



A Proactive Approach to Patient Safety: Three Essential Elements

With the ongoing global occurrence of adverse events in primary and outpatient healthcare, patient safety remains a global public health concern and the primary focus of interventions in healthcare organizations. However, choosing the right technology that is holistically focused on patient safety built upon core requirements that address infection prevention, reduce patient misidentification errors and mitigate electromagnetic interference can help organizations ensure they are providing the most effective and high-quality care to their diverse patient population.

The healthcare landscape continues to evolve in remarkable – and sometimes unexpected – ways. As healthcare systems have shifted to a value-based care model, with the increased adoption of new technologies and treatment paradigms, healthcare providers find themselves struggling to balance critical time with patients while working in increasingly complex environments with more demands on their time and abilities.¹ While technological advances have enabled hospitals and other providers to deliver greater access to care while also demonstrating a correlation to improved patient outcomes, the accompanying complexity that comes with the adoption of a new technology can often create unintended consequences. Too often, these innovations contribute to factors that may increase the likelihood

that an adverse event may occur while a patient receives treatment in a hospital, ambulatory setting, long-term acute-care hospital (LTACH) or skilled nursing facility (SNF). Per the World Health Organization (WHO), approximately 1 in 10 patients experience an adverse event resulting in patient harm – and nearly 50% of those events are considered preventable.² Furthermore, the occurrence of adverse events, such as venous thromboembolism (blood clots), pressure ulcers (bed sores) and infections result in a significant number of deaths and disabilities each year, estimated to cost in trillions of U.S. dollars. As such, patient safety issues pose a significant cost burden for healthcare worldwide.¹



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Daniel Colling, RN | Global Lead for Healthcare Industry Solutions | HP Inc.

“Healthcare organizations still struggle with preventable adverse events like delayed or inaccurate diagnoses and medication errors,” said Daniel Colling, RN, Global Lead for Healthcare Industry Solutions at HP Inc. “Investing in patient safety prevention efforts, as well as engaging patient involvement, can help organizations provide the highest quality care instead of paying the costs of treatment for alarmingly common problems. Patient safety must be at the forefront of providing care.”

Despite the many innovations in delivering healthcare through technology, preventable adverse events that affect patient safety remain a global challenge. To better protect patients, healthcare organizations around the globe have implemented systemwide policies and protocols to improve patient safety through preventative care initiatives. With a focused approach, patient safety improvements have been successfully measured and have also reduced the cost burden for healthcare with an estimated savings greater than \$28 billion in the United States alone.³ By addressing patient safety challenges that can be improved through implementing purpose-built, clinical evidence-based technologies, acute-care and ambulatory environments can better mitigate the associated risks.

Three of the leading patient safety challenges that can be better managed with the right technologies include the following:

- The spread of healthcare-associated infections (HAIs) and epidemic viruses
- Patient identification errors
- Electromagnetic interference (EMI) events

All are preventable – but only if healthcare organizations take a strong, proactive stance to make them so.

Patient safety, however, is not just a clinical concern. It also affects the business side of health systems. Issues with patient safety can result in longer hospital stays, more invasive interventions and long-term health problems for the patients who are affected. With the shift to value-based care, healthcare organizations must absorb any costs associated with this issue. Over time, those costs can grow exponentially. A lack of attention to patient safety best practices can also lead to poorer patient experiences and, consequently, lower scores on the Healthcare Consumer Assessment of Healthcare Providers and Systems (HCAHPS). If scores are low enough, healthcare organizations risk forfeiting vital reimbursement dollars, as the Centers for Medicare and Medicaid Services (CMS) currently withhold 1% of Medicare payments, whereas 30% of that reimbursement amount is tied to an organization’s HCAHPS.

“Poor patient safety also harms a hospital’s reputation,” said Doe Kley, Senior Infection Preventionist with Clorox Healthcare. “HAIs are



reportable and therefore public. Leapfrog safety grades are also public. Savvy consumers are going online to see how a facility is performing. Large employers are also looking when buying health insurance to see how different health systems measure up. If patient safety isn’t a focus at your hospital, there can be dire consequences for patients. But it’s going to affect a hospital’s financial standing, as well.”

