Microbial Contamination of Antiseptics and Disinfectants

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Objective : *To study the bacterial contamination of antiseptics and disinfections in-use and the risk factors for contamination.*
Material and Method : *Bacterial contamination of antiseptics and disinfectants was done by culturing in-use solutions. Eight commonly used solutions were studied : alcohol 70%, chlorhexidine 4%, and 0.5%, povidone iodine 7.5% and 10%, tincture iodine 1-2%, lysol 2% and sodium hypochlorite 0.5%.*
Results : *The following risk factors for contamination were found : preparation by unskilled personnel, improper containers and prolonged use. Contamination with bacteria were found in 1.8% of 16,142 samples tested. Highest rate of contamination was found in Lysol 2%. There was no contamination of povidone iodine 10% and tincture iodine 1-2%. Bacterial contamination of antiseptics and disinfectants was highest in provincial hospitals and was not found in university hospitals. The rates of contamination correlated with the duration of use. Most bacteria isolated were those found in the environment.*
Conclusion : *The contamination of in-use antiseptics and disinfectants was as high as 1.8%. Risk factors for contamination were improper preparation and prolonged use.*

Keywords : *Contamination, Antiseptic, Disinfectants*

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Antiseptics and disinfectants are commonly used chemicals in healthcare settings. They are used to reduce microbes on the skin or mucosa (antiseptics) or on the surface of medical equipment or inanimate surface (disinfectants). The choice of antiseptics or disinfectants is based on the levels of destruction of microbes of individual chemicals; they should be safe on handling and free from contamination[1-3]. Contamination of antiseptics and disinfectants is not uncommon[4-8] resulting infection in patients[9-11]. It has been reported that stock solutions of disinfectants/antiseptics, diluted solutions prepared in hospital pharmacy, and in-use products were contaminated[4-8].

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In Thailand, most antiseptics/disinfectants are diluted and prepared in hospitals in the pharmacy department and in patients wards. Preparation by unskilled personnel in an unhygienic environment, use of unsterilized containers and prolonged use were not uncommon. These improper practices can lead to microbial contamination of antiseptics/disinfectants. The magnitude of this problem has not been studied at a national level. The authors, therefore, studied the rate of microbial contamination of antiseptics/disinfectants and risk factors for contamination in Thai hospitals.

Material and Method

The present study in 2002 was done in 39 hospitals across the country enrolled by stratified randomization. Six antiseptics/ disinfectants, 2 of them with 2 different concentrations were selected. They were

the most commonly used solutions. The present study consisted of 2 parts : (1) a laboratory study and (2) a questionnaire component. Contamination of antiseptics/disinfectants were done by culturing individual solutions immediately after preparation for use, the second sample was done on the third day, the third sample on the fifth day and the fourth sample on the seventh day. The study was repeated one month later. Samples of antiseptics/ disinfectants were cultured by two different methods. The first method was direct plating of 0.01 ml of antiseptics/disinfectants on blood agar. The second method was diluting 1 ml. of antiseptics/ disinfectants in 9 ml of tryptic soy broth and 0.01 ml of the broth was spread on the blood agar plate. Visible growths of microbes were subsequently identified by conventional methods.

Sets of questionnaires on the amount of use, preparation and clinical use of antiseptics/disinfectants were sent to the heads of pharmacy departments and head nurses of the hospital wards. Data on microbial culture and questionnaires were collected by researchers and analysed. Descriptive statistics were used for analysis.

