HEALTHCARE-ASSOCIATED INFECTIONS AT SELECTED HOSPITALS IN THAILAND

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Abstract. This study aimed to determine the prevalence of healthcare-associated infections (HAIs), all-cause mortality, document the bacterial pathogens isolated in HAIs, and determine the risk factors associated with HAIs and all-cause mortality at selected hospitals in Thailand. A survey with a total time frame of 10 days was conducted at selected 50 hospitals across Thailand during January 2014: 19 primary government hospitals, 15 secondary government hospitals, 13 tertiary government hospitals, 2 private hospitals and 1 government university hospital. Of 15,475 cases reviewed, 688 patients had 791 HAIs (1.1 HAI per infected patient). The rate of HAI was 4.4% (95%CI: 4.1-4.8): 7.3% (95%CI: 4.6-9.3) at the university hospital surveyed, 5.0% (95%CI: 4.6-5.4) at the tertiary hospitals surveyed, 3.9% (95%CI: 3.4-4.6) at the secondary hospitals surveyed, 2.0% (95%CI: 1.3-2.7) at the primary hospitals surveyed, and 1.6% (95%CI: 0.5-2.8) at the private hospitals surveyed. The ward with the frequent number of HAI was the intensive care unit (17%). The two most commonly affected age ranges were those aged >60 years and <1 year. Of the 791 HAIs found in this survey, the 3 most frequently reported types of HAI were: respiratory tract infections (n=377, 48%), urinary tract infections (n=176, 22%) and surgical site infections (n=55, 7%). Of the 688 patients with a HAI, 24% died within three months of this survey. The most frequently reported bacterial pathogen was *Acinetobacter* species (17%). On multivariate analysis, HAIs were significantly associated with patient age <1 year, a university hospital, having major surgery, urinary catheterization, being on a respiratory ventilator, having a tracheostomy, and having central venous catheterization (p <0.05). Death was associated with patient age <1 year, a university hospital, being on a surgical or medical ward, being on a ventilator, and having a central venous catheter (p <0.05). HAIs are major public health problems in the studied hospitals and result in substantial mortality.

Keywords: healthcare-associated infections, prevalence, Thailand

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INTRODUCTION

Hospital-associated infections (HAIs) are a major problem worldwide. They cause substantial morbidity, mortality, and financial cost (Klevens *et al*, 2007; Plowman *et al*, 2001). Most studies of HAIs are done in high-income countries.

The prevalence of HAIs among some high-income countries is less than 7.0% (Scheel and Stormark, 1999; Vaque *et al*, 1999; Zarb *et al*, 2012; Magill *et al*, 2014). The prevalence of HAIs in a multi-state survey conducted in the United States in 2010 was 4.0% (Magill *et al*, 2014). The European Center for Disease Prevention and Control reported a HAI prevalence in Europe of 6.0% during 2011-2012 (ECDC, 2014). Data for HAIs in low- and middle-income countries is limited. The World Health Organization reported a high prevalence burden of HAIs in low- and middle- income countries, especially in the intensive care unit and among neonates (WHO, 2010). The frequency of overall infections in the intensive care unit has been reported to be as high as 42.7 episodes per 1,000 patient-days (WHO, 2010). Among hospital-born babies, HAIs are responsible for 4% to 56% of all causes of death in the neonate (WHO, 2010). The rate of device-associated infections in the low- and middle-income countries has been reported to be 13 times greater than in high-income countries (WHO, 2010). Risk factors associated with HAIs include: insufficient application of standard precautions, immuno-suppressed patients and inappropriate use of antibiotics and devices (WHO, 2010).

A number of nationwide surveys of the prevalences of HAIs have been conducted in Thailand. The reported prevalences of HAIs range from 7.3% to 11.7% (Danchaivijitr and Chokloikaew, 1989; Danchaivijitr *et al*, 2007; Rongrungruang *et al*, 2013). HAIs are preventable. They result in increased cost, morbidity and mortality. Monitoring the occurrence of and factor associated with HAIs is important to develop preventive programs, guidelines and policies. We aimed to study the prevalences of HAIs, determine all-cause mortality, document the bacterial pathogens isolated in HAIs, and determine the risk factors associated with HAIs and all-cause mortality.

