Infection control practices in intensive care units of 14 European countries

Moro, M.L.; Jepsen, O.B.; Study group members AMC, :; Dankert, J.

Published in:
Intensive Care Medicine

Intensive Care Med (1996) 22: 872–879

ORIGINAL

M. L. Moro
O. B. Jepsen
The EURO.NIS Study Group

Infection control practices in intensive care units of 14 European countries

Received: 17 January 1995
Accepted: 29 December 1995

This study was carried out within the European Research Project "EURO.NIS: Nosocomial Infections in Intensive Care Units in Europe" sponsored by the European Economic Community

M.L. Moro (✉)
Laboratorio di Epidemiologia e Biostatistica
Istituto Superiore di Sanità, Viale Regina Elena, 299, I-0161 Roma, Italy

O.B. Jepsen
The National Center for Hospital Hygiene, Statens Seruminstitute, Copenhagen, Denmark

Abstract *Objective:* To evaluate compliance with recommended patient-care practices for the prevention of hospital-acquired infections (HAI) in the intensive care unit (ICU).
Design: European descriptive survey by questionnaire mailed to all the directors of ICUs.
Patients and participants: A total of 1642 general ICUs with more than three beds in 14 countries were contacted; 1005 units participated in the study (overall response rate of 61.2%).
Measurements and results: Data on the general characteristics of the hospital and of the ICU, surveillance activities, and patient-care practices relevant to the control of HAIs were collected. Compliance varied significantly by the type of practice evaluated. Comprehensive programs adopting all the recommended preventive practices for specific infections were maintained in a very low proportion of units, ranging from 18% for antibiotic policy to 39% for urinary tract infections. Moreover, 14% of the units claimed to adopt three or more practices that are clearly unsafe, and only 35% of the units claimed not to adopt any risky practice. The presence of an infection control nurse was significantly associated with a lower frequency of substandard care. A great variability was observed by country in the adoption of 29 patient-care practices, mostly for practices for which clear-cut guidelines are lacking.
Conclusion: Interpretation of data is made difficult by the lack of consensus among experts with respect to some of the practices investigated. Nevertheless, the implementation of standard practices for preventing HAIs is far from satisfactory in the hospitals surveyed, even in a high priority hospital area such as intensive care. Documented European guidelines could be worthwhile in increasing awareness of the ICU staff. The availability of at least one infection control nurse in each hospital should be strongly advocated.

Key words Intensive care units · Nosocomial infections · Control measures · Compliance

Introduction

Several studies, both in experimental settings and under actual day-to-day conditions [1–5], have shown conclusively that a number of patient-care practices are effective in reducing the risk of infectious complications in hospitals, especially in patients exposed to invasive procedures. When these practices (or standards of care) are not adopted, patients are at risk of acquiring infections that could have been prevented.

In addition to the measures which have been scientifically shown to be effective, there exist many other infection control measures, some of which are still highly controversial and others which have gained popularity despite the lack of scientific evidence on their efficacy. To increase health professionals' awareness of patient-care practices scientifically proven to be safe, while promoting the abandonment of noncost-effective measures, several institutions and professional health organizations have issued recommendations on patient-care practices [6–10]. The majority of proposed recommendations were issued by the Centers for Disease Control and Prevention (CDC) in Atlanta and were adopted by European infection control officers during the 1980s.

Nevertheless, some studies, mostly those conducted in the United States, have shown that the adoption of these recommendations is far from universal. In 1985, the CDC investigated the adoption of 16 specific recommendations in 445 US hospitals selected at random. Compliance varied from 23 to 75%, and 5 of the 16 recommendations were adopted as policy by less than half of the US hospitals [11]. Similarly, while the Study on the Efficacy of Nosocomial Infection Control (SENIC) reported that 32% of hospital-acquired infections could have been prevented by intensive surveillance and control programs, nationwide only 9% of these infections were actually being prevented [12].

To date, no large-scale survey has been conducted on the adoption of infection control measures in Europe. Information on which practices show a lower overall degree of compliance or a great variability from country to country would be very useful for targeting intervention programs at the European level, such as issuing practice guidelines or developing consensus conferences on controversial issues.

Since many hospital-acquired infections occur in intensive care units (ICUs) [13–16], these units represent one of the most important targets for intervention programs aimed at reducing the incidence of infection. The present study is the first survey on infection control activities in ICUs in Europe. It was the first step in a large-scale European collaborative research project, which, as a subsequent activity, carried out a multicenter prospective study on pneumonia to evaluate the influence of practices on patient outcome. In this paper we describe the distribution of patient-care practices for the control of hospital infections.

Materials and methods

Study population

The survey was conducted in 14 European countries: Belgium, Denmark, France, Greece, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. In each country, a study coordinator was responsible for providing the official list of ICUs from which ICUs satisfying inclusion criteria were selected: general ICUs with more than three beds were eligible, but specialized ICUs were not (for example, coronary care units and hematologic, infectious disease, newborn, and burn units). Overall, 1642 ICUs were contacted, and 1005 participated in the study. The overall response rate was 61.2%, varying from 34% in the UK and Ireland to 100% in Portugal. The low response rate in the English centers was probably due to the fact that another study in ICUs had recently been performed [17].

The participating units were distributed as follows: France 296 (29.4%), Germany 145 (14.4%), Italy 125 (12.4%), the UK and Ireland 97 (9.6%), Belgium and Luxembourg 78 (7.8%), Sweden 68 (6.8%), the Netherlands 55 (5.5%), Switzerland 43 (4.3%), Spain 41 (4.1%), Portugal 26 (2.6%), Denmark 19 (1.9%), and Greece 12 (1.2%). Ireland and Luxembourg have very few ICUs and were thus grouped together with the UK and Belgium, respectively.

Study methods

In February 1990, a questionnaire was mailed to all the directors of the ICUs; units that did not reply were contacted again in July 1990. The following information was collected: (a) general characteristics of the hospital and of the unit (i.e., number of beds, university affiliation, public/private status, main activity of the unit, mean length of patient stay in the ICU, mean number of admissions per year, mean percent of scheduled admissions, mean percent of ventilated patients, and size of medical and nursing staff); (b) structural characteristics of the unit (i.e., physical size of the unit, number of beds per single room, and number of adequately equipped handwashing sinks); (c) surveillance activities; and (d) patient-care practices relevant to the control of hospital-acquired infections. The patient-care practices investigated are shown in Table 1; the standards for recommended practices were taken from guidelines issued by the CDC [6–8].

Data analysis

All questionnaires were checked manually for completeness and consistency before being coded and entered into the database. Data were analyzed using the statistical package SPSS PC [18]. To describe the extent to which infection control policies were adopted in ICUs, 12 incorrect patient-care practices were selected on the basis of the following criteria: (1) practices considered to be relevant for all the units involved (i.e., those potentially found in most of the patients admitted to any type of unit); and (2) incorrect practices strongly associated with an increased risk of acquiring an infection. The following patient-care practices were selected: (1) no antimicrobial policy (neither written protocol, informal mutual consent nor restricted antimicrobial list); (2) no gloves for suctioning (sterile or not); (3) no sterile catheter for suctioning; (4) no policy for change of i.v. sets used for clear fluids; (5) no policy for change of i.v. sets used for blood; (6) no policy for change of i.v. sets used for total parenteral nutrition; (7) open urinary drainage or closed drainage that is broken often or most of the time; (8) routine bladder irrigation; (9) no use of single rooms, not even for isolating infected patients when appropriate; (10) no use of gloves; (11) no use of masks when caring for selected infected patients or carrying out selected at-risk procedures; and (12) no use of overgowns when caring for selected infected patients. These variables were used to create a new quantitative variable (range 0–12) for identifying the possible characteristics associated with "substandard" care (ICUs adopting three or more of

Table 1 Patient care practices investigated

Area of interest	Recommended measures	Other measures investigated
Antibiotic policy	* Written guidelines for antibiotic use * Restricted list of antibiotics	* Selective digestive decontamination
Pneumonia prevention	* Perioperative chest physiotherapy * Use of gloves for suctioning * Use of sterile catheter for suctioning * Use of disposable humidifiers or sterilization/disinfection of non-disposable humidifiers every 24–48 h at least * Change of breathing circuit every 24–48 h	* Type of gloves for suctioning * Type of humidifiers used * Filter on the expiration tube
Prevention of i.v. line infection	* Change of peripheral catheters every 48–72 h at least * Change of i.v. sets every 24–72 h for clear fluids * Change of i.v. sets every 24–48 h for blood products, total parenteral nutrition	* Type of antiseptic product used for site care
Prevention of urinary tract infection	* Written protocol for catheter insertion * Written protocol for catheter care * Closed drainage * No break of closed drainage * No routine bladder irrigation	* Daily meatal antiseptic care * Disinfectant or antibiotics in the drainage bag
Isolation procedures	* Single room of specific infections * Gloves, mask, overgowns for specific infections and procedures	* Overshoes * Head cover * Member of nursing staff with mild infections continuing work

the 12 incorrect patient-care practices). A multiple logistic regression was then performed to obtain an adjusted estimate of the odds ratios and to identify which factors were independently associated with substandard care.

To identify which patient-care practices showed a greater variability between countries, 29 selected patient-care practices were ranked according to the interquartile range [19] of the distribution by country of each practice. The results are presented using the box-and-whisker-plot method (Fig. 1) [20].

Results

General characteristics of the ICUs and distribution of patient-care practices

The general characteristics of the 1005 participating units are described in Table 2. The majority (72%) were mixed units, and one-fourth were located in teaching hospitals. Surgical units accounted for 21.4% and were usually located in larger hospitals. In the medical units (6.4%) the mean number of beds was higher and the patients stayed significantly longer than in surgical or mixed units. The mean percentage of ventilated patients was significantly higher in mixed units.

Table 3 shows that the reported compliance with infection control measures varied and no measure was universally adopted by all the participating units. The use of antibiotics was governed by written guidelines in only one-third of the units, and less than 20% of the units adopted all the recommended measures for maintaining a restrictive policy.

There was little evidence of a consensus on the use of selective digestive decontamination (SDD). Specifically, SDD was routinely used in 247 ICUs (24.7%): in 57 cases (23.4%) SDD was administered to all patients and in 187 cases (76.6%) to specific groups of patients only. The preferred SDD regimen was oropharyngeal and intragastric (128, 52.5%), followed by oropharyngeal alone (59, 24.2%); in 37 ICUs (15.2%) both the oropharyngeal regimen and the oropharyngeal plus intragastric regimen were used in specific groups of patients. The SDD regimen included the administration of systemic antimicrobials in 134 ICUs (54.9%); systemic antimicrobials were most frequently used in ICUs where specific groups of patients only were treated with SDD (60.4%) compared to the ones in which all the patients received SDD (36.8%) ($\chi^2 = 8.89$, $p = 0.0029$). Similarly, systemic antimicrobials were more frequently administered in ICUs where an oropharyngeal plus intragastric SDD regimen was used (64.8%), compared to the ones where only an oropharyngeal regimen was adopted (23.7%) ($\chi^2 = 30.57$, $p = 0.000001$).

Table 2 Characteristics of the participating units

	Type of unit			
	Overall ($n = 1005$)	Mixed ($n = 726$)	Surgical ($n = 215$)	Medical ($n = 64$)
Hospital size (n, %)				
<250	194 (19.7)	151 (21.2)	29 (13.9)	14 (21.9)*
< 250–499	318 (32.3)	247 (34.6)	54 (26.0)	17 (26.6)
500–999	320 (32.5)	234 (32.8)	67 (32.2)	19 (29.7)
⩾1000	153 (15.5)	81 (11.4)	58 (27.9)	14 (21.9)
University affiliation (n, %)	387 (38.5)	223 (30.7)	124 (57.9)	40 (62.5)*
Length of stay (days)				
Median, interquartile range	5.0 (2.0)	5.0 (2.0)	5.0 (2.0)	6.0 (2.0)**
No. of ICU beds				
Median (interquartile range)	8.0 (3.0)	8.0 (3.0)	9.0 (3.0)	9.5 (4.5)
% of ventilated patients				
Median (interquartile range)	30.0 (22.5)	33.0 (22.5)	30.0 (20.8)	25.0 (17.4)**
% of scheduled admissions				
Median (interquartile range)	20.0 (22.5)	15.0 (15.0)	60.0 (22.5)	1.0 (5.0)**

* $\chi^2 = 0.00001$
** 0.0083 median test; 0.05 median test; 0.00001 median test

The adoption of infection control procedures recommended for the prevention of nosocomial pneumonia, infections associated with i.v. lines, and urinary tract infections showed large variations, and only a minority of units have adopted all the recommended measures.

Perioperative chest physiotherapy for surgical patients undergoing major thoracic and abdominal operations was routinely applied in 821 ICUs (84.6%), more frequently in surgical units (92%) compared to medical units (86%) and mixed units (82.4%) ($\chi^2 = 11.86$, $p = 0.0027$).

In 573 ICUs, only one type of humidifier was used: in 229 (22.9%) non-disposable humidifiers, in 165 (16.5%) heat/moisture exchanger only, and in 115 (11.5%) disposable humidifiers. In 427 ICUs more than one type of humidifier was adopted.

The intervals between changing breathing circuits were significantly longer in ICUs where only the artificial nose was used (⩾72 h: 62.1%) compared to units where other types or several types of humidifiers were used (⩾72 h: 47.9%) ($\chi^2 = 14.16$, $p = 0.0027$). In 313 ICUs (31.1%) all the recommended investigated practices for prevention of hospital-acquired pneumonia (see Table 1) were adopted.

In most of the ICUs (68.8%), peripheral intravascular catheters were changed on suspicion on infection only; in 46 ICUs (4.6%) they were changed every 24 h, in 132 (13.2%) every 48 h, and in 134 (13.4%) every 72 h. An alcohol solution for site care antisepsis was preferred in most of the units (73.5%). The policies most frequently adopted for changing i.v. sets included change at least every 24–72 h for clear fluids (88.9%), after each infusion for blood (76.4%), and every 24–48 h for total parenteral nutrition (TPN) (71.4%). Only 218 ICUs (21.7%) adopted all the recommended investigated practices for prevention of intravascular catheter-related infection.

Compliance with recommended practices for preventing urinary tract infections was high (i.e., written protocols for urinary catheter insertion and care, closed drainage never or rarely broken, no routine bladder irrigation), but only 393 ICUs (39.1%) adopted all these practices.

Isolation and barrier precautions (single room, gloves, mask, and gown) were adopted by more than 90% of the units. Single rooms, masks, overgowns, and head cover were more frequently used for specific infections (61.2, 68.9, 57.5, and 69.9%, respectively), while gloves were used with similar frequency for all patients (40.2%), all infected patients (27.5%), and specific infections (32.3%). Overshoes were rarely used, and mostly for specific infections only (68.7%). In 70% of the units, nursing staff as a rule discontinued work if they were suffering from mild infections.

Frequency of substandard care

In 349 ICUs (34.7%) no risky patient-care practice (see Methods) was reported; one or two of these practices were reported in 516 (51.3) ICUs, three or four in 124 (12.3%) ICUs, and four to six in 48 (4.8%) ICUs. When the distribution of ICUs with ⩾3 or <3 at-risk patient-care practices was cross-tabulated with the characteristics of the hospital (number of beds, university

Table 3 Proportion of units adopting the various patient-care practices investigated ($n = 1005$) (Data were missing for the following variables as follows: guidelines for antibiotic use 15; restricted list 9; perioperative chest physiotherapy 35; sterile gloves 8; nonsterile gloves 10; sterile catheter 8; heat moisture exchange 3; disposable humidifiers 6; nondisposable 8; disinfection of humidifiers 11; breathing circuit change 17; filter 13; peripheral catheter change 6; disinfection of catheter site 2; change of i.v. sets for clear fluids 5; for blood 5; for TPN 9; written protocol for urinary catheter insertion 5; for catheter care 9; urinary drainage 5; meatal care 9; bladder irrigation 12; disinfectant in the drainage bag 12)

1. Antibiotic policy	
a. Guidelines for use	
– written guidelines	31.1
– informal mutual consent	51.9
– no uniform practice	17.0
b. Official restricted list of antibiotics	42.5
c. Written guidelines plus restricted list	17.9
2. Pneumonia prevention	
a. Perioperative chest physiotherapy	84.6
b. Gloves for suctioning	
– sterile	52.7
– nonsterile	37.8
– both	1.5
– none	8.0
c. Sterile catheter for suctioning	94.2
d. Type of humidifier	
– heat/moisture exchange	59.0[a]
– disposable	38.7
– nondisposable	58.1
e. Sterilization/disinfection interval for non-disposable humidifier	
– between each patient	36.6
– every 24–48 h	45.1
– over 48 h	18.3
f. Breathing circuit change interval	
– between each patient	24.1
– every 24–48 h	49.7
– over 48 h	26.2
g. Filter on the expiration tube	48.9
h. Compliance with all recommended practice[b]	31.1
3. i.v. line infection prevention	
a. Change of i.v. catheter on suspicion of infection only	68.8
b. Disinfection of the catheter site	
– aqueous solution	23.3
– alcohol solution	73.5
– both	3.2
c. Change of i.v. sets used for clear fluids infusion	
– 24–72 h at least	88.9
– at various intervals	11.1
d. Change of i.v. sets used for blood infusion	
– after each infusion	76.4
– 24–48 h	14.7
– at various intervals	8.9
e. Change of i.v. sets used for TPN infusion	
– after each infusion	23.2
– 24–48 h	71.4
– at various intervals	5.4
f. Compliance with all recommend practices[c]	21.7
4. Urinary tract infection prevention	
a. Written protocol for	
– catheter insertion and care	59.6
– catheter insertion only	10.8
– catheter care only	3.8
– none	25.8
b. Type of urinary drainage	
– open	10.5
– closed	80.0
– both	9.5
c. Breaking of closed drainage:	
– never or rarely	90.2
– quite often	8.0
– most of the time	1.8
d. Daily meatal antiseptic care	65.3
e. Bladder irrigation	13.4
f. Disinfectant or antibiotics in the drainage bag	2.3
g. Compliance with all recommended practices[d]	39.1
5. Isolation measures	
a. Single room	91.0
b. Gloves	98.6
c. Mask	90.8
d. Overgown	93.1
e. Head cover	63.3
f. Overshoes	42.6
g. Member of nursing staff with mild infections continuing work:	
– no	29.2
– rarely	40.9
– quite often	20.5
– always	9.4

[a] The sum is greater than 100% because more than one type of humidifier was used in several units

[b] Perioperative chest physiotherapy, use of gloves for suctioning, use of sterile catheter for suctioning, use of disposable humidifiers or sterilization/disinfection of nondisposable humidifiers every 24–48 h at least, change of breathing circuits every 24–48 h

[c] Change of peripheral catheters at regular intervals, change of i.v. sets every 48–72 h for clear fluids infusion and every 24–48 h for blood or TPN infusions

[d] Written protocols for catheter insertion and care, closed drainage never or rarely broken, no routine bladder irrigation

Table 4 Factors associated with substandard care (*CI* confidence interval)

Factor	Univariate analysis Odds ratio (CI)	Logistic regression Odds ratio (CI)
No infection control physician	1.43* (0.99 to 2.07)	
No infection control nurse	1.45* (0.99 to 2.11)	1.46* (1.02 to 2.10)
No information on nosocomial infections	1.47* (0.99 to 2.11)	
ICU beds <7	1.57* (1.06 to 2.32)	

*$p < 0.05$

affiliation), characteristics of the unit (main activity, number of beds, length of stay, percentage of ventilated patients, total nursing staff per bed), and infection control resources (infection control committee, infection control physician, infection control nurse, information on nosocomial infections available to the unit), significant associations between substandard care and the following factors were found in the univariate analysis: smaller size ICUs, lack of an infection control physician, lack of an infection control nurse, and lack of information on nosocomial infections. When these associations were further analyzed by logistic regression analysis, only lack of an infection control nurse was still statistically significant (Table 4).

Variability of patient-care practices by country

Figure 1 shows the distribution of 29 selected patient-care practices among the countries, ranked in descending order from the one which shows the greatest variability between countries to that which shows the least variability. The practices for which a greater variability was found (above the median) were the following: use of sterile gloves for suctioning (interquartile range 52.45), alcohol solutions for catheter site disinfection (IR 36.65), daily antiseptic meatal care (IR 33.4), i.v. sets changed after each blood infusion (IR 31.95), member of nursing staff with mild infections not continuing work (IR 30.05), change of breathing circuit at least every 24–48 h (IR 27.5), gloves for use with every patient (IR 27.1), overgown for specific infections (IR 26.7), mask for specific infections (IR 24.55), nondisposable humidifiers (IR 23.85), selective digestive decontamination (IR 22.55), protocol for urinary catheter insertion (IR 22.2), restricted list of antibiotics available to the unit (IR 21.4), heat/moisture exchangers (IR 20.85), and head cover for specific infections (IR 19.8).

