Original Article

Prevalence and Risk Factors of Healthcare-Associated Infections in Thailand 2018: A Point-Prevalence Survey

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Background: Healthcare-associated infections (HAIs) are one of the most important challenges in contemporary medicine. Surveillance of HAIs is essential for infection control programs and reduction of HAIs.

Materials and Methods: A national point prevalence survey was conducted in accordance with the protocol of the HAIs Control Group of Thailand between 19 and 23 February, 2018 in 37 randomly selected hospitals across Thailand. Thailand's protocol followed the United States of America's Centers for Disease Control and Prevention surveillance definition of HAIs.

Results: There were 12,643 patients admitted to the participating hospitals. The point prevalence of HAIs was 4.2% (528/12,643, 95% CI 3.82 to 4.54). The highest prevalence of HAIs was observed in patients younger than one year (4.6%, 95% CI 3.36 to 5.88) and older than 60 years (5.9%, 95% CI 5.24 to 6.60) at government university hospitals (5.4%, 95% CI 4.37 to 6.35) and in intensive care units (ICU) wards (14.6%, 95% CI 11.60 to 17.60). The most common procedures associated with HAIs were tracheostomy (27.3%, 95% CI 22.86 to 31.78), central line (17.6%, 95% CI 13.70 to 21.44), endotracheal tube (13.8%, 95% CI 11.83 to 15.85), and urinary catheter (9.6%, 95% CI 8.55 to 10.73). Multivariate analysis showed HAIs were significantly associated with patient younger than one year, government university hospital, government tertiary hospital, government secondary hospital, treatment in ICU, having urinary catheterization, central line, having a tracheostomy, on respirator, and surgery management (all $p<0.05$). The most common HAIs were ventilator-associated pneumonia (26.9%), followed by non-ventilator-associated pneumonia (19.0%), catheter-associated urinary tract infection (13.5%), and surgery site infection (11.2%). The most common causative bacteria were gram-negative bacteria, of which *Klebsiella pneumoniae* (18.5%) was the most common, followed by *Acinetobacter baumannii* (17.8%) and *Pseudomonas aeruginosa* (12.6%).

Conclusion: The point prevalence of HAIs was 4.2% with a decreasing trend. Pneumonia and gram-negative bacteria were prominent problems among inpatients. Continued efforts to prevent and control HAIs are effective and should be further strengthened.

Keywords: Healthcare-associated infections, Prevalence, Thailand, 2018

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Globally, hundreds of millions of people are affected every year by avoidable Healthcare-associated infections (HAIs)[1]. A worldwide estimate indicated more than 1.4 million people suffer from infections acquired in hospitals, and such risk is 2 to 20 times higher in developing countries. HAIs accounted for 16 million additional hospital stays in Europe with an estimated total cost of €7 billion while HAIs in the United States of America's healthcare system cost an estimated \$30 to \$45 billion each year[2-5]. The overall burden of HAIs remains high although efforts in infection prevention and control (IPC) have resulted in HAIs reduction in some countries[6]. HAIs are extremely high and contribute to prolonged hospital stays, long-term disability, increased resistance of microorganisms to antimicrobials, massive additional financial burden for health systems, high costs for patients and their family, and unnecessary deaths[7-9].

As early as 1981, a group of World Health

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Organization (WHO) experts recommended the use of national point prevalence survey (PPS) as a tool to estimate the global burden of HAIs[10]. According to the WHO, 7% of patients in developed countries and 16% in developing countries have at least one HAI at any one time during hospitalisation with a mortality rate estimated at 10%[2]. A number of Thai national surveys of the prevalence of HAIs have been conducted that reported prevalences of HAIs ranging from 4.4% to 11.7%[11-14].

Ventilator-associated pneumonia (VAP), central-line-associated blood stream infections (CLABSI), and catheter-related urinary tract infection (CA-UTI) are all considered as the principal contributors to healthcare hazard and as threats to patient safety[15,16]. The United States of America's Centers for Disease Control and Prevention (U.S. CDC) focus on monitoring and preventing CLABSI, CA-UTI, and VAP because they are important threats to patient safety[17].

