms
- **Non-critical device**: surface that contacts only intact skin- low level disinfection required BUT…FDA specifically states that items that come into contact with blood or bodily fluids require intermediate disinfection

2015 FDA REPROCESSING GUIDANCE- KEY DEFINITIONS

- What is Intermediate Level Disinfection: A lethal process utilizing an agent that kills 99.9999% of vegetative bacteria and 99.9% of viruses, mycobacteria and fungi.

Mattresses cleaning has changed

- New MIFUs require a 5-6 step process
  - Preclean (remove visible soil)
  - Rinse
  - Clean (clean prior to using a disinfectant)
  - Rinse off cleaner
  - Disinfect (must be a distinct step, not part of cleaning)
  - Rinse
  - Inspect mattress for damage

XAVIER UNIVERSITY

LARGEST 3 MFGS REQUIRE MIFU COMPLIANCE TO MEET WARRANTY TERMS
MIFU COMPLIANCE ADDS 30 MINUTES TO ROOM TURN TIME

MATTRESS	NUMBER OF OPERATORS REQUIRED	INSPECT BETWEEN PATIENTS FOR DAMAGE	RINSE AND DRY AFTER CLEANING /DISINFECTION	PRE CLEAN	USE SOAP AND WATER TO CLEAN	RINSE AND DRY	DISINFECT	RINSE AND DRY	EXPECTED LIFE OF MATTRESS	EXPECTED LIFE OF TOP COVER
Low Airloss	2	x	x		x	x	x	x	5 yrs.	2 yrs
Static	1	x	x		x	x	x	x	10 yrs.	3 yrs
Low Air loss		x	x	X	(X) use Stryker wipe	X	(X) use Stryker Wipe	X	10 yrs.	Std= 5 yrs, specialty = 1 yr
Static				x	x		x	Rinse- Mattress must be completely dry		2

Leading disinfectants do not have EPA registration for non-porous mattresses

And bleach MGF does not recommend using product on mattresses

Mattresses have changed

Like the old vinyl car seats, vinyl hospital mattresses were more easily cleaned but caused excessive perspiration & skin irritation.

No EPA-registered disinfectant for soft surfaces (Current disinfectants often are not compatible with the fabric.) UV light has no soft surface claim

1970's
Mattress Covers were Vinyl
Non-porous – Hard Surface Disinfectants Worked
Expected fabric life 10+years

Bed sores & skin breakdown

2019's
Microclimate
High MVT porous surface
Expected fabric life 1-2 years

One Step Process Does Not Work

Hooker (2012) showed that 51/62 (83%) of terminally cleaned beds (cleaned with one-step process) were still contaminated with bacteria, including MDROs.

Bacteria Isolated

- *MRSA*- Methicillin Resistant *Staphylococcus aureus*
- *VRE*- Vancomycin-resistant *Enterococcus*
- *Acinetobacter lwoffii*
- *Acinetobacter baumannii*
- *Enterobacter cloacae*
- *Pseudomonas fluorescens*
- *Pseudomonas aeruginosa*
- *Stenotrophomonas maltophilia*
- *Streptococcus viridans*
- *Klebsiella* pneumonia
- *Rhizobium radiobacter*
- *Proteus mirabilis*
- *Bacillus* species
- *Micrococcus* species
- Coagulase negative *Staphylococci*

Must Follow MIFUs

CMS includes the presence of manufacturers' instructions for use (MIFUs) on the Infection Control Surveyor Worksheet and surveyors were instructed to cite lack of compliance under 42 CFR 482.42(a) (Tag A-0749)

RESOLVED, That our American Medical Association work with the accrediting bodies and interested stakeholders to make sure all possible appropriate care and maintenance measures be undertaken to mitigate infection related to hospital bed and mattress use (Directive to Take Action).

https://www.aami.org/productspublications/articledetail.aspx?ItemNumber=7343

Joint Commission Online

March 27, 2019

Accreditation and Certification

Top 5 most challenging requirements for 2018

The Joint Commission collects data on organizations' compliance with standards, National Patient Safety Goals (NPSGs), the Universal Protocol for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery™, and Accreditation and Certification Participation Requirements to identify trends and focus education on challenging requirements.

The table below identifies the Top 5 Joint Commission requirements identified most frequently as "not compliant" during surveys and reviews from Jan. 1, 2018, through Dec. 31, 2018.

