Surgical Site Infections: A New Paradigm for Detection

When treatments lead to more problems, it's ironic for healthcare, distressing for doctors, and simply tragic for patients. No one wants to go into a hospital to get one problem addressed only to come out with something new to worry about. Infections acquired in healthcare facilities—healthcare-associated infections (HAIs)—are a typical example. No wonder, controlling and overcoming them has been a top priority of health systems around the world. Nevertheless, they represent a real and serious threat. Some of the most notorious among them are surgical site infections.

Undergoing surgery, irrespective of its nature, is a universally stressful experience for patients. It generates fear and anxiety. There are many doubts and questions: Will the medical team have everything under control? How long will it take for me to fully recover and get back to my daily routine? When can I rejoin my work?

An important question that often pops up in patients' minds is: Is it possible that my wound can get infected after surgery? That would be terrible.

Surgical site infections (SSIs) are infections that occur after surgery, in or near the wound created by the invasive surgical procedure. These may sometimes be superficial infections that involve the skin only, but in other cases, they may be more serious and affect the underlying tissues and organs. SSIs constitute a major portion of healthcare-associated infections all around the world.[1, 2]

The Staggering Burden of SSIs: Incidence, Morbidity, and Mortality

Despite major advancements in surgical practice, the development of surgical site infections remains a frequent complication after surgery. In a study conducted by the National Healthcare Safety Network (NHSN), information was collected on approximately 850,000 general surgeries performed across the United States. Data from the study revealed that the overall incidence of SSIs was around 1.9%.[3] According to the European Centre for Disease and Prevention Control (ECDC), SSIs accounted for 19.6% of all healthcare-associated infections in 2011-2012.[4]

SSIs are associated with significant morbidity and can cause considerable pain and discomfort to the patient. They put patients at a higher risk of developing secondary infectious complications and can increase the length of stay in the hospital, resulting in an increase in healthcare costs. Overall, SSI is considered to be the costliest type of healthcare-associated infection and additional average costs of approximately $20,000 per SSI have been reported. The main additional costs are related to extra nursing care and interventions, drug treatment costs, and re-operation. Moreover, the mortality risk is increased in patients with SSIs compared with those who do not develop them. SSIs account for almost 8% of all deaths resulting from a nosocomial infection and are implicated in one-third of all of postoperative deaths.[5]
SSIs not only hamper recovery after surgery but also affect patients psychologically by causing a significant amount of emotional distress. Prolonged recovery or chronic disability caused by

factors such as severe postoperative pain can contribute to the development of anxiety or depression in patients. It has been reported that patients who experience serious adverse events following a surgical procedure demonstrate higher levels of distress compared with people who go through bereavement or serious accidents.[6]

Early vs. Late Detection Makes All the Difference

A surgical site infection may develop at any time following surgery until the wound has healed, which usually takes up to a few weeks after the procedure. The timing of detection of an SSI following a surgical procedure has notable implications for treatment, as both the choice of subsequent treatment as well as the overall treatment success will depend on the duration of infection prior to the intervention.[7]

A delay in diagnosis has been associated with significant financial costs and worsened health outcomes. It has been estimated that more than half of the patients with delayed detection of an SSI require readmission to the hospital. Identification of an SSI in the early discharge period, on the other hand, enables outpatient treatment and prevents the need for readmission.[8]

Current Methods of Detection of SSIs

Calor, dolor, tumor, and rubor, that is, warmth, pain, swelling, and redness, respectively, are the **cardinal signs of inflammation** that physicians have relied on for thousands of years to follow the clinical course of a patient's injury. With time and appropriate supportive care, injuries heal and the inflammation resolves. However, when an injury gets infected, making the distinction between "normal" inflammation following injury and pathologic infection can be extremely challenging. This is because the same four signs are present in both inflammation and infection, and no clear markers have yet been identified that can indicate as to when these signs represent infection rather than inflammation.

