

A Disposable Wireless Electrocardiogram Monitoring System Designed to Reduce Healthcare-associated Infections

a report by

Denise M Korniewicz, DNSc, RN, FAAN

Professor, and Senior Associate Dean, University of Miami School of Nursing and Health Studies

Today, healthcare-associated infections (HAIs) continue to have an impact on both reimbursement for healthcare providers (HCPs) and the way in which HCPs are held accountable for patient care. In spite of efforts to decrease the number of HAIs in acute care settings, an estimated 4.5 million patients are exposed to HAIs and 2.5 million patients develop HAIs in the US each year.¹ Annually, this results in 90,000 deaths and over \$5.7 billion dollars of additional healthcare costs.² HAIs are a major concern to infection control practitioners in acute care and outpatient settings. Adequate nurse staffing, compliance with proper hand hygiene, environmental factors associated with medical equipment, and improved surveillance of HAIs are strategies being used to improve patient care outcomes and reduce the incidence of HAIs. The purpose of this paper is to discuss infection control practices for the environment, provide evidence about electrocardiogram (ECG) lead wires and monitoring device systems (wireless versus non-wireless), and discuss innovative technologies that may reduce cross-contamination between monitored patients.

Prevention of HAIs in acute care facilities has been complex. Several studies^{3,4} have been conducted to demonstrate that the surfaces of medical equipment as well as surfaces in the general hospital environment can be associated with methicillin-resistant *Staphylococcus aureus* (MRSA) or other antibiotic-resistant pathogens. Malik et al.⁵ evaluated the efficacy of cleaning systems in the hospital by visual assessment, standardized microbiologic audits, and environmental monitoring. Microbiologic benchmarking was applied and demonstrated that although visual assessments were satisfactory, use of a rapid microbiologic audit system provided a better indicator for evaluating the cleanliness of equipment and surfaces. Others⁶ have suggested that design improvements in single beds, electronic records, and room layouts or using enhanced technological equipment (monitoring devices, standardization of equipment) would provide improved patient-centered safety, effectiveness, and efficiency, leading to quality patient care. Moreover, Sexton et al.⁷ have suggested that more effective methods of cleaning and decontaminating surfaces and equipment are imperative to eradicate MRSA and other HAIs.

Infection Control and Electrocardiogram Monitoring

An early study conducted by Soklaski⁸ demonstrated that cross-contamination occurred from patient to patient via a 12-lead electrocardiogram bulb, resulting in an outbreak of *Serratia marcescens* in a group of post-operative cardiac surgery patients. When disposable ECG leads were introduced, the issue was resolved. This report provides scientific evidence that the use of disposable equipment has a direct impact on reducing cross-contamination of pathogens from patient to patient when use of reusable equipment is ceased. Falk⁹ described a vancomycin-resistant

enterococci (VRE) outbreak in a burn unit when a contaminated ECG lead wire was used in a number of patients. Once the ECG lead wire was decontaminated or replaced, VRE was eradicated. More recently, Brookmeyer demonstrated that 77% of reusable ECG lead wires were contaminated for multidrug-resistant bacterial pathogens (MRSA, VRE) and could be a source of HAIs in hospitalized patients.¹⁰ The clinical outcomes associated with non-disposable ECG lead wires demonstrate that cross-contamination can occur between or among patients.

LifeSync Technology

One way to combat cross-contamination of ECG lead wires and enhance infection control practices is to develop innovative technologies that provide 'single use' and 'remote monitoring.' Both of these principles have been developed by LifeSync Corporation, which uses Bluetooth® technology to monitor patients without the need for 'tethered' lead wires. The Bluetooth wireless technology provides two-way communication between the patient and a monitor station and allows mobility of the patient both within and outside the immediate hospital unit. Other advantages include the radiolucency of the ECG electrodes, which allows patients to continue to be monitored while undergoing diagnostic procedures such as X-ray or fluoroscopy. Additionally, a 12-lead ECG can be completed while continuously monitoring the patient without attaching additional ECG wire leads. Using the LifeSync monitoring system has a direct impact on HAIs since the disposable system is used once only. HCPs do not need to attach or re-attach lead wires during the patient's hospital stay, nor do they need to clean or decontaminate re-usable lead wires. The disposable single-use lead wire feature also allows for decreased hand-to-skin contact by HCPs by eliminating the need to re-adjust monitoring leads during transport, diagnostic testing, or a 12-lead ECG.

Use of Wireless versus Non-wireless Monitoring for Infection Control

Currently, the new wireless (LifeSync Corporation, Fort Lauderdale, Florida) ECG lead wire monitoring system has demonstrated positive



Denise M Korniewicz, DNSc, RN, FAAN, is a Professor of Research and Assistant Dean at the University of Miami. She has written and presented extensively on the area of infection control and has received a number of professional awards recognizing her work in this field. Dr Korniewicz earned her DNSc from The Catholic University of America in 1986, followed by a post-doctoral fellowship in infection prevention at Johns Hopkins University in 1989.

