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# Performance of simplified surgical site infection (SSI) surveillance case definitions for resource limited settings: Comparison to SSI cases reported to the National Healthcare Safety Network, 2013–2017

**Matthew D. Westercamp, PhD**,

**Margaret A. Dudeck, MPH**,

**Kathy Allen-Bridson, MScPH**,

**Rebecca Konnor, MPH**,

**Jonathan R. Edwards, MStat**,

**Benjamin J. Park, MD**,

**Rachel M. Smith, MD**

Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Diseases, US Centers for Disease Control and Prevention (CDC), Atlanta, Georgia

## Abstract

Surgical site infections (SSIs) are among the most common healthcare-associated infections in low- and middle-income countries. To encourage establishment of actionable and standardized SSI surveillance in these countries, we propose simplified surveillance case definitions. Here, we use NHSN reports to explore concordance of these simplified definitions to NHSN as 'reference standard.'

Surgical site infections (SSIs) are among the most common healthcare-associated infections (HAIs) in low- and middle-income countries (LMICs) with an incidence >3 times higher than rates in developed nations.[1] SSIs result in longer patient hospital stays and greater healthcare costs.[2] Because many SSIs are preventable, this increased burden is avoidable in many LMIC settings.

The CDC National Healthcare Safety Network (NHSN) SSI surveillance methodology and case definitions have been designed to support quality improvement efforts within US hospitals and fulfill US regulatory requirements. Although NHSN case definitions have become a de facto gold standard for use internationally, limited resources and differing regulatory contexts limit the appropriateness of NHSN methods and case definitions outside the United States. Where limited technical, structural, and material resources hamper even basic HAI surveillance, NHSN methodology requires substantial simplification and modification for missing definition requirements for feasible implementation. The resulting

**Author for correspondence:** Matthew D. Westercamp, mwestercamp@cdc.gov.

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differences limit comparability between systems and can promote inappropriate comparison to published NHSN metrics.

To encourage the establishment of simple, actionable, and standardized SSI surveillance in LMIC settings, we developed an SSI surveillance strategy using simplified SSI surveillance case definitions. To better understand the usefulness of these definitions, we took advantage of available NHSN reports to provide a novel exploration of concordance of our proposed simplified definitions to NHSN as a 'reference standard.'

## Methods

We defined 2 simplified, non–laboratory-based case definitions. Cases were defined as postoperative patients with (1) wound purulence or painful, spreading inflammation (redness, swelling, warmth) surrounding the surgical site with evidence of fever in the 30 days following surgery (ie, symptom based); or (2) wound purulence or purposeful reopening of the surgical wound in the 30 days following surgery (ie, operation based).

Both definitions limit complexity by excluding depth of infection and restricting inputs to observable, objective criteria. Definitions were based on those proposed by the WHO,[3] the UK National Prevalence Survey Study (NPS),[4] the UK Surgical Infection Study Group (SISG),[5] and in consultation with experienced surgeons providing service in LMIC for review and comment.[6]

Proposed definitions were compared to data reported to the NHSN Patient Safety Component Procedure-Associated Module for the years 2013–2017, restricted to in-plan facilities.[7] Elements of interest included the event criteria reported for each case, the type of surgical procedure performed, depth of infection, physician diagnosis, and laboratory findings. Only data from reported NHSN cases were available.

We described concordance for the entire dataset (all surgical procedures) and separately for cesarean birth because this procedure is a commonly performed surgical procedures and is a focus of surveillance in many LMICs. Percent agreement (PA) was defined as the proportion of SSI cases reported to NHSN captured by each simplified definition.

## Findings

Between 2013 and 2017, the NHSN database contained 215,729 SSI case reports available for analysis. Of these 215,729 SSI case reports, 155,020 met the symptom-based case definition (PA, 72%) and 172,497 met the operation-based case definition (PA, 80%). Restricting the results to the 9,897 infections after cesarean birth, the symptom-based case definition identified 6,688 cases (PA, 68%) and the operation-based case definition identified 6,731 cases (PA, 68%). The PAs of each definition element and the impact of adding physician diagnosis, pathogen isolation, and wound dehiscence are provided in Table 1.

Of the 60,709 NHSN-reported infections that did not meet the symptom-based definition, 22,825 (38%) were diagnosed by a physician, 45,662 (75%) had an organism identified on culture, and 3,544 (6%) had radiologic evidence of infection. Of the 45,351 infections that

did not meet the operation-based definition, 15,849 (35%) were diagnosed by a physician, 32,852 (72%) had an organism identified on culture, and 4,993 (11%) had radiologic evidence of infection. Restricting the results to the 3,209 postcesarean infections that failed to meet the symptom-based definition, 1,813 (57%) were diagnosed by a physician, 2,118 (66%) had an organism identified by culture, and 37 (1%) had radiologic evidence of infection. Of 3,233 postcesarean infections missed by the operation-based infection, 1,692 (52%) were diagnosed by a physician, 1,714 (53%) had a positive culture, and 117 (4%) had radiographic evidence of infection.

The symptom-based definition was able to identify 104,180 (79%) of the 131,874 severe infections (deep or organ space), and the operation-based definition identified 107,191 (81%) of these severe infections. Limiting to infections after cesarean birth, 89% of severe infections were captured by the symptom-based definition, and 65% were captured by the operation-based infection. The proportion of infections identified by depth of infection is provided in Table 2.

## Discussion

In resource-limited settings such as LMICs, sustainable surveillance implementation generally requires increased dedicated resources and/or methods to reduce resource burden. Because increased resources are often challenging, we present an early validation of simplified SSI surveillance case definitions to reduce system complexity or burden and support more universally feasible SSI and HAI surveillance.

