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Major Article

Health care–associated infection surveillance system in Iran: Reporting and accuracy

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Background: Valid data are a crucial aspect of infection prevention and control programs. The aim of this study was to examine the accuracy of routine reporting in the Iranian Nosocomial Infection Surveillance System in intensive care units.

Methods: A blinded retrospective review of general intensive care unit medical records was performed with a standard case-finding form. Infection control nurses (ICNs) were also interviewed to explore possible reasons for differences.

Results: The results of 951 events in 856 medical records were assessed. Sensitivity, specificity, and positive and negative predictive values of routine surveillance were 27.5%, 97.2%, 69%, and 85.3%, respectively. The results indicate 82.2%, 68.4%, 62.7%, and 57.3% under-reporting of surgical site infections, urinary tract infections, bloodstream infections, and pneumonia, respectively. Over-reporting of approximately 8%-15% was detected in 4 types of health care–associated infections (HAIs). Misinterpretation of HAI definition, high ICN workload, and inactivity of infection control link nurses were the main causes of inaccurate reporting.

Conclusions: Under and over-reporting of HAIs are main challenges of HAIs reporting in Iran. Developing guidelines, empowering ICNs through specialized training and activating infection control link nurses are necessary to achieve more accurate data in the Iranian Nosocomial Infection Surveillance System.

Health care–associated infections (HAIs) are one of the main challenges of patient safety in health care organizations.[1,2] These infections lead to an increase in illness, mortality, cost, and length of hospitalization.[3,4] Approximately 10% of patients admitted to intensive care units (ICUs) are diagnosed with at least 1 infection.[5,6] These patients are at higher risk of acquiring HAIs associated with the use of invasive devices.[7-9] It has been estimated that 30%-70% of HAIs are generally preventable.[10,11]

Surveillance of HAIs is one of the core components of infection prevention and control (IPC) programs.[12] In this regard, the Iranian Nosocomial Infection Surveillance System (INIS) was established in 2007.[1,5] According to a national report based on INIS data, the rate of HAIs was reported to be 1.18% in 2015.[5] However, based on previous studies, the rate of HAIs in developing countries should be >25%.[13,14] Low reporting and inadequate documentation have been reported as 2 of the serious weaknesses of the HAI surveillance system in Iran.[15-17] As a result, in light of the mentioned issues, there are considerable concerns regarding data accuracy after a decade of INIS implementation.[5,14,17]

The accuracy and reliability of the surveillance system data play an important role in infection surveillance programs.[14,18,19] Moreno

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et al[20] showed the rate of HAIs was 3-5 times higher than that demonstrated by routine reporting systems in ICUs. In another study, the actual rate of HAIs was 3 times higher than what had been reported.[21] Backman et al[22] also referred to low reporting of central line–associated bloodstream infections (CLABSIs), which were under-reported >50% of the time. Several authors have attempted to show that the accuracy of routine reporting is questionable and should be evaluated.

The lack of accuracy in HAI reporting has serious consequences, including absent or incomplete treatment of infectious patients, poor quality of patient care, transmission of HAIs to other patients, decision- and policy-making based on incomplete information, and failure of hospital IPC programs.[22-24]

The HAI reporting system in Iran is generally considered to have an issue with under-reporting. There is a scarcity of data on the validity, accuracy, and predictive values of INIS statistics. The goal of this study was to evaluate the sensitivity, specificity, and predictive values of HAIs in the ICU component of INIS.