E: dkorniewicz@miami.edu

results in a clinical setting. Patients who remain on 'hard-wired' ECG leads often experience mobility problems since HCPs have to provide monitors to transport patients and have to continuously connect or re-connect ECG wires when performing 12-lead ECG. Pilot data from several hospital personnel who have used the LifeSync wireless monitoring system have reported positive patient outcomes related to patient transport, improved infection rates associated with cross-contamination from MRSA or VRE, and increased patient satisfaction with mobility during diagnostic testing (cath labs, stress tests). One hospital administrator has reported that within six months of the implementation of the the LifeSync® LeadWear® Disposable, all central-line bloodstream infections were eliminated. Additionally, at the same hospital a cost saving of \$96,300 occurred during 2007 and an estimated saving of \$231,300 was projected for 2008 due to use of the LifeSync LeadWear Disposable.¹¹

Costs—Disposable versus Re-use

When new technology is introduced into a healthcare delivery system, the 'start-up' costs often include the need for new equipment, costs associated with educating HCPs, and clinical practice changes associated with patient safety policies. The use of re-usable hospital equipment had become the gold standard of choice because of the cost of the initial equipment and

If one new technology (lead wires) can reduce or eradicate the potential for a healthcare-associated infection, the long-term effects of implementing a disposable monitoring system would pay for themselves.

concern about environmental recycling, and also as a means to decrease the overall cost of healthcare.¹² However, today—in an era of concern about the cost of HAIs and future patient reimbursement for infections related to the urinary tract, surgical site, bloodstream, or pneumonia—administrators need to re-evaluate the use of single-use disposable equipment or re-using outdated equipment. Since an HAI increases the patient's length of hospital stay (9.5 days¹³), costs have been estimated to be an additional \$38,656 per patient.¹³ If one new technology (lead wires) can reduce or eradicate the potential for an HAI, the long-term effects of implementing a disposable monitoring system would pay for themselves.

Given the fact that in March 2008 the US Government Accountability Office recommended new reimbursement guidelines for HALs beginning in fall 2008, it seems logical that most hospital administrators will embrace new technologies that prevent or reduce HAIs.

Patient Safety

The use of a wireless monitoring system for hospitalized patients may have several patient safety advantages. These include:

- reduction in patient falls from tripping on 'hard wires' during transport or toileting;
- reduction in cross-contamination post-operatively since each unit is disposable and hand contact between HCPs and patients is minimized;
- increased patient mobility since patients do not have to worry about becoming 'tangled' in the equipment; and
- increased monitoring time since fewer 'leads' will become detached, thus decreasing false alarms.

The use of a wireless monitoring system may be one method to improve the overall clinical outcomes of monitored patients and enhance patient safety efforts within a hospital environment.

Future Platforms

Today, hospital administrators continue to strive to reduce the cost of patient care. Although the US healthcare industry has improved in terms of providing better clinical outcomes, HCPs continue to lack knowledge about the use of innovative technologies associated with monitoring patients, improving clinical data record-keeping, enhancing direct bedside care, providing virtual educational programs for patients or HCPs, and promoting systematic changes that influence patient safety measures. Perhaps future clinical information computer system platforms will be developed that allow the integration of patient data and assist HCPs to electronically record or obtain the data needed to reduce hospital stays, improve patient care outcomes, and promote prevention strategies both within and outside the hospital environment. Seamless systems of healthcare need to be developed to provide patients with information before, during, and after hospitalization so that they can be involved in their own healthcare needs. The future of the healthcare delivery system must embrace simple, proficient, and readily engineered technologies that improve the overall quality of patient care. ■

Disclosure

This project was supported by an educational grant from LifeSync Corporation, Fort Lauderdale, Florida (www.LifeSyncCorp.com).

1. Centers for Disease Control and Prevention, Guidelines for hand hygiene in health-care setting (No. RR-16), Atlanta: CDC, 2002;444.
2. Burke J, Infection control: a problem for patient safety, *N Engl J Med*, 2003;348(7):651–6.
3. Melzer M, Bain L, Drabu YJ, Rapid screening for MRSA: Preventing infections from cannulas reduces MRSA, *BMJ*, 2008;336(7653):1085–6.
4. Alfa MJ, Dueck C, Olson N, et al., UV-visible marker confirms that environmental persistence of *Clostridium difficile* spores in toilets of patients with *C. difficile*-associated diarrhea is associated with lack of compliance with cleaning protocol, *BMC Infect Dis*, 2008;8:64.
5. Malik RE, Cooper RA, Griffith CJ, Use of audit tools to evaluate the efficacy of cleaning systems in hospitals, *Am J Infect Control*, 2003;31(3):181–7.
6. Henriksen K, Isaacson S, Sadler BL, Zimring CM, The role of the physical environment in crossing the quality chasm, *Jt Comm J Qual Patient Saf*, 2007;33(Suppl 11):68–80.
7. Sexton T, Clarke P, O'Neill E, et al., Environmental reservoirs of methicillin-resistant *Staphylococcus aureus* in isolation rooms: correlation with patient isolates and implications for hospital hygiene, *J Hosp Infect*, 2006;62(2):187–94.
8. Sokalski SJ, Jewell MA, Asmus-Shillington AC, et al., An outbreak of *Serratia marcescens* in 14 adult cardiac surgical patients associated with 12-lead electrocardiogram bulbs, *Arch Intern Med*, 1992;152(4):41–4.
9. Falk PS, Winnike J, Woodmansee C, et al., Outbreak of vancomycin-resistant enterococci in a burn unit, *Infect Control Hosp Epidemiol*, 2000;21:575–82.
10. Jancin B, Antibiotic resistant pathogens found on 77% of ECG lead wires, *Cardiol News*, 2004;2:14.
11. Furtado D, Poster presentation: American Association of Critical Care Nurses National Teaching Institute, May 2008. Health-care associated infection in hospitals. (2008) U.S. Government Accountability Office March: #GAO-08-283.
12. Bush LM, Disposable items help prevent healthcare-acquired infections, *Infection Control Today*, 2005;6.
13. Zahn C, Miller MR, Excess length of stay, charges and mortality attributable to medical injuries during hospitalization, *JAMA*, 2003;290:1917–19.