HHS Public Access

Author manuscript

Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2015 December 31.

Published in final edited form as:

Infect Control Hosp Epidemiol. 2013 December ; 34(12): 1281–1288. doi:10.1086/673985.

Incidence and Pathogen Distribution of Healthcare-Associated Infections in Pilot Hospitals in Egypt

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Abstract

Objective—To report type and rates of healthcare-associated infections (HAI) as well as pathogen distribution and antimicrobial resistance patterns from a pilot HAI surveillance system in Egypt.

Methods—Prospective surveillance was conducted from April 2011–March 2012 in 46 intensive care units (ICUs) in Egypt. Definitions were adapted from the CDC's National Healthcare Safety Network. Trained healthcare workers identified HAIs and recorded data on clinical symptoms and up to four pathogens. A convenience sample of clinical isolates was tested for antimicrobial

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Potential conflicts of interest. All authors report no conflicts of interest relevant to this article.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Centers for Disease Control and Prevention, the Department of the Navy, Department of Defense, the Egyptian Ministry of Health and Population, or the Egyptian Universities.

This project was approved by the IRB at the US Naval Medical Research Unit, No.3, Cairo, as a non-research protocol #1114.

resistance at a central reference laboratory. Multidrug resistance was defined by international consensus criteria.

Results—ICUs from 11 hospitals collected 90,515 patient-days of surveillance data. Of 472 HAIs identified, 47% were pneumonia, 22% were bloodstream infections, and 15% were urinary tract infections; case fatality among HAI case-patients was 43%. The highest rate of device-associated infections was reported for ventilator-associated pneumonia (pooled mean rate: 7.47 VAP/1,000 ventilator-days). The most common pathogens reported were *Acinetobacter* spp. (21.8%) and *Klebsiella* spp. (18.4%). All *Acinetobacter* spp. isolates tested (31/31) were multidrug-resistant, and 71% (17/24) of *Klebsiella pneumoniae* isolates were extended spectrum beta-lactamase producers.

Conclusions—Infection control priorities in Egypt should include preventing pneumonia and preventing infections due to antimicrobial-resistant pathogens.

Background

Healthcare-associated infections (HAIs) are a significant global threat to patient safety. In the United States, based on data from 2002, HAIs were estimated to cause 99,000 deaths annually, with an incidence in intensive care units (ICUs) of 13.6 HAI/1,000 patient-days [1]. Since then, substantial progress has been made towards prevention of HAIs in the United States [2,3]. However, in the developing world, a recent meta-analysis of HAI data has reported a pooled incidence of 46.9 HAI/1,000 patient-days, over a three-fold greater incidence compared to historic data from the United States [4].

To identify HAI prevention targets and reduce thus disparities between countries, ongoing surveillance is necessary [5]. However, resources are severely limited in the developing world, creating difficulties implementing surveillance and establishing effective measures for infection control and HAI prevention [6,7]. In Egypt, efforts to improve infection control training and begin HAI surveillance have been underway [8]. However, previous reports of HAIs in Egypt were limited to device-associated infections and did not address the broad spectrum of HAIs [9,10,11,12].

In April 2011, in collaboration with the Ministry of Health and Population and university hospitals, the U.S. Naval Medical Research Unit No. 3 (NAMRU-3) implemented a pilot HAI surveillance system in selected hospitals in Egypt to establish baseline HAI rates for a broad spectrum of HAI types. The objectives of the pilot were to determine HAI burden and increase awareness, to inform specific prevention efforts to reduce HAI rates, and to inform planning for a large-scale national surveillance system for HAIs in Egypt. We report the distribution of types and rates of HAI, as well as associated pathogen distributions and patterns of antimicrobial resistance.

Methods

Setting

Prospective surveillance for HAIs was performed in 46 ICUs in 11 Egyptian hospitals from April 2011 through March 2012. Hospitals represented both university-affiliated hospitals

and public Ministry of Health and Population hospitals located in Cairo, Giza, Alexandria, Luxor, and Sharm el-Sheikh. All participating hospitals were required to have at least one full-time infection-control professional, a clinical microbiology laboratory with the capacity to process cultures, at least one ICU, and a data manager.