METHODS

This retrospective study was conducted in 2017 at 6 general ICUs (GICUs) of public and private hospitals affiliated with Tehran University of Medical Sciences in Iran. The retrospective approach has been introduced in several studies as a standard method of validating surveillance systems of HAIs.[4,24,25] The sample size calculations were based on HAI prevalence in ICUs (mean, 10%).[7,25] The total sample size was estimated to be 856 medical records. Proportionate stratified random sampling was used to select medical records. First, the GICUs were categorized into HAIs of <10%, 10%-20%, and >20% based on annual HAI surveillance reporting data, which are provided by the Iranian Center for Communicable Diseases Control (ICDC). These data are accessible to each infectious disease specialist who is a member of the hospital infection control team. The research team could use the data after the agreement of the ICDC. Second, 2 hospitals were randomly selected from each stratum (6 hospitals in total). Finally, the medical records were proportionally selected from the patients admitted to GICUs of each hospital from June 22 to September 22, 2016. Inclusion criteria for medical records were admission and discharge dates, medical history, nursing report, and progress note.

Data were collected using a standard form that was prepared and approved by ICDC. This form has also been used for HAI case-finding (Appendix 1). The form includes the following items: full name, medical record number, national identification number, primary and final diagnoses, dates of admission and discharge, admission ward, invasive procedures and dates, surgeries and locations and dates, signs and symptoms of the 4 main infections—pneumonia, urinary tract infection (UTI), bloodstream infection (BSI), and surgical site infection (SSI)—individually, history of cultures and results, radiology findings, and prescribed antibiotics and changes. First names and surnames of patients were deleted from the form to protect patient anonymity. The form was completed by reviewing medical history, progress note, nursing note, laboratory results, and report of stereotyped imaging (if available).

First, to assess inter-rater agreement between reviewers (L.R. and V.G.), 20 medical records were assessed by both. Cohen's kappa correlation coefficient was 86%. Medical records were then assessed by reviewers individually. Second, to diagnose HAI events, evaluators (A.S. and L.R.) checked all completed forms using Centers for Disease Control and Prevention (CDC) case definition criteria for HAIs. Third, evaluators compared the types and numbers of HAIs that were detected by them and reported by infection control nurses (ICNs) in routine surveillance systems for each medical record. The reviewers and evaluators were blinded to patients' HAI status in these surveillance systems until comparison. Finally, after analyzing the data, the ICN responsible for HAI case-finding and reporting in each hospital was interviewed about case-finding methods and causes of discordance. The main questions of the interview were the following: "How do you find HAI cases in your hospital wards?" and "What are the main possible causes of inaccurate reporting (over- and under-reporting) of HAIs in your hospital?"

Data analysis

Types and numbers of HAIs for each medical record, identified by research team and reported in INIS. Data were analyzed using SPSS 16.0 software (SPSS Inc, Chicago, IL). True positives, true negatives, false positives, and false negatives of routine surveillance were calculated by choosing evaluators' results based on CDC case definition criteria for HAIs. Then, the sensitivity, specificity, and predictive values of routing surveillance data were calculated. McNemar's test was also used to compare the number of HAIs reported by ICNs and evaluators. Interviews were transcribed and analyzed using the content analysis approach: (1) dividing texts into meaning units, (2) condensing and labeling meaning units with codes, and (3) sorting codes into categories based on similarities and differences.

RESULTS

In terms of sex, the proportions of men (52.9%) and women (47.1%) were nearly equal. The average length of stay was 4.73 ± 7.21 days. Overall, 574 of the patients enrolled (57.1%) were cases of surgery; other patients (42.9%) were nonsurgery cases (internal, poisoning, neurology, cardiovascular).

Using 856 medical records, 951 events were assessed. The difference between the number of medical records and events is a result of some patients having 2 or more events. Of the 71 HAIs reported by ICNs, 49 events were confirmed by the evaluators (ie, true-positive events). Twenty-two HAIs reported by ICNs were incompatible with HAI definitions (ie, false-positive events). Evaluators also detected 129 new HAI events (ie, false-negative events) (Table 1). Among the false-negative events, 84 had not had any diagnostic workup, or workup was incomplete, and 45 had a diagnostic workup but were not reported as HAIs by ICNs. The overall sensitivity and specificity of routine surveillance were 27.5% and 97.2%, respectively. The overall positive predictive value was 69%, and the overall negative predictive value was 85.3%.

