Healthcare-Associated Infection Case Finding: Nursing Students' Knowledge About HAIs Signs and Symptoms: A Cross-Sectional Study

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Abstract

Background: Nurses' lack of knowledge about healthcare-associated infection (HAI) signs and symptoms is one reason for poor case finding and inaccurate reporting of HAIs.

Objectives: This study aimed to assess internship nursing students' knowledge of HAI signs and symptoms.

Methods: This survey included internship nursing students who were selected from Kermanshah University of Medical Sciences (KUMS). The participants completed a standardized form on HAI signs and symptoms developed by the Iranian Center for Communicable Diseases Control (ICDC). Microsoft Office Excel was used to calculate the frequency and percentage of responses.

Results: The most commonly identified signs and symptoms included positive culture, leukocytosis, having an invasive device, and fever (80%). In contrast, less than 70% of students considered leukopenia, hypotension, antibiotic therapy, chills, and deliberate opening of incisions as indicators of infection in patients.

Conclusions: The findings indicated that while nursing students are familiar with common signs and symptoms of HAIs, their knowledge concerning the less prevalent criteria is limited. These findings highlight the potential knowledge gaps and educational needs regarding HAI detection and reporting.

Keywords: Healthcare-Associated Infections, Pneumonia, Urinary Tract Infection, Surgical Site Infection, Bloodstream Infection, Reporting, Nursing Student

1. Background

Healthcare-associated infections (HAIs) are defined as infections that occur 48 - 72 hours after patient admission to a hospital, which were not in the incubation period at the time of admission (1). The HAIs are adverse health events (2) that significantly increase antibiotic resistance, morbidity, mortality, cost, and prolong hospitalization (3-7). Therefore, they are a critical challenge for health systems worldwide (1). Several studies have estimated that the rates of HAIs in developed and developing countries are 5 - 15% and 15 - 25%, respectively (8-10). Eshrati et al., in a national report

from Iran, reported that the prevalence of HAIs is 1.18% (11). In 2021, Masoudifar et al. published an update on the frequency of HAIs in Iran as follows: Pneumonia (29.1%), urinary tract infections (UTI; 25.6%), surgical site infection (SSI; 21.8%), and bloodstream infection (BSI; 11.6%) (12). This underreporting is mentioned as one of the main issues of HAI surveillance in Iran (13-15). Seifi et al. reported that the sensitivity of HAI reporting is less than 30% (14). One reason given for this low sensitivity is the insufficient knowledge of nurses about the signs and symptoms of HAIs in Iran (14, 16). Furthermore, other researchers have suggested that nursing and

medical students have inadequate knowledge about infection prevention and control (IPC) procedures (2, 17).

As nursing students have close contact with patients, they can play a vital role in the prevention of HAIs (1). Therefore, it is crucial to examine nursing students' knowledge and performance regarding HAIs (1, 2, 4, 18). According to the World Health Organization, understanding the standard definitions of infection and the reporting criteria of HAIs is one of the necessities of implementing IPC (1).

2. Objectives

While previous studies in Iran and other countries have focused on students' knowledge and performance regarding IPC strategies, particularly hand hygiene (2, 3, 18-20), this study specifically investigates nursing students' knowledge about HAI signs and symptoms relevant for case finding and reporting.

3. Methods

3.1. Study Design

This descriptive cross-sectional study was conducted among nursing students at the Nursing and Midwifery Faculty of Kermanshah University of Medical Sciences (KUMS). Due to the small number of samples, we did not use the sample size determination formula to avoid missing any samples. Instead, we included all seventh and eighth-semester students who began their internship during the first semester of 2020 - 2021 at Taleghani Hospital, affiliated with KUMS, as long as they were willing to participate in the study. Inclusion criteria for participation in the study included the following: Student willingness to participate in the study, students in semester 7 or 8, and completion of the infection control workshop in semester 2. Exclusion criteria included incomplete completion of the checklist. Data collection took place from September 2020 to January 2021.