MATERIALS AND METHODS

We conducted a secondary data analysis from a survey of HAIs over a 10 day period at 50 hospitals in Thailand during January 2014: 19 primary government hospitals, 15 secondary government hospitals, 13 tertiary government hospitals, 2 private hospitals, and 1 government university hospital. The primary objective of the study was to survey the prevalence and types of hospital-associated infections at selected hospitals from each of the region in Thailand. The prevalence of HAIs was defined as the percentage of patients with at least one HAI divided by the total number of patients at the surveyed hospitals. The secondary objectives of the study were to determine: (1) all-cause mortality among patients with a HAI, (2) determine the risk factors associated with HAIs and all-cause mortality, and (3) determine the bacterial pathogens isolated from patients with HAIs. The rates of HAIs and types of isolated bacterial pathogens were reported using the total number of HAIs as the denominator.

The hospitals sampled were selected based on their sizes and disease prevention and control areas. At least one tertiary hospital, two secondary hospitals, and 3 primary hospitals in thirteen disease prevention and control regions were sampled and selected to participate as shown in Table 1. The hospital type categories were defined. The tertiary hospitals refers to the hospitals located in provincial capitals, having a capacity of at least 500 beds and a comprehensive set of specialists on staff or a specialty hospital. Secondary hospitals

Table 1
Number of selected hospitals and disease prevention and control regions.

Disease prevention and control regions	Tertiary government hospitals	Secondary government hospitals	Primary government hospitals	Private hospitals	Government university hospital
Region 1	1	2	1	2	1
Region 2	1	2	3	-	-
Region 3	2	1	1	-	-
Region 4	1	1	3	-	-
Region 5	1	0	1	-	-
Region 6	1	1	1	-	-
Region 7	1	1	1	-	-
Region 8	1	0	2	-	-
Region 9	1	2	2	-	-
Region 10	1	1	1	-	-
Region 11	1	1	3	-	-
Region 12	1	2	1	-	-
Total	13	14	20	2	1

are located in provincial capitals or major districts and have a capacity of 200 to 500 beds. Primary hospitals are located in districts and have a capacity of <150 beds.

Infection control nurses from each participating hospital received 2-day training in the protocol and standardized case definitions of HAIs, derived from the US Centers for Disease Control and Prevention surveillance definition of HAIs (CDC, 2014). Data from each studied ward was collected during a single day. The total survey time was 10 days. The patients with HAIs were followed for three months after study survey. Data about the patients, wards admitted, HAIs and antibiotic used were retrieved from the medical records and reviewed.

All statistical analyses were conducted using STATA, version 11.0. Means [± standard deviations, (SD)], medians [interquartile range (IQR) from the 25th and 75th percentiles] and frequencies (%) were used to describe variables. The chi-square and Mann-Whitney *U* tests were used to compare categorical and continuous variables between the two groups, *ie*, patients with and without HAIs, respectively. Risk factors associated with HAIs and all-cause mortality were evaluated with binary logistic regression models adjusting for confounding factors. A *p*-value <0.05 was considered statistically significant.

This study was reviewed and approved by the ethics committees of the Bamrasnaradura Infectious Diseases Institute, Department of Disease Control, Ministry of Public Health. Appropriate authorities of the private hospital and public sector hospitals approved the survey at their respective sites.

RESULTS

Of the 15,475 cases reviewed, 688 patients had 791 HAIs. The prevalence of patients with at least one hospital-associated infection was 4.4% (95%CI: 4.1-4.8): 7.3% (95%CI: 4.6-9.3) at the government university hospital, 5.0% (95%CI: 4.6-5.4) at the tertiary government hospitals, 3.9%

Table 2
Selected variables and healthcare-associated infections.