Results

The survey of contamination of antiseptics/ disinfectants was done in 39 hospitals across the country (Table 1). They were enrolled by stratified randomization to represent categories of hospitals and their geographical location. The types of antiseptics/disinfectants selected in the present study were the most commonly used (Table 2). The average cost of these chemicals was 1,949.72 baht (48.74 US dollar) per bed per year. Alcohol 70% was accountable for over one half of the cost followed by chlorhexidine 4%. As shown in Table 3 and 4 these antiseptics/ disinfectants were diluted and prepared in different places and by different personnel. Containers for antiseptics/ disinfectants were sterilized by hot-air or autoclaving in less than 50% of all (Table 5). Only 16.1% and 7.0% of containers for chlorhexidine 4% and hypochlorite 0.5% were sterilized before use. Single use of antiseptics/disinfectants was found in only 4.9%. Use within 3 days after preparation was found in 45.2%. In 17.8%, there was no specified expiry date. A total of 16,142 samples of antiseptics/disinfectants were cultured for aerobic bacteria and yeast, alcohol 70% accounted for 40% of the total (Table 7). Microbial contamination was found in 1.8% of the samples (Table 8). The highest rate of contamination was found in lysol 2% (4.7%) followed by

Table 2. The amount of use and costs of antiseptics/ disinfectants per bed per year

Antiseptics/Disinfectant	Amount (Liter)	Cost (baht)*
Alcohol 70%	12.92	1,059.53
Chlorhexidine 4%	1.89	485.02
Chlorhexidine 0.5%	0.77	55.37
Povidone iodine 7.5%	0.93	182.20
Povidone iodine 10%	0.18	37.73
Tincture iodine 1-2%	0.06	10.47
Lysol 2%	4.05	48.57
Hypochlorite 0.5%	31.48	70.83
Total		1,949.72

*40 baht = 1 US dollar

Table 1. Hospitals and wards enrolled

Hospital Categories	No.	No. Wards*					Total wards
		Med.	Sur.	Obs.	Ped.	Other	
University	2	4	4	4	4	4	40
Regional	4	3	3	3	3	3	60
Provincial	10	2	2	2	2	2	100
District	19	1	1	-	-	-	38
Private	4	2	2	2	2	2	40
Total	39	12	12	11	11	11	378

*Med. = medicine
Sur. = surgery
Obs. = obstetric-gynecology
Ped. = pediatrics

chlorhexidine 4% and alcohol 70% (2.8% and 2.3%) respectively. No contamination was found in povidone iodine 10% and in tincture iodine. The rates of contamination rose from 0.7% on day 1 to 3.7% on day 7 after preparation. No microbial contamination was found in antiseptics/ disinfectants samples from university hospitals (Table 9). Contamination was most common in provincial hospitals (3.3%) followed by district hospitals (2.4%). Co-agulase-negative staphylococci was the commonest microbial isolates (35.9%) followed by Bacillus species (20.0%) and Pseudomonas aeruginosa (18.3%) respectively (Table 10). Candida species was isolated from 1 of 290 samples.

Table 3. Places where antiseptics/disinfectants were prepared

Antiseptics/Disinfectants	No. Wards	Places (%) Pharmacy	Ward	C.S.S.D.*	Other
Alcohol 70%	281	59.4	23.1	1.8	15.8
Chlorhexidine 4%	144	37.4	37.5	2.1	22.9
Chlorhexidine 0.5%	68	72.1	20.6	-	7.3
Povidone iodine 7.5% / Povidone iodine 10%	324	63.0	18.2	0.3	18.5
Tincture iodine 1-2%	53	71.7	17.0	3.8	7.5
Lysol 2%	56	19.6	58.9	1.8	19.6
Hypochlorite 0.5%	134	21.6	59.7	2.2	16.4

*C.S.S.D. = central sterile supply department

Table 4. Persons who prepared antiseptics/disinfectants used in wards

Antiseptics/Disinfectants	No. Wards	Persons (%) Pharmacists	Nurses	Company*	Other
Alcohol 70%	281	43.1	12.5	13.2	31.3
Chlorhexidine 4%	144	26.4	9.7	22.2	41.7
Chlorhexidine 0.5%	68	35.3	4.4	7.4	52.9
Povidone iodine 7.5% / Povidone iodine 10%	262	38.2	12.2	17.2	32.4
Tincture iodine 1-2%	53	66.0	5.7	7.5	20.8
Lysol 2%	56	17.9	12.5	14.3	55.4
Hypochlorite 0.5%	133	16.5	18.8	11.3	53.4