Computers, displays and Internet of things (IoT) devices like multi-function printers and hand-held devices are critical technologies that healthcare providers utilize every day for a variety of tasks. Providers use them to access and complete patients’ electronic medical records (EMRs), as well as to execute computerized physician order entry (CPOE). Such tools enable providers to view and transmit patient images and data, access and print healthcare literature, provide patient and family education, and facilitate learning. As these devices are often used at the point of care or in common areas where patient care is delivered, they need to be part of a healthcare organization’s patient safety strategy. By using devices designed specifically for clinical use and with patient safety at the forefront, healthcare organizations can better prevent and manage HAIs and epidemic viruses, patient identification errors and EMI events.

1 ***HAI prevention and control: Getting a firm handle***

According to the U.S. Centers for Disease Control and Prevention (CDC), more than 1.7 million hospitalized patients each year acquire healthcare-associated infections. More than 98,000 patients (1 in 17) will die due to these infections while being treated for other health issues in a hospital environment.⁴ Previously known as nosocomial infections in reference to infections associated to treatment in an acute-care hospital, and now referred to as healthcare-associated infections that can extend beyond the acute-care environment, these events can appear within the first 48 hours after hospitalization or even

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Graham Snyder, MD | Epidemiologist & Medical Director — Infection Prevention & Hospital Epidemiology | University of Pittsburgh Medical Center

within 30 days of receiving treatment in multiple healthcare settings such as long-term care facilities, ambulatory settings, family medical clinics and home care.⁵

More than 98,000 patients (1 in 17) will die due to these infections while being treated for other health issues in a hospital environment.

With the CDC and WHO advocating, promoting and educating healthcare providers and healthcare workers systemwide to practice effective infection prevention and control policies to reduce such infections, some improvements such as reducing surgical site infections (SSIs), central line-associated bloodstream infections (CLABSIs) and catheter-associated UTIs have been realized through focused national initiatives.⁶ Despite a national focus and significant investment, however, a considerable number of HAI outbreaks continue to occur in the U.S., resulting in costs upwards of US\$45 billion. Many of these events occur due to cross-contamination between patients and healthcare workers, as well as patients with reduced immune responses.^{7, 8}

In addition to HAIs, viral epidemics also impact patient safety. Viruses such as influenza and the novel coronavirus (COVID-19) add even further strain to an organization’s ability to provide safe, quality care to patients. They also come with significant costs. The total estimated annual average economic burden to the U.S. healthcare system and society is US\$11 billion for influenza alone.⁹ As such, healthcare organizations across the country are struggling to reduce the number of HAIs through several initiatives, as increased numbers of HAIs not only affect Medicare and Medicaid reimbursements, but also affect an organization’s HCAHPS scores and Leapfrog safety ratings.

“This continues to be a big issue in healthcare organizations of all sizes because we know all the consequences when healthcare workers breach infection control and a patient picks up an HAI, which increases morbidity and mortality,” said Clorox Healthcare’s Kley. “It’s going to affect care. It’s going to affect how long your patient stays in the hospital. And it’s going to affect how that patient views your organization.”

No clinical worker wants to be responsible for passing a pathogen to a vulnerable patient, Kley added. Yet, as nurses and other clinical staff focus on caring for patients and documenting care in the EMR, breaks with infection prevention protocol can and do occur. Unfortunately, the healthcare professional responsible will most likely never know the role he or she played in transmitting that pathogen.

“As a nurse, I can tell you we’ve all made a medical error at some point, and it scares you to death,” she said. “You won’t make that mistake again because you have immediate feedback that you made that error and about how and why it happened. When you breach infection control, you don’t get that kind of feedback. There aren’t those dots to connect to show that you were involved, so it’s much harder to change those behaviors.”

