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Major Article

Taking advantage of public reporting: An infection composite score to assist evaluating hospital performance for infection prevention efforts

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Key Words:
Health care–associated infection
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Background: The standardized infection ratio (SIR) evaluates individual publicly reported health care–associated infections, but it may not assess overall performance.

Methods: We piloted an infection composite score (ICS) in 82 hospitals of a single health system. The ICS is a combined score for central line–associated bloodstream infections, catheter-associated urinary tract infections, colon and abdominal hysterectomy surgical site infections, and hospital-onset methicillin-resistant *Staphylococcus aureus* bacteremia and *Clostridium difficile* infections. Individual facility ICSs were calculated by normalizing each of the 6 SIR events to the system SIR for baseline and performance periods (ICS_{ib} and ICS_{ip}, respectively). A hospital ICS_{ib} reflected its baseline performance compared with system baseline, whereas a ICS_{ip} provided information of its outcome changes compared with system baseline.

Results: Both the ICS_{ib} (baseline 2013) and ICS_{ip} (performance 2014) were calculated for 63 hospitals (reporting at least 4 of the 6 event types). The ICS_{ip} improved in 36 of 63 (57.1%) hospitals in 2014 when compared with the ICS_{ib} in 2013. The ICS_{ib} 2013 median was 0.96 (range, 0.13-2.94) versus the 2014 ICS_{ip} median of 0.92 (range, 0-6.55). Variation was more evident in hospitals with ≤100 beds. The system performance score (ICS_{sp}) in 2014 was 0.95, a 5% improvement compared with 2013.

Conclusions: The proposed ICS may help large health systems and state hospital associations better evaluate key infectious outcomes, comparing them with historic and concurrent performance of peers.

Hospitals, health systems, many state hospital associations, and quality improvement networks struggle in evaluating their performance for the Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN) publicly reported infection measures outcomes.[1,2] Many health care–associated infections (HAIs) are publicly reported, and some are tied to the Centers for Medicare and Medicaid Services (CMS) hospital-acquired conditions penalty and value-based purchasing programs.[3,4] Although the standardized infection ratio (SIR) adjusts for patient and hospital characteristics, it does not evaluate a hospital's performance compared with others concurrently.[5] Hospitals may benefit from having a single composite score that evaluates their performance to previous periods and compares them with other hospitals in real time. In addition, health systems and state hospital associations involved in improving outcomes related to infectious events may be able to identify hospitals that are underperforming in general, not only those that underperform for specific event types. We evaluated an infection composite score (ICS) over 2 consecutive years in a large U.S. health care system.

METHODS

We piloted an ICS based on publicly reported HAI outcome measures in 82 hospitals from a single health system for years 2013 and 2014. The ICS was calculated as a combined score reflecting the SIRs for CDC's NHSN-defined central line–associated bloodstream infection (CLABSI) and catheter-associated urinary tract infection (CAUTI) in adult intensive care units, inpatient colon and abdominal hysterectomy surgical site infections, and inpatient facility-wide hospital-onset methicillin-resistant *Staphylococcus aureus* bacteremia and *Clostridium difficile* infection (CDI).

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The ICS normalizes each of the 6 SIR events to the system aggregate SIR and results in a single (mean) SIR. Each of the 6 events is given the same weight when calculating the ICS. An individual facility ICS (ICS_i) is calculated based on the following formula:

$$ICS_i = \frac{1}{n}\sum_{j}^{n}\left(\frac{O_{ij}E_{sj}}{E_{ij}O_{sj}}\right) = \frac{1}{n}\sum_{j}^{n}\left(\frac{SIR_{ij}}{SIR_{sj}}\right),$$

where j represents the type of event, i represents the facility, s represents the system, and n represents the 6 types of events included. In addition, O_{sj} represents the observed number of events for the system, O_{ij} represents the observed number of events for the facility, E_{sj} represents the expected number of events for the system, E_{ij} represents the expected number of events for the facility, SIR_{sj} represents the system SIR for a particular measure, and SIR_{ij} represents the facility SIR for a particular measure.

ICS_i is calculated comparing the individual facility with the system for a period of time, where it is the same period for baseline ICS (ICS_{ib}), where

$$ICS_{ib} = \frac{1}{n}\sum_{j}^{n}\left(\frac{SIR_{ibj}}{SIR_{sbj}}\right),$$

or different periods for performance period ICS (ICS_{ip}) ,where

$$ICS_{ip} = \frac{1}{n}\sum_{j}^{n}\left(\frac{SIR_{ipj}}{SIR_{sbj}}\right),$$

evaluating a facility performance compared with a previous period using the system baseline period as a reference. A facility $ICS_{ib} > 1$ reflects worse outcomes compared with the system baseline, whereas $ICS_{ip} > 1$ indicates worse outcomes than the system baseline for the performance period. A facility's performance is better than the system if the score is <1. $ICS_{ib} = 1$ or $ICS_{ip} = 1$ represent similar outcomes for the facility compared with the system for the period evaluated.

