Development of Quality Indicators of Nosocomial Infection Control

Somwang Danchaivijitr MD*,
Yong Rongrungruang MD*, Sumalee Pakaworawuth RN**,
Duangporn Jintanothaitavorn MSc**, Kakanang Naksawas MSc***

*Department of Medicine, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok,
**Center for Nosocomial Infection Control, Siriraj Hospital,
***Department of Medicine, Faculty of Nursing, Mahidol University, Bangkok

Objectives : *To study the rates of catheter associated urinary tract infection (CAUTI), Ventilator-associated pneumonia (VAP), Central venous catheter blood stream infection (CVCBSI) and surgical site infection (SSI) in Thai hospitals. The rates of the infections will be used as quality indicators.*
Material and Method : *Active surveillance in 38 hospitals in Thailand during 2003-2004. Risk stratification of NI rates and utilization of devices were calculated.*
Results : *The rates of CAUTI, VAP, CVCBSI and SSI were obtained. Pooled means, and rates of NI at 10, 25, 50,75 and 90 percentiles were calculated for CAUTI, VAP, CVCBSI. The infection rates were also presented for each type of hospital. The above NI rates were comparable to those reported by the National Nosocomial Infection Surveillance System (NNIS) in the United States. Surgical site infection was studied in 21 procedures with risk index categories 0-2. The rates of SSI in the present study was lower than those in the U.S. study due to different methods of study.*
Conclusion : *The risk stratified rates of CAUTI, VAP, CVCBSI and SSI were obtained. They were similar to a larger scale of study in the United States. The NI rates could be used for evaluating the efficacy of NI control in Thai hospitals.*

Keywords : *Development, Quality indicators, Nosocomial nfection, Control*

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Nosocomial infection (NI) is a major risk for patients in hospitals[1-3]. Control of NI was started in Thailand in 1971[4] and the practice led to substantial reduction of the prevalence of NI[5]. Nosocomial infection control is required in every hospital and quality of NI control is a major criteria for hospital accreditation. Evaluation of a NI control program should include organization, practice and outcome. In evaluating cutcome of NI control, a national pooled data on NI incidence are needed for reference[6]. The study was to develop quality indicators of common NI with risk stratification.

Correspondence to : Danchaivijitr S, Department of Medicine, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand. E-mail: sisdc@mahidol.ac.th

Material and Method

A multi-centered prospective study was conducted in 38 hospitals located in different parts of Thailand. They were middle to large-sized hospitals providing secondary and tertiary medical services. Infection control nurses (ICNs) in each hospital collected data on four major sites of NI, viz., catheter-associated urinary tract infection (CAUTI), ventilator-associated pneumonia (VAP), surgical site infection (SSI) and central venous catheter blood stream infection (CVCBSI) among patients admitted in various departments. All study data were collected using standardized protocols for three calendar months consecutively. Standard definitions of Center for Disease Control were applied[7].

The incidence of NI was calculated as follows:

$$\text{Infection rate} = \frac{\text{Number of device-associated infection}}{\text{Number of device-days}} \times 1000$$

$$\text{SSI rate} = \frac{\text{Number of SSI}}{\text{Surgical procedures}} \times 100$$

$$\text{Device utilization ratio} = \frac{\text{Number of device days}}{\text{Number of patient days}}$$

Windows® version 10.1. Continuous and categorical variables were expressed in frequency and percentages.

Results

The study was conducted in 38 hospitals across Thailand from October 2003 to September 2004. Types and number of hospitals enrolled in the study are shown in Table 1.

The hospitals were large-sized, referral, and teaching medical centers providing tertiary care for general populations in their regions across Thailand. Tables 2, 3, 4 demonstrate rates and percentiles of CAUTI, VAP, CVCBSI stratified by departments and hospitals.

The average rate of CAUTI in the present study was 5.2 episodes per 1,000 catheter-days. The highest rates were found in the orthopedic department and university hospitals, at 7.5 and 7.7 episodes per 1,000 catheter-days, respectively. Obstetric-gynecology department and provincial hospitals had the lowest rates at 3.3 and 4.3 episodes per 1,000 catheter-days respectively. At 75th percentile, CAUTI was at 11.0, 7.6, and 7.5 episodes per 1,000 catheter-days for university, provincial and regional hospitals respectively.