Of 51 cases compatible with BSI definitions, 32 were not reported by ICNs. ICNs also reported 6 cases that did not fulfill CDC criteria for BSI. Of the BSI cases, 62.7% were false negatives and 11.8% were false positives (Table 2). McNemar's test showed significant differences between ICN and evaluator reports ($P < .001$). Fifteen cases of SSI (82.2%) were false negatives and 2 (11.8%) were false positives (Table 3). False-positive cases of SSI had infection at time of admission to the ICU. There was a significant difference between ICN and evaluator reports of SSI ($P < .003$).

Table 1
Comparison of evaluated events by evaluators and reported events by ICNs

		ICN reports		Total
		HAIs+	HAIs⁻	
Evaluator reports	HAIs+	49 (5.2)	129 (13.6)	178 (18.8)
	HAIs⁻	22 (2.3)	751 (78.9)	773 (81.2)
Total		71 (7.5)	880 (92.5)	951 (100)

NOTE. Values are presented as N (%).
HAI, health care–associated infection; *ICN*, infection control nurse.

Table 2
Comparison of BSIs reported by ICNs and evaluators

		ICN reports		Total
		No	Yes	
Evaluator reports	No	0 (0)	6 (11.8)	6 (11.8)
	Yes	32 (62.7)	13 (25.5)	45 (89.2)
Total		32 (62.7)	19 (37.3)	51 (100)

NOTE. Values are presented as n (%).
BSI, bloodstream infection; *ICN*, infection control nurse.

Table 3
Comparison of SSIs reported by ICNs and evaluators

		ICN reports		Total
		No	Yes	
Evaluator reports	No	0 (0)	2 (11.8)	2 (11.8)
	Yes	15 (82.2)	0 (0)	15 (88.2)
Total		15 (82.2)	2 (11.8)	17 (100)

NOTE. Values are presented as n (%).
ICN, infection control nurse; *SSI*, surgical site infection.

Evaluators found 43 (57.3%) new cases of pneumonia (Table 4). Only 6 cases of pneumonia reported by ICNs did not fulfill diagnostic criteria of HAIs. McNemar's test showed a significant difference between ICNs and evaluators with respect to pneumonia ($P < .000$).

Regarding UTI, 39 new cases (false negatives) were detected by evaluators, and ICNs mistakenly reported 8 cases (Table 5). McNemar's test revealed significant differences between ICN and evaluator reports in cases of UTI (false positives) ($P < .000$). HAI case-finding methods and causes of inaccurate reporting:

According to the semistructured interviews, checking laboratory results (6 of 6), daily visits to ICUs (4 of 6), weekly or monthly checking of other wards (6 of 6), and receiving reports from infection control link nurses (ICLNs) (3 of 6) were the most common HAI case-finding methods. ICNs filled out a standard case-finding form for each case of HAI that was found by them or by ward notification.

ICNs (4 of 6) explained that one of the possible reasons behind poor case-finding could be high workload. Most participants (4 of 6) were both clinical supervisor and ICN. As a result, ICNs did not have enough time for ward visits and checking medical records of patients to find possible cases of HAIs. According to an ICN in a private hospital, "In our hospital, usually one person is in several positions; for example, I'm not just an infection control nurse. In some shifts, I do the tasks of an ICN and a clinical supervisor or hospital nursing manager simultaneously. Eventually, this multitasking led to disruption in my focus on infection control programs."

Moreover, ICNs experienced difficulties in interpreting BSI case definitions. Two of them explained they reported every positive blood culture as a BSI. Half of participants expressed that when there is a similar microorganism in a blood culture and another site's culture simultaneously, they have doubts as to whether it is a BSI. Most ICNs (4 of 6) stated that to develop their knowledge regarding such complicated cases, they need continuous training and to participate in seminars and conferences related to HAIs. According to an ICN in a government hospital, "My previous colleague reported all positive cultures as an HAI, but actually they were not an HAI. For example, a patient was hospitalized with an infection's sign. His cultures were positive. My colleague reported it as an HAI. At the beginning of my work as an ICN, I also reported all positive blood cultures as a BSI. After attending some meetings and seminars, I realized that other factors had to be considered. I think ICNs need specialized training at the beginning of their work as an ICN."