For more information, see the April issue of *Perspectives* or the Standards Frequently Asked Questions. (Contact: Standards Interpretation Group, 630-792-5900 or online question form)

In this issue

Non-compliance percentage	Standard	Program
		Hospital Accreditation
88.85%	LS.02.01.35	The hospital provides and maintains systems for extinguishing fires.
78.68%	EC.02.05.01	The hospital manages risks associated with its utility systems.
73.85%	EC.02.06.01	The hospital establishes and maintains a safe, functional environment.
72.90%	LS.02.01.30	The hospital provides and maintains building features to protect individuals from the hazards of fire and smoke.
70.85%	IC.02.02.01	The hospital reduces the risk of infections associated with medical equipment, devices, and supplies.

Joint Commission

Joint commission statements on manufacturer's instructions for use recommendations for medical devices and CDC recommendations:

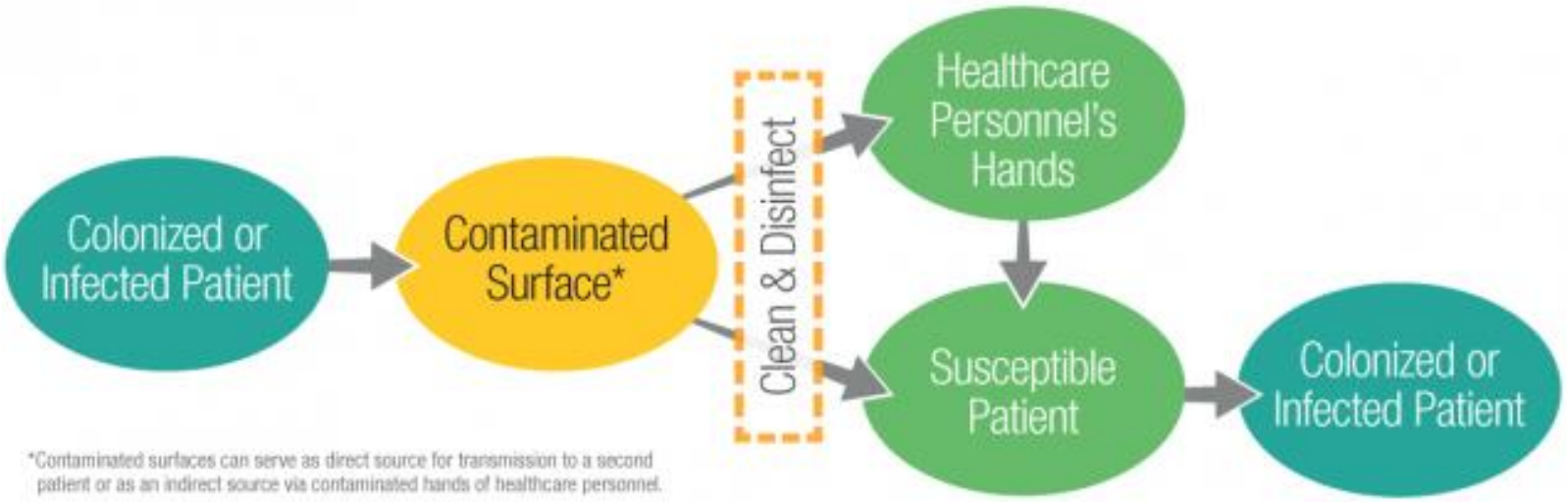
"It is important to understand that each patient care item has its own IFUs for cleaning and disinfection and the expectation is that the organization will follow those instructions. Failure to follow such instructions or misuse creates significant risk to safe, quality care."

https://www.jointcommission.org/standards/standard-faqs/office-based-surgery/infection-prevention-and-control-ic/000002250/?p=1

Real Reason to Follow MIFU

Failure to follow the MIFU will result in contaminated mattresses that will spread infections among patients.

CDC: Contaminated Surfaces affect Hand Hygiene



https://www.cdc.gov/hai/prevent/environment/surfaces.html

CDC: Contaminated Surfaces

- Surfaces contaminated with microorganisms can serve as reservoirs of potential pathogens.
- Many of these microorganisms are continuously shed or spread by direct skin contact onto surrounding environment surfaces.
- Contamination of surfaces…reusable patient care equipment that is moved between rooms (beds), can lead to:
  - (1) transmission to the next patient who occupies the room or uses the same equipment, or
  - (2) contamination of the hands or clothing of healthcare personnel with transmission to other patients (Figure on previous slide).
- Therefore, cleaning and disinfection of environmental surfaces is fundamental to reduce potential contribution to healthcare-associated infections. Inadvertent exposures to environmental opportunistic pathogens may result in infections with significant morbidity and/or mortality.

Why Do 1-Step Processes Fail

Fabrics changed – vinyl (hard/non-porous) to polyurethane (soft/porous).

One step process does not provide second cleaning step and prevents effective disinfection.

Manual wiping is inconsistent at best and is not sufficient for rewetting.