Multiple research studies have found that poor cleaning of surfaces in acute-care, ambulatory and long-term care settings is a major source of HAIs. Commonly, the transmission of viral pathogens can occur because of the cross-contamination of many dangerous microorganisms such as MRSA, vancomycin-resistant Enterococcus spp. (VRE), *C. difficile*, Acinetobacter spp. and norovirus.^{10, 11} Graham Snyder, MD, an epidemiologist and Medical Director for Infection Prevention and Hospital Epidemiology at the University of Pittsburgh Medical Center (UPMC), said, “In the hustle and bustle of the healthcare world, hand hygiene protocols, which every American hospital has put in place, unfortunately are still not followed as closely as infection control staff would like. In addition, it’s often unclear who is responsible for cleaning certain equipment such as computers, tablets, displays and keyboards.” Numerous studies have shown that

HAIs a Worldwide Problem

HAIs are not just a major patient safety challenge in the U.S. They are also significantly problematic in developing nations and elsewhere in the world.



For every **100 hospitalized patients**, **10 patients** in emerging countries will acquire an HAI.¹⁵



In more advanced countries, **7 out of 100 patients** will get an HAI.¹⁵



HAIs continue to escalate at a disconcerting rate in emerging countries with infection rates **3-20 times** higher than advanced countries.¹⁶

“Doing it all [blood draws and printing labels] in one place...brought our error rate pretty much down to zero because the nurses can stay engaged with that single task...from start to finish.”

Sherri Hess, RN | Chief Nursing Informatics Officer | Banner Health

these commonly used technologies are often highly contaminated with pathogenic bacteria and viral pathogens from the environment as well as the hands of healthcare providers.^{12, 13, 14}

“No one thinks about touching the keyboard or how many other people have touched it or when it was last cleaned,” he said. “They are just trying to get their orders in and get care documented. The same can be said for hand-held devices and smartphones. These are all potential reservoirs for pathogens. It’s really an unexplored challenge for healthcare, and one that needs to be thoroughly addressed to reduce HAIs.”

Another device that healthcare staff members don’t think twice about touching is the printer. Kley recalled a recent assessment she conducted of potential bacterial reservoirs on a hospital floor to help better inform infection prevention policy.

“We swabbed the bathroom floor, the doorknobs, the countertops and the printer,” she said. “One of the highest bacterial counts wasn’t in the bathroom, but on that printer. Everyone was shocked. But while people know to wash their hands after using the bathroom, they may not think about what happens when touching the printer if they just came out of a patient’s room. It’s an interaction point that we need to consider more carefully as we look at improving infection control efforts.”

Both Kley and Snyder agree that developing successful infection prevention policies starts with getting the right people, including clinical staff, at the table to thoroughly explain healthcare workflows to identify gaps that could lead to HAIs. Snyder added that it’s also important to make whatever protocols are developed as easy as possible for clinical staff to implement.

“We put a lot on our clinical staff members,” Snyder said. “They want to do the right thing. They understand the potential consequences when it doesn’t happen. But, for infection prevention strategies to work, we need to make it as simple as possible, or nothing will change.”

There is now strong clinical evidence that links surface contamination to HAIs.¹⁷ Thus, in order to achieve successful initiatives for improving patient safety in correlation to reducing healthcare-associated infections, it is vital to set standards for cleaning all hospital surfaces including IT and IoT devices in order to reduce the risk of transmitting viral pathogens and antibiotic-resistant pathogens.¹⁸ That’s why having carefully designed purpose-built technologies for clinical settings that can be easily cleaned and disinfected with germicidal wipes, as well as keypads and touchscreens that work when clinicians are wearing gloves, are such an important factor to successfully achieve patient safety initiatives for infection prevention, especially now as viral epidemics grow and microbial pathogens become exceedingly resistant.

Most computers and printers simply were not designed to be regularly cleaned by common hospital-grade disinfectant wipes such as Clorox Healthcare® Bleach Germicidal Wipes®. Repeated use will damage the integrity of the plastic – and, ultimately, the device itself. To combat HAIs and the transmission of viral pathogens, healthcare organizations are best served by investing in devices that were designed for clinical settings and patient safety at the forefront in mind.