The objective of the present Thai national PPS was to estimate the prevalence of HAIs and to identify the risk factors of HAIs and their pathogens in 37 randomly selected hospitals in Thailand.

Materials and Methods

Study design

The present national PPS study was conducted among all patients admitted to 37 randomly selected hospitals between 19 and 23 February, 2018 in Thailand. The primary study objective was to determine the prevalence of HAIs. The secondary study objectives were to identify the risk factors associated with HAIs and their pathogens.

Thailand is divided into the five regions, northern Thailand, northeastern Thailand, eastern Thailand, central Thailand and southern Thailand. Three criteria were used to frame the sample, 1) inclusion of at least one tertiary hospital, two secondary hospitals, and three to four primary hospitals in each of the five regions of the country; 2) inclusion of at least one government university hospital and one private hospital in Thailand, both of which were randomly selected, and 3) inclusion only if the hospitals had a fully operational infection control team (ICT). The participating hospitals were as follows, Chiangrai Prachanukroh Hospital, Chiang Khong Crown Prince Hospital, Chiangsaen Hospital, Phrae Hospital, Chiang Kham Hospital, Sukhothai Hospital, Pichit Hospital, Saraburi Hospital, Angthong Hospital, Viset Chai Chan Hospital, Kasemrad International Rattanatibeth Hospital, Bamrasnaradura Infectious Diseases Institute, Photharam Hospital, Makarak Hospital, Nakhon Pathom Hospital, Prapokklao Hospital, Sakaeo Crown Prince Hospital, Kabin Buri Hospital, Chao Phya Abhaibhubejhr Hospital, Pongnamron Hospital, Phon Hospital, Phen Hospital, Pimai Hospital, Sapphasitthiprasong Hospital, Yasothon Hospital, Warin Chamrap Hospital, Surat Thani Hospital, Thungsong Hospital, Chumphon Hospital, Bannasan Hospital, Aow Lom Hospital, Phramongkutklao Hospital, Lerdsin Hospital, Taksin Hospital, Paolo Chockchai 4 Hospital, Phyathai 3 Hospital, and Siriraj Hospital.

Each hospital had an ICT with an infection control practitioner (ICP) who had received two-days of training in the protocol by the HAIs Group of Thailand in Nonthaburi, Thailand following the protocol and standardised case definitions of HAIs, derived from the U.S. CDC's 2017 surveillance definition of HAIs[18] and who had passed a proficiency examination before retrospective data collection. All hospitals collected data within an electronic database that was used for the national PPS.

An infection was considered an HAIs if the date of event of the NHSN site-specific infection criterion occured on or after the third calendar day of admission to an inpatient location where the day of admission is calendar day 1[19]. The hospital type categories were defined. A tertiary hospital was defined as a hospital located in a provincial capital, with a capacity of at least 500 beds and a comprehensive set of specialists as staff or a specialty hospital. A secondary hospital was defined as a hospital located in a provincial capital or major district with a capacity of 200 to 500 beds. A primary hospital was defined as a hospital located in a district with a capacity of less than 150 beds[14]. An HAIs case was defined as at least one HAI at any one time during one hospitalization[2]. The prevalence of HAIs was defined as the percentage of events of HAI divided by the total number of patients at the surveyed hospitals.

Sample size calculation and statistical analyses

All continuous data were compared with the Student's t-test and the Mann-Whitney U test as appropraite. Categorical data were compared with the chi-square test. A p-value of less than 0.05 was considered statistically significant. A multinomial-regression model studied the factors associated with HAIs. All variables with p-value less than 0.05 in bivariate analyses were selected for multivariate analyses. Factors considered were sex, age, type of hospital and unit, device status including urinary catheterization, intravenous line, endotracheal tube, tracheostomy tube, on respirator, and surgical status.

The investigators calculated that 10,506 patients would be required to estimate an anticipated HAI point prevalence of 7%[20] with a precision of ±1% at the national level, based on an average hospital size of 260 beds and 35,120 beds. The present study used an estimated design effect of 4.5 to account for clustering at the hospital level[21].