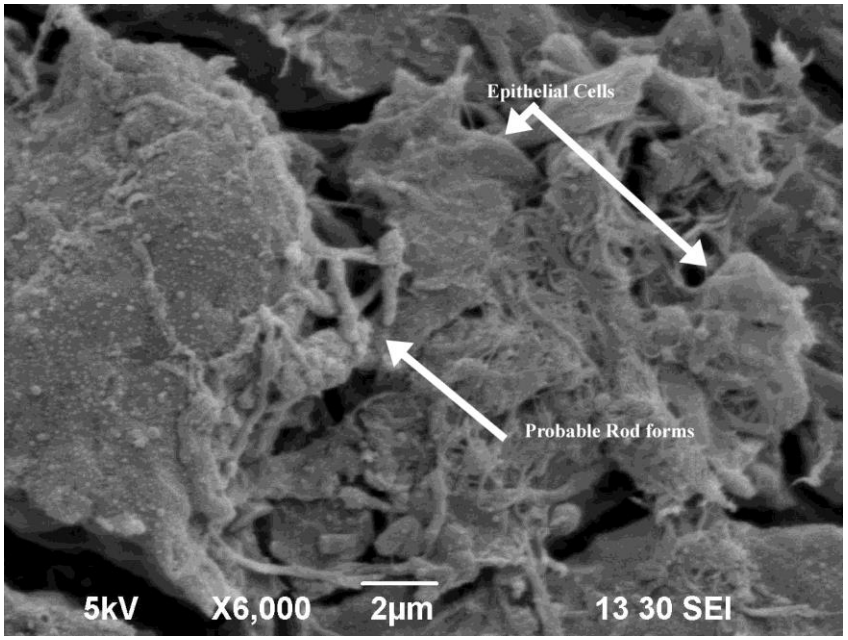
Disinfection requirements changed due to multi drug resistant organisms (MDRO).

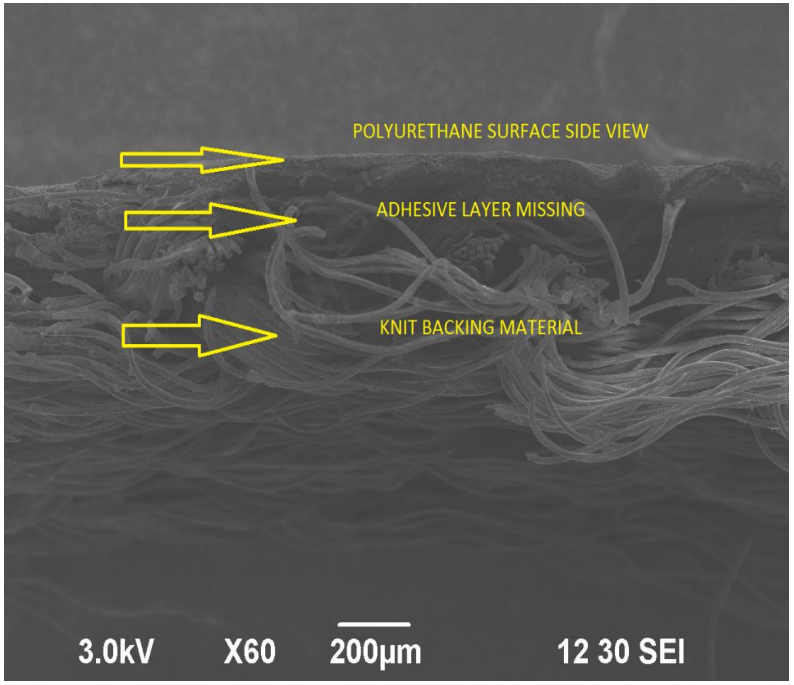
Clorox Surface Compatibility

Surface	Examples	 Clorox Healthcare® Bleach Germicidal Wipes	 Dispatch® Hospital Cleaner Disinfectant Towels with Bleach	 Clorox Healthcare® Hydrogen Peroxide Cleaner Disinfectant Wipes	 Clorox Healthcare® Multi-Surface Quat Alcohol Cleaner Disinfectant Wipes
Polyurethane (PU)	Upholstery, lights, tubing, mattress covers	★	★	★	★
Polyvinylchloride (PVC)	Furniture, mattress covers, tubing, floors	★★★	★★★	★★★	★★★

3-star system	
★★★	No visible surface damage or effect on the material is likely to occur when used according to label directions. No change to the integrity of the material is expected.
★★	Some visible surface damage such as tarnishing or clouding may be seen with long-term exposure. Little to no effect on material integrity is expected. Periodic wiping of surfaces with a clean damp cloth to remove residue can help to minimize damage.
★	Visible damage to the surface is likely to occur with long-term exposure and some effect on material integrity is possible. Surfaces should be wiped with a clean damp cloth immediately after the contact time has been reached to reduce the risk of

Damage Caused by 1-step process





Even Repeated Cleaning Fails to Disinfect

Manian (2012) showed that…

"…elimination of ABC and MRSA from hospital room surfaces is often challenging, with approximately 1 of 4 rooms remaining contaminated with either one of these organisms even after 4 rounds of cleaning and disinfection with bleach"

Wipes actually spread contamination

- Nkemngong (2020)
  - Showed that as disinfectant wipes are used, they contaminate previously uncontaminated surfaces.
  - Wipes still had viable spore on them after use.