Training and Technical Support

Hospital staff participating in HAI surveillance (e.g., physicians, nurses, clinical microbiologists, infection control professionals, laboratory technicians) received a four-day training course by NAMRU-3 staff that covered topics such as HAI case definitions and diagnosis, test ordering practices for microbiology cultures, microbiology laboratory procedures, and instructions for surveillance data collection and reporting. In addition, NAMRU-3 staff regularly visited participating hospitals to provide continued technical assistance for surveillance.

Definitions

A HAI was considered to be an infection developing during a hospitalization. Major and specific HAI site definitions were adapted from the Centers for Disease Control and Prevention's (CDC's) 2008 National Healthcare Safety Network (NHSN) case definitions [13]. Because of limitations in laboratory infrastructure, clinical sepsis (which is not currently included in NHSN) was included among HAIs under surveillance in neonatal intensive care units (NICU). Surgical site infections were not monitored because surveillance focused on infections detected in ICU patients. An infection episode met HAI criteria when it occurred on or after the third calendar day in the ICU or within two calendar days of discharge from the ICU. Serologic and antigen test results were not included in case definitions because laboratories in participating hospitals did not have the capability to perform these tests. In addition, institution of antimicrobial treatment by a physician was not considered to be sufficient for diagnosis of an HAI because of widespread use of empiric antimicrobial therapy. An infection was defined as device-associated (i.e., urinary catheter-, ventilator-, or central line-associated) if the corresponding device was in place on the date of infection or within two calendar days prior.

ICU type was classified according to NHSN's criteria: if 80% or more of the patients were of a given type then the ICU was classified accordingly (e.g., if 90% of an ICU's patients are neonates, then the ICU would be classified as a NICU) [14]. In instances where the ICU population consisted of an equal mix of adult and pediatric patients and therefore could not be assigned an existing NHSN location code, new codes for combined adult/pediatric ICUs were created (see Table 1).

Multidrug resistance was defined in accordance with current published interim standard definitions, which were used in the most recent NHSN antimicrobial resistance report [15,16]. Specifically, an isolate of *Acinetobacter* spp. was defined as having multidrug resistance (MDR) if it tested non-susceptible (i.e., resistant or intermediate) to at least one drug in three of the following six antimicrobial agents/groups: piperacillin or piperacillin/tazobactam, extended-spectrum cephalosporins (cefepime or ceftazidime), aminoglycosides, ampicillin/sulbactam, carbapenems, and fluoroquinolones. For *Pseudomonas aeruginosa*

isolates, MDR was defined as testing non-susceptible (i.e., either resistant or intermediate) to at least one drug in three of the five following antimicrobial groups: piperacillin or piperacillin/tazobactam, extended-spectrum cephalosporins (cefepime or ceftazidime), fluoroquinolones, aminoglycosides, and carbapenems.

Data Collection

Healthcare workers in ICUs screened patients for signs and symptoms of HAI during clinical rounds three days per week, and also by reviewing laboratory and radiology data. Personal digital assistants (PDAs) were used by healthcare workers as decision support devices to perform HAI surveillance. If an HAI was suspected, then information entered into the PDA about the patient's clinical signs and symptoms, microbiology results, and laboratory and radiology testing was run against an HAI case determination algorithm stored in the PDA to evaluate whether case criteria for an NHSN-defined HAI were met. PDA data were uploaded to NAMRU-3 weekly for review and analysis.

Up to four pathogens per HAI were recorded. Coagulase-negative *Staphylococcus* spp. and *Corynebacterium* spp. were only considered pathogens when isolated from sterile sites. For bloodstream infections specifically, "common commensal" organisms (e.g., coagulase-negative staphylococci, *Bacillus* spp.) were only considered pathogens if isolated from at least two blood cultures with signs or symptoms of a bloodstream infection, in accordance with NHSN criteria [13].