The present study was reviewed and approved by the Institutional Review Board of the Bamrasnaradura Infectious Diseases Institute, Ministry of Public Health, Nonthaburi, Thailand. The reference approval letter codes were S008h/62_ExPD.

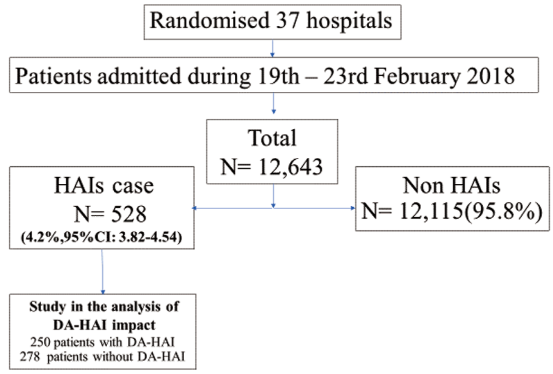

Figure 1. Schematic of study subjects.

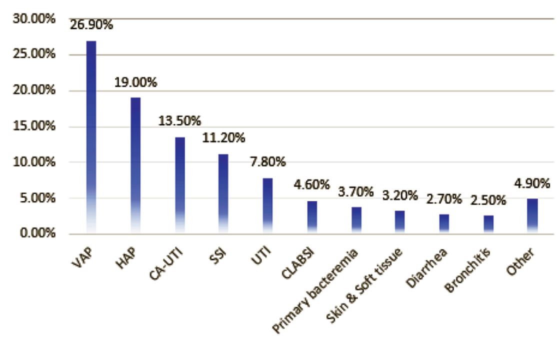

Figure 2. Prevalence of types of healthcare-associated infections (n=562).

VAP: ventilator-associated pneumonia, HAP: hospital-acquired pneumonia, CA-UTI: catheter-related urinary tract infection, SSI: surgery site infection, UTI: urinary tract infection, CLABSI: central-line-associated blood stream infections

Lower respiratory tract infection including VAP, HAP and bronchitis=48.4%

Results

Figure 1 shows a schematic of the study subjects. Twelve thousand six hundred forty-three patients were enrolled and included in the final analysis. Of these, 528 (4.2%) were HAIs, and the prevalence of patients with at least one HAI was 4.2% (95% CI 3.82 to 4.54).

Table 1 displays the demographic characteristics of the hospitalised patients who were HAI, their inpatient hospital settings and their associated treatments. The highest prevalence of HAIs was observed in patients younger than one year (4.6%, 95% CI 3.36 to 5.88) and older than 60 years (5.9%, 95% CI 5.24 to 6.60), government university hospitals (5.4%, 95% CI 4.37 to 6.35), and intensive care unit (ICU) (14.6%, 95% CI 11.60 to 17.60). With regards to procedures, the strongest associations were observed for tracheostomy (27.3%, 95% CI 22.86 to 31.78), central line (17.6%, 95% CI 13.70 to 21.44), on respirator (17.5%, 95% CI 15.41 to 19.51), endotracheal tube (13.8%, 95% CI 11.83 to 15.85), urinary catheterization (9.6%, 95% CI 8.55 to 10.73), and surgery status (6.5%, 95% CI 5.56 to 7.36).

HAIs were significantly associated with patient age, type of hospital, ward, having urinary catheterization, central line, endotracheal tube, having a tracheostomy, on respirator, and surgery status ($p<0.05$).

Table 2 displays the bivariate and multivariate analysis for the factors associated with hospital-acquired infections. On multivariate analysis, HAIs were significantly associated with patient younger than one year, government university hospital, government tertiary hospital, government secondary hospital, treatment in ICU, having urinary catheterization, central line, having a tracheostomy, on respirator, and surgery management ($p<0.05$).

VAP was the most frequent HAI type (26.9%), followed by hospital-acquired pneumonia (HAP) (19.0%), CA-UTI (13.5%), surgery site infection (SSI) (11.2%), UTI (7.8%), and CLABSI (4.6%). The prevalence of lower respiratory tract infection including VAP, HAP, and bronchitis was 48.4% (Figure 2).