*prepared by distributing companies

Table 5. Methods of disinfection/sterilization of containers for antiseptics/disinfectants

Antiseptics/Disinfectants	No. Wards	Methods (%) Cleaning	Hot-air	Auto-claving	Other
Alcohol 70%	281	16.9	3.1	41.8	38.3
Chlorhexidine 4%	136	63.2	5.1	11.0	20.6
Chlorhexidine 0.5%	62	37.1	-	46.8	16.1
Povidone iodine 7.5% / Povidone iodine 10%	249	12.4	5.6	44.2	37.7
Tincture iodine 1-2%	46	21.7	4.3	32.6	41.3
Lysol 2%	52	59.6	1.9	3.8	34.6
Hypochlorite 0.5%	130	83.1	0.8	6.2	10.0

Table 6. Duration of use of diluted antiseptics/disinfectant (days)

Antiseptics/ Disinfectants	No. Response	Duration (%) Single	1	3	5	7	Other	Not specified
Alcohol 70%	267	5.2	31.1	19.9	1.5	27.3	3.0	12.0
Chlorhexidine 4%	128	3.1	11.7	20.3	1.6	35.9	7.0	20.3
Chlorhexidine 0.5%	57	-	12.3	19.3	3.5	31.6	15.8	17.5
Povidone iodine 7.5%	223	4.9	16.1	16.1	6.3	27.4	6.3	22.9
Povidone iodine 10%								
Tincture iodine 1-2%	40	5.0	12.5	22.5	2.5	27.5	10.0	20.0
Lysol 2%	45	13.0	40.7	-	3.7	5.6	5.6	31.5
Hypochlorite 0.5%	125	4.8	41.6	4.0	1.6	16.8	16.8	12.0
Total	894	4.9	24.6	15.7	3.0	26.4	7.6	17.8

Table 7. Samples of antiseptics/disinfectants cultured (%) (Total = 16,142)

Antiseptics/Disinfectants	Days in-use (days) 1	3	5	7	Total
Alcohol 70%	16.8	10.9	7.1	5.8	40.7
Chlorhexidine 4%	7.0	4.2	3.2	2.4	16.9
Chlorhexidine 0.5%	2.7	1.5	1.2	1.1	6.5
Povidone iodine 7.5%	9.0	5.9	4.2	3.5	22.6
Povidone iodine 10%	1.4	1.3	0.8	0.6	4.2
Tincture iodine 1-2%	0.8	0.5	0.4	0.4	2.1
Lysol 2%	0.5	0.4	0.4	0.4	1.7
Hypochlorite 0.5%	2.2	1.3	1.1	0.8	5.4
Total	40.4	26.6	18.5	14.9	100.0

Table 8. Microbial contamination of antiseptics/disinfectants (%)

Antiseptics/Disinfectants	No. Tested	Days In-use 1	3	5	7	Average
Alcohol 70%	6,562	0.8	1.9	4.4	4.7	2.3
Chlorhexidine 4%	2,722	1.8	2.8	4.0	4.0	2.8
Chlorhexidine 0.5%	1,054	0	0.9	4.0	6.3	2.0
Povidone iodine 7.5%	3,648	0.3	0.7	0.4	1.0	0.5
Povidome iodine 10%	671	0	0	0	0	0
Tincture iodine 1-2%	337	0	0	0	0	0
Lysol 2%	872	0	5.6	9.8	5.7	4.7
Hypochlorite 0.5%	276	0.3	1.9	1.7	0.8	1.0
Total	16,142	0.7	1.7	3.1	3.7	1.8

Table 9. Contamination of antiseptics/disinfectants by categories of hospitals (%)