A self-reporting form was used to gather the data. The form comprised two parts. The first part contained demographic information such as age, gender, and previous participation in IPC workshops. The second part consisted of a standardized form about HAI signs and symptoms or detection criteria. This form was originally developed by the Centers for Disease Control

and Prevention. Then, the Iranian Center for Communicable Diseases Control (ICDC) translated and adapted it into the Persian language for case finding and reporting of HAI cases. Its face and content validity were approved by a group of IPC experts, including physicians and nurses. After that, the form was introduced to all hospitals across Iran for HAI case finding (21) (Appendix 1 in Supplementary File). Since this is a standard form that lists the signs and symptoms of each of the four main types of HAIs seperately, it can be used as an educational tool for HAIs case finding.

The case finding form consisted of 47 items related to signs and symptoms of four types of HAIs: The UTIs (13 items), pneumonia (19 items), BSIs (10 items), and SSIs (15 items). Students were asked to select what they thought were signs or symptoms of each HAI. A score of 0 (no) or 1 (yes) was given to each item. The participants completed the form before they started their internship period at Taleghani Hospital. Microsoft Office Excel version 2013 was used to calculate the frequency and percentage of responses.

3.2. Ethical Considerations

The Research Ethics Committee of KUMS approved and supervised the project (IR.KUMS.REC.1401.059). Participants were informed that their participation in the research project was voluntary and that they could withdraw from the study at any time. Participants also expressed their verbal consent to participate in the study. Verbal informed consent was obtained from all subjects. Finally, the confidentiality of participants' data was maintained.

4. Results

A total of 116 students participated in the survey, including 64 females and 52 males. Among them, 66 were seventh-semester students and 50 were eighth-semester students. All participants had completed the IPC workshop in the second semester. Formal signs of pneumonia — fever, leukocytosis, having an invasive airway (tracheostomy or tracheal tube), positive lung secretion culture, change in respiratory secretion, formation of abscess, positive erythrocyte sedimentation rate (ESR), or C-reactive protein (CRP) test — were considered indicators of new HAIs and should be reported (more than 80% of participants). However, less than fifty percent of students reported leukopenia,

Table 1. Frequency and Percentage of Selected Signs and Symptoms of Pneumonia and Bloodstream Infection as Healthcare-Associated Infections [a]

HAI Types	Total		Semester 7		Semester 8	
	Yes	No	Yes	No	Yes	No
Pneumonia						
Having tracheal tub	93 (80.2)	23 (19.8)	53 (80.3)	13 (19.7)	40 (80)	10 (20)
Having tracheostomy tube	94 (81)	22 (19)	56 (84.8)	10 (15.2)	38 (76)	12 (24)
Fever (> 38°C)	88 (75.9)	28 (24.1)	50 (75.8)	16 (24.2)	38 (76)	12 (24)
Leukopenia (WBC1 < 4000)	56 (48.3)	60 (51.7)	28 (42.4)	38 (57.6)	28 (56)	22 (44)
Leukocytosis (WBC > 12000)	93 (80.2)	23 (19.8)	50 (75.8)	16 (24.2)	43 (86)	7 (14)
Change in LOC	54 (46.6)	62 (53.4)	29 (43.9)	37 (56.1)	25 (50)	25 (50)
New onset of purulent sputum or change in character of sputum, increased respiratory secretions, or increased suctioning requirements	86 (74.1)	30 (25.9)	47 (71.2)	19 (28.8)	39 (78)	11 (22)
New onset or worsening cough, or dyspnea, or apnea, or tachypnea	76 (65.5)	40 (34.5)	43 (65.2)	23 (34.8)	33 (66)	17 (34)
Rales or bronchial breath sounds	70 (60.3)	46 (39.7)	41 (62.1)	25 (37.9)	29 (58)	21 (42)
Worsening gas exchange [such as O_2 desaturations (for example pulse oximetry < 94%, $PaO_{22}/FiO_{23} \leq 240$), increased oxygen requirements, or increased ventilator demand]	44 (37.9)	72 (62.1)	21 (31.8)	45 (68.2)	23 (46)	27 (54)
Positive quantitative culture or corresponding semi-quantitative culture as a result of lung tissue	103 (88.8)	13 (11.2)	59 (89.4)	7 (10.6)	44 (88)	6 (12)
≥ 5% BAL4-obtained cells contain intracellular bacteria on a direct microscopic exam (for example Gram's stain)	78 (67.2)	38 (32.8)	45 (68.2)	21 (31.8)	33 (66)	17 (34)
Abscess formation or foci of consolidation with intense PMN5 accumulation in bronchioles and alveoli	99 (85.3)	17 (14.7)	53 (80.3)	13 (19.7)	46 (92)	4 (8)
Evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae	84 (72.4)	32 (27.6)	48 (72.7)	18 (27.3)	36 (72)	14 (28)
Evidence of fungi (positive culture of fungi)	72 (62.1)	44 (37.9)	38 (57.6)	28 (42.4)	34 (68)	16 (32)
Antibiotic therapy	46 (39.7)	70 (60.3)	25 (37.9)	41 (62.1)	21 (42)	29 (58)
ESR (> 30) and CRP (> 100)	86 (74.1)	30 (25.9)	46 (69.7)	20 (30.3)	40 (80)	10 (20)
Radiologic evidence (infiltrate, consolidation, cavitation)	90 (77.6)	24 (20.7)	53 (80.3)	13 (19.7)	38 (76)	12 (24)
BSI						
Having temporary CVL6	78 (67.2)	38 (32.8)	45 (68.2)	21 (31.8)	33 (66)	17 (34)
Having permanent CVL	102 (87.9)	14 (12.1)	59 (89.4)	7 (10.6)	45 (90)	5 (10)
Having arterial line	92 (79.3)	24 (20.7)	54 (81.8)	12 (18.2)	38 (76)	12 (24)
Fever (> 38°C)	94 (81)	22 (19)	55 (83.3)	11 (16.7)	39 (78)	11 (22)
Leukopenia (WBC < 4000)	73 (62.9)	43 (37.1)	45 (68.2)	21 (31.8)	32 (64)	18 (36)
Leukocytosis (WBC > 12000)	96 (82.8)	20 (17.2)	53 (80.3)	13 (19.7)	43 (86)	7 (14)
ESR (> 30) and CRP (> 100)	93 (80.2)	23 (19.8)	53 (80.3)	13 (19.7)	40 (80)	10 (20)
Chills	73 (62.9)	43 (37.1)	41 (62.1)	25 (37.9)	32 (64)	18 (36)
Hypotension	53 (45.7)	63 (54.3)	29 (43.9)	37 (56.1)	24 (48)	26 (52)
Organism(s) identified in blood are not related to an infection at another site	100 (86.2)	16 (13.8)	58 (87.9)	8 (12.1)	42 (84)	8 (16)

Abbreviations: HAI, healthcare-associated infection; LoC, level of consciousness; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; BSI, bloodstream infection; CVL, central venous line.

[a] Values are expressed as No. (%).

change in the level of consciousness (LoC), worsening of gas exchange, and starting a new antibiotic as important criteria for pneumonia (Table 1).

A higher percentage of eighth-semester nursing students selected leukopenia, change in the LOC, change in respiratory tract secretion or new onset of cough, worsening of gas exchange, formation of abscess, positive fungal culture, and positive ESR or CRP as important signs and symptoms that should be reported as HAIs.

Concerning the BSI signs and symptoms (Table 1), the vast majority of students correctly selected having a permanent central venous line (CVL) (87.9%) and arterial line (79.3%), fever (81%), leukocytosis (82.8%), laboratory test results in ESR and CRP tests (80.2%), and positive blood culture (86.2%) as signs and symptoms of BSI. However, 45% of students selected hypotension as a criterion for reporting BSI. A closer inspection of Table 1 shows that chills, leukopenia, and having a temporary CVL were criteria that nearly 40 percent of students selected as not important criteria for reporting a BSI.

Table 2. Frequency and Percentage of Selected Signs and Symptoms of Surgical Site Infection and Urinary Tract Infections as Healthcare-Associated Infections [a]

HAI Types	Total		Semester 7		Semester 8	
	Yes	No	Yes	No	Yes	No
SSI						
Date of surgery (date of event occurs within 30 to 90 days following operative procedure)	60 (51.7)	56 (48.3)	33 (50)	33 (50)	27 (54)	23 (46)
Fever (> 38°C)	75 (64.7)	41 (35.3)	47 (71.2)	19 (28.8)	28 (56)	22 (44)
Leukopenia (WBC < 4000)	51 (44)	65 (56)	28 (42.4)	38 (57.6)	23 (46)	27 (54)
Leukocytosis (WBC > 12000)	87 (75)	29 (25)	51 (77.3)	15 (22.7)	36 (72)	14 (28)
Positive wound culture	87 (75)	29 (25)	53 (80.3)	13 (19.7)	34 (68)	16 (32)
Localized pain around the incision	76 (65.5)	40 (34.5)	47 (71.2)	19 (28.8)	29 (58)	21 (42)
Warmth around the incision	82 (70.7)	34 (29.3)	46 (69.7)	20 (30.3)	36 (72)	14 (28)
Erythema around incision	84 (72.4)	32 (27.6)	48 (72.7)	18 (27.3)	36 (72)	14 (28)
Localized swelling around the incision	83 (71.6)	33 (28.4)	50 (75.8)	16 (24.2)	33 (66)	17 (34)
Localized tenderness around the incision	83 (71.6)	33 (28.4)	49 (74.2)	17 (25.8)	34 (68)	16 (32)
Purulent drainage from the superficial incision	74 (63.8)	42 (36.2)	42 (63.6)	24 (36.4)	32 (64)	18 (36)
Purulent drainage from the deep incision	84 (72.4)	32 (27.6)	48 (72.7)	18 (27.3)	36 (72)	14 (28)
Evidence of an abscess	81 (69.8)	35 (30.2)	47 (71.2)	19 (28.8)	34 (68)	16 (32)
An incision that is deliberately opened by a surgeon, physician, or physician designee.	70 (60.3)	46 (39.7)	40 (60.6)	26 (39.4)	30 (60)	20 (40)
An incision that is spontaneously opened.	83 (71.6)	33 (28.4)	48 (72.7)	18 (27.3)	35 (70)	15 (30)
UTI						
Having urinary catheter	85 (73.3)	31 (26.7)	47 (71.2)	19 (28.8)	38 (76)	12 (24)
Fever (> 38°C)	87 (76.7)	27 (23.3)	54 (81.8)	12 (18.2)	35 (70)	15 (30)
Leukopenia (WBC < 4000)	45 (38.8)	71 (61.2)	25 (37.9)	41 (62.1)	20 (40)	30 (60)
Leukocytosis (WBC > 12000)	85 (73.3)	31 (26.7)	49 (74.2)	17 (25.8)	36 (72)	14 (28)
Suprapubic tenderness	79 (68.1)	37 (31.9)	49 (74.2)	17 (25.8)	30 (60)	20 (40)
Suprapubic pain	78 (67.2)	38 (32.8)	47 (71.2)	19 (28.8)	31 (62)	19 (38)
Dysuria	92 (79.3)	24 (20.7)	53 (80.3)	13 (19.7)	39 (78)	11 (22)
Urinary frequency	76 (65.5)	40 (34.5)	41 (62.1)	25 (37.9)	35 (70)	15 (30)
Urinary urgency	68 (58.6)	48 (41.4)	40 (60.6)	26 (39.4)	28 (56)	22 (44)
Ouligoryia	70 (60.3)	46 (39.7)	38 (57.6)	28 (42.4)	32 (64)	18 (36)
ESR (> 30) and CRP (> 100)	70 (60.3)	46 (39.7)	39 (59.1)	27 (40.9)	31 (62)	19 (38)
Pyuria	85 (73.3)	31 (26.7)	50 (75.8)	16 (24.2)	35 (70)	15 (30)
Positive urine culture	96 (82.8)	20 (17.2)	56 (84.8)	10 (15.2)	40 (80)	10 (20)

Abbreviations: HAI, healthcare-associated infection; SSI, surgical site infection; UTI, urinary tract infections; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein.
[a] Values are expressed as No. (%).

Further analysis of the data reveals that there was no significant difference between the answers of seventh- and eighth-semester students.

In response to signs and symptoms of SSI, more than 70% of the students selected leukocytosis, positive wound culture, warmth, erythema, tenderness and swelling around the incision, purulent drainage from the deep incision, evidence of an abscess, and spontaneously opened incision as important criteria for reporting (Table 2). From Table 2, it is clear that passing more than 30 days from surgery was chosen by nearly half of the students as a criterion for SSI. Deliberately opening the incision by a physician was also selected by 60 percent of students as an SSI reporting criterion. The most striking result to emerge from the data is that leukopenia was not considered by more than half of the students as an SSI criterion. The most significant difference between the responses of the seventh- and eighth-semester students was seen in selecting fever, positive wound culture, localized pain around the incision, and swelling and tenderness around the incision as SSI criteria.

When queried about UTI criteria, a significant majority of students prioritized reporting the presence of a urinary catheter, fever, leukocytosis, suprapubic pain and tenderness, dysuria, pyuria, and positive urine culture (Table 2). Notably, leukopenia was not considered a key criterion for UTI reporting by over two-thirds of the surveyed students. When the students were asked about UTI criteria, more than two-thirds of students selected having a urinary catheter, fever, leukocytosis, suprapubic pain and tenderness, dysuria, pyuria, and positive urine culture as important criteria for UTI reporting (Table 2). Interestingly, leukopenia was not selected as a criterion for UTIs by more than two-thirds of students.

Moreover, nearly 40% of students did not consider urgency, oliguria, and abnormal ESR or CRP results as significant criteria for UTI reporting. There was a notable difference in the responses of seventh- and eighth-semester students regarding the reporting criteria for UTI symptoms such as fever, suprapubic tenderness and pain, urinary frequency, and oliguria.

5. Discussion

In many developing countries, HAI surveillance systems encounter a significant obstacle in identifying and reporting HAI cases. This challenge is often due to

healthcare professionals' limited awareness of the signs and symptoms (14, 16). This study aimed to evaluate the knowledge of nursing students during their internship period concerning HAI signs and symptoms. This approach aims to improve reporting practices and tackle the problem at its source.

The study showed that students were able to accurately identify the most common signs and symptoms of pneumonia, such as fever, leukocytosis, positive lung secretion, and having an invasive airway, as indicators of HAIs in a patient. However, a lower percentage of participants were able to recognize less known symptoms, such as changes in the LoC, worsening of gas exchange, leukopenia, and starting a new antibiotic, as indicators of pneumonia in their patients. This finding is similar to the results of Hammoud et al.'s study, which reported that nurses have a low level of knowledge about HAIs (22).

A possible explanation for this might be that patients on mechanical ventilation are critically ill. Therefore, they frequently suffer from a complex acute illness complicated by multiple comorbidities and may require extraordinary life-saving measures (23). As a result, nursing students may have thought that some of the signs and symptoms could be related to the critical situation of the patients. Another explanation for selecting some signs and symptoms (fever, leukocytosis, etc.) is that these are the most commonly known criteria of infection in patients. Shaaban Ali also revealed that nurses have unsatisfactory knowledge scores about ventilator-associated pneumonia (24). Although a higher percentage of eighth-semester students selected some of the uncommon signs of pneumonia, Shaaban Ali shows that there is no relation between the level of education and knowledge about pneumonia (24).

Robson et al. indicated that some of the ward's nurses have poor knowledge about the signs and symptoms of sepsis. Sixty-six percent of participating nurses in Robson's study believed that low temperature and nearly half of the participants indicated that leukopenia is not a sign or symptom of sepsis (25). Contrary to our findings, Robson showed that 66% of nurses selected hypotension as a sign of sepsis (25). Chua et al. reported that nurses have moderate knowledge about sepsis signs and symptoms and its epidemiology (26).

The study findings regarding SSI signs and symptoms reveal that nursing students correctly selected common wound infections (27). This finding is consistent with Val Reynolds, who found that 90% of healthcare workers correctly identified pain, increased body temperature (pyrexia), strong malodor, itching, warmth of the peri-wound skin, and delayed healing as signs of wound infection (27). A possible explanation for this might be that these signs and symptoms have been taught through all other nursing courses. Therefore, students may have thought that deliberately opening an incision could not be a sign of SSI or that they did not know about the time of SSI occurrence after surgery. Therefore, it is suggested that signs and symptoms of all types of HAIs and their diagnostic criteria be taught to nursing students in the IPC education program.

Another result of this survey is students' knowledge about UTI signs and symptoms. The study results indicated that the students selected the most popular criteria for UTIs, while other infrequent signs and symptoms were not selected by students as possible UTI diagnostic criteria. The results of this survey show the lack of familiarity of students with some of the changes in urine flow or systemic signs and symptoms of UTI (leukopenia, ESR, and CRP results). Therefore, it is recommended that these signs and symptoms of UTIs be taught to nursing students. This finding confirms the Midthum results, which demonstrated that physicians and nurses selected formal clinical signs and symptoms of UTI as the main criteria for the assessment of UTI in geriatric patients (28).

This survey was conducted based on a consensus sampling method and in a single medical university. Caution should be taken in generalizing the results. This survey revealed that nursing students lack familiarity with some of the signs and symptoms of UTIs, such as leukopenia, ESR, and CRP results. The students selected only the most common criteria of UTI, neglecting other less frequent symptoms. This suggests a need to teach nursing students about the various changes in urine flow and systemic signs and symptoms of UTIs. The study's findings align with the Midthum results, which found that physicians and nurses also rely on formal clinical signs and symptoms of UTI when assessing geriatric patients (28).

It seems previous training or experience regarding HAI detection and reporting could influence students'

knowledge. However, as nearly all of the students have not had previous training or job experience, this is not applicable in the present research. Therefore, it is suggested that these factors should be considered at the time of data analysis.

It is important to note that the use of a census method for selecting students from only one hospital affiliated with KUMS may limit the generalizability of the findings. Future studies could benefit from a more diverse sample, encompassing multiple institutions, to better represent the broader population of internship nursing students. Another limitation of this study was the use of a form and self-report to assess the status of students' knowledge. It is suggested that future studies use other methods, such as direct observation, to assess students' knowledge.

5.1. Conclusions

The survey findings suggested that nursing students have a good understanding of the common signs and symptoms of various types of HAIs. However, they lack knowledge of some of the uncommon signs and symptoms of these infections. This indicates that their knowledge regarding the signs and symptoms of HAIs for case identification is not comprehensive. As a result, there is room for improvement in terms of some of the uncommon signs and symptoms being used as indicators of HAIs. The survey results can be utilized to develop an IPC training program aimed at improving the reporting and surveillance of HAIs among nursing students.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

Authors' Contribution: Conceptualization, methodology, funding acquisition, project administration, writing, reviewing, and editing: L. R.; Writing, reviewing, and editing: A. G.; Visualization and writing-original draft: L. Gh.; Data collection, visualization, reviewing, and editing: V. Gh.

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