Characteristics	Total = 15,475 Number (%)	Healthcare-associated infections Yes Total = 688 Number (%)	Healthcare-associated infections No Total = 14,787 Number (%)	*p*-value comparing those with and without a HAI
Age in years				<0.001
<1	1,500 (9.7)	72 (10.5)	1,428 (9.7)	
1-17	1,540 (10.0)	42 (6.1)	1,498 (10.1)	
18-24	852 (5.5)	20 (2.9)	832 (5.6)	
25-60	6,022 (38.9)	207 (30.1)	5,815 (39.3)	
>60	5,561 (35.9)	347 (50.4)	5,214 (35.3)	
Sex				0.004
Male	7,901 of 15,475 (51.1)	388 (56.4)	7,513 (50.8)	
Female	7,574 of 15,475 (48.9)	300 (43.6)	7,274 (49.2)	
Hospital type				<0.001
Primary government	1,464 (9.5)	29 (4.2)	1,435 (9.7)	
Secondary government	3,667 (23.7)	145 (21.1)	3,522 (23.8)	
Tertiary government	9,407 (60.8)	473 (68.8)	8,934 (60.4)	
University government	453 (2.9)	33 (4.8)	420 (2.8)	
Private	484 (3.1)	8 (1.2)	476 (3.2)	
Patient wards				<0.001
Intensive care unit	687 (4.4)	117 (17.0)	570 (3.9)	
Medicine ward	5,030 (32.5)	230 (33.4)	4,800 (32.5)	
Surgical ward	3,176 (20.5)	152 (22.1)	3,024 (20.5)	
Other wards	6,582 (24.2)	189 (52.1)	6,393 (56.3)	
Medical procedures				<0.001
Urinary catheterization				
No	11,624 of 15,091 (77.0)	281 (41.7)	11,343 (78.7)	
Yes	3,467 of 15,091 (23.0)	393 (58.3)	3,074 (21.3)	
Respiratory ventilator				<0.001
No	13,019 of 15,005 (86.8)	293 (43.3)	12,726 (88.8)	
Yes	1,986 of 15,005 (13.2)	383 (56.7)	1,603 (11.2)	
Endotracheal intubation				<0.001
No	13,076 of 14,992 (87.2)	328 (48.4)	12,478 (89.1)	
Yes	1,916 of 14,992 (13.2)	349 (51.6)	1,567 (10.9)	
Tracheostomy tube				<0.001
No	14,393 of 14,912 (96.5)	478 (72.9)	13,915 (97.6)	
Yes	519 of 14,912 (3.5)	178 (27.1)	341 (2.4)	
Central venous catheterization				<0.001
No	14,871 of 15,470 (96.1)	532 (77.6)	14,339 (97.0)	
Yes	599 of 15,470 (3.9)	154 (22.4)	445 (3.0)	
Surgical procedure				<0.001
No	11,625 of 15,213 (76.4)	424 (62.4)	11,201 (77.1)	
Yes	3,588 of 15,213 (23.6)	256 (37.6)	3,332 (22.9)	

Table 3
Univariate and multivariare analysis for the factors associated with hospital-acquired infections.

Risk factors	Univariate analysis			Multivariate analysis		
	OR	95%CI	*p*-value	OR	95%CI	*p*-value
Age in years			<0.001			0.003
<1	1.00			1.00		
1-17	0.56	0.38 - 0.82		0.62	0.39 - 0.97	
18-24	0.48	0.29 - 0.79		0.49	0.28 - 0.87	
25-60	0.71	0.54 - 0.93		0.58	0.40 - 0.85	
>60	1.32	1.02 - 1.71		0.78	0.54 - 1.14	
Sex			0.001			0.144
Male	1.00			1.00		
Female	0.80	0.69-0.93		0.88	0.74-1.05	
Hospital type			<0.001			0.012
Primary government	1.00			1.00		
Secondary government	2.04	1.36 - 3.05		1.07	0.69 - 1.65	
Tertiary government	2.62	1.79 - 3.83		1.14	0.76 - 1.72	
University government	3.89	2.33 - 6.48		1.78	1.02 - 3.10	
Private hospitals	0.83	0.38 - 1.83		0.45	0.19 - 1.03	
Patient wards			<0.001			0.397
Intensive care unit	1.00			1.00		
Medicine ward	0.23	0.18 - 0.30		1.27	0.93 - 1.73	
Surgical ward	0.24	0.19 - 0.32		1.06	0.77 - 1.46	
Others	0.14	0.11 - 0.18		1.17	0.83 - 1.63	
Medical procedures			<0.001			<0.001
Urinary catheterization						
No	1.00			1.00		
Yes	5.16	4.41 - 6.05		2.03	1.62 - 2.54	
Respiratory ventilator			<0.001			<0.001
No	1.00			1.00		
Yes	10.37	8.84 - 12.19		2.56	1.64 - 4.00	
Endotracheal intubation			<0.001			0.096
No	1.00			1.00		
Yes	8.66	7.38 - 10.15		1.43	0.94 - 2.17	
Tracheostomy tube			<0.001			<0.001
No	1.00			1.00		
Yes	15.2	12.41 -18.61		5.15	3.98 - 6.67	
Central venous catheterization				<0.001		<0.001
No	1.00			1.00		
Yes	9.33	7.62 - 11.42		2.86	2.21 - 3.70	
Surgery			<0.001			<0.001
No	1.00			1.00		
Yes	2.03	1.73 - 2.38		1.61	1.29 - 2.01	