Candida auris

- Emerging threat
- Very had to kill, even with bleach, on hard surfaces.
- Quaternary Ammonia not very effective
- Mattress is porous and you are not going to disinfect. Get rid of it.
  - Many studies of outbreaks have shown contamination of the mattress

Biswal (2017)

What does FDA/CDC say?

Mattress covers prevent mattresses from being contaminated with bodily fluids and substances.

Linens are not considered mattress covers.

Disinfect mattress with disinfectant that is compatible with mattress cover materials.

Cleaning/sanitization (99.9%) and disinfection (99.99 - 99.9999%) are different.

Pre-cleaning must be done to remove visible soil and then cleaning to remove non-visible soil.

Efficacy claims on hard surface disinfectants are not applicable to soft surfaces.

Disinfection

- NEED a log6 reduction in bacteria to consider the medical device disinfected.
- If you only get a log1 reduction, you will get recolonization.

One Step Doesn't Work!

Quaternary Ammonia Compounds only get less than a log1 reduction (Hooker, 2013) and most surfaces still contaminated after cleaning (Manian, 2013; Sigler, 2013)

One Step Doesn't Work!

Hydrogen peroxide/peracetic acid only gets a log2 to log3 reduction (Doan, 2012) and did not reduce C. diff infections (Alfa, 2015)

One Step Doesn't Work!

Bleach failed to reduce C. diff counts and did not reduce C. diff infections (Anderson, 2017)

Must preclean in order to get any efficacy from the bleach

Bleach destroys the mattress and bed deck.

One Step Doesn't Work!

UV light only reduced C. diff counts by only log1 or less (Anderson 2013 & 2017; Randive 2017) and failed to reduce C. diff infections (Anderson, 2017)

One Step Doesn't Work!

UV light does not work

Chin (2019)
UV light added to bleach did not work for terminal cleaning. Patients became infected with MDROs that remained after cleaning.

Health Quality Ontario (2018)
Systematic review that showed evidence for value of UV light is extremely poor and that the costs are huge.

Anderson (2017)
UV failed to decrease C. diff or MRSA infections
No bed manufacturer recommends use of UV light for disinfection.

Damaged Mattresses Are Common!

Marks (2018) showed 32% of hospital mattresses (n=2561) were damaged.

Bradbury (2014) Showed 27% of hospital mattresses (n=656) had failed and had damage on interior.

Hooker (2021) showed 72% of hospital mattresses (n=727) were damaged.

