An overview of healthcare-associated infections in a tertiary care hospital in Egypt

Rania Hassan a, Abdel-Hady El-Gilany b,*, Amina M. Abd elaal c, Noha El-Mashad c, Dalia Abdel Azim d

a Clinical Pathology, Ministry of Health, Egypt
b Public Health & Preventive Medicine, Faculty of Medicine, Mansoura University, Egypt
c Clinical Pathology, Faculty of Medicine, Mansoura University, Egypt
d Director of Molecular Genetics, Department of Pathology, NYU Winthrop University Hospital, USA

ARTICLE INFO
Article history:
Received 6 February 2020
Accepted 7 April 2020
Available online 19 May 2020

Keywords:
Healthcare-associated infection-risk factors-causative pathogens

SUMMARY

Background: Healthcare-associated infection (HAI) is a major problem in healthcare facilities and is associated with increased morbidity and mortality and prolonged hospital stay. This study aims to determine the incidence rate, risk factors, and bacterial aetiology of HAI in a tertiary care hospital in Mansoura, Egypt.

Methods: This is a prospective observational study carried out over 12 months in different departments of Mansoura New General Hospital (MNGH). Data were collected from patient’s records and laboratory results of the ongoing HAI surveillance program.

Results: The incidence of HAI was 3.7% among 6912 patients studied. The independent predictors of HAI were multiple devices (AOR = 88.1), central venous catheter (CVC) (AOR = 34), urinary catheter (AOR = 28.9) and length of stay >20 days (AOR = 3.1). Surgical site infections (SSI) were the most frequent (24%) followed by catheter associated urinary tract infections (CAUTI) (20%). The most frequently isolated pathogens were Klebsiella spp. (27.2%), and E. coli (18%).

Conclusions: HAI is a significant problem in MNGH. Klebsiella spp. were the predominant causative organisms of HAI, as has been described in other studies from developing countries.

© 2020 The Authors. Published by Elsevier Ltd on behalf of The Healthcare Infection Society. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Healthcare-associated infections (HAI) are acquired from hospitals after the second day of admission [1]. It is estimated that up to 80% of all hospital deaths are directly or indirectly related to HAI [2]. The prevalence of HAI depends on the level of development of the health system; its prevalence is low in developed countries compared to developing ones [3,4] and is associated with different risk factors [5]. The most frequent types of infections include central line associated bloodstream infections, CAUTIs, SSIs and ventilator-associated pneumonia [6]. Bacteria are responsible for about 90% of HAI [7].

Objectives

There is limited data about the burden and risk factors of HAI in Egypt. Therefore, this study aims to describe HAI in all departments in a general hospital in terms of incidence rate,
sites of infection, associated factors and the causative pathogens.

Methods

This is a prospective observational study in a 450 bed tertiary care hospital, Mansoura New General Hospital (MNGH) in Egypt from January 1 to December 31, 2017. Of 18,333 patients admitted to the hospital during the study period, 6912 patients were admitted for >48 hours and were included in the study. All patients were monitored daily for the development of infection during their hospital stay and were followed up till hospital discharge to acquire data on length of hospital stay, department, devices (e.g. CVC, urinary catheter, mechanical ventilation or combined), and demographic data (age, sex). HAI were diagnosed according to standard definitions of Centers for Disease Control and Prevention [1].

Age was categorized into age groups: neonate (first 28 days of life), post neonate (from day 29 to the end of the first year of age), children (from the second to 18th year), adult (from 18 to 60 years), and geriatric (>60 years).

Microbiological samples were taken according to site of infection. Bacterial isolates were identified by Gram-stain, cultures on routine media (e.g. Blood agar, MacConkey agar) and where necessary, selective media followed by specific biochemical tests (following standard protocols).

Ethical consideration

This study was done after approval from the manager of the MNGH and research ethics committee of Faculty of Medicine, Mansoura University.

Statistical analysis

Data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL, USA). Categorical variables were presented as number and percent. A Chi-square test was used for comparison between groups. Crude odds ratios (COR) and their 95% confidence intervals (CI) were calculated. Significant factors associated with HAI on bi-variate analysis were entered into multivariate logistic regression models using step-wise forward Wald method to detect the independent predictor of HAI. Adjusted odds ratios (AOR) and their 95% CI were calculated. p≤0.05 was considered statistically significant.

Results

The overall incidence of HAI was 3.7%. The highest incidence was in the Burns Unit (48.1%) followed by General Intensive Care Unit (ICU) (20.9%) and Neurosurgical ICU (18.9%). The lowest incidence was in Special Surgery (1.7%), and Internal Medicine (0.1%). HAI in all ICUs (General ICU, CCU, NICU, PICU, and Neurosurgical ICU) represented 46.7% of all HAI. HAI are most likely to occur in neonates and children (COR = 4.3 and 2.5; respectively), patients who stay in hospital >20 days (COR = 3.9), patients with multiple devices, CVC (COR = 84.4 and 31.5; respectively), and in the Burns Unit (COR = 54.7) (table 1).

The logistic regression model revealed that the most independent predictors of HAI were multiple devices (AOR = 88.1), CVC (AOR = 34.0), urinary catheter (AOR = 28.9), length of stay >20 days (AOR = 3.1), adults and children (AOR 2.8 and 2.6; respectively) (table 2).

SSIs were the most frequent HAI (24%), followed by CA-UTI (20%), Burn infection (19%), and the least frequent is laboratory-confirmed blood stream infection (4%) (table 3).

The most frequently isolated bacteria were Klebsiella spp. (27.2%), E. coli (18%), and S. aureus (15.8%). The most frequent bacteria in different sites are E. coli (53.7%) in CAUTI, Klebsiella spp. (60% of Ventilator associated pneumonia (VAP), 38.1% of HAP and 33.3% of SSI) and Pseudomonas spp. (31.4% in burns) (table 4).

Discussion

The overall incidence of HAI was 3.7%. This is lower than 8.5% revealed in a community hospital in Saudi Arabia [8] but higher than 1.46% and 1.96% in Turkey and China; respectively [9,10]. However, it is comparable to another Saudi study (4.0%) and USA studies (4.0%-4.4%) [11,12]. The relative lower incidence of hospital-wide HAI reflects the effectiveness of currently implemented infection control program.

The incidence of HAI was in our Burn Unit was 48.1%. Two previous studies in Turkey reported rates of 23.1% and 14.7/1000 patient days [13,14]. Burn patients have unique predisposition to different infections which are linked to impaired resistance from disruption of the skin’s mechanical integrity and generalized immune suppression [15].

HAI in all ICUs represented 46.7% of all HAI. The incidence rate of HAI in different ICU was 12.6%. This is lower than 23% and 21.4% found in two Pediatric ICUs in Egypt [16,17]. This is higher than 9.3% reported in mixed medical-surgical ICU in Italy [18]. Although the ICU provides vital support to critically ill patients, HAI are one of the most serious complications in these patients. Patients admitted to ICUs are at risk for acquiring HAI because of their debilitated immune systems and exposure to invasive devices, such as ventilators, urinary catheters, and CVCs during their stay [9].

These differences between incidence rates of HAI in different countries and hospitals could be due to different morbidity patterns, treatment protocols, level of development of health system, HAI control measures as well as different operational definitions of HAI adopted in these studies.

The logistic regression for risk factors revealed that the most independent predictors of HAI were multiple devices and length of stay >20 days. These results agreed with previous findings from different countries [19-22]. Invasive procedures and poor compliance of staff to infection control guidelines expose patients to increase HAI [23].

In this study SSI were the most frequent infections (24%), followed by CAUTI (20%). This is in concordance with a study at a rural hospital in Gabon [24] and with study in a tertiary care hospital in India [25]. In contrast to study in a pediatric ICU in Alexandria, Egypt where the most frequent HAI was bloodstream infection (BSI) followed by UTI and VAP [16]. In another study set across 46 ICUs in 11 Egyptian hospitals the most frequent HAI was hospital acquired pneumonia (HAP) followed by CAUTI and CLABSI [26]. This difference in the site of infection may be due to different population demographics; our study included hospital-wide surveillance (including surgical departments). Many other studies focus on nosocomial
infections occurring in ICUs only. Also a Burn Unit is a specialized ward not present in all hospitals. SSIs represent a major problem worldwide. It was the most frequent site of infection reported in our study; this can point to the importance for implementation of preventive bundle measures especially for preoperative prophylactic antibiotics and preoperative preparation of patients.

In this study, the most frequently isolated bacteria were *Klebsiella* spp. (27.2%) followed by *E.coli* (18%). This is consistent with data reported from a study in a tertiary hospital.

| Table 3 | Rate of healthcare-associated infection in different sites |
|---------|------------------------------------------------------|
| SSI     | CA-UTI | Burns | VAP | CLABSI | HAP | HAP | LCBI | Total |
| No.     | 66 | 54 | 51 | 35 | 33 | 21 | 12 | 272 |
| %      | 24.3% | 19.6% | 18.6% | 12.9% | 12.1% | 7.7% | 4.4% | 100% |

SSI (surgical site infection), CA-UTI (catheter-associated urinary tract infections), VAP (Ventilator-associated Pneumonia), HAP (hospital acquired pneumonia), CLABSI (central line-associated blood stream infection), LCBI (laboratory confirmed blood stream infection).
neonatal ICU in Egypt [27], also with a study in teaching hospitals in Iran [28]. Surveys in 183 US hospitals revealed that C. difficile was the most common pathogen followed by S. aureus and K. pneumoniae [12].

The most prevalent pathogen causing SSI was Klebsiella spp. which is similar to findings of a study of hospitalized cancer patients in Egypt [29]. Whilst a study in Ethiopia, reported that S. aureus was the most frequently detected pathogen in SSI followed by E. coli [30]. The major pathogen causing CAUTI was E. coli, which is in concordance with results from medical and surgical ICUs in Turkey and India [23,31]. The most frequent pathogens causing burn infection were Pseudomonas spp., Proteus and S. aureus. This is similar to findings in Burn Centers in Turkey and Bulgaria [14,32]. In the current study, the major pathogen causing pneumonia (either VAP or HAP) was Klebsiella spp. This agrees with a study in Germany [33]. However, a study in Turkey found that the main pathogen were S. aureus and P. aeruginosa [34]. The major pathogens causing bloodstream infections were Enterococcus spp. and S. aureus. This agrees with a study in Assiut university hospital, Egypt [35]. However, an Indian study in adult ICUs found that Klebsiella spp., Acinetobacter spp. and Candida spp. were most common pathogens causing CLABSI [36]. This study showed a predominance of Gram negative pathogens as causative agents of nosocomial infections. This could be explained by inefficient hand hygiene by medical staff between patients.

Conclusions

HAI is a significant problem in MNGH. Gram-negative bacteria, especially Klebsiella spp., was the predominant cause of HAI. There is still potential for decreasing HAI in this hospital (with special emphasis on departments with high rates). Application of a surveillance system of HAI by all hospitals by using standard definitions would facilitate inter- and intra-hospitals comparisons.

Study limitation

It is a single center study over a single year.

Table 4

| Pathogen          | SSI N (%) | CA-UTI N (%) | Burns N (%) | VAP N (%) | CLA-BSI N (%) | HAP N (%) | LCBI N (%) | Total N (%) |
|-------------------|-----------|--------------|-------------|-----------|---------------|-----------|------------|-------------|
| Klebsiella spp.   | 22(33.33) | 6 (11.1)     | 8 (15.69)   | 21 (60)   | 7 (21.2)      | 8 (38.1)  | 2 (16.67)  | 74 (27.2)   |
| E.coli            | 8 (12.12) | 29 (53.7)    | 2 (3.92)    | 2 (5.7)   | 4 (12.1)      | 3 (14.3)  | 1 (8.33)   | 49 (18)     |
| Staphylococcus aureus | 14(21.21) | 2 (3.7)      | 11 (21.57)  | 1 (2.86)  | 8(24.3)       | 4 (19)   | 3 (25)     | 43 (15.8)   |
| Pseudomonas spp.  | 6 (9.09)  | 7 (13)       | 16(31.37)   | 3 (8.6)   | 4 (12.1)      | 2 (9.5)  | 1 (8.33)   | 39(14.34)   |
| Enterococcus spp. | 5 (7.58)  | 6 (11.1)     | -           | 3 (8.6)   | 8 (24.3)      | -        | 3 (25)     | 25 (9.19)   |
| Proteus spp.      | 7 (10.61) | -            | 14 (27.45)  | -         | 2 (9.5)       | -        | -          | 23 (8.46)   |
| CoNS              | 2 (3.03)  | 2 (3.7)      | -           | 1 (2.86)  | 1 (3)         | -        | 2 (16.67)  | 8 (2.94)    |
| Acinetobacter spp.| 1 (1.52)  | -            | 4 (11.4)    | 1 (3)     | 1 (4.8)       | -        | 7 (2.57)   | -           |
| B hemolytic Streptococci | 1 (1.52) | 2 (3.7)      | -           | -         | 1 (4.8)       | -        | 4 (1.47)   | -           |
| Total             | 66(100)   | 54(100)      | 51(100)     | 35(100)   | 33 (100)      | 21(100)  | 12 (100)   | 272(100)    |

Percentage value denotes column percentage. CAUTI (catheter-associated urinary tract infections), VAP (Ventilator-associated Pneumonia), HAP (hospital acquired pneumonia), CLA-BSI (central line-associated blood stream infection), BSI (blood stream infection), SSI (surgical site infection), CoNS (coagulase negative Staphylococcus).

Funding

None.

Conflict of interest

None declared.

References

[1] NHSN. National. Healthcare Safety Network (NHSN) patient safety components manual. Atlanta, Georgia: CDC; 2017 [Online] Available from: https://www.cdc.gov/nhsn/pdfs/validation/2017/compsmanual2017.pdf [Accessed on January, 2017].

[2] Sheng WH, Wang JT, Lin MS, Chang SC. Risk factors affecting in-hospital mortality in patients with nosocomial infections. J Formos Med Assoc 2007;106:110–8.

[3] Nouetchognou JS, Ateudjieu J, Jemea B, Mesumbe EN, Mbanya D. Surveillance of nosocomial infections in a district hospital in Turkey. Biomed Res India 2015;26(2):299.

[4] Talaat M, El-Shokry M, El-Kholy J, Ismail G, Kotb S, Hafez S, et al. National surveillance of health care-associated infections in Egypt: Developing a sustainable program in a resource-limited country. Am J Infect Control 2016;44(11):1296–301.

[5] Yallew WW, Kumie A, Yehuala FM. Risk factors for hospital-acquired infections in teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. PLoS One 2017;12(7):e0181145. https://doi.org/10.1371/journal.pone.0181145.

[6] Khan HA, Baig FK, Mehbboob R. Nosocomial infections: Epidemiology, prevention, control and surveillance. Asian Pac J Trop Biomed 2017;7:478–82.

[7] Khan HA, Ahmad A, Mehbboob R. Nosocomial infections and their control strategies. Asian Pac J Trop Biomed 2015;5:509–14.

[8] Al-Ghamdi S, Gedebou M, Bilal N. Nosocomial infections and misuse of antibiotics in a provincial community hospital, Saudi Arabia. J Hosp Infect 2002;50(2):115–21.

[9] Ozer T, Deveci O, Yula E, Tekin A, Yankik, Durmaz S. Nosocomial infections in a district hospital in Turkey. Biomed Res India 2015;26(2):299–303.

[10] Liu WP, Tian Y, Hai Y, Zheng Z, Cao Q. Prevalence survey of nosocomial infections in the Inner Mongolia Autonomous Region of China [2012–2014]. J Thorac Dis 2015;7(9):1650–7.
Scherbaum M, Kösters K, Mürbeth R, Ngoa U, Kremsner G, Lell B, et al. Endemic nosocomial infections and misuse of antibiotics in a maternity hospital in Saudi Arabia. APMIS 2002;110:140–7.

Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, et al. Multistate point-prevalence survey of health care-associated infections. NEJM 2014;370:1196–208.

Öncü O, Öksüz S, Acar A, Ulkür E, Turhan V, Uygur F, et al. Nosocomial infection characteristics in a burn intensive care unit: Analysis of an eleven-year active surveillance. Burns 2014;40(5):835–41.

Alp E, Coruh A, Gunay GK, Yontar Y, Doganay M. Risk factors for nosocomial infection and mortality in burn patients: 10 years of experience at a University Hospital. J Burn Care Res 2012;33(3):379–85. https://doi.org/10.1097/BCR.0b013e318234966c.

Bayram Y, Parlık M, Aypak C, Bayram I. Three-year review of bacteriological profile and antibiotic of burn wound isolates in Van, Turkey. Int J Med Sci 2013;10(1):19–23.

El-Nawawy A, Abd-El-Fattah M, Metwally HA, Barakat SS, Hassan I. One year study of bacterial and fungal nosocomial infections among patients in pediatric intensive care unit (PICU) in Alexandria. J Trop Pediatr 2006;52(3):185–91.

Abdel-Wahab F, Ghoneim M, Khashaba M, El-Gilany AH, Abdel-Hady D. Nosocomial infection surveillance in an Egyptian neonatal intensive care unit. J Hosp Infect 2013;83:196–9.

Chelazzi C, Pettini E, Villa G, De Gaudio AR. Epidemiology, associated factors and outcomes of ICU-acquired infections caused by Gram-negative bacteria in critically ill patients: an observational, retrospective study. BMC Anesthesiol 2015;15:125.

Ozer B, Tatman-Ötkun M, Memis D, Ötkun M. Nosocomial infections and risk factors in intensive care unit of a university hospital in Turkey. Cent. Eur J Med 2010;5(2):203–8.

Yesilbag Z, Karadeniz A, Başaran S, Kaya F. Nosocomial infections and risk factors in intensive care unit of a university hospital. J Clin Exp Invest 2015;6(3):233–9.

Aktar F, Tekin R, Güne A, Ulgen C, Tan E, Ertugrul S, et al. Determining the Independent Risk Factors and Mortality Rate of Nosocomial Infections in Pediatric Patients. Biomed Res Int 2016;7240864.

Askarian M, Yadollahi M, Assadian O. Point prevalence and risk factors of hospital acquired infections in a cluster of university-affiliated hospitals in Shiraz, Iran. J Infect Public Health 2012;5:169–76.

Ak O, Batirel A, Ozer S, Colakoglu S. Nosocomial infections and risk factors in the intensive care unit of a teaching and research hospital: A prospective cohort study. Med Sci Monit 2011;17(5):29–34.

Scherbaum M, Kösters K, Mürbeth R, Ngoa U, Kremsner P, Lell B, et al. Incidence, pathogens and resistance patterns of nosocomial infections at a rural hospital in Gabon. BMC Infectious Diseases 2014;14:124.