Table 4
Comparison of pneumonia reported by ICNs and evaluators

		ICN reports		Total
		No	Yes	
Evaluator reports	No	0 (0)	6 (8)	6 (8)
	Yes	43 (57.3)	26 (34.7)	69 (92)
Total		43 (57.3)	32 (42.7)	75 (100)

NOTE. Values are presented as n (%).
ICN, infection control nurse.

Table 5
Comparison of UTIs reported by ICNs and evaluators

		ICN reports		Total
		No	Yes	
Evaluator reports	No	0 (0)	8 (14)	8 (14)
	Yes	39 (68.4)	10 (17.5)	49 (86)
Total		39 (68.4)	18 (31.6)	57 (100)

NOTE. Values are presented as n (%).
ICN, infection control nurse; *UTI*, urinary tract infection.

Inactivity of ICLNs in most wards was another problem expressed by ICNs. It was mentioned that ICNs did not receive any active reports from ICLNs about HAIs. According to participants' narrations, most ICLNs, in addition to caring for patients, have several other responsibilities. For example, they can be ICLNs, patient safety link nurses, and patient education link nurses simultaneously, but they are not paid for these additional responsibilities. According to an ICN in a teaching hospital, "Nowadays, each ward has an infection control link nurse. They may be the patient's safety link nurse or education link nurse as well. . . . Although our ICLNs have acceptable knowledge regarding HAI types, their collaboration is poor. They are not motivated to collaborate. Our hospital is crowded. The number of patient hospitalizations and discharges is high. Therefore, the infection link nurse has no additional time to perform infection control–related tasks during her/his patients' care. Moreover, there is no financial motivation if she/he wants to do these delegated tasks."

DISCUSSION

Surveillance of HAIs is one of the essential aspects of an IPC program. Examining the accuracy of surveillance results is strongly suggested.[21,26] Our study provides further evidence of the inaccuracy of routine surveillance of HAIs, which has been reported as a major concern of INIS in previous studies.[5,15,17]

The overall sensitivity and specificity of routine surveillance were 27.5% and 97.2%, respectively. Masia et al[27] revealed that sensitivity and specificity of routine ICU surveillance for all types of infections were 82% and 97.2%, respectively. Zuschneid et al[28] indicated reporting of BSI and lower respiratory tract infection in ICUs had sensitivity of 66% and specificity of 99.4%. Although the specificity of routine surveillance of HAIs in INIS is consistent with previous validation studies, the sensitivity is significantly lower than other validation investigations. Based on the interviews, ICNs experience a high level of discontinuity in the execution of IPC tasks because of high workload and multitasking. Unclear job descriptions and responsibilities and lack of sufficient time can negatively affect ICNs' performance.[26] The ICLN program is an initiative that is implemented to enhance the quality of HAI data gathering in each ward, ICNs complained that ICLNs are inactive and collaborate little in case-finding and HAI reporting. It is not surprising that case-finding and reporting programs, which are the main responsibilities of ICNs, are not fully and properly implemented.

The overall negative predictive value of 85.3% indicated an under-reporting of HAIs. Under-reporting was found in 82.2%, 68.4%, 62.7%, and 57.3% of SSI, UTI, BSI, and pneumonia cases, respectively. Surprisingly, nearly 10% of HAI events (84) had evidence of infection, yet diagnostic workup was either not done or was incomplete. If the workup was complete, ICNs would be more confident in reporting or not reporting infection cases based on the evidence. Therefore, if with incomplete or without workup have a HAIs, they will be missed and not reported. Some underlying reasons for under-reporting, as described by ICNs, include misinterpretation, incomplete history-taking, lack of enough time, and weakness in identifying patients who have been started on treatment before cultures have been sent or results received. Eshrati et al[5] mentioned that improper classification and underdiagnosis of HAI are 2 reasons for under-reporting in Iran. Under-reporting of HAIs is highlighted in other validation studies as well.[18,19,21,22,26,27,29]