The average rate of VAP in the present study was 12.6 episodes per 1,000 ventilator-days. The highest rates were found in the surgical department and provincial hospitals, at 14.1 and 14.3 episodes per 1,000 ventilator-days, respectively. Pediatric ICU and university hospitals had the lowest VAP rate at 11.2 and 11.5 episodes per 1,000 ventilator-days respectively. At the 75th percentiles VAP was found at 20.8, 17.6, and 15.7 episodes per 1,000 ventilator-days for provincial, regional, and university hospitals respectively. At the 75th percentile, the infection rate could be used as the reference to compare quality on CAUTI and VAP control in similar types of hospitals.

Table 1. Types of hospitals enrolled (N=38)

Hospitals	No	%
Regional	20	52.6
Provincial	15	39.5
University	3	7.9

Table 2. CAUTI rates in different departments and types of hospitals

Category	No. Hospitals	Urinary-catheter-Days	Pooled mean (%)	Percentile 10	20	50(median)	75	90
Departments								
Total	38	162,964	5.2	0.0	0.0	3.2	8.3	14.7
OB/GYN*	15	6,124	3.3	0.0	0.0	0.0	5.1	19.5
Medicine	34	46,984	6.9	0.0	2.8	6.3	11.3	15.2
Surgery	30	50,995	4.2	0.0	0.0	2.3	5.7	10.7
Orthopedic	15	8,364	7.5	0.0	0.0	4.9	11.6	19.9
Medical ICU	37	25,826	5.7	0.0	0.0	3.7	8.5	14.1
Surgical ICU**	27	24,205	3.0	0.0	0.0	0.0	5.3	13.1
Type of hospital								
Regional hospital	20	97,646	4.8	0.0	0.0	3.4	7.5	15.0
Provincial hospital	15	37,498	4.3	0.0	0.0	0.7	7.6	14.1
University hospital	3	27,820	7.7	0.0	2.7	7.0	11.0	17.5

*OB/GYN = obstetrics and gynecology
**ICU = intensive care unit

These CVCBSI rates were collected from 24 out of 38 study hospitals, because the rest of them performed too small a number of central vascular cannulation. The average rate of CVCBSI in the present study was 3.4 episodes per 1,000 catheter-days. The highest mean rates were found in the pediatric department and university hospitals at 11.7 and 4.4 episodes per 1,000 catheter-days respectively. Surgical department and provincial hospitals had the lowest CVCBSI rate at 0.8 and 2.7 episodes per 1,000 catheter-days. At the 75th percentiles CVCBSI were at 7.5, 4.7, and 0 episodes per 1,000 catheter-days in university, regional, and provincial hospitals, respectively (Table 4).

The Tables 5 to 7 demonstrate urinary catheter, ventilator, and vascular catheter device utilization (DU) ratio stratified by types of departments and hospitals.

The average DU ratio of urinary catheter was 0.24. The highest mean ratio was found in surgical ICU and university hospitals at 0.83 and 0.27, respectively. Medicine department and regional hospitals had the lowest ratios at 0.17 and 0.23, respectively.

The average DU ratio of ventilator in the present study was 0.26. The highest mean ratio was found in medical ICU at 0.69. These ratios were comparable in different types of hospitals.

Table 3. VAP rates in different departments and types of hospitals

Category	No. hospitals	Urinary-catheter-days	Pooled mean (%)	Percentile				
				10	20	50(median)	75	90
Departments								
Total	38	100,966	12.6	0.0	5.3	11.5	18.6	27.9
Pediatrics	1	336	11.9	7.9	7.9	11.8	16.1	16.1
Medicine	26	26,427	11.8	0.0	6.4	12.1	16.3	23.2
Surgery	17	12,224	14.1	0.0	5.6	13.1	23.9	34.1
Orthopedic	1	186	10.8	0.0	0.0	11.8	19.6	19.6
Medical ICU	37	28,174	13.1	0.0	5.0	11.8	18.4	26.4
Surgical ICU	27	20,295	13.1	0.0	6.0	11.7	20.4	25.5
Pediatric ICU	23	13,113	11.2	0.0	0.0	8.7	18.9	26.3
Type of hospital								
Regional hospital	20	69,327	12.3	0.0	5.3	10.8	17.6	26.4
Provincial hospital	15	19,411	14.3	0.0	5.1	12.7	20.8	34.2
University hospital	3	12,228	11.5	0.0	6.0	12.5	15.7	22.4