“These devices don’t clean themselves,” Kley said. “Everyone thinks someone else will do it. So, if we can make it easier for nurses and other clinical staff members to clean them so that they are automatically wiping them down after use without having to think twice about it, we will reduce the risk of these pathogens spreading and improve patient safety across the board. It provides healthcare organizations an opportunity to promote real change.”

Improving patient identification: Toward an errorless first step

At this moment, in hundreds of hospital rooms across the country, a nurse has just walked toward the bed and asked the inhabiting patient for his or her name, date of birth and reason for admission. The nurse will then check that reply against the information on the identification wristband the patient received at admission. Not doing so could have severe consequences.

“Patient identification must be the first step in any hospital procedure,” said Rikki Jennings, RN, Chief Nursing Informatics Officer at Zebra Technologies Corporation. “It’s important. If there’s an error in that first step, the downstream effects can have varying degrees of harm, from giving patients the wrong medication to putting them in a position where they receive the wrong surgical procedure.”

Yet, despite the well-understood importance of patient identification, misidentification errors remain one of the biggest threats to patient safety in the healthcare setting. As noted in a 2019 *Journal of Clinical Nursing* editorial, while your average nurse will describe patient identification errors as “rare and unlikely” events, the average annual safety report will tell you otherwise. They are remarkably common and can lead to serious reportable events that harm not only the patient’s health, but also the clinical standing of the healthcare facility where such an error occurred.¹⁹

“Patient identification may seem fairly simplistic, but it’s actually quite complex,” said Sherri Hess, RN, Chief Nursing Informatics Officer for Banner Health, a nonprofit health system of 28 hospitals and specialty facilities spanning six states. “It becomes even more complex when you factor in what clinicians have to deal with. No one thinks they are going

to come in and make an identification error. But when you are being pulled in a million different directions – with call lights going off or patients who need immediate assistance – you may end up not following protocol. And, unfortunately, not doing so can lead to misidentification and consequent problems.”

To better manage the identification process, the vast majority of healthcare organizations use specialized identification wristbands placed at admission. Today, technology has advanced so that such wristbands can be printed not only with basic information such as name, date of birth and the hospital’s unique identifier for the patient, but also with barcodes, quick response (QR) codes or radio-frequency identification (RFID) capabilities. These “extras” assist with identification verification and make it easier for healthcare workers to associate laboratory samples or medications with a patient.

Advanced multifunction print technologies can also add color-coded warnings to the wristbands to make it easier for hospital personnel to see if a patient has a medication allergy or is considered a fall risk. These advances have all helped in promoting patient safety efforts, said Jennings. But if those wristbands are difficult to access, or the associated barcode is unreadable because of a poor printout or damage, nurses and other clinical staff members may be more prone to rely on workarounds.

“If the bracelet irritates the skin, a patient might take it off and put it on the bedside table. It could fall off in transit somewhere,” Hess said. “If we are dealing with an infant in the neonatal intensive care unit (NICU), the wristband may just be attached to the window of the isolette, which may make it easier to misplace. Patients in the operating room may be lying in such a way that you can’t get to the bracelet. In those cases, the nurses may have printouts of the labels they can scan instead. And, in doing so, they may accidentally scan the label for the wrong patient.”

Such scanning errors can lead to patients receiving the wrong medicine, receiving diagnostic or laboratory tests ordered for someone else, or having to do repeat procedures or laboratory tests when the drawn samples are not successfully associated with their medical records. Jennings said even if these mix-ups don’t result in direct harm to the patient, they can lead to high levels of patient dissatisfaction.

“When nurses come back and tells patients they have to redraw blood because the specimen wasn’t labeled correctly, patients, understandably, will be frustrated,” she said. “Maybe those patients are waiting to go home, and you just delayed them for another hour or two. Maybe they are waiting for surgery and that misidentification error means they can’t get into the operating room that day. There are so many downstream effects that you just can’t anticipate which really inconvenience patients. That’s going to affect patient satisfaction and your HCAHPS scores.”

Identification errors also harm the patient-provider relationship, Hess added. “When you make this kind of error, it really decreases trust between the patient and the clinician. That will influence all of your interactions moving forward.”