(95%CI: 3.4-4.6) at the secondary government hospitals, 2.0% (95%CI: 1.3-2.7) at the primary government hospitals, and 1.6% (95%CI: 0.5-2.8) at the private hospitals.

Table 2 shows the baseline characteristics of HAIs. The 3 types of hospital wards with the most frequently reported hospital-associated infection were the in-

Table 4
Univariate and multivariare analysis for the factors associated with death.

Risk factors	Univariate analysis			Multivariate analysis		
	OR*	95%CI**	*p*-value	OR	95%CI	*p*-value
Age in years			0.082			0.0034
<1	1.00			1.00		
1-17	0.22	0.07 - 0.70		0.05	0.01 - 0.27	
18-24	0.71	0.13 - 3.99		0.29	0.03 - 2.48	
25-60	0.60	0.22 - 1.63		0.17	0.04 - 0.77	
>60	0.48	0.18 - 1.24		0.17	0.04 - 0.74	
Sex			0.494			0.365
Male	1.00					
Female	0.80	0.55 - 1.33		0.78	0.45 - 1.34	
Hospital type			<0.001			<0.001
Primary government	1.00			1.00		
Secondary government	0.27	0.09 - 0.83		0.17	0.05 - 0.61	
Tertiary government	2.34	0.76 - 2.00		1.84	0.53 - 6.40	
University government	2.58	0.44 - 15.30		1.33	0.20 - 8.92	
Patient wards			0.013			0.004
Intensive care unit	1.00			1.00		
Medicine ward	1.63	0.90 - 2.96		3.14	1.35 - 7.29	
Surgical ward	3.41	1.55 - 7.50		5.20	1.78 - 15.24	
Others	1.39	0.75 - 2.55		1.70	0.67 - 4.32	
Medical procedures			0.043			0.386
Urinary catheterization						
No	1.00			1.00		
Yes	0.62	0.39 - 0.99		0.73	0.37 - 1.47	
Respiratory ventilator			0.738			0.005
No	1.00			1.00		
Yes	1.08	0.69 - 1.69		11.13	2.09 - 59.16	
Endotracheal intubation			0.791			0.078
No	1.00			1.00		
Yes	0.94	0.60 - 1.47		0.23	0.05 - 1.18	
Tracheostomy tube			0.009			0.095
No	1.00			1.00		
Yes	0.53	0.33 - 0.84		0.54	0.26 - 1.11	
Central venous catheterization			0.007			0.042
No	1.00			1.00		
Yes	0.51	0.32 - 0.82		0.48	0.23 - 0.97	
Surgery			0.091			0.212
No	1.00			1.00		
Yes	1.51	0.93 - 2.46		1.53	0.79 - 2.96	

tensive care units (17.0%), surgical wards (4.8%) and medicine wards (4.6%). The age ranges for those with the most HAIs were >60 years old (6.2%), <1 year old (4.8%), and 25-60 years (3.4%). Of the 791 HAIs found, the three most frequent types were: respiratory tract infections (*n*=377, 47.7%), urinary tract infections (*n*=176, 22.2%) and surgical site infections (*n*=55, 6.9%).

Fig 1 shows the patient outcome at 3

months after the survey date. Of the 688 patients with a hospital-associated infection, 24% had died by three months.

The three most frequently reported bacterial pathogens were *Acinetobacter* species (17.3%), *Pseudomonas aeruginosa* (9.6%), and *Klebsiella* species (9.4%).

Tables 3 and 4 show the univariate and multivariate analyses for the factors associated with HAIs and death, respectively. Multivariate analysis showed having HAIs was significantly associated with patient age <1 year, being at the university hospital, having had major surgery, urinary catheterization, being on a ventilator, having a tracheostomy tube, and having a central venous catheter (all p <0.05). Death was associated with patient age <1 year, being at the university hospital, being on a surgical or medicine ward, being on a respiratory ventilator, and having a central venous catheter (all p <0.05).

