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Nurses and hospital infection control: knowledge, attitudes and behaviour of Italian operating theatre staff

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Summary: This study examined the disinfection and sterilization practices used by hospital operating theatres and evaluated the knowledge, attitude and behaviour of nursing staff with regard to infection control. Of the 216 nurses responding, knowledge concerning such practices was not consistent since 10% did not believe that items should be rinsed in water after contact with glutaraldehyde and more than 25% thought that 10 min contact time provided sterilization. Almost all were aware that improper practices increased the risk of nosocomial infections in patients. Nurses in orthopaedic surgery had a significantly lower level of knowledge compared with others. The great majority of nurses agreed that guidelines for disinfection and sterilization practice should be maintained and applied. With regard to the use of surgical instruments, the majority used steam or dry heat sterilizers for the appropriate time and temperature. Glutaraldehyde was used by 95% to sterilize endoscopes, but at different temperatures and times of exposure. Similar procedures were reported as used for laryngoscopes, though a higher percentage used heat sterilization. Only 38% routinely used all barrier techniques (gloves, masks, and protective eye-wear). Predictors for the routine use of all barrier techniques included attendance at continuing education courses on nosocomial infections, and nurses who were male and those involved in orthopaedic operations. Data support the need for finding and implementing interventions related to the prevention of hospital infection activities, in order to motivate nurses to use the correct procedures as a routine.

Keywords: Attitudes; behaviours; hospital infection; knowledge; Italy; nurses; operating rooms.

Introduction

The need for appropriate disinfection and sterilization procedures is well documented in the literature, since failure to employ correct practices has been responsible for occupational risks among healthcare professionals and for nosocomial infections.[1,2] In particular, operation theatre staff are at high risk of acquiring blood-transmitted infections because they are frequently exposed to blood and other bodily secretions from patients.[3–8] Moreover, it is well known that surgical site infections largely contribute to the burden of nosocomial infections and that the main risk factors include the behaviour of operating theatre personnel regarding decontamination practices, hand hygiene/antisepsis, and compliance with universal precautions.[1,9–12]

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In Italy, as in several other countries, each hospital has a multidisciplinary Infection Control Committee, which provides advice on the issues of control of infection, defines standards, and recommends policies. However, despite guidelines regarding the practice and strategy of hospital infection control, in most Italian hospitals these still remain controversial issues. Several studies have evaluated disinfection and sterilization procedures in hospitals,[13,14] knowledge and practices of hospital staff,[15–17] and compliance with universal precautions,[18–22] but similar data are not available in Italy. Information on this topic is necessary to assess whether personnel are prepared to assume their responsibilities in preventing hospital infections.

The purposes of this study were to determine the disinfection and sterilization practices employed by Italian hospitals in operating theatre and to evaluate knowledge, attitudes and behaviours of nursing staff concerning infection control.

Materials and Methods

From June to September 1998, all operating theatre head nurses and other working nurses in 16 randomly selected hospitals in Calabria were surveyed. All nurses in the sample were mailed a letter explaining the purpose of the study, a questionnaire (a copy is available upon request from the corresponding author), and a stamped, addressed envelope to facilitate the return of the completed questionnaire. Second and third questionnaires for non-respondents were mailed. In an attempt to maximize the response rate, telephone calls were made to all hospitals managers before mailing the questionnaire and before each of the follow-up mailings.

The questionnaire consisted of 34 questions focusing on nurses' demographics, practice characteristics, knowledge about disinfection and sterilization practices and universal precautions, attitudes about nosocomial infections control, and their attitudes to barrier techniques. Moreover, the questionnaire addressed to the head nurses also included a set of 12 questions focusing on the availability of various disinfection/sterilization techniques, the practice of antisepsis/disinfection/sterilization, and the effective control of sterilization.