Jennings said that healthcare organizations can work to fill in some of these gaps, reducing misidentification issues significantly by using new technologies such as portable, multifunction printers that can print labels with barcodes and RFID codes at the point of care. In fact, Hess said that Banner Health recently implemented a pilot program using such devices to improve patient identification in medication administration and laboratory tests.

“When nurses or phlebotomists have to draw blood on a patient, they need to put a lab label around the tube and take it down to the lab. A lot can happen between all of those steps,” she said. “Maybe you grab the wrong labels at the printer when a doctor stops you to ask a question. Once you are in the room, you need to scan the wristband, then the labels, and add your initials, date and time. Then you need to get it to the lab. There are a lot of places where, in just the day-to-day of providing care, a mistake can be made and then the test has to be redone.”

To fill those gaps, Banner Health decided to try using a portable printer that can travel with the nurse into the patient’s room along with a computer.

“You enter what lab you will draw into the EMR on the computer. You print the labels right there in the patient’s room. You then draw the labs and scan the patient and lab labels,” Hess said. “Doing it all there in one place, all at once, brought our error rate pretty much down to zero because the nurses can stay engaged with that single task, without interruptions, from start to finish.”

There are many ways that technology can help healthcare organizations improve patient identification errors, according to Jennings. But, in doing so, they need to be sure they focus on the human aspect and how nurses and other clinical staff actually do their work. If they don’t, they run the risk of buying expensive technology – only to add another piece to the patient safety puzzle that clinicians will just work around.

“Wristbands are foundational to patient safety,” she said. “Healthcare organizations can find ways to enhance them in ways to help avoid errors. But, any changes to your process, including the addition of new technologies to help with patient identification, have to be clinically driven. Focusing on solutions designed for the environment that clinical staff actually work in, capable of withstanding the rigors of that environment, really is the key to improving identification and, ultimately, providing safer care.”

3 *Mitigating EMI: Uncovering the threat*

While quite a bit of attention is paid to infection prevention and control and patient identification management, there is another patient safety issue that is not as widely discussed: electromagnetic interference (EMI).

EMI, sometimes referred to as radio-frequency interference, occurs when the performance of a medical equipment's internal electronic circuitry is degraded, delayed or even halted by the activity of an external device.²⁰ As medical devices and equipment have become more sophisticated, it has become much more common for them to send information to wireless receivers, EMRs or other computer systems via wireless connectivity or Bluetooth signaling. With such advances come a heightened risk of potential interference, said Lee Kim, Director of Privacy and Security for HIMSS. That's why, she argued, hospitals need to have effective strategies in place to ensure patient safety.

"In today's hospital environment, there are so many devices and pieces of equipment that are now part of the medical internet of things, from simple diagnostic tools to life-saving equipment," she explained. "Since these things operate on certain frequencies, ensuring that their signals both work and reach their intended targets is increasingly important. In some cases, such as with defibrillator implants or life support systems, it may even be a matter of life and death."

As the number of "connected" hospitals increases, integrating increasingly more wireless technology for both direct healthcare needs as well as patient experience improvements, it is crucial to find ways to mitigate potential signaling conflicts. But, Kim added, it's not just the devices within the hospital walls that are of concern. Patients, as well as their friends and family, are now also bringing a remarkable number of smartphones, tablets, laptops, e-readers, smart watches and fitness trackers into the hospital. And, often unaware of the dangers, they don't always adhere to posted signs or warnings about their permitted use.

"Healthcare organizations need to understand the landscape to more effectively manage EMI," Kim said. "But these are consumer devices that are not designed for medical grade use which are coming into that landscape on a regular basis. It makes it much more challenging to reliably detect any problems and establish the right policies to ensure they don't occur again."

Patient devices are not the only issue. Clinical workers likely carry their own personal smartphones on their person during shifts, too. This adds to the probability of an EMI incident occurring. The result, Kim said, is a growing number of potential sources of interference, many of which will end up within 6 feet of a patient's hospital bed.