The most common microorganisms of the 104 identified were *Klebsiella pneumoniae* (18.5%), followed by *Acinetobacter baumannii* (17.8%), *Pseudomonas aeruginosa* (12.6%), *Escherichia coli* (6.9%), *E. coli*, ESBL positive (5.0%), *Enterobacter faecalis* (3.7%), *Enterobacter faecium* (2.3%), *Stenotrophomonas maltophilia* (1.8%), *Acinetobacter* spp. (1.6%), MSSA (1.6%), MSCNS (1.1%), MRSA (0.9%), and other (26.2%) (Figure 3).

Discussion

The present survey estimated the prevalence

Table 1. Characteristics of hospitalised patients including HAIs and non-HAIs, their inpatient setting and healthcare associated infections

Characteristics	Total (n=12,643) n (%)	HAIs (n=528) n (%)	Prevalence %	Prevalence 95% CI	p-value
Sex					0.253
Male	6,397 (50.6)	280 (53.0)	4.4	3.87 to 4.89	
Female	6,246 (49.4)	248 (47.0)	4.0	3.48 to 4.46	
Age (year)					<0.001
Mean±SD	47.0±27.4	56.3±28.0			
Min-max	0 to 102	0 to 100			
Median (IQR)	52 (43)	63 (36)			
<1	1,104 (8.7)	51 (9.7)	4.6	3.36 to 5.88	
1 to 17	1,308 (10.3)	29 (5.5)	2.2	1.41 to 3.03	
18 to 24	635 (5.0)	15 (2.8)	2.4	1.16 to 3.56	
25 to 60	4,816 (38.1)	150 (28.4)	3.1	2.61 to 3.61	
>60	4,780 (37.8)	283 (53.6)	5.9	5.24 to 6.60	
Hospital type					<0.001
Primary	568 (4.5)	2 (0.4)	0.4	0.15 to 0.85	
Secondary	3,673 (29.1)	126 (23.9)	3.4	2.83 to 4.03	
Tertiary	5,935 (46.9)	286 (54.2)	4.8	4.26 to 5.38	
University	2,091 (16.5)	112 (21.2)	5.4	4.37 to 6.35	
Private	376 (3.0)	2 (0.4)	0.5	0.22 to 1.28	
Inpatient setting					<0.001
Medicine	4,133 (32.7)	183 (34.7)	4.4	3.79 to 5.07	
Surgery	2,901 (22.9)	149 (28.2)	5.1	4.32 to 5.96	
Pediatric	1,362 (10.8)	51 (9.7)	3.7	2.71 to 4.77	
Orthopedics/accident/trauma/burns	1,026 (8.1)	30 (5.7)	2.9	1.87 to 3.97	
Obstetric and neonatal care unit	991 (7.8)	5 (0.9)	0.5	0.05 to 0.95	
Intensive care unit	541 (4.3)	79 (15.0)	14.6	11.60 to 17.60	
Others	1,689 (13.4)	31 (5.9)	1.8	1.19 to 2.49	
Medical device and surgery procedure					
Urinary catheterization					<0.001
Yes	2,935 (23.2)	283 (53.6)	9.6	8.55 to 10.73	
No	9,708 (76.8)	245 (46.4)	2.5	2.2 to 2.84	
Central line					<0.001
Yes	387 (3.1)	68 (12.9)	17.6	13.7 to 21.44	
No	12,256 (96.9)	460 (87.1)	3.8	3.41 to 4.09	
Endotracheal tube					<0.001
Yes	1,185 (9.4)	164 (31.1)	13.8	11.83 to 15.85	
No	11,458 (90.6)	364 (68.9)	3.2	2.85 to 3.51	
Tracheostomy tube					<0.001
Yes	399 (3.2)	109 (20.6)	27.3	22.86 to 31.78	
No	12,244 (96.8)	419 (79.4)	3.4	3.09 to 3.75	
Respirator					<0.001
Yes	1,369 (10.8)	239 (45.3)	17.5	15.41 to 19.51	
No	11,274 (89.2)	289 (54.7)	2.6	2.26 to 2.86	
Surgery					<0.001
Yes	2,971 (23.5)	192 (36.4)	6.5	5.56 to 7.36	
No	9,672 (76.5)	336 (63.6)	3.5	3.1 to 3.84	