Criteria for judging the effective use of antisepsis, disinfection and sterilization procedures as well as exposure times and temperatures for dry heat and steam sterilizers, were derived from previously published standards.[23–26]

All knowledge and attitude responses were based on a five-point Likert scale with options for 'strongly agree', 'agree', 'uncertain', 'disagree' and 'strongly disagree'. Responses regarding use of barrier techniques were in a five-answer format of 'never', 'rarely', 'sometimes', 'often', 'always', whereas questions on procedures for sterilization, disinfection and antisepsis were open-ended and provided more than one answer, requesting type of procedure, time and temperatures of exposures.

For the purpose of reporting results, the two scales designating agreement, 'agree' and 'strongly agree', and disagreement, 'disagree' and 'strongly disagree', were combined into 'agree' and 'disagree' categories, respectively.

The questionnaire was pretested and modifications made to improve the validity of responses.

Statistical analysis

Multiple logistic regression analysis was performed. Two models were developed to determine variables that were significantly associated to the following outcomes of interest: knowledge about disinfection and sterilization practices (an item soaked in glutaraldehyde should be rinsed in water before use; a contaminated item soaked in glutaraldehyde for 10 min is sterilized; a non-correct application of the disinfection/sterilization procedures increases risk of infections in personnel; masks should be changed between patients) (Model 1); use of all barrier techniques (Model 2). For purposes of analysis, outcome variables originally consisting of multiple categories were reduced to two

levels. In the knowledge model, nurses were divided into two groups: those who agreed with all the authors' interpretation of the correct responses and all others. For the barrier techniques model, respondents were grouped according to whether they reported routine use of all barrier techniques, or used them irregularly, or not at all.

The explanatory variables included in the models were the following: sex (1=female; 0=male); age (continuous, in years); number of years in practice (continuous); role (1=head nurse; 0=ordinary nurse); having attended continuing education courses (0=no; 1=yes); ward of practice (categorical, 0=Gynaecology/Obstetrics; 1=General Surgery; 2=Special Surgery; 3=Orthopaedics; 4=Operating Room). The model building strategy included the following steps: (1) univariate analysis of each variable considered, using the appropriate test statistic (chi-square test or *t*-test); (2) inclusion of any variable whose univariate test has a *P* value lower than 0·25; (3) backward elimination of any variable which does not contribute to the model by the Likelihood Ratio Test, using a cutoff significance level of 0·05; variables whose exclusion altered the coefficient of the remaining variables were kept in the model; (4) testing of interaction terms using a cutoff of 0·15 level significance.[27] Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Data were analyzed using the Stata software program.[28]

Results

Of the 36 head nurses and 259 ordinary nurses, 29 and 187 returned the questionnaire, respectively, with a total response rate of 73·2%.

Knowledge

Nurses' knowledge about disinfection, sterilization and universal precautions is shown in Table I. Broad knowledge about procedures was lacking, since almost 10% were uncertain or disagreed that items should be rinsed in water after contact with glutaraldehyde and more than 25% agreed or were uncertain that only 10 min contact with glutaraldehyde provided sterilization. Moreover, almost all nurses knew that operating instruments should be sterilized, since 99·5% agreed that surgical instruments and endoscopy forceps should undergo sterilization and 97·6% were aware that improper application of disinfection/sterilization procedures increased the risk of nosocomial infections in patients. Only 58·4% agreed that masks should be changed between patients and 6·5% did not consider protective eyewear useful

Table I *Knowledge of respondents about disinfection, sterilization and universal precautions*

Statement	% agree	% uncertain	% disagree
An item soaked in glutaraldehyde should be rinsed in water before use (214)	91·6	–	8·4
A contaminated item soaked in glutaraldehyde for 10 minutes is sterilized (208)	11·6	13·9	74·5
A non-correct application of the disinfection/sterilization procedures increases risk of infection in personnel (215)	93·0	2·3	4·7
Bioptic forceps endoscopes should be sterilized (213)	99·5	0·5	–
Items used during a surgical practice should be sterilized always (213)	99·5	–	0·5
A non correct application of the disinfection/sterilization procedures increase risk of infection in patients (213)	97·6	0·5	1·9
Hands should be washed after using gloves (211)	97·6	–	2·4
The use of gloves, masks and protective glasses reduces the risk of infection (210)	99·0	0·5	0·5
Masks should be changed between patients (214)	58·4	5·1	36·5
Protective eyewear should be used during surgical practice (214)	93·5	2·8	3·7