Denominator data (i.e., patient-days, central line-days, urinary catheter-days, and ventilator-days) were recorded daily by hospital staff on a denominator reporting form, which was sent to NAMRU-3 for electronic data entry.

Data validation

A team of CDC and NAMRU-3 staff reviewed medical records from three ICUs: one unit reporting a high HAI rate and two units reporting low rates. Medical records of all patients with a reported HAI and a random sample of controls (i.e., patients without an HAI reported) that were present in the selected ICUs during August 2011 were reviewed, for a total of up to 11 patients per ICU. Based on available clinical data, the reviewing team determined whether a patient met HAI case definitions. These decisions were considered to be the gold standard for comparison with reported HAI data.

Sensitivity was calculated as $\frac{(\#\text{ patients reported to have HAI})}{(\#\text{ patients reported to have HAI})+(\text{estimated }\#\text{ controls with HAI})}$. The estimated number of controls with HAI was calculated by

$$\frac{(\#\text{ of controls determined to have HAI})}{(\#\text{ of controls reviewed})} \times (\#\,\text{of all controls}).$$

Laboratory Testing

A convenience sample of isolates from HAI cases was sent to NAMRU-3 for verification of identification and antimicrobial resistance testing. All *Klebsiella* spp. and *Escherichia coli* isolates received by NAMRU-3 were tested for extended-spectrum beta-lactamase (ESBL) production by combination disk testing according to guidelines from the Clinical and Laboratory Standards Institute (CLSI). Inhibition of growth with ceftazidime and cefotaxime

disks was compared to ceftazidime/clavulanate and cefotaxime/clavulanate disks, respectively. Isolates were considered to be ESBL-producing if the combination disk increased the zone of inhibition by >5mm.

Data Analysis

Patient-days and device-days were pooled by ICU type and hospital. Device-utilization ratios were calculated as device-days divided by patient-days. Rates for device-associated infections were reported as the number of device-associated infections per 1,000 device days. Infection rates for other HAIs were reported as number of infections per 1,000 patient-days. Data analysis was performed using SAS 9.2 (SAS Institute Inc., Cary, NC).

Human Subjects

The project was approved by the NAMRU-3 Institutional Review Board as a non-research protocol.

Results

Characteristics of participants

During April 2011–March 2012, 46 ICUs in 11 hospitals (64% general, 18% pediatric, and 18% women's hospitals) reported HAI surveillance data over 90,515 patient-days (Table 1). A median of three ICUs from each hospital participated in HAI surveillance (range: 1–11).

Epidemiologic characteristics and outcomes of HAI cases

During the surveillance period, 472 HAIs were reported with an overall pooled mean incidence of 5.2 HAI/1,000 patient-days. The pooled mean incidence of HAI varied by ICU type, from 1.4 HAI/1,000 patient-days in adult/pediatric medical ICUs to 15.3 HAI/1,000 patient-days in burn ICUs (Table 1).

Pneumonia, primary bloodstream infections (BSI), and urinary tract infections (UTI) together accounted for 84% of all HAIs reported. Most pneumonia and UTI cases were device-associated. A minority of BSI (42%) were central line-associated (Figure 1). Of BSI, 71/103 (69%) occurred in patients <1 year old, of which 59/71 (83%) were laboratory-confirmed BSI and the remainder (12/71, 17%) clinical sepsis. Of the HAI case-patients identified, 43% died before discharge. In-hospital deaths within 7 days of infection onset, suggesting association between the infection and outcome, occurred in 20% of HAI case-patients (Table 2).

Device-associated infections

Device utilization ratios (DURs) for ventilators, urinary catheters, and central lines, and corresponding device-associated infection rates in participating ICUs, are summarized in Table 3. The highest device utilization was reported for urinary catheters (median DUR: 0.606). The highest pooled mean rate for device-associated infections was reported for ventilator-associated pneumonia (7.5 VAP/1,000 ventilator-days).

Rates of device-associated infections pooled by ICU type are shown in Table 4. The highest central line-associated blood infection (CLABSI) rates were reported in NICUs (5.1 CLABSI/1,000 central line-days).