Using a large set of SSIs reported to the NHSN, we tested the ability of 2 simplified surveillance case definitions to identify reported infections. For all infections, purulence alone identified 69% of SSIs, with pain and/or redness and/or swelling identifying an additional 3% and “wound reopened” identifying an additional 10%. For cesarean births, purulence identified 60% of SSIs, pain and/or redness and/or swelling identified an additional 8%, and “wound reopened” identified an additional 7%. Generally, our simplified definitions had improved agreement with NHSN in more severe infections. A notable exception was the relatively poor agreement observed for the operational-based definition in organ-space infections (Table 2).

Our findings provide evidence for the limits of SSI/HAI surveillance that does not consider microbiologic findings. As many as 75% of infections not captured would have been identified if microbiologic data were considered. Although we acknowledge the critical importance of microbiology in guiding clinical treatment and appropriate antibiotic use, many facilities in LMICs lack access to quality microbiology, which highlights the need for feasible HAI surveillance strategies that provide immediately actionable results without microbiologic infrastructure. With appreciation of the inherent limitations, the simplified definitions proposed, if used systematically and appropriately, can allow appreciation of a consistent and meaningful proportion of infections to help guide and monitor IPC activities.

Several important limitations should be appreciated in consideration of our findings. Reliance on infections reported to the NHSN allows no appreciation of possible over-

or under-identification of infections. Additionally, nuances in NHSN reporting may have affected our assessment in ways that could not be well controlled. Specifically, the NHSN does not capture a fever-symptom for superficial infections, which likely limited the agreement of our symptom-based definition and NHSN-reported superficial infections. Finally, the impact of excluding physician diagnosis is highly physician and context dependent and is difficult to generalize.

The NHSN is the most widely used HAI tracking system in the United States, and the value provided to stakeholders is substantial. However, relying on NHSN definitions and methods in non-US limited-resource settings may decrease system efficiency in those settings and limit the value of surveillance results. In settings where gaps in evidence-based infection prevention and control are recognized, direct action to address those practices should be prioritized. However, where evidence and surveillance are required to guide or justify prevention, HAI surveillance must balance system requirements to the benefit the information will provide. Here, we have presented 2 definitions that offer reasonable agreement with the NHSN despite considerable simplification. Along with efforts to build microbiology capacity, further development and validation of HAI surveillance definitions and methods specifically addressing performance and feasibility in limited-resource settings should be prioritized.

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**Table 1.**

Percent Agreement for Symptom-Based and Operation-Based Definitions by Definition Elements for All SSI Infections and Restricted to Infections After Cesarean Birth—National Healthcare Safety Network, 2013–2017

| | All Infections | | | Cesarean Section Only | | |
|---|---|---|---|---|---|---|
| **Definition Elements** | **PA Element, %[a]** | **Symptom,[b] PA Added, %[c]** | **Operation,[d] PA Added, %[e]** | **PA Element, %[a]** | **Symptom,[b] PA Added, %[c]** | **Operation,[d] PA Added, %[e]** |
| Sensitivity of full definition | NA | 72 | 79 | NA | 68 | 67 |
| **Evidence of purulence** | 69 | 69 (base) | 69 (base) | 60 | 60 (base) | 60 (base) |
| Pain + fever | 11 | 72 | NA | 14 | 68 | NA |
| Redness + fever | <1 | 72 | NA | 0 | 68 | NA |
| Swelling + fever | <1 | 72 | NA | 0 | 68 | NA |
| Wound reopened | 28 | NA | 79 | 23 | NA | 67 |
| **Other elements** | **PA Element, %** | **Symptom PA Including, %** | **Operation PA Including, %** | **PA Element, %** | **Symptom PA Including, %** | **Operation PA Including, %** |
| Physician diagnosis | 33 | 82 | 86 | 50 | 86 | 84 |
| Organism identified | 76 | 93 | 94 | 63 | 89 | 85 |
| Radiologic evidence | 14 | 74 | 81 | 5 | 68 | 69 |

Note. SSI, surgical site infection; PA, percentage agreement; NA, not available.

[a]The percent agreement of infection detection of listed element only.

[b]Symptom-based definition: wound purulence or painful, spreading inflammation (redness, swelling, warmth) surrounding the surgical site with evidence of fever in the 30 d following surgery.

[c]The percent agreement of infection detection of the listed element plus definition elements listed previously.

[d]Wound purulence or purposeful reopening of the surgical wound in the 30 d following surgery.

[e]The percent agreement of infection detection of listed element plus the full symptom-based case definition.

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**Table 2.**

Proportion of Infections Identified by Depth of Infection for All Surgical Site Infections and Infections After Cesarean Birth Only by Simplified Symptom-Based and Operation-Based Case Definitions, National Healthcare Safety Network, 2013–2017

| | All Infections | | | C-section Only | | |
|---|---|---|---|---|---|---|
| **Infection Depth** | **Total No.** | **Symptom-Based Infection, %** | **Operation-Based Infection, %** | **Total No.** | **Symptom-Based Infection, %** | **Operation-Based Infection, %** |
| Superficial[a] | 81,097 | 61 | 76 | 7,217 | 60 | 68 |
| Deep tissue[b] | 47,507 | 75 | 91 | 1,113 | 85 | 90 |
| Organ space[c] | 84,367 | 81 | 76 | 1,564 | 92 | 47 |

[a]Infection involves only skin and subcutaneous tissue of the incision.

[b]Infection involves deep soft tissues of the incision (for example, fascial and muscle layers).

[c]Infection involves any part of the body deeper than the fascial/muscle layers, that is opened or manipulated during the operative procedure.

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