Antiseptics/Disinfectants	Average	Categories of Hospitals*				
		U	R	P	D	Pri
Alcohol 70%	2.3	0	0.5	4.4	1.5	2.6
Chlorhexidine 4%	2.8	0	0.7	7.2	9.7	0
Chlorhexidine 0.5%	2.0	0	0	4.2	0.7	0
Povidone iodine 7.5%	0.5	0	0	1.0	0.8	0
Povidome iodine 10%	0	0	0	0	0	0
Tincture iodine 1-2%	0	0	0	0	0	0
Lysol 2%	4.7	0	25.0	0	0	0
Hypochlorite 0.5%	1.0	0	0	0	3.3	0
Total	1.8	0	0.7	3.3	2.4	1.0

*U = University, R = Regional, P = Provincial, D = District, Pri = Private

Table 10. Microbial isolates (%) (Total = 290)

Microbials	Percent
Co-ag-neg. *Staphylococcus*	35.9
Bacillus spp.	20.0
Pseudomonas aeruginosa	18.3
Enterbacter spp.	13.8
Acinetobacter spp.	4.1
Other	7.9

Discussion

This nation wide prevalence study on microbial contamination of in-use antiseptics/disinfectants involved 278 wards in 39 hospitals across the country (Table 1). The data could represent the situation of the country in 2002. Six antiseptics/disinfectants were chosen because they were the most commonly used (Table 2). The annual costs per bed of these chemicals varied from 10.47 baht for tincture iodine to 1,059.53 baht for alcohol 70% with an average cost of 1,949.72 baht (48.74 US dollar). Risk factors for contamination are shown in Tables 3-6. The antiseptics/disinfectants was diluted and prepared in several places (Table 3). The hygiene of these places was not suitable for preparing sterile solutions. In most hospitals, preparing antiseptics/disinfectants was done in different places for different chemicals. Even though the same one, it was prepared in different places, ie: pharmacy wards and central sterile supply departments and others.

Antiseptics/disinfectants were prepared by different personnel. Only 16.5% to 66.0% of the solutions were prepared by pharmacists (Table 4). On many occasions, they were prepared in the wards by nurses and other unskilled personnel. The containers for antiseptics/disinfectants were sterilized before use in only 5.7% to 49.8% (Table 5). Sterilized containers were used for hypochlorite 0.5%, chlorhexidine 4% and alcohol 70% in only 7.0%, 16.1% and 44.9% respectively. Unsterilized containers are likely to be contaminated by microbes which may be resistant to antiseptics/ disinfectants[13]. The fact that microbes can be resistant to antiseptics/disinfectants should be made known to the medical community to increase the awareness of microbial contamination. The duration for use of antiseptics/disinfectants should also be standardized. A very high proportion of these chemicals was used for more than 7 days after being prepared (Table 6). Up to 12.0% to 31.5% of antiseptics/ disinfectants in-use, there was no expiry date and the containers were topped up with these solutions when they were nearly empty. Microbial contamination was tested on 16,142 samples of antiseptics/disinfectants (Table 7). Alcohol 70% was the largest sample (40.7%) followed by povidone iodine 7.5% (22.6%) and chlorhexidine 4% (16.9%) respectively. The average prevalence rate of contamination was 1.8% (Table 8). There was no contamination of povidone iodine 10% and tincture iodine. Lysol 2% was the most contaminated (4.7%) followed by chlorhexidine 4% (2.8%), alcohol 70% (2.3%) and chlorhexidine 0.5% (2.0%) respectively. Lysol 2% was prepared in wards, mostly by ward workers using unsterile containers. These factors contributed to the high contamination rate. The overall contamination rates in the present study, even though at a concern level, were