System change may also be calculated using the following formula:

$$ICS_{sp} = \frac{1}{n}\sum_{j}^{n}\left(\frac{SIR_{spj}}{SIR_{sbj}}\right),$$

where j represents the type of event, b represents the baseline outcomes, p represents the performance period outcomes, and s represents the system. In addition, SIR_{spj} represents the system SIR for a particular measure during performance period, and SIR_{sbj} represents baseline system SIR for a particular measure. A system ICS_{sp} >1 reflects worse outcomes compared with its baseline period, whereas a ICS_{sp} <1 indicates improved system outcomes compared with the baseline period. $ICS_{sp} = 1$ represents similar outcomes for the baseline and performance periods (system ICS_{sb} baseline period being set at 1). The study received exemption by the St John Hospital & Medical Center Institutional Review Board as a quality improvement project.

RESULTS

A total of 3,919 and 3,965 events occurred in 2013 and 2014, respectively (Table 1). There was a 14.1% increase in the aggregate system hospital-onset CDI event SIR, affected by adopting more sensitive testing methods (molecular instead of toxin only) in many of the facilities.[6] On the other hand, system CAUTIs showed the greatest improvement (−15.2%), followed by abdominal hysterectomy surgical site infection (−11.4%), CLABSI (−10.3%), methicillin-resistant *S aureus* infection (−6.2%), and colon surgical site infection (−1.0%). Noteworthy is the number of hospital-onset laboratory-identified CDI events, which represented 57.4% in 2013 and 63.1% in 2014 of the 6 publicly reported HAIs. CDI, because of its high prevalence, would have disproportionately affected the overall outcomes had we not assigned equal weight to the different types of infectious events.

Out of 82 facilities reporting for the years 2013 and 2014, 57 reported data on the 6 HAIs for both years, 2 reported 5 events, 4 reported 4 events, and 19 facilities reported ≤3 event types yearly. We included those that reported at least 4 event types when evaluating the ICS each year. We calculated each facility ICS_i for 2013 (ICS_{ib}) and 2014 (ICS_{ip}) normalized to the system 2013 baseline. The ICS_{ib} and ICS_{ip} for all the hospitals are shown in Figure 1 by descending order according to 3 groups of hospital bed size. For example, considering the facility-level ICS evaluation for our facilities with >300 beds (Fig 1A), hospitals 57, 61, 5, 36, 4, 60, and 74 demonstrate substantial improvement from their baseline ICS. Hospitals 24, 16, 90, and 14 show notable decline in performance, with the remaining hospitals showing lesser degrees of change. From a quality improvement perspective, this provides a rapid evaluation of changes in performance of individual hospitals over 2 periods. The ICS_{ip} improved in 36 of 63 (57.1%) hospitals in 2014 when compared with the ICS_{ib} in 2013. The ICS_{ib} 2013 median was 0.96 (range, 0.13-2.94) versus the 2014 ICS_{ip} median of 0.92 (range, 0.0-6.55) ($P = .71$). Variation was more evident in hospitals with ≤100 beds (Table 2). Although smaller hospitals had a lower median ICS, they had the widest range and largest SEM when compared with hospitals 101-300 beds or >300 beds in size. The variation that smaller hospitals exhibited is reflective of the impact of a few events on their overall scores (Fig 1C and Table 2), a finding that is less prominent in larger and medium size hospitals (Fig 1A and Fig 1B, Table 2). Finally, the system performance ICS_{sp} in 2014 was 0.95, a 5% improvement compared with 2013.

DISCUSSION

We have evaluated an ICS to assess changes in outcomes for 6 different publicly reported infections to the CMS. The ICS has the

Table 1
Proportion of health care–associated infection events for 63 hospitals over the 2 periods of 2013 and 2014

Type of event	Observed events, 2013	Expected events, 2013	System SIR, 2013	Observed events, 2014	Expected events, 2014	System SIR, 2014	Change in SIR (%) (2014 vs 2013)
CLABSI	171	440.4	0.39	151	431.2	0.35	−10.3
CAUTI	693	555.3	1.25	562	529.5	1.06	−15.2
CDI	2,250	2,641.5	0.85	2,500	2,580.1	0.97	+14.1
MRSA	252	258.7	0.97	235	259.5	0.91	−6.2
SSI-Colo	427	437.8	0.98	405	417.9	0.97	−1.0
SSI-Hyst	126	142.5	0.88	112	144.2	0.78	−11.4

CAUTI, catheter-associated urinary tract infections in adult intensive care units; *CDI*, *Clostridium difficile* infection; *CLABSI*, central line–associated bloodstream infection in adult intensive care units; *MRSA*, inpatient facility-wide hospital-onset methicillin-resistant *Staphylococcus aureus* bacteremia; *SIR*, standardized infection ratio; *SSI-Colo*, inpatient colon surgical site infections; *SSI-Hyst*, abdominal hysterectomy surgical site infections.