Data validation

A total of 26 medical charts were reviewed for data validation: five from patients reported to have HAI and an additional 21 charts of controls. Of patients reported as having HAI, 5/5 (100%) were determined to have HAI on external chart review, and 2/21 (10%) of controls were also found to meet case definitions for HAI. The sensitivity of the system was estimated to be 41%.

Organisms causing HAI

Among all 472 HAI, a total of 523 organisms were identified (Table 5). Considering all HAI types together, *Acinetobacter* spp. were most commonly reported, accounting for 22% of all organisms, followed by *Klebsiella* spp. (18% of organisms) and *Pseudomonas aeruginosa* (16% of organisms); these were the same organisms reported most commonly for pneumonia cases. For BSI, *Klebsiella* spp. were most commonly reported (26% of organisms), followed by *Staphylococcus aureus* and coagulase negative staphylococci (14.6% of organisms each). In contrast, for UTI, *Candida* spp. were most commonly reported (47.6% of organisms), followed by *Pseudomonas aeruginosa* (13.4% of organisms).

Antimicrobial resistance

By June 2012, 168 clinical isolates from HAI cases had been processed for identification and antimicrobial susceptibility testing by NAMRU-3 (Table 6). All *Acinetobacter* spp. isolates tested were MDR and 84% were carbapenem-resistant. In addition 70% of *E. coli* and 71% of *Klebsiella pneumonia* isolates tested were ESBL-producing. Methicillin resistance was found in 93% of *S. aureus* isolates tested.

Discussion

HAI surveillance data are crucial for informing priorities for infection control. The surveillance data described in this report identify several priority areas for prevention. First, pneumonia, primary BSIs, and UTIs represented over 80% of HAIs reported and should be the focus for infection prevention (e.g., prevention of device-associated infections [17,18,19,20]) and continued surveillance efforts. The highest CLABSI rate was reported from NICUs, indicating an important target for CLABSI prevention. Second, gram-negative organisms were commonly associated with HAIs, and high rates of antimicrobial resistance were present in participating ICUs.

This report presents the first surveillance data across all HAI types from Egypt. Surveillance for surgical site infections was not performed in this pilot assessment; otherwise the distribution of HAI types reported was similar to that reported from recent HAI prevalence surveys from the US and Argentina [21,22]. The primary difference is that in the United States, gastrointestinal infection (mostly caused by *Clostridium difficile)* is one of the main

HAI types reported. In contrast, gastrointestinal infection and *C. difficile* do not appear to contribute substantially to the burden of HAIs in participating ICUs in Egypt.

Pneumonia was the most commonly identified HAI in this pilot surveillance system. However, in Argentina, only 45% of pneumonia cases reported were ventilator-associated, whereas from these Egyptian ICUs, most (85%) cases of pneumonia were ventilator-associated. Therefore, not only must proper attention be paid to prevention measures for healthcare-associated pneumonia in general [19], but specifically practices regarding the care and reprocessing of ventilator equipment should be evaluated closely in the context of VAP prevention measures [20].

Comparing rates of device-associated infections between the Egyptian pilot system and the US-based NHSN provides further support for making prevention of VAP a major priority. Rates of CAUTI and CLABSI reported from Egypt (1.7/1,000 device-days and 1.2/1,000 device-days, respectively) are comparable to NHSN rates reported for many ICU types. However, even though Egyptian ICUs reported less ventilator utilization than is reported in NHSN, the VAP rate of 7.5/1,000 ventilator-days from Egypt is markedly higher than the pooled mean rates reported from different ICU types in NHSN (range: 1.1–1.8 among medical ICUs, and 2.5–3.5 among surgical ICUs) [23].

Bloodstream infections were most commonly reported from NICUs; of these BSIs, the majority (83%) were laboratory-confirmed indicating that the high incidence of BSI in NICUs was not an artifact of the inclusion of the clinical sepsis definition. In the United States, high BSI rate in NICUs has been attributed in part to high utilization of invasive central lines, duration the lines are in place, and immaturity of the neonatal immune system [22]. Further exploration is needed in these Egyptian hospitals to characterize BSI occurring in the neonatal population and what preventive measures might reduce the burden of nosocomial BSIs in NICUs.