HAI=hospital-acquired infections; CI=confidence interval; SD=standard deviation; IQR=interquartile range

Table 2. Bivariate and multivariate analyses of factors associated with hospital-acquired infections

Risk factors	Univariate analysis			Multivariate analysis		
	cOR	95% CI	p-value	aOR	95% CI	p-value
Sex			0.253			0.411
Male	1			1		
Female	0.90	0.76 to 1.08		1.08	0.90 to 1.30	
Age (year)			<0.001			<0.001
<1	1			1		
1 to 17	0.47	0.30 to 0.74		0.36	0.22 to 0.59	
18 to 24	0.50	0.28 to 0.90		0.33	0.16 to 0.68	
25 to 60	0.64	0.48 to 0.91		0.35	0.21 to 0.58	
>60	1.30	0.96 to 1.76		0.46	0.28 to 0.75	
Hospital type			<0.001			<0.001
Primary Hospital	1			1		
Secondary Hospital	10.05	2.48 to 40.75		5.47	1.32 to 22.58	
Tertiary Hospital	14.33	3.56 to 57.72		6.05	1.47 to 24.85	
University Hospital	16.02	3.94 to 65.04		7.55	1.83 to 31.25	
Private	1.513	0.21 to 10.79		1.41	0.20 to 10.11	
Inpatient setting			<0.001			<0.001
Intensive care unit	1			1		
Medicine	0.27	0.21 to 0.36		0.14	0.05 to 0.35	
Surgery	0.32	0.24 to 0.42		0.80	0.47 to 1.36	
Pediatric	0.23	0.16 to 0.33		1.04	0.74 to 1.46	
Orthopedics/accident/trauma/burns	0.18	0.11 to 0.27		1.02	0.72 to 1.45	
Obstetric and neonatal care unit	0.03	0.01 to 0.07		0.83	0.51 to 1.35	
Others	1.05	0.64 to 1.73		0.77	0.48 to 1.26	
Urinary catheterization			<0.001			<0.001
No	1			1		
Yes	4.12	3.46 to 4.92		1.97	1.58 to 2.47	
Central line			<0.001			<0.001
No	1			1		
Yes	5.47	4.14 to 7.22		1.87	1.34 to 2.60	
Endotracheal tube			<0.001			0.659
No	1			1		
Yes	4.90	4.03 to 5.95		1.11	0.70 to 1.76	
Tracheostomy tube			<0.001			<0.001
No	1			1		
Yes	10.61	8.34 to 13.50		4.39	2.99 to 6.43	
Respirator			<0.001			<0.001
No	1			1		
Yes	8.04	6.70 to 9.64		2.79	1.79 to 4.35	
Surgery			<0.001			<0.001
No	1			1		
Yes	1.92	1.60 to 2.30		1.65	1.31 to 2.08	

CI=confidence interval; cOR=crude odds ratio; aQR=adjusted odds ratio

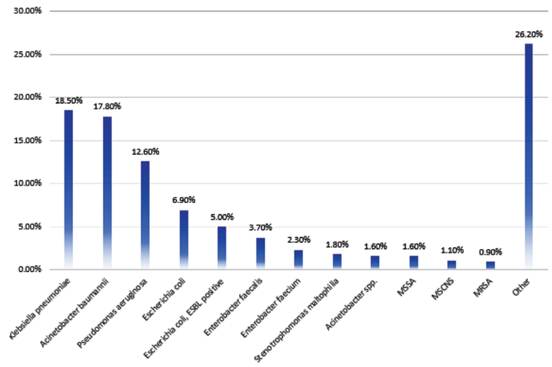

Figure 3. Prevalence of groups of microorganism (n=562).