Table 4. CVCBSI rates in different departments and types of hospitals

Category	No. hospitals	Urinary-catheter-days	Pooled mean (%)	Percentile				
				10	20	50(median)	75	90
Departments								
Total	24	20,775	3.2	0.0	0.0	0.0	5.6	11.3
Pediatrics	1	257	11.7	10.0	10.0	10.9	15.4	15.4
Medicine	3	841	3.6	0.0	0.0	0.0	8.1	11.5
Surgery	4	2,496	0.8	0.0	0.0	0.0	0.0	7.3
Medical ICU	14	5,567	2.7	0.0	0.0	0.0	4.9	11.9
Surgical ICU	15	6,763	3.3	0.0	0.0	0.0	2.7	11.5
Pediatric ICU	14	4,851	5.2	0.0	0.0	0.0	6.4	16.9
Type of hospital								
Regional hospital	15	11,884	3.0	0.0	0.0	0.0	4.7	10.8
Provincial hospital	6	2,943	2.7	0.0	0.0	0.0	0.0	17.0
University hospital	3	5,948	4.4	0.0	0.0	0.0	7.5	12.8

Table 5. Urinary catheter utilization ratio in different departments and hospitals

Category	No. hospitals	Urinary-catheter-days	Pooled mean (%)	Percentile				
				10	20	50(median)	75	90
Departments								
Total	38	686,132	0.24	0.11	0.15	0.25	0.71	0.90
OB/GYN	15	43,489	0.14	0.09	0.11	0.14	0.17	0.21
Medicine	34	283,480	0.17	0.09	0.12	0.16	0.19	0.24
Surgery	30	229,511	0.22	0.13	0.17	0.22	0.27	0.30
Orthopedic	15	57,833	0.14	0.08	0.10	0.13	0.18	0.30
Medical ICU	37	40,234	0.64	0.45	0.56	0.70	0.81	0.92
Surgical ICU	27	29,241	0.83	0.65	0.73	0.88	0.94	0.99
Type of hospital								
Regional hospital	20	428,728	0.23	0.11	0.15	0.25	0.68	0.88
Provincial hospital	15	154,098	0.24	0.10	0.14	0.24	0.76	0.92
University hospital	3	103,306	0.27	0.14	0.18	0.25	0.71	0.87

Table 6. Ventilator utilization ratio in different departments and types hospitals

Category	No. hospitals	Urinary-catheter-days	Pooled mean (%)	Percentile				
				10	20	50(median)	75	90
Departments								
Total	38	388,955	0.26	0.10	0.15	0.57	0.76	0.87
Pediatrics	1	2,934	0.11	0.09	0.09	0.12	0.13	0.13
Medicine	26	212,637	0.12	0.06	0.10	0.11	0.14	0.17
Surgery	17	74,526	0.16	0.07	0.11	0.15	0.26	0.36
Orthopedic	1	1,915	0.10	0.07	0.07	0.10	0.11	0.11
Medical ICU	37	40,744	0.69	0.48	0.65	0.74	0.83	0.91
Surgical ICU	27	28,117	0.72	0.51	0.67	0.76	0.86	0.93
Pediatric ICU	23	25,738	0.51	0.18	0.37	0.57	0.70	0.82
Type of hospital								
Regional hospital	20	265,018	0.26	0.06	0.13	0.63	0.76	0.86
Provincial hospital	15	75,484	0.26	0.10	0.13	0.70	0.80	0.90
University hospital	3	48,453	0.25	0.06	0.13	0.63	0.76	0.86

The average DU ratio of central vascular catheter was 0.30. The highest mean ratio was found in the pediatric and medical ICU at 0.39 and 0.37 respectively. The medicial department had the lowest mean ratio at 0.07.

The SSI, rates stratified by types of procedures and risk index category are shown in Tables 8-10.

An extremely low SSI rate among the risk index category 0 was found, ranging from 0 to 0.47 episodes per 100 procedures. Specifically, no SSI was found in splenectomy, oral surgery, thoracotomy and prostatectomy.

Among the group with risk index category 1, thoracotomy was associated with the highest rate of SSI at 5.77 episodes per 100 procedures.

For category 2, the highest SSI rate at 5.0 episodes per 100 procedures was found among patients who undergone abdominal hysterectomy, followed by open reduction of fracture and Caesarian section at 4.72 and 4.55 episodes per 100 procedures respectively.