Acinetobacter spp. and *Pseudomonas aeruginosa*, two of the three most commonly reported organisms associated with HAI in Egypt, are notably gram-negative organisms that can persist in the patient care environment. In contrast, in NHSN, *S. aureus* is the most commonly reported pathogen, whereas *Acinetobacter baumannii* ranks only 14th among pathogens reported [16]. The predominance of organisms that may be commonly found in the patient care environment suggests that greater efforts at environmental infection control might play a critical role in reducing or preventing HAI transmission in Egypt.

Furthermore, high-level antimicrobial resistance was reported for an alarming proportion of isolates sent to NAMRU-3. These high rates of resistance are similar to those reported previously for device-associated infections in Cairo University Hospitals [9], with approximately 70% of *E. coli* and *K. pneumoniae* isolates tested being ESBL-producers. In contrast, in the United States, only approximately 20% of *E. coli* and *K. pneumoniae* isolates reported to the NHSN have extended-spectrum cephalosporin resistance. Resistance rates for other organisms are also substantially higher in Egypt. For instance, 100% of *Acinetobacter* spp. isolates from HAI in Egypt are multidrug-resistant versus approximately 70% in

NHSN; 93% of *S. aureus* isolates tested in Egypt were methicillin-resistant, compared to approximately 50% in NHSN [16].

Overall, high case-fatality rates were reported in association with HAI. Surprisingly, the highest case-fatality rate among HAI types was reported for urinary tract infections. The reason for this finding is not known. However, one possible explanation is that there might be a bias in Egyptian ICUs towards late clinical diagnosis of urinary tract infections; hence UTIs might be diagnosed either in patients with more severe underlying illness, or late in the course of infection with a more severe clinical course for the infection. In addition, baseline mortality rates for ICU patients are not available to use to determine the mortality attributable to HAI. However, the large proportion of deaths within seven days of diagnosis suggest HAIs could have an important role in excess mortality.

In summary, these surveillance data suggest that enhanced hospital environmental infection control, investigating the cause of bloodstream infections in NICUs, evaluation and improvement of ventilator equipment processing, stopping transmission of MDROs, and carefully evaluating antimicrobial use are critical needs in Egyptian hospitals.

HAI surveillance in the developing world is challenging because of limitations in both experience and resources. Two characteristics of the surveillance system used in this pilot project may have facilitated HAI case finding, data collection, and reporting. The PDAs programmed with HAI definitions helped surveillance staff apply definitions despite the complexity of the large number of HAI types under surveillance. Also, most staff performing surveillance focused on data collection in only one or two ICUs. Given that staff time is scarce in the developing world, distributing the workload of surveillance amongst healthcare workers might ease the burden on individual staff.

This analysis is subject to the following limitations. First, the hospitals and ICUs participating might not be representative of Egypt. For example, the hospitals enrolled in this pilot were required to meet minimum standards for surveillance (e.g., presence of a full-time infection control practitioner and a data manager); thus resources for case finding, data collection, and reporting in participating hospitals may surpass resources available in non – participating hospitals. Second, only a limited number of isolates were available for antimicrobial susceptibility testing. However, as noted, results from antimicrobial resistance are similar to other reports from Egypt. Third, these results likely underestimate the true HAI burden. Data validation efforts suggested a low sensitivity for detection of HAI, which likely stems from several factors: (1) case definitions are complex and healthcare workers were unfamiliar with definitions prior to the start of surveillance; (2) owing to limitations in resources, occasionally microbiology and laboratory testing becomes temporarily unavailable; and (3) in Egypt there is widespread use of empiric antimicrobial therapy and limited use of the clinical microbiology laboratory for therapeutic decision making as compared to the United States. Indeed, factors (2) and (3) might contribute to why pneumonia, which can be identified without positive culture results, was reported more often than either urinary tract infections or bloodstream infections, which do require laboratory confirmation. Nevertheless, during data validation all reported HAI cases were found to satisfy surveillance criteria for HAI.

Resource limitations create challenges with HAI surveillance in Egypt. To adapt surveillance to these realities, one option would be to modify surveillance definitions to include more syndromic detection of HAI (i.e., fewer requirements for laboratory testing). However, given the high rates of antimicrobial-resistant pathogens isolated, increased awareness that microbiology data are necessary to guide clinician decisions is critical. Moreover, even if more syndromic definitions were implemented, further development in hospital infrastructure might still be needed to allow expansion of HAI surveillance to other hospitals.

This pilot surveillance system demonstrates that despite the challenges experienced during this pilot, implementing HAI surveillance in Egypt is feasible and can identify priorities for intervention. This system represents an important step towards ensuring safety of patients in Egyptian hospitals. Continuing HAI surveillance can only improve awareness of the need for control of HAI in Egypt and spur efforts towards global HAI elimination.

Acknowledgments

We would like to thank the following people for their invaluable assistance coordinating the implementation of the pilot surveillance system: Elham Feky, Hanan El Sayed, Mona Mohiedden (Cairo University Hospitals); Magda Hanafi (Ain Shams University Hospitals); Elham Hassan, Eman Ahmed, Manal Elnawasany, Ayad El Sayed (Alexandria University Hospitals); and Sally Mohamed, Mohamed Hamdy, Magdy Abdu (Ministry of Health and Population).

Financial support. This work was supported by the United States Agency for International Development, (USAID), Work Unit 263-P-00-10-00005-00. The authors wish to thank Drs. Randy Kolstadt and Akmal El-Erian for their support during the conduct of this work.

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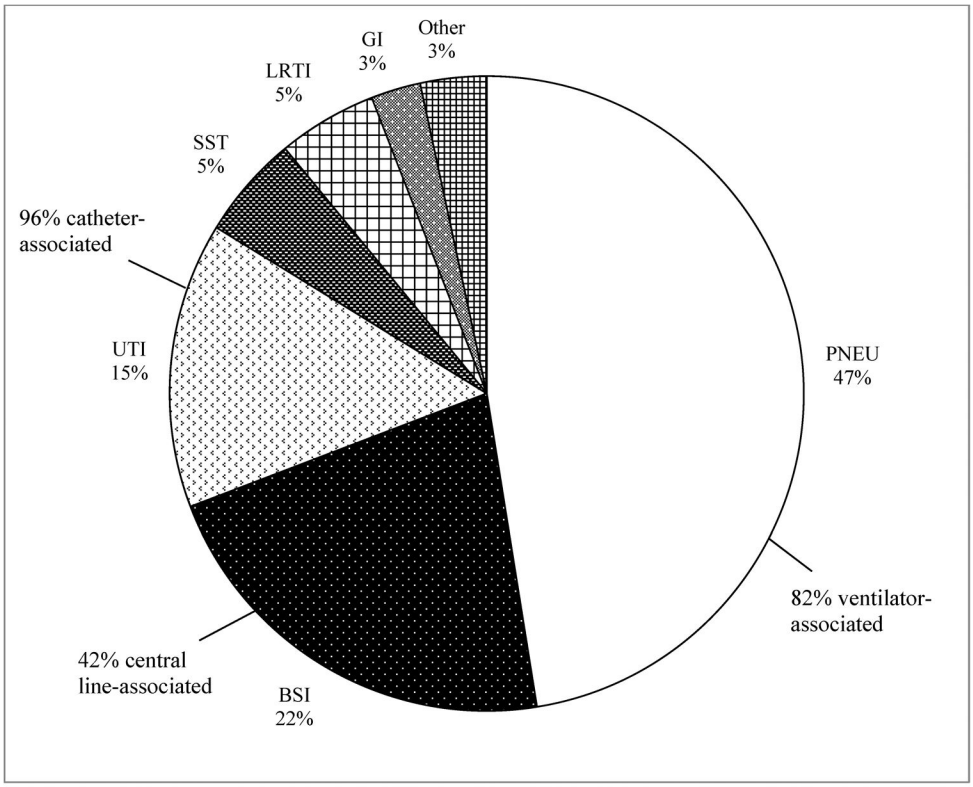

Figure 1.