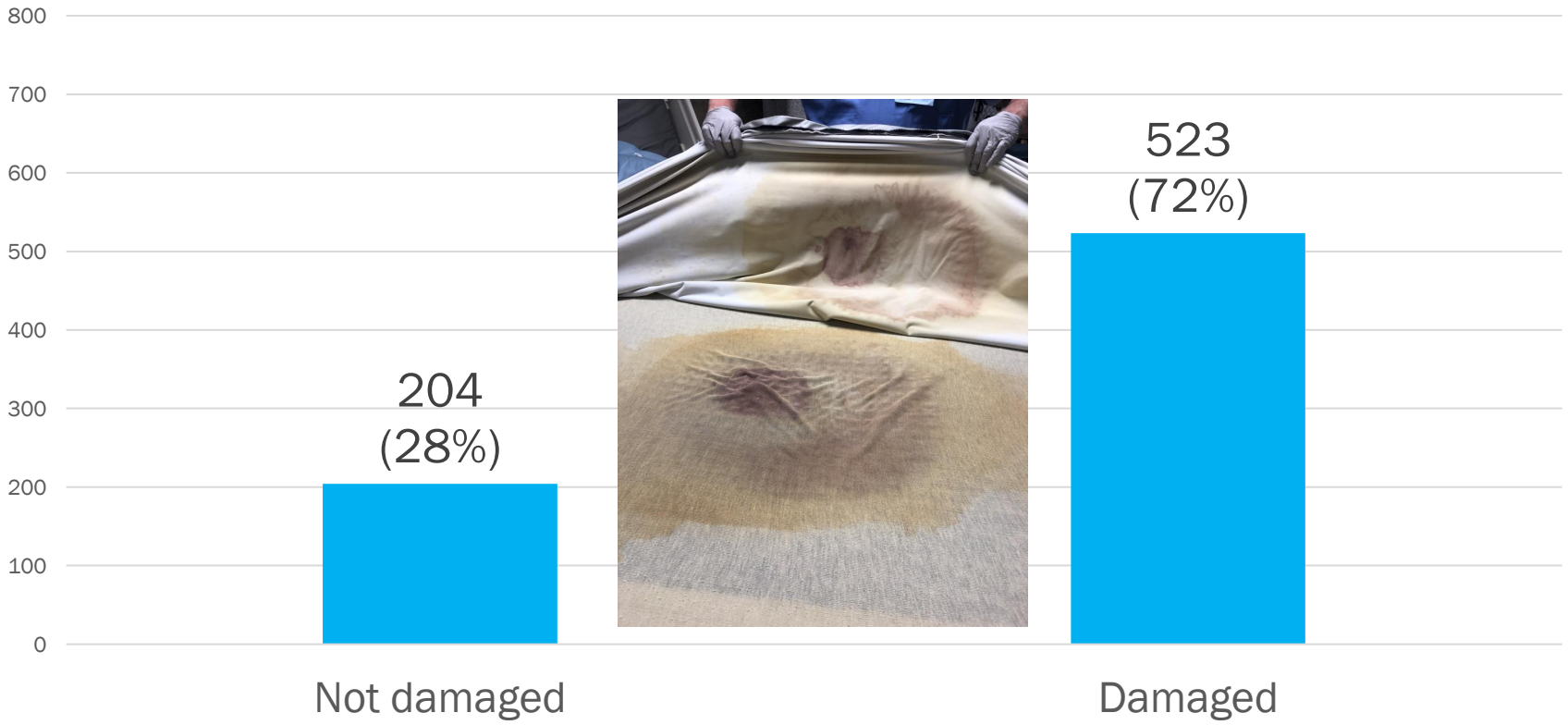
340 (47% of total beds) required a new cover.

183 (25% of total beds) required complete replacement.