"It's a lot, and it increases the probability of some sort of EMI event," she said. "These devices are all designed for wireless use, and they are all using what has become a very congested radio spectrum. The radio waves they use can travel quite a distance, and there also have been

reports of devices achieving weird harmonic effects when their signals clash. It all increases the risk of interference. Some of these effects may only be momentary, but they can still pose a huge risk to patients."

The Center for Devices and Radiological Health at the Food and Drug Administration (FDA) issues stringent guidelines to promote electromagnetic compatibility in healthcare facilities, starting with the ongoing assessment and management of the electromagnetic environment, but also including the coordination of new purchases with existing technologies, carefully vetting manufacturer specifications regarding electromagnetic compatibility.²¹ By looking carefully at mission-critical equipment, and then making tactical decisions about future purchases, hospitals can better ensure patient safety across the facility, Kim said.

But that kind of coordination needs to go beyond just medical equipment purchases, added Colling.

"Managing EMI isn't limited to just your medical devices and related equipment," he said. "Hospitals are full of printers that are also part of the Internet of things. They emit signals and use the same wireless networks that these other devices do. It's important that stakeholders in charge of equipment procurement consider multifunction print devices that are certified EN/IEC 60601-1-2, meaning they can be used within the patient sphere without risk of EMI."

Kim agrees: Hospitals need to look beyond the usual suspects, such as high-end medical equipment or smartphones, when developing their strategies to avoid potential interference events.

"EMI really is a hidden threat," she said. "There simply isn't enough education or awareness among clinical or procurement staff regarding all these different devices and how an EMI event can affect patient care. There needs to be more of that awareness to ensure the right policies are put into place and actually enforced. The safety of patients depends on it."

Moving toward a safer future in healthcare

The only constant in healthcare is change. As the healthcare landscape continues to evolve, adopting innovative technologies to improve patient care, it's unlikely that the complexity of the environment will decrease. That makes it even more imperative that provider



organizations continue to prioritize patient safety initiatives. Today, worldwide challenges remain concerning the implementation of critical sanitization procedures across different hospital environments to prevent HAI transmissions, concerning opportunities to improve patient identification processes, and concerning the effects of EMI on patient care. But advanced print and computing technologies can help to fill workflow gaps where those patient safety errors are most likely to occur.

Yet, as healthcare organizations consider how to best address these aspects of patient safety, one thing is clear: Technology, in and of itself, is not the answer. Whatever solutions hospitals or health systems implement must be grounded in the clinical needs and workflows of their providers.

“It’s important to realize that there is no one-size-fits-all solution to patient safety issues. And while technology can help, implementing new technologies is not always straightforward,” said Jennings. “You need to carefully consider what technologies you select, the efforts required to

bring them to life, and how well they will actually work within the care environment and for your clinical staff.”

Raja Bhadury, Head of Care Delivery Solutions at HP Inc. wholeheartedly agrees. Too often, healthcare organizations are simply unaware of available solutions that can help them better facilitate patient safety in the healthcare setting, according to Bhadury. A variety of personal computers, keyboards and multifunction printers are on the market that can be appropriately sanitized to reduce the risk of pathogen transmission, can help facilitate patient identification from admission to discharge and can mitigate EMI events.

“When you add in these technologies and applications designed with the healthcare environment in mind to optimize workflows and make it easier for clinicians, who are under enormous amount of strain to do their jobs, both care and patient safety improve,” he said. “In doing so, you protect your patients. But you also provide a better patient experience.”