Discussion

The risk-adjusted infection rates in the present study was actively collected by trained ICNs. Common

Table 7. Central vascular utilization ratio in different departments and types of hospitals

Category	No. hospitals	Urinary-catheter-days	Pooled mean (%)	Percentile				
				10	20	50(median)	75	90
Departments								
Total	24	68,668	0.30	0.11	0.23	0.37	0.50	0.67
Pediatrics	1	1,462	0.18	0.13	0.13	0.20	0.20	0.20
Medicine	3	12,820	0.07	0.03	0.05	0.07	0.08	0.10
Surgery	4	12,770	0.20	0.05	0.07	0.11	0.45	0.63
Medical ICU	14	14,869	0.37	0.22	0.29	0.36	0.46	0.62
Surgical ICU	15	14,424	0.04	0.23	0.36	0.46	0.66	0.79
Pediatric ICU	14	12,323	0.39	0.23	0.27	0.39	0.49	0.66
Type of hospital								
Regional hospital	15	38,185	0.31	0.16	0.23	0.38	0.48	0.63
Provincial hospital	6	9,405	0.31	0.15	0.28	0.97	0.60	0.94
University hospital	3	21,078	0.28	0.07	0.11	0.36	0.56	0.76

Table 8. SSI rates of different types of procedures at risk index category 0

Procedures	75^{th} percentile operation time (min)	No of infection	Total no of procedures	SSI rate
Abdominal hysterectomy	112	13	1117	1.16
Appendectomy	60	18	1501	1.20
Caesarean section	55	31	6312	0.49
Cardiac surgery	250	2	205	0.98
Cataract surgery	35	5	2524	0.20
Cholecystectomy	60	3	643	0.47
Craniotomy	130	3	435	0.69
Inquinal hernia repair	60	3	1296	0.23
Laceration < 4hr	60	6	507	1.18
Lung operation	140	0	59	0.00
Mastectomy	140	1	212	0.47
Open reduction of fracture	90	13	2049	0.63
Oral surgery	91	0	295	0.00
Prostatectomy	70	0	79	0.00
Splenectomy	116	0	55	0.00
Thyroid surgery	120	2	430	0.47
Vaginal hysterectomy	106	1	128	0.78

NI associated with device utilization included CAUTI, VAP and CVCBSI. Surgical site infection risk index were calculated according to wound types, patients' condition and operation time[8-9]. Detailed infection rates were reported and could be used as references[6]. Owing to different clinical environment, evaluation of NI control by rates of infection in one's own country would be more practical. The study enrolled 38 hospitals of varied sizes and at different geographical distribution of Thailand (Table 1).

Catheter-associated urinary tract infection rates, as shown in Table 2, were similar to those reported from the United States[6]. In the latter, it was done in more patients and in intensive care units where patients are more susceptible to infections. Ventilation associated pneumonia was much higher in the present

Table 9. SSI rates of different types of procedures at risk index category 1

Procedures	75th percentile operation time (min)	No of infection	Total no of procedures	SSI rate
Abdominal hysterectomy	112	6	516	1.16
Appendectomy	60	8	931	0.86
Caesarean section	55	7	1857	0.39
Cardiac surgery	250	3	175	1.71
Cataract surgery	35	0	856	0.00
Cholecystectomy	60	7	1919	0.36
Craniotomy	130	15	800	1.88
Dirty trauma case_delayed 4 hr or more	70	15	699	2.15
Inquinal hernia repair	60	1	416	0.24
Laeeration < 4hr	60	2	239	0.84
Lung operation	140	3	52	5.77
Mastectomy	140	1	68	1.47
Open reduction of fracture	90	7	846	0.83
Oral surgery	91	3	169	1.78
Prostatectomy	70	0	22	0.00
Splenectomy	116	0	43	0.00
Surgical insion and drainage abscess	45	9	491	1.83
Thyroid surgery	120	1	145	0.69
Traumatic wound repair	60	3	213	1.41
Traumatic wound retained devitalized tissue	50	3	676	0.44
Vaginal hysterectomy	106	2	62	3.23

Table 10. SSI rates of different types of procedures at risk index category 2

Procedures	75th percentile operation time (min)	No of infection	Total no of procedures	SSI rate
Abdominal hysterectomy	112	1	20	5.00
Appendectomy	60	8	289	2.77
Caesarean section	55	1	22	4.55
Cardiac surgery	250	2	80	2.50
Cataract surgery	35	0	65	0.00
Cholecystectomy	60	4	544	0.74
Craniotomy	130	7	184	3.80
Dirty traumatic wound	70	11	241	4.56
Inquinal hernia repair	60	0	17	0.00
Laceration < 4hr	60	0	28	0.00
Lung operation	140	0	11	0.00
Mastectomy	140	0	3	0.00
Open reduction of fracture	90	5	106	4.72
Oral surgery	91	0	22	0.00
Prostatectomy	70	0	5	0.00
Splenectomy	116	0	15	0.00
Surgical insion and drainage abscess	45	4	155	2.58
Thyroid surgery	120	0	4	0.00
Traumatic wound repair	60	0	68	0.00
Traumatic wound retain devitalized tissue	50	9	259	3.47
Vaginal hysterectomy	106	0	3	0.00

