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

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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.

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,

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sites of infection, associated factors and the causative pathogens.

Methods

This is a prospective observational study in a 450 bedtertiary 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 stepwise forward Wald method to detect the independent predictor of HAI. Adjusted odds ratios (AOR) and their 95% CI were calculated. $p \leq 0.05$ 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, HAIs 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

Table 1
Overall incidence of Healthcare-associated infection and its associated risk factors

Factors	No. of patients stayed >48 hours	HAI N (%)	p	**COR (95%CI)**
Overall	6912	259 (3.7)		**(3.3-4.2)**
Age				
Neonate	341	28 (8.2)	≤0.001	**4.3 (2.6–7.2)**
Post neonate	319	13 (4.1)	0.03	2 (1.1–3.9)
Children	938	46 (4.9)	≤0.001	2.5 (1.6–4)
Adults	3744	140 (3.7)	≤0.001	1.9 (1.3–2.8)
Geriatric	1570	32 (2)		r (1)
Sex				
Female	2784	92 (3.3)	0.1	0.8 (0.6–1.1)
Male	4128	167 (4)		r (1)
Stay				
3–20 days	6315	194 (3.1)		r (1)
>20 days	597	65 (10.9)	≤0.001	**3.9 (2.9–5.2)**
Device				
No device	5751	35 (0.6)		r (1)
Urinary catheter	721	104 (14.4)	≤0.001	27.5 (18.6–40.7)
CVC	167	27 (16.2)	≤0.001	31.5 (18.6–53.4)
Multiple devices[a]	273	93 (34.1)	≤0.001	**84.4(55.7–128)**
Departments				
General ICU	278	58 (20.9)	≤0.001	15.6 (10.3–23.6)
CCU	128	6 (4.7)	=0.01	2.9 (1.2–7)
NICU	311	26 (8.4)	≤0.001	5.3 (3.3–8.9)
PICU	130	10 (7.7)	≤0.001	4.9 (2.4–10)
Neurosurgery ICU	111	21 (18.9)	≤0.001	13.7 (7.8–24.2)
Nephrology	389	19 (4.9)	≤0.001	3 (1.7–5.3)
Internal medicine[b]	2215	9 (0.1)	≤0.001	0.2 (0.1–0.5)
General surgery	689	29 (4.2)	≤0.001	2.6 (1.6–4.2)
Burns	79	38 (48.1)	≤0.001	**54.7 (32–93.3)**
Special surgery[c]	2582	43 (1.7)		r (1)

HAI (Healthcare-associated infection). COR (Crude odds ratio). CVC (central venous catheter). General ICU (general intensive care unit). CCU (cardiology care unit). NICU (neonatal intensive care unit). PICU (pediatric intensive care unit). Neurosurgery ICU (Neurosurgery intensive care unit).
[a] Ventilator and more than one device.
[b] Cardiology, Internal medicine, Neuromedicine, and Pediatric.
[c] Orthopedics Neurosurgery Gynecology & obstetrics ENT Vascular surgery Plastic surgery, Urology, cardiothoracic and maxillofacial.

Table 2
Logistic regression analysis of independent predictors of HAI

	Number	β	p	AOR (95%CI)
Age				
Neonate	341	0.84	0.006	2.3 (1.3–4.2)
Post neonate	319	0.43	0.250	1.5 (0.7–3.2)
Children	938	0.96	≤0.001	2.6 (1.6–4.3)
Adults	3744	1.0	≤0.001	2.8 (1.9–4.3)
Geriatric	1570			r (1)
Stay				
3–20 days	6315			r (1)
>20 days	597	1.1	≤0.001	3.1 (2.2–4.4)
Device				
No device	5751			r (1)
Urinary catheter	721	3.4	≤0.001	28.9 (19.5–43)
CVC	167	3.5	≤0.001	34 (19.7–58.4)
Multiple devices	273	4.5	≤0.001	88.1 (56.9–136.5)
Constant		-6.1		
Model χ^2		758.6, $p \leq 0.001$		
% correctly predicted		96.2		

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	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), CAUTI (catheter-associated urinary tract infections), VAP (Ventilator-associated Pneumonia), HAP (hospital acquired pneumonia), CLA-BSI (central line-associated blood stream infection), LCBI (laboratory confirmed blood stream infection).

Table 4
Distribution of causative bacteria causing nosocomial infections in different sites

	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).

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.

Funding

None.

Conflict of interest

None declared.

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