References

1. Slawomirski L, et al. The economics of patient safety: Strengthening a value-based approach to reducing patient harm at national level. Paris: OECD; 2017 (<http://www.oecd.org/els/health-systems/The-economics-of-patient-safety-March-2017.pdf>, accessed 23 July 2019).
2. World Health Organization. Patient safety - Global action on patient safety. Report by the Director-General. Geneva: World Health Organization; 2019 (https://apps.who.int/gb/ebwha/pdf_files/WHA72/A72_26-en.pdf, accessed 23 July 2019).
3. National scorecard on rates of hospital-acquired conditions 2010 to 2015: Interim data from national efforts to make health care safer. In: Quality and patient safety [website]. Rockville (MD): Agency for Healthcare Research and Quality; 2016.
4. Centers for Disease Control and Prevention. Healthcare-associated Infections Report. 2018. <https://www.cdc.gov/hai/data/portal/progress-report.html#2018>
5. Revelas A. Healthcare - associated infections: A public health problem. *Niger Med J.* 2012;53(2):59-64.
6. Cassini A, Plachouras D, Eckmanns T, et al. Burden of Six Healthcare-Associated Infections on European Population Health: Estimating Incidence-Based Disability-Adjusted Life Years through a Population Prevalence-Based Modelling Study. *PLoS Med.* 2016;13(10): e1002150.
7. Nuvials X, Palomar M, Alvarez-Lerma F, et al. Healthcare associated infections. Patient characteristics and influence on the clinical outcome of patients admitted to ICU. *Ervin-Helics registry data. Intensive Care Med Exp.* 2015;3(Suppl 1): A82.
8. Scott RD. The direct medical costs of healthcare-associated infections in US hospitals and the benefits of prevention. 2009. https://www.cdc.gov/hai/pdfs/hai/scott_costpaper.pdf
9. Putri WCWS, Muscatello DJ, Stockwell MS, Newall AT. Economic burden of seasonal influenza in the United States. *Vaccine.* 2018;36(27):3960-3966.
10. Otter JA, Yezli S, Salkeld JA, French GL. Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. *Am J Infect Control.* 2013;41(5 Suppl):S6-S11.
11. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, Clostridium difficile, and Acinetobacter species. *Am J Infect Control.* 2010;38(5 Suppl 1):S25-S33.
12. N. Ide et al., “What’s on Your Keyboard? A Systematic Review of the Contamination of Peripheral Computer Devices in Healthcare Settings,” *BMJ Open*, 2019 Mar 8;9(3):e026437. <https://www.ncbi.nlm.nih.gov/pubmed/30852549>
13. Contamination of healthcare workers’ mobile phones by epidemic viruses. [https://www.clinicalmicrobiologyandinfection.com/article/S1198-743X\(15\)01034-4/fulltext](https://www.clinicalmicrobiologyandinfection.com/article/S1198-743X(15)01034-4/fulltext)
14. Investigation into the cleaning methods of smartphones and wearables from infectious contamination in a patient care environment (I-SWIPE). [https://www.ajicjournal.org/article/S0196-6553\(19\)30845-4/pdf](https://www.ajicjournal.org/article/S0196-6553(19)30845-4/pdf)
15. Danasekaran R, Mani G, Annadurai K. Prevention of healthcare-associated infections: protecting patients, saving lives. *Int J Community Med Public Health.* 2014;1(1):67-68.
16. World Health Organization. Report on the Burden of Endemic Health Care-Associated Infection Worldwide. WHO Press, WHO, Geneva, Switzerland: 2011.
17. Leas BF, Sullivan N, Han JH, Pegues DA, Kaczmarek JL, Umscheid CA. Environmental Cleaning for the Prevention of Healthcare-Associated Infections. Rockville, MD: Agency for Healthcare Research and Quality (US). August 2015 Report No.: 15-EHC020-EF. AHRQ Comparative Effectiveness Technical Briefs.
18. Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. *Clin Microbiol Rev.* 2014;27(4):665-690.
19. Ferguson C, et al., “The Wicked Problem of Patient Misidentification: How Could the Technological Revolution Help Address Patient Safety?” *J Clin Nurs*, 2019 July;28(13-14):2365-2368. <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jocn.14848>
20. Yadin D, Paperman WD. “Chapter 55 – Electromagnetic Interference in Healthcare Environment,” *Clinical Engineering Handbook (Second Edition)*, Academic Press, 2020, pp: 362-373. <https://www.sciencedirect.com/science/article/pii/B9780128134672000560>
21. U.S. Food and Drug Administration, “FDA/CDRH Recommendations for EMC/EMI in Healthcare Facilities,” *FDA.gov*, Accessed on 2/19/20: <https://www.fda.gov/radiation-emitting-products/electromagnetic-compatibility-emc/fdacdrh-recommendations-emcemi-healthcare-facilities>



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