ICNs explained 1 of the possible reasons for under-reporting BSIs was that in sepsis situations, physicians sometimes start antibiotics immediately, without appropriate blood culture sampling. Taking blood samples after initiating antibiotics results in negative microbiologic cultures. This is consistent with Backman et al,[22] who reported under-reporting of CLABSIs in ICUs >50% of the time. ICNs also expressed that incomplete history-taking and workup of patients could be underlying causes of SSI under-reporting. ICNs explained that patients who underwent reoperation because of secretions from the surgical site or other signs of infection did not have a complete workup with respect to HAIs.

One possible explanation of UTI and pneumonia under-reporting could be lack of attention to new or changing clinical symptoms or antibiotic treatment because of high ICN workload or inactivity of ICLNs with regard to sending reports to ICNs about these changes. Most new cases of pneumonia have some clinical symptoms, such as new onset of purulent sputum, change in sputum character, increased respiratory secretions, or increased need for suction, new onset of or worsening cough, dyspnea, or tachypnea, rales or bronchial breath sounds, or worsening gas exchange. These changes were found by evaluators in progress notes and nursing reports of patients. In UTI cases, the most common method for case-finding was checking urine culture results. In some cases, antibiotic treatment was started prior to sending a urine culture. As a result, it was possible these cases were not detected by ICNs. Mahomed et al[30] and Kousha et al[14] noted inadequate human resources, high ICN workload, and poor ICLN collaboration as some challenges of HAI surveillance systems. This highlights the fact that some HAI cases were missed because ICNs had inadequate information regarding the clinical situation of their patients.

The overall positive predictive value of 69% indicated an over-reporting of HAIs. The results showed over-reporting of 14%, 11.8%, 11.8%, and 8% in UTI, SSI, BSI, and pneumonia, respectively. Previous HAI validation studies also confirm over-reporting in routine surveillance systems.[18,27] Some ICNs stated that they reported every positive culture as an HAI without paying attention to other HAI signs and symptoms. Sameness of microorganism in microbiologic reports of samples from blood and other sites was another cause of over-reporting of BSIs in this study, whereas secondary BSIs should not be reported as a new HAI. Two cases of SSI were reported based on signs and symptoms of infection at admission. This over-reporting was owing to lack of attention to time and location of attribution criteria. Backman et al[22] revealed misinterpretation of time and location criteria as one of the reasons for over-reporting of CLABSI.

We found pneumonia over-reporting was related to uncertainty of ICNs in diagnosing HAIs. Positive culture specimens were reported in 4 patients with no objective evidence of pneumonia. Cases of pneumonia were reported in 2 patients within a 2-week period, without change in the microorganisms. Most of the UTI over-reporting was related to positive urine cultures owing to colonization in patients who had prolonged indwelling Foley catheters and were admitted from other wards (2 patients) and elderly care centers (4 patients). These were mistakenly reported by ICNs. One possible explanation of UTI and pneumonia over-reporting is misinterpretation of case definitions and deviation from HAI protocol. A similar explanation has been reported by Zuschneid et al.[28]

Our study showed over-reporting is a result of insufficient training of ICNs. Although staff training is one of the main components necessary for IPC program success,[30,31] ICNs in Iran do not receive specialized and continuous training.

CONCLUSIONS

We were able to document important limitations of routine surveillance systems, including under- and over-reporting. Based on our results, to have reliable information, empowering ICNs through specialized training, clarification of job descriptions, and ICLN activation seems to be necessary. The results of this research also indicate that incomplete patient workups can be 1 of the reasons for poor case-finding in HAIs. The present findings have significant implications for policy makers and health care authorities in the planning and implementation of new IPCs. Further research is needed to explore the causes of inaccurate HAI reporting in routine surveillance systems.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2018.12.028.

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