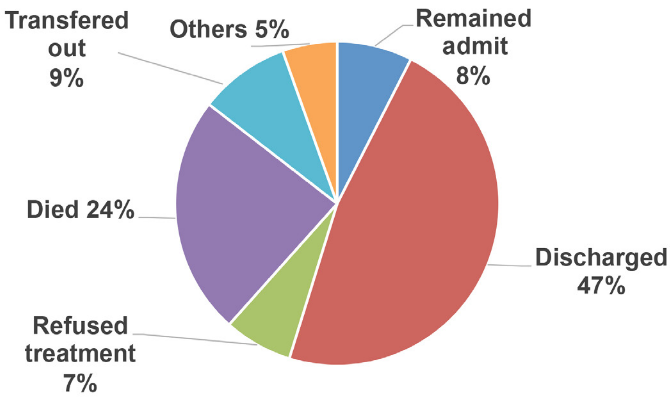

Fig 1–Clinical outcomes within 3 months of the date of survey among patients with hospital-associated infections.

DISCUSSION

Monitoring HAIs is mandatory to determine the effectiveness of national policies and programs for infection control. In the present survey, the prevalence of inpatients with at least 1 hospital-associated infection was 4.4%. This figure is comparable to that of some from high-income countries (4.0-7.1%) (Zarb *et al*, 2012; Magill *et al*, 2014). The prevalence found in our study is lower than that of studies from Thailand in 1988 (11.7%), 2006 (6.5%) and 2011 (7.3%) (Danchaivijitr and Chokloikaew, 1989; Danchaivijitr *et al*, 2007; Rongrungruang *et al*, 2013).

HAIs are challenging to manage in low- and middle- income countries because of limited finances, non-sustainable infection control policies and lacking of adequately trained medical staff (Burke, 2003; Lynch *et al*, 2007; Raka, 2010). In Thailand, there has been a decrease in HAIs over the past decade (Danchaivijitr and Chokloikaew, 1989; Rongrungruang *et al*, 2013). This could be due to programs and policies currently implemented to decrease them.

The three most common HAIs in our study were respiratory tract infections, urinary tract infections and surgical site infections. This finding is consistent with another study from Thailand (Rongrungruang *et al*, 2013). One-forth of the patients in this study with HAIs died within three months of the survey. This figure is high; we did not determine the etiologies of these deaths. One factor associated with death was being a neonate. Having a low birth weight has been found to be a factor strongly associated with HAIs (Goldmann *et al*, 1983; Auriti *et al*, 2010).

The most frequently isolated bacterial infection in HAIs in our study was *Acinetobacter* species. Over the past decade, the frequency of *Acinetobacter*, especially multidrug-resistant strains, has been increasing worldwide (Karageorgopoulos and Falagas, 2008; Maragakis and Perl, 2008). Outbreaks of this pathogen have been reported, most commonly in the intensive care units (Karageorgopoulos and Falagas, 2008; Maragakis and Perl, 2008). Extensive environmental contamination has been demonstrated in numerous outbreaks (Weber *et al*, 2010). Enhanced environmental cleaning and disinfection have often been part of intervention programs for controlling *Acinetobacter* outbreaks (Weber *et al*, 2010). Interventions emphasizing hand hygiene, contact precautions for colonized or infected patients are needed (Weber *et al*, 2010). Recent reports from high-income countries found *Clostridium difficile* was the most common pathogen causing HAIs (Zerey *et al*, 2007; Dubberke *et al*, 2010). The incidence of this pathogen has increased among patients with emergency operations and among patients with intestinal tract resections (Zerey *et al*, 2007).

In summary, the prevalence of HAIs was 4.4% in our survey of selected hospitals in Thailand. Respiratory tract infections were the most commonly infected site. The patient age <1 year, a university hospital, being on a surgical or medical ward, being on a ventilator, and having a central venous catheter were found to be associated with high mortality. *Acinetobacter* was the most common bacterial pathogen isolated among those with a HAI in our study. HAIs are major public health problems in the studied hospitals and result in substantial mortality.

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