MSSA: methicillin-sensitive *Staphylococcus aureus*, MSCNS: methicillin-susceptible coagulase-negative *Staphylococcus*, MRSA: methicillin-resistant *S. aureus*, ESBL: extended-spectrum beta-lactamases

of HAIs in Thailand in 2018 to be 4.2% with data collected from 37 randomly selected hospitals across Thailand. These data included patients at various levels of health service delivery in different parts of the country. The prevalence of HAIs in the present survey is lower than previous surveys from Thailand in 1988 (11.7%)[11], 2006 (6.5%)[12], 2011 (7.3%)[13], and 2014 (4.4%)[14]. A previous Polish PPS that aggregated data from a 2-year period reported prevalence of HAIs of 6.2%[22]. This was higher than the EU-PPS HAI&AU data (5.7%)[23]. The most recent PPS in Switzerland in 2004 identified a HAI prevalence of 10.4% for a subset of large hospitals[24]. The Thailand national PPS HAIs prevalence was low compared with findings from other low and middle income countries. There may have been many reason for this. Firstly, the authors included only 12 large hospitals (two government university hospitals and 10 government tertiary hospitals) while other hospitals (25 hospitals) were non-large hospital, which may have decreased the overall prevalence of HAIs. In a multi-centred PPS of hospital acquired infections in Ghana, the prevalence across the various hospitals ranged from 3.5% to 14.4% with a higher proportion of infections found in secondary and tertiary care facilities[25]. A survey in three large Swiss medical centres demonstrated a pooled HAI prevalence of 5.6% (95% CI 4.7% to 6.5%)[26]. The variability between the present survey and others could also have been due to differences in the methodologies used, particularly the fact that the present study also included children. Furthermore, the rates of HAI vary in different ICUs in the same hospital or same ICU at different periods, with higher rates in teaching hospitals[27,28]. Finallly, the sustained national IPC policies in Thailand from 1986 to the present may have reduced the prevalence of HAIs. A previous study in Africa demonstrated that high rates of HAIs persisted due to lack of national IPC policies, lack of IPC-personnel and poor adherence to existing HAI guidelines[29].

HAIs are most commonly associated with invasive medical devices or surgery procedures. Lower respiratory tract and bloodstream infections are the most lethal[30]. Interestingly, the percentage of device-associated infections among HAIs in the present survey was high at 45.0% including VAP 26.9%, CA-UTI 13.5%, and CLABSI 4.6%. The previous Polish study demonstrated that the percentage of device-associated infections was 61.9%[22]. In addition, other PPS have also reported high prevalences of device-associated infections[31,32]. To reduce the risk of infection in hospitalised patients, device-associated HAI (DA-HAI) surveillance is important because it effectively describes and addresses the importance and characteristics of the threatening situation created by DA-HAI[33].

The nine most common microorganisms in the present survey were gram-negative bacteria (GNB). Similarly, previous studies have reported almost one-third of all HAIs and 60% of HAIs in ICU were caused by GNB[6,34-36]. GNB are becoming increasingly resistant to available antibiotics as widespread antibiotic use has surged globally[37,38].

Limitation

Firstly, the present PPS studies could not evaluate day patient bed-days because this survey was conducted over a short time (five days). Secondly, data collection was done by local IPC professionals and not by the same study team at all sites. However, all participating data collectors had experience with performing local PPSs and were trained before data collection. Thirdly, the data may not be sufficiently generalizable to Thailand because only 37 hospitals were included. Nevertheless, the present survey covered all region of Thailand and all levels of healthcare facility, so the authors suggest it may be representing the prevalence of HAIs in Thailand.

Conclusion

The prevalence of HAIs was 4.2% in the authors' survey of randomly selected 37 hospitals. HAIs were significantly associated with patient younger than one year, government university hospital, government tertiary hospital, government secondary hospital, treatment in ICU, having urinary catheterization, central line, having a tracheostomy, on respirator, and surgery management.

What is already known on this topic?

Prevalence and risk factors of HAIs in Thailand.

What this study adds?

The point prevalence of HAIs was 4.2% and a decreasing trend. Continued efforts to prevent and control HAIs are effective and should be further strengthened.

Acknowledgement

The investigators thank all patients and local IPC professionals in 37 randomly selected hospitals.

Conflicts of interest

The authors declared no potential conflicts of interest with repect to the research, authorship, or publication of this article.

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