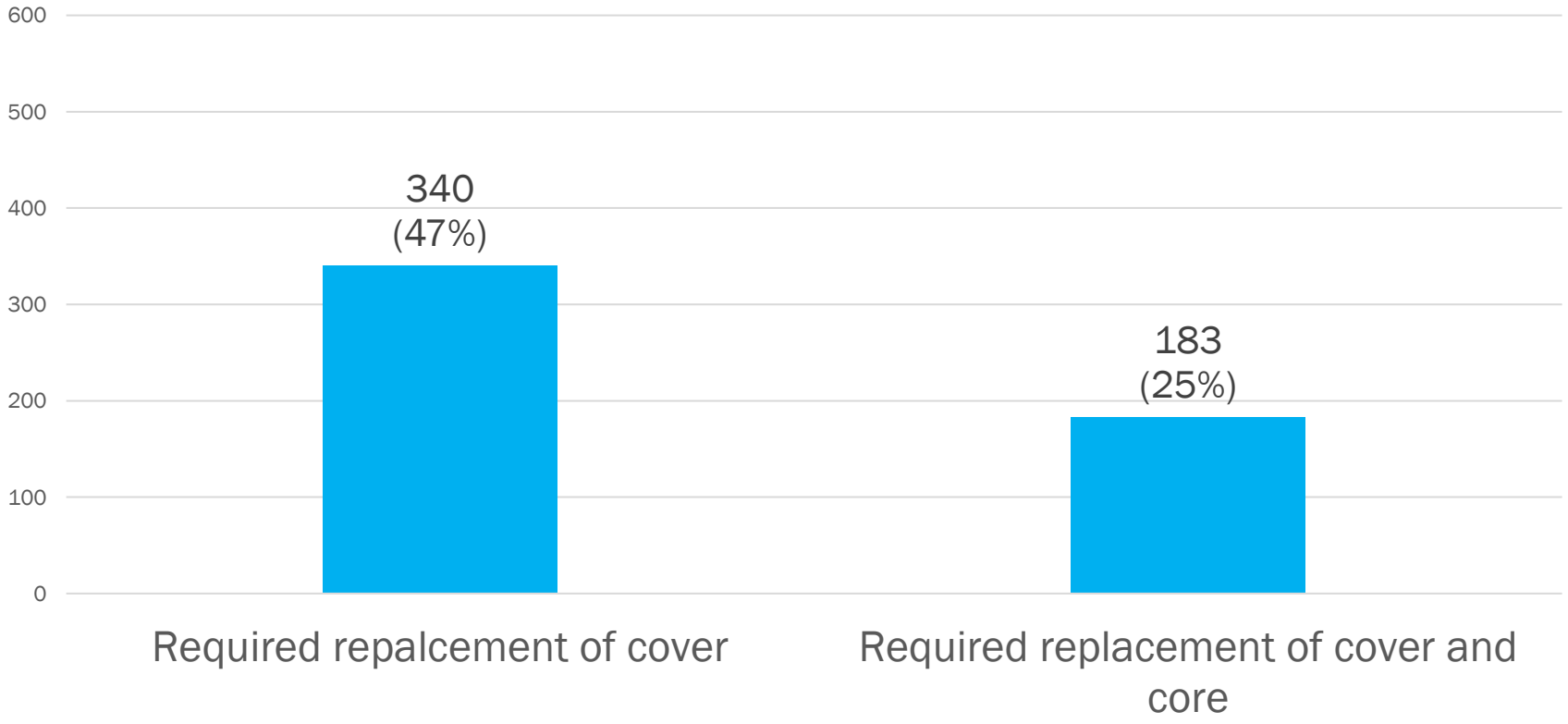
Types of Damage

- Holes in the mattress cover (n=428) (59%)
  - 113 (16%) were visible to the naked eye
  - 315 (43%) small holes only detected by using an LED light
- Stains on the exterior cover (n=173) (24%)
- Stains on the interior
  - of the top cover (n=215) (30%)
  - of the bottom cover (n=192) (26%)

72% of 727 mattresses at 4 hospitals were damaged

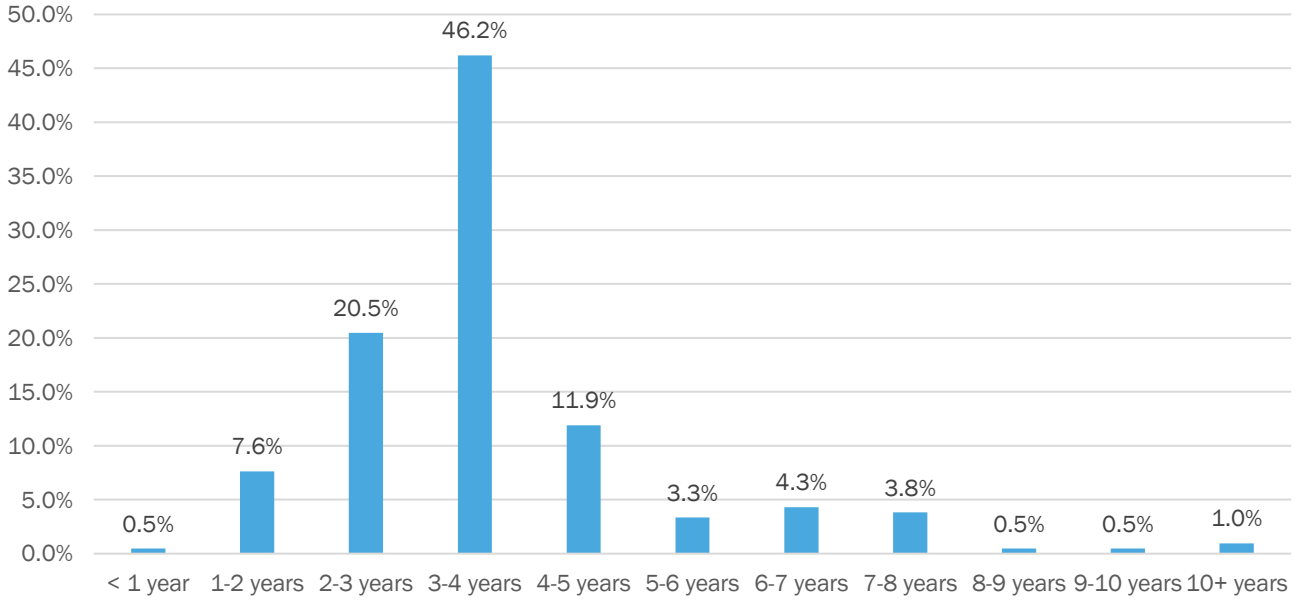


47% required a new cover and 25% needed complete replacement



XAVIER UNIVERSITY

STUDY OF FAILED MATTRESSES FROM DATE OF MANUFACTURE[1]



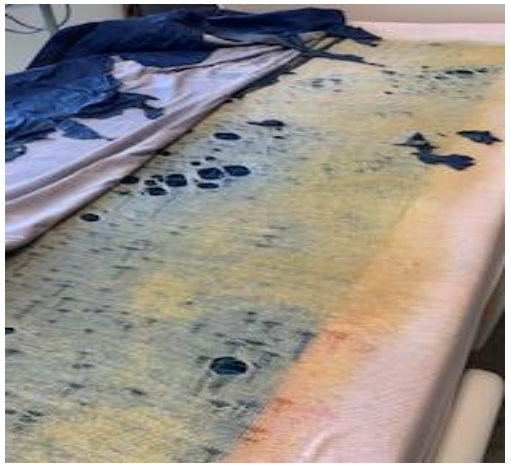
- AHA DEPRECIATION TABLE CALLS FOR ASSET LIFE OF 5 YRS ON MATTRESS AND 12 YRS FOR BED
- FAILURES AT 2 YEARS DOUBLES PER PATIENT COST- NO INCREASE IN REIMBURSEMENT- WASTING CAPITA

1) Hooker, Edmond A, Hospital mattress failures – A hidden patient danger Infection Control and Hospital Epidemiology 2021:doi 10.1017/Ice2021.486

Three Examples of Failure

Possible Soiling
EMBEDDED
in fabric

Fluid Emersion INSIDE
Mattress Staining on
Bottom of Top Cover,
Fire Barrier & Foam



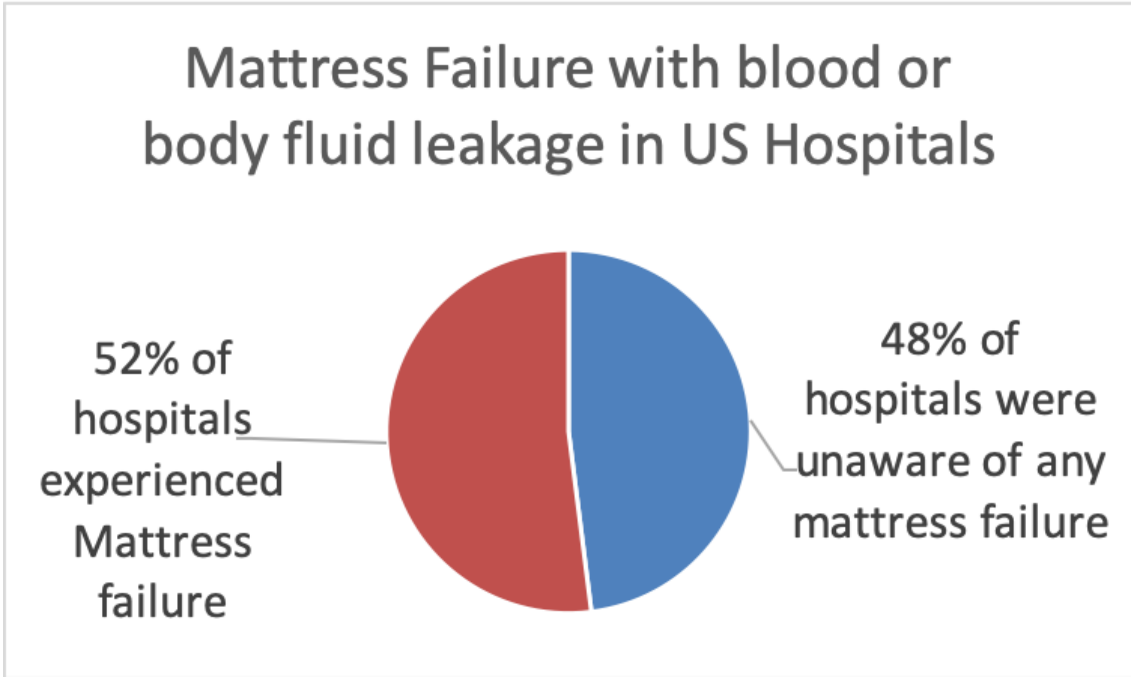
Inside of top mattress cover is DISINTEGRATED BY DISINFECTANT use as well as fire barrier sock protecting the patient

Bed Frame Rust

Rust was identified on 175 beds (24%)

- 65 had widespread rust (9%)
- 110 had localized rust (15%)

Patients are being put at risk



Based on a sample of at 2019 APIC conference.

Hooker, E. A. (2021). Disinfecting hospital beds and mattresses: A time for change. *AJIC*, *49*(10), 1341.

Blood inside of mattresses

Infections Related to Mattresses

Bousquet, A., et al. (2017). Outbreak of CTX-M-15–producing Enterobacter cloacae associated with therapeutic beds and syphons in an intensive care unit. American journal of infection control, 45(10), 1160-1164.

4 deaths, 18 infected or colonized

Infections Related to Mattresses

van der Mee-Marquet, N., et al. (2006). Multiresistant Enterobacter cloacae outbreak in an intensive care unit associated with therapeutic beds. Critical Care, 10(1), 405.

15 colonized or infected

Infections Related to Mattresses

Cadot, L., et al. (2019). Extended spectrum beta-lactamase-producing Klebsiella pneumoniae outbreak reveals incubators as pathogen reservoir in neonatal care center. European journal of pediatrics, 178(4), 505-513.

21 neonates infected. All mattress contaminated

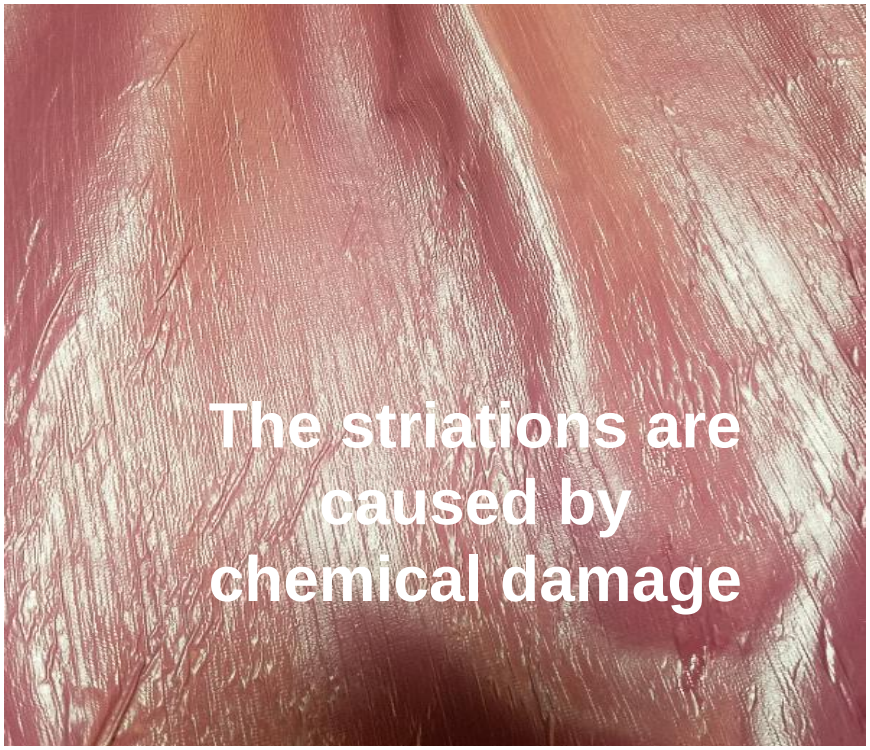
Risk to Future Occupants

Cohen, B., Liu, J., Cohen, A. R., & Larson, E. (2018) Association between healthcare-associated infection and exposure to hospital roommates and previous bed occupants with the same organism. infection control & hospital epidemiology, 39(5), 541-546.

531% increase in infections if previous patient had the infection.

Damaged Mattresses must be replaced

- The FDA, CDC, ECRI, and manufacturers recommend routine mattress inspection and replacement of mattresses with any visible signs of stains, wear, or damage.
- Damaged mattresses have been linked HAI outbreaks and deaths.



Summary of Issues

- Disinfectants accelerate destruction of mattress cover.
- Expected life of integrated cover is different than mattress core- requires changing not changing the integrated cover voids warranty of mattress core.
- One step cleaning/disinfection process is deficient by a factor of 6x
- Mattress manufacturer warning on infection risk of not replacing cover at expected life
- Disinfectants cause bed rust requiring additional maintenance
- New MIFU adds 20-30 min to room turn time, but still may not eliminate C. difficile.

What can you do?

- Follow the MIFUs
  - Required 5-6 step process that improves cleaning and removes the disinfectants that are destroying your mattress
- Follow the FDA and manufacturer's recommendation for routine inspection
- Mattresses likely to last only 1-2 years
  - Plan and budget for replacement

Inspection (per FDA)

- Regularly check each hospital bed mattress cover for any visible signs of damage or wear such as cuts, tears, cracks, pinholes, snags, or stains.
- Check all sides of the mattress
- Open cover (most have a zipper)
  - Look for staining or wet spots inside
- Immediately Replace (not repair) all damaged mattresses

Other options

- Use launderable mattress covers
  - Some manufacturers have covers that can be removed and laundered
  - Use a mattress cover that can be laundered
    - Cannot just buy a plastic cover because they do not breathe and will result in pressure ulcers.

Contact

For additional information, please contact:

hookere@Xavier.edu

Authors:

Edmond A Hooker, MD, DrPH