less than previously reported rates of 3 to 42%[6-8,14,15]. It is interesting that there was no contamination of antiseptics/disinfectant samples from university hospitals (Table 9). The microbial contamination rate was highest in provincial hospitals (3.3%) followed by district hospitals (2.4%). In private hospitals, only alcohol 70% was found to be contaminated. The practice in provincial hospitals must be urgently reviewed by these findings. Micro-organisms isolated from antiseptics/disinfectants were mainly environment microbes (Table 10). Co-agulase-negative staphylococci and Bacillus species accounted for over one half of the bacteria. *Pseudomonas aeruginosa, Enterobacter* species and *Acinetobacter* species were among the leading isolates. The findings were similar to other reports[6,15]. The risk of causing infection by contaminated antiseptics/disinfectants will be greater if they are used in high risk areas such as surgical wards, intensive care units, pediatric/neonatal wards etc. Any nosocomial infection resulted from the contamination could have grave consequences[16-18].

Conclusion

The contamination rate of 8 antiseptics/ disinfectants in 39 hospitals in Thailand in 2002 was 1.8%. The contamination rates varied with the in-use duration. There was no contamination of povidone iodine 10% and tincture iodine 1-2%.The contamination was not found in university hospitals. Risk factors for contamination included improper preparation, unsterilized containers and prolonged in-use period.

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การปนเปื้อนน้ำยาฆ่าเชื้อและน้ำยาทำลายเชื้อ

สมหวัง ด่านชัยวิจิตร, เชิดศักดิ์ ธีระบุตร, ยงค์ รงค์รุ่งเรือง, นิตยา ศรีหาผล, วราภรณ์ พุ่มสุวรรณ

วัตถุประสงค์ : *หาอัตราการปนเปื้อนแบคทีเรียของน้ำยาฆ่าเชื้อและน้ำยาทำลายเชื้อขณะที่ใช้และหาปัจจัยที่ทำให้เสี่ยงต่อการปนเปื้อนเชื้อ*

วัสดุและวิธีการ : *ศึกษาการปนเปื้อนแบคทีเรียของน้ำยาฆ่าเชื้อและน้ำยาทำลายเชื้อโดยวิธีเพาะเชื้อจากน้ำยาที่ใช้บ่อย ๆ 8 ประเภทคือ alcohol 70%, chlorhexidine 4% และ 0.5%, povidone iodine 7.5 และ 10%, tincture iodine 1-2%, Lysol 2%, และ hypochlorite 0.5%. การหาปัจจัยเสี่ยงต่อการปนเปื้อนเชื้อโดยการใช้แบบสอบถาม*

ผลการศึกษา : *จากการศึกษาในโรงพยาบาล 39 แห่ง ในพ.ศ. 2545 ปัจจัยที่ทำให้เสี่ยงต่อการปนเปื้อนเชื้อคือการเตรียมโดยบุคลากรที่ไม่ชำนาญ, ภาชนะไม่เหมาะสมและใช้เป็นเวลานาน พบการปนเปื้อนแบคทีเรีย 1.8% จากตัวอย่างที่ส่งตรวจ 16,142 ตัวอย่าง น้ำยาที่ปนเปื้อนมากที่สุดคือ Lysol 2% ส่วนน้ำยาที่ไม่ปนเปื้อนเลยคือ povidone iodine 10% และ tincture iodine 1-2%. โรงพยาบาลที่พบการปนเปื้อนน้ำยาสูงที่สุดคือ โรงพยาบาลทั่วไป ส่วนโรงพยาบาลมหาวิทยาลัยไม่พบการปนเปื้อน อัตราการปนเปื้อนแปรตามอายุของน้ำยาที่ใช้ เชื้อที่แยกได้ส่วนใหญ่เป็นเชื้อที่พบในสิ่งแวดล้อม*

สรุป : *อัตราการปนเปื้อนแบคทีเรียของน้ำยาฆ่าเชื้อและน้ำยาทำลายเชื้อสูงถึง 1.8% ปัจจัยที่ทำให้เสี่ยงต่อการปนเปื้อนได้แก่การเตรียมที่ไม่เหมาะสมและการใช้น้ำยาที่เตรียมแล้วเป็นเวลานาน*