study compared to a previous report[6]. The infection was the commonest NI in Thailand[5], efforts to reduce VAP are urgently needed. Overall CVCBSI rates in our study was lower than those reported in the United States[6]. As previously mentioned, the latter was carried out in ICU while in this study in different departments. However, when NI rates in the same types of ICUs, were compared, CVCBSI in the present study was lower. Device utilization ratios are shown in Tables 5-7. Urinary catheterization in the present series was lower, when compared to that in a U.S. study, in medical and surgical ICUs. This could be due to the effects of a study in this country which demonstrated that urinary catheterization could be avoided in some occasions[10]. On the contrary, ventilation utilization ratio was higher compared to the same study. The need of artificial ventilation and the care of patients on ventilators have yet to be studied to reduce VAP in Thai hospitals. The utilization of central lines was much lower in the present study as were CVCBSI rates in ICUs.

The data on SSI in 21 procedures with risk index categories 0-2 is demonstrated in Tables 8-10. The rates of SSI in cholecystectomy risk index categories 0 and 1 in the present study were 0.47 and 0.36 compared to 0.67 and 1.78 in another study[6]. Lower SSI rates were found in other procedures, for example : mastectomy, cesarean section, abdominal hysterectomy, craniotomy etc. These findings are partly attributed to different methods of study. In the present series, no post-discharge SSI was included resulting in low SSI rates. Post-discharge surveillance, especially on SSI should be encouraged even though it is not feasible for the health care system in Thailand at the present time.

Conclusion

An active surveillance on risk stratified rates of CAUTI, VAP, CVCBSI and SSI was done in 38 hospitals in Thailand in 2003-2004. The rates of the infections were not much different from those reported from the United States and they could be used for evaluating the efficacy of NI control in Thai hospitals.

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การพัฒนาตัวชี้วัดคุณภาพของการป้องกันและควบคุมโรคติดเชื้อในโรงพยาบาล

สมหวัง ด่านชัยวิจิตร, ยงค์ รงค์รุ่งเรือง, สุมาลี ภควรวุฒิ, ดวงพร จินตโนทัยถาวร, คัคนางค์ นาคสวัสดิ์

วัตถุประสงค์ : *ศึกษาอัตราการติดเชื้อระบบทางเดินปัสสาวะที่สัมพันธ์กับการใส่สายสวนปัสสาวะ ปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ การติดเชื้อในกระแสโลหิตที่สัมพันธ์กับการใส่สายสวนเข้าหลอดเลือดกลาง และการติดเชื้อบาดแผลผ่าตัดในโรงพยาบาลในประเทศไทย*

วัสดุและวิธีการ : *เฝ้าระวังการติดเชื้อที่ตำแหน่งข้างต้นในโรงพยาบาล 38 แห่งในประเทศไทยระหว่าง พ.ศ. 2546-2547 อัตราการติดเชื้อคำนวณโดยแบ่งตามความเสี่ยงและเฝ้าอัตราการใช้อุปกรณ์ทางการแพทย์*

ผลการศึกษา : *ได้อัตราการติดเชื้อทางเดินปัสสาวะที่สัมพันธ์กับการใส่สายสวนปัสสาวะ ปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ การติดเชื้อในกระแสโลหิตที่สัมพันธ์กับการใส่สายสวนเข้าหลอดเลือดกลาง. อัตราการติดเชื้อคำนวณเป็นค่าเฉลี่ยรวมและที่เปอร์เซ็นไทล์ที่ 10, 25, 50, 75 และ 90 และแยกอัตราการติดเชื้อตามประเภทของโรงพยาบาล อัตราการติดเชื้อในการศึกษานี้คล้ายคลึงกับอัตราที่ศึกษาในประเทศสหรัฐอเมริกา อัตราการติดเชื้อที่แผลผ่าตัด 21 ตำแหน่งแยกตามดัชนีความเสี่ยง 0-2 อัตราการติดเชื้อที่แผลผ่าตัดต่ำกว่าที่รายงานจากประเทศสหรัฐอเมริกา เนื่องจากการศึกษาด้วยวิธีต่างกัน*

สรุป : *การศึกษานี้ได้อัตราการติดเชื้อ 4 ตำแหน่งโดยจำแนกตามความเสี่ยงของการติดเชื้อ อัตราการติดเชื้อใกล้เคียงกับรายงานจากประเทศสหรัฐอเมริกา อัตราการติดเชื้อจากการศึกษานี้สามารถใช้อ้างอิงเพื่อประเมินประสิทธิผลของการควบคุมโรคติดเชื้อในโรงพยาบาลในประเทศไทย*