Number of subjects responding to the questions is in parentheses

Table II *Logistic regression models results*

Variable	OR	SE	95% CI	*P* value
Model 1: Outcome: Knowledge about disinfection and sterilization practices and universal precautions				
Age	1·03	0·03	0·96–1·10	0·352
Years in practice	0·96	0·25	0·91–1·01	0·202
Hospital ward				
Gynaecology/Obstetrics	1·0*	–	–	–
General Surgery	0·36	0·25	0·93–1·45	0·154
Special Surgery	0·27	0·20	0·65–1·16	0·079
Orthopaedics	0·12	0·91	0·02–0·53	0·005
Operating Room	0·38	0·27	0·09–1·60	0·196
Model 2: Outcome: Routine use of all barrier techniques				
Sex	0·34	0·14	0·15–0·76	0·009
Years in practice	0·97	0·01	0·94–1·01	0·254
Attending continuing education course	0·38	0·14	0·18–0·82	0·014
Hospital ward				
Gynaecology/Obstetrics	1·0*	–	–	–
Special Surgery	0·30	0·20	0·16–1·07	0·070
Orthopaedics	0·30	0·16	0·10–0·89	0·030
Operating Room	0·52	0·24	0·21–1·28	0·160

* Reference category

during operations. Overall, 67·3% of nurses agreed with the correct answer to all of the four questions on knowledge chosen by the authors as an indicator of 'good' knowledge, and results of the multiple logistic regression analysis indicated that nurses in orthopaedic surgery had a significantly lower knowledge compared to others (P=0·005) (Model 1 in Table II). No significant interactions among the variables were detected.

The respondents learned about nosocomial infections preventive measures primarily from continuing education courses (67·6%); however, they also relied on colleagues (31·6%) and mass-media (18·9%). Almost all nurses surveyed wanted to learn more (95%).

Attitudes

Table III shows the nurses' attitudes towards nosocomial infection prevention and control. Fear of infection from patients (HIV) was indicated by a high percentage of nurses who agreed or was uncertain that HIV/HCV/HBV-infected patients should be treated in a specialist centre (55·3%), that it was necessary for a nurse to know whether a patient was HIV/HCV/HBV seropositive (93·4%), and the belief that in surgical practice, infection control measures to prevent HIV transmission should be more stringentt than for hepatitis B virus (40·3%). A positive attitude was reported by the great majority of nurses who agreed that guidelines for disinfection and sterilization practice should be used and maintained (96·2%), that the number of subjects in the operating theatre should be minimized (99·5%), and that doors should be kept closed during operations (100%).

Behaviours

A centralized department for sterilization of supplies was reported to be present in 37·5% of hospitals, while the availability of steam and dry heat sterilizers in theatres was 85·7% and 44%, respectively. All head nurses specified correct times and temperatures for regulating dry heat sterilization, while only 92·4% specified steam sterilization. Biological monitoring of sterilization cycles effectiveness was not performed at all in 18·5% of the departments, though most of the sample (91·3%) practiced controls with physical and/or chemical indicators.

Table III *Attitudes of respondents towards nosocomial infections prevention and control*

Statement	% agree	% uncertain	% disagree
HIV/HCV/HBV seropositive patients should be treated only in a specialist centre (208)	48·6	6·7	44·7
It is necessary for a nurse to know whether a patient is HIV/HCV/HBV seropositive (213)	93·4	0·9	5·7
In surgical practice infection control measures to prevent HIV transmission should be more severe than for hepatitis B virus (211)	40·3	2·4	57·3
Guidelines are necessary for a correct application of disinfection/sterilization procedures (211)	96·2	3·3	0·5
The number of subjects in the operating room should be mantained at minimum (209)	99·5	0·5	–
Operating room doors should be closed during interventions (208)	100	–	–
Periodic control of sterilization devices is useful (209)	99·5	0·5	–
In surgical practice screening for AIDS should be carried out (212)	83·5	6·6	9·9