Distribution of healthcare-associated infection types reported, Egypt, 2011–2012 (N=472). *PNEU*, pneumonia; *BSI*, bloodstream infection; *UTI*, urinary tract infection; *SST*, skin and soft tissue infection; *LRI*, lower respiratory tract infection; *GI*, gastrointestinal tract infection. Other infection types include bone and joint infection; central nervous system infection; cardiovascular system infection; eye, ear, nose, throat and mouth infection; and reproductive system infection.

Table 1

Description of types and number of ICUs, ICU beds, patient-days and healthcare-associated infections (HAI) reported for each type of ICU, and pooled mean HAI incidence for each ICU type.

Type of ICU	Units participating, n	Total beds, n	Total patient days, n	HAI reported, n	Pooled mean incidence HAI/1,000 patient days
Adult medical	13	126	23,198	60	2.6
Adult med/surg	3	25	2,204	15	6.8
Adult surgical	5	45	6,594	16	2.4
Adult/ped medical	1	5	1,471	2	1.4
Adult/ped med/surg	3	41	11,111	143	12.9
Adult/ped surgical	7	42	7,705	76	9.9
Burn	1	14	654	10	15.3
NICU	8	113	28,310	105	3.7
Pediatric medical	4	26	7,043	26	3.7
Pediatric surgical	1	30	2,225	19	8.5
Total	46	459	90,515	472	5.2

NICU, neonatal intensive care unit

Table 2

Demographic characteristics and clinical outcomes of cases of healthcare-associated infections reported, Egypt, 2011–2012.

	n (%)			
Variable	**All HAI (N=472)**	**PNEU (N=225)**	**BSI (N=103)**	**UTI (N=69)**
Male sex*	269 (57)	130 (58)	55 (53)	40 (58)
Age range† (years)				
< 1	132 (28)	44 (20)	71 (69)	2 (3)
1–4	26 (6)	11 (5)	4 (4)	2 (3)
5 – 17	45 (10)	29 (13)	5 (5)	6 (9)
18 – 44	100 (21)	47 (21)	10 (10)	27 (39)
45 – 64	103 (22)	52 (23)	7 (7)	24 (35)
≥65	62 (13)	41 (18)	3 (3)	8 (12)
Outcome				
Died	203 (43)	95 (42)	40 (39)	32 (46)
Death within 7 days	95 (20)	38 (17)	20 (19)	20 (29)
Discharged	91 (19)	29 (13)	37 (36)	11 (16)
Transfer to another hospital	13 (3)	8 (4)	4 (4)	1 (1)
Transfer within hospital	70 (15)	37 (16)	7 (7)	12 (18)
Unknown	95 (20)	56 (25)	15 (15)	13 (19)

PNEU, pneumonia; *BSI*, bloodstream infection; *UTI*, urinary tract infection

*Sex not reported for 7 cases.

†Age not known for 4 cases (1 case of PNEU, 3 cases of BSI).

Table 3

Pooled mean device utilization ratios (DUR) and device-associated infection (DAI) rates across all participating ICUs, Egypt, 2011–2012. Total patient-days=90,515.

DAI type	Device-days, n	Pooled mean DUR	Percentiles for DUR			DAI cases reported, n	DAI rate/1,000 patient-days	DAI rate/1,000 device-days
			25%	50%	75%			
VAP	24,638	0.27	0.09	0.24	0.36	184	2.03	7.47
CLABSI	34,442	0.39	0.17	0.43	0.67	43	0.48	1.25
CAUTI	37,969	0.42	0.19	0.61	0.88	66	0.73	1.74

CLABSI, central line-associated bloodstream infection; *VAP*, ventilator-associated pneumonia; *CAUTI*, catheter-associated urinary tract infection. DUR=device-days/patient-days. DUR and DAI calculated by pooling data across all participating ICUs.

Table 4

Device-associated infection rates by intensive care unit (ICU) type, Egypt, 2011–2012. Rates calculated as HAI/1,000 device-days.

ICU type	ICUs, n	Central line-days	CLABSI rate	Ventilator-days	VAP rate	Urinary catheter-days	CAUTI rate
Adult medical	13	7,500	0.93	3,488	4.0	11,635	0.9
Adult med/surg	3	1,320	1.52	649	9.2	1,748	1.1
Adult surgical	5	3,456	0.29	1,109	9.0	5,398	0
Adult/ped med/surg	3	6,813	0.73	5,767	14.2	9,007	3.6
Adult/ped surgical	7	5,541	0.54	2,804	10.3	5,739	2.3
NICU	8	3,515	5.12	6,097	3.3	–	–
Pediatric medical	4	2,946	2.38	2,984	2.0	1,343	0

CLABSI, central line-associated bloodstream infection; *VAP*, ventilator-associated pneumonia; *CAUTI*, catheter-associated urinary tract infection; *NICU*, neonatal intensive care unit. ICU types only included if > 500 device-days were reported and > 1 ICU of the given type reported data (3 ICU types did not meet these criteria and were excluded). Urinary catheter-days and CAUTI rate not applicable for NICU.

Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2015 December 31.

Table 5

Pathogens reported during surveillance for healthcare-associated infections (HAI), Egypt, 2011–2012 (N = 523 organisms reported from 350/472 HAI)

	% of organisms reported (rank order)			
Organism	**All HAI (N=523)**	**PNEU (N=295)**	**BSI (N=96)**	**UTI (N=82)**
Acinetobacter spp.	21.8 (1)	30.2 (1)	12.5 (4)	6.1 (4)
Klebsiella spp.	18.4 (2)	18.3 (2)	26.0 (1)	7.3 (3)
Pseudomonas aeruginosa	15.7 (3)	17.6 (3)	8.3 (5)	13.4 (2)
Staphylococcus aureus	12.4 (4)	14.9 (4)	14.6 (2)	2.4 (8)
Candida spp.	9.4 (5)	0 (NA)	8.3 (5)	47.6 (1)
Escherichia coli	5.4 (6)	5.8 (5)	0 (NA)	6.1 (4)
Enterobacter spp.	3.3 (7)	2.7 (7)	4.2 (7)	3.7 (7)
Coagulase negative staphylococcus	3.1 (8)	0 (NA)	14.6 (2)	1.2 (9)
Proteus spp.	2.5 (9)	3.7 (6)	0 (NA)	1.2 (9)
Enterococcus spp.	2.3 (10)	1.0 (9)	4.2 (7)	6.1 (4)
Other*	5.9	5.8	7.3	4.9

PNEU, pneumonia; *BSI*, bloodstream infection; *UTI*, urinary tract infection. At least one organism was reported for 350/472 HAI, including 168/225 PNEU, 83/103 BSI, and 66/82 UTI.

* "Other" includes 11 different organisms.

Table 6

Antimicrobial resistance patterns for clinical isolates of HAI cases received by NAMRU-3, selected pathogens, 2011–2012 (168 isolates processed in total)

Pathogen/Resistance class	Isolates received, n	Isolates resistant, n (%)
Staphylococcus aureus	27	
Methicillin resistance		25 (93)
Escherichia coli	10	
ESBL production		7 (70)
Carbapenem resistance		none
Klebsiella pneumonia	24	
ESBL production		17 (71)
Carbapenem resistance		5 (21)
Acinetobacter spp.	31	
Multidrug resistance		31 (100)
Carbapenem resistance		26 (84)
Pseudomonas aeruginosa	23	
Multidrug resistance		13 (57)

NAMRU-3, Naval Medical Research Unit-3; *ESBL*, extended-spectrum beta-lactamase. Multidrug resistance defined for *Acinetobacter* spp. and *P. aeruginosa* as described in the Methods section.