One of the strategies used for the identification of SSIs is the determination of predisposing risk factors in patients. Multiple risk scores have been introduced, ranging from simple scores such as the National Nosocomial Infections Surveillance (NNIS) System which includes 3 predictors to complex scores like the Surgical Site Infection Risk Score (SSIRS) that involves 12 covariates and 4 interactions. However, the currently available methods are highly variable in their ability to identify SSIs accurately. These models are based on the consideration of baseline risk factors only and fail to incorporate a timely and proximate data source, i.e., the wound itself. Therefore, they are unable to provide a time-specific prediction of post-surgical infections.[5]

In addition to this, over 60% of surgical site infections have been found to develop after hospital discharge, which places the burden of problem recognition on the patients who are usually ill-prepared to deal with such situations.[9] During the hospital stay, wound dressings are routinely checked for any signs of infection. However, it is difficult to monitor these signs once patients leave the hospital. Signs of a surgical site infection may not always be recognized by the patient and a delay in seeking care may result in serious infection-related complications. Hence, despite the advancements in the diagnosis of infections, there is no definitive, instantaneous method available for the identification of an SSI.

Crely's Early Warning System—SSIs Meet Their Match

The gravity of the consequences associated with delayed SSI detection highlights the need for an effective diagnostic tool that can provide reliable, credible, and timely evidence of an imminent surgical site infection. Crely's Early Warning System (EWS) is just that—an AI-based system that can predict and detect the likelihood of developing an SSI using a self-contained and non-invasive wearable medical device.

The device is applied adjacent to the wound after surgery and continuously monitors biomarker and vital sign data for about 2 weeks while the patient is at home, providing real-time input to the surgeon or designated surrogate. Crely's early warning system is thus expected to predict the early onset of a surgical site infection and alert the surgeon to take action—even before the infection is suspected visually.

No one should suffer because of delayed detection of a surgical site infection. Such a delay can leave patients feeling disconnected from their doctors as well as physically and emotionally unsatisfied at a critical time in their recovery. Crely's Early Warning System is an innovative solution to detect and predict postoperative SSIs. It minimizes the risk of complications, drastically reduces healthcare costs, and provides patients undergoing surgery and their families peace of mind. In fact, it gives a lot of reassurance and confidence to healthcare providers too. It's not hard to imagine how such a device changes the paradigm with regard to SSIs.

References

1. Haque M, Sartelli M, McKimm J, Abu Bakar M. Health care-associated infections - an overview. *Infect Drug Resist*. 2018;11:2321–2333. Published 2018 Nov 15. doi:10.2147/IDR.S177247z
2. Owens CD, Stoessel K (2008) Surgical site infections: epidemiology, microbiology and prevention. *J Hosp Infect* 70 Suppl 2: 3-10. doi:10.1016/S0195-6701(08)60017-1
3. Carvalho RLR, Campos CC, Franco LMC, Rocha AM, Ercole FF. Incidence and risk factors for surgical site infection in general surgeries. *Rev Lat Am Enfermagem*. 2017;25:e2848. Published 2017 Dec 4. doi:10.1590/1518-8345.1502.2848
4. de Oliveira AC, Sarmento Gama C. Surgical site infection prevention: An analysis of compliance with good practice in a teaching hospital. *J Infect Prev*. 2017;18(6):301–306. doi:10.1177/1757177417703190
5. Sanger PC, van Ramshorst GH, Mercan E, et al. A Prognostic Model of Surgical Site Infection Using Daily Clinical Wound Assessment. *J Am Coll Surg*. 2016;223(2):259–270.e2. doi:10.1016/j.jamcollsurg.2016.04.046

6. Pinto A, Faiz O, Davis R, Almoudaris A, Vincent C. Surgical complications and their impact on patients' psychosocial well-being: A systematic review and meta-analysis. *BMJ Open*. 2016 Feb 16;6(2):e007224. doi: 10.1136/bmjopen-2014-007224
7. Lewis SS, Dicks KV, Chen LF, et al. Delay in diagnosis of invasive surgical site infections following knee arthroplasty versus hip arthroplasty. *Clin Infect Dis*. 2015;60(7):990–996. doi:10.1093/cid/ciu975
8. Gibson A, Tevis S, Kennedy G. Readmission after delayed diagnosis of surgical site infection: a focus on prevention using the American College of Surgeons National Surgical Quality Improvement Program. *Am J Surg*. 2014;207(6):832–839. doi:10.1016/j.amjsurg.2013.05.017
9. Woelber E, Schrick EJ, Gessner BD, Evans HL. Proportion of surgical site infections occurring after hospital discharge: a systematic review. *Surg Inf* 2016;17:510–519.

By Dr. Andrew Jeffers
Chief Medical Officer, Crely Healthcare