Number of subjects responding to the question is in parentheses

Table IV *Procedures used for sterilization or disinfection in operating room*

	Procedures for sterilization or disinfection (%)							
	SS	DHS	G	CLOR	A	BC	CC	DD
Surgical instruments (28)	89·5	10·7	7·1	–	–	–	–	–
Endoscopes (20)	5	–	95	–	–	5	–	–
Laryngoscopes (18)	22·3	–	94·5	–	–	5·6	–	–
Linen (28)	100	–	–	–	–	–	–	–
Surgical brushes (21)	28·6	–	4·8	14·3	4·8	33·3	4·8	14·3
Metal prostheses (12)	83·4	–	8·13	–	–	–	–	8·3
Plastic prostheses (10)	70	–	20	–	–	–	–	10
Endotracheal tubes (16)	25	–	25	–	–	–	–	59·3

Number of subjects responding to the questions is in parentheses
SS, steam sterilizer; DHS, dry heat sterilizer; G, glutaraldehyde; CLOR, chlorhexidine; A, alcohols; BC, benzalkonium chloride; CC, chlorine and chlorine compounds; DD, disposable devices.

Table IV shows the procedures reported by head-nurses for the sterilization or disinfection of different items. The majority used steam or dry heat sterilizers for appropriate times and temperatures (89·5% and 10·7%, respectively) to sterilize surgical instruments. With endoscopes, 95% used glutaraldehyde, but at different temperatures and exposure times ranging from 10 min (10%) to 10 h (20%). Similar methods were reported for laryngoscopes, though a higher percentage used sterilization by heat (22·3%). The majority of head nurses reported the use of steam sterilizers for metal and plastic prostheses (83·4% and 70%, respectively), 8·3% and 10% used disposable devices, and 8·3% and 20% used glutaraldehyde ranging from 30 min to 10 h. Finally, procedures for endotracheal tubes showed 59·3% used a disposable devices, 25% used steam sterilization and 25% glutaraldehyde, with contact times ranging from 20 min to 10 h.

Table V shows the procedures used by head-nurses for antisepsis in the operating room. Surgical hand scrub was appropriate for 82·2% of cases. For surgical site antisepsis and wound care, povidone-iodine was the first choice, preferred by 82·8% and 64·3% of nurses, respectively. Appropriate procedures were observed in 82·2% for surgical hand scrub, 81·3% for placement of central intravenous catheters, and in 38·9% for urinary catheters.

Table V *Antiseptics used in operating room*

	Type of antiseptic (%)								
	CC	G	AB	PE	NS	BC	PI	CLOR	MC
Surgical hand scrub (28)	3·6	–	–	–	10·6	3·6	3·6	78·6	–
Surgical site preparation (29)	–	–	–	–	–	17·2	82·8	3·6	3·5
Wound care (28)	–	–	7·1	10·7	–	21·4	64·3	7·1	–
Central iv catheter insertion (16)	6·2	6·2	–	–	–	6·2	81·3	–	–
Urinary catheter insertion (18)	33·3	5·6	5·6	–	–	22·2	27·8	11·1	–

Number of subjects responding to the questions is in parentheses
CC, chlorine and chlorine compounds; G, glutaraldehyde; AB, antibiotics; PE, hydrogen peroxide; NS, neutral soap; BC, benzalkonium chloride; PI, povidone-iodine; CLOR, chlorhexidine; MC, mercurial compounds.

Almost all nurses always wore sterile gloves (99%) and of these, all reported changing them after a surgical procedures, washed their hands before and after surgical procedure (98·2% and 95·4%, respectively), and wore masks (98·1%), while only 38·4% reported the use of protective eyewear. Only 38·4% of nurses routinely used all these barrier techniques. Results of the multiple logistic regression analysis showed that the use of all barrier techniques was more likely achieved by nurses who had attended continuing education courses about nosocomial infections preventive measures, if they were involved in orthopaedic operating rooms, and the prevalence was higher in male nurses (Model 2 in Table II). No significant interactions among the variables were detected.

Discussion

Many studies have been undertaken to analyse the practice of disinfection and sterilization procedures in hospital,[14] address specific issues, such as endoscopes,[13] application of standard universal precautions,[15–18,20,21] or the knowledge and attitudes regarding disinfection/sterilization and control of infection.[15–18] To the best of our knowledge, this study is the first to address all of these issues concerning prevention of infection both in patients and personnel in such a critical setting such as operating theatres.

Our findings demonstrate the limited knowledge in hospitals about disinfection and sterilization practices and the outcomes show that nurses are not allowed effective roles in containing and preventing nosocomial infections. Only 67·3% of responders agreed with the author's interpretations of the correct responses regarding general knowledge about infection control. Of even more concern was their lack of knowledge about the use of barrier techniques, since only 58·4% of nurses, knew that masks should be changed between patients. The striking differences in nurses' knowledge according to speciality supports the need for targeted education programmes. It seems evident that Italian nurses do not feel comfortable in providing assistance to HIV/HCV/HBV-positive patients, since almost half (48·6%) of the responders surveyed would rather refer these patients to specialized centres and 93·4% considered it necessary for a nurse to know if a patient was seropositive for any of these infections.

Several procedures observed in our study are clearly inappropriate according to international published guidelines. The most non appropriate practices found were the use of steam sterilizers for sterilization or disinfection of plastic prostheses, endotracheal tubes, and laryngoscopes, and the use of benzalkonium chloride for surgical brushes. Moreover, several hospitals used chlorine and chlorine compounds as antiseptic for urinary catheter insertion and benzalkonium chloride in almost all procedures, ranging from 3·6% for surgical hand scrub to 22·2% for urinary catheter insertion. The use of benzalkonium chloride has been widely discouraged because it is a poor disinfectant and allows for the growth of bacteria

within the disinfectant. Whilst appreciating the importance of disinfection and sterilization there was a considerable lack of knowledge on the appropriate of several procedures, especially in the use of glutaraldehyde.

The fact that only 38·4% of Italian nursing staff in operating rooms routinely used all barrier techniques such as gloves, masks, and protective eyewear is unacceptable, since less than optimal levels of universal precautions compliance rates might be an important risk factor for hospital infection. Routine glove use was 99% in our study which was higher than the values reported in the United States by O'Boyle Williams *et al*.[19] (64%) and by Henry *et al*.[21] (67·2%) among registered nurses and nurse-assistants in emergency departments. Moreover, Zimakoff *et al*.[20] surveyed healthcare workers in intensive care units in university hospitals in Scandinavia and reported that they used gloves in only 17% of the procedures and were not used appropriately for dirty procedures. Moreover, Sproat and Inglis[17] in a detailed survey of hand hygiene in intensive care units in the UK reported that only 42% of nurses used gloves during surgical wound care. Almost all nurses surveyed washed their hands before (98·2%) and after (95·4%) surgical practice, and this result was similar to 92% among nursing staff in the obstetric/gynaecological wards and neonatal intensive care unit in the UK.[16] Sproat and Inglis[17] showed poor compliance by nurses, since handwashing was more frequent after patient care than before and 14% nurses did not report any type of hand hygiene before wound care dressing. Almost all respondents routinely used masks (98·1%), whereas studies in the United States reported that only 24%[19] and 16%[21] routinely wore masks. Protective eye-wear prevalence in our study was, 38·4% which is considerably lower than that observed by Henry *et al*.[27] (50·7%). We found that attending continuing education courses about hospital infection and whether the responder was male and was involved in orthopaedic operations, were the only variables significantly associated with the routine use of all barrier techniques. This finding is in accordance with several previous studies that demonstrated there was a positive association between knowledge of infection control procedures and compliance with barrier techniques.[19,22] Considering the extreme importance of precaution in surgical procedures in theatre to prevent the spread of hospital infection, we strongly urge further educational efforts to improve the use of all types of barrier techniques.

In conclusion, our data support the need for finding and implementing interventions, related to the prevention of hospital infection activities, in order to motivate nurses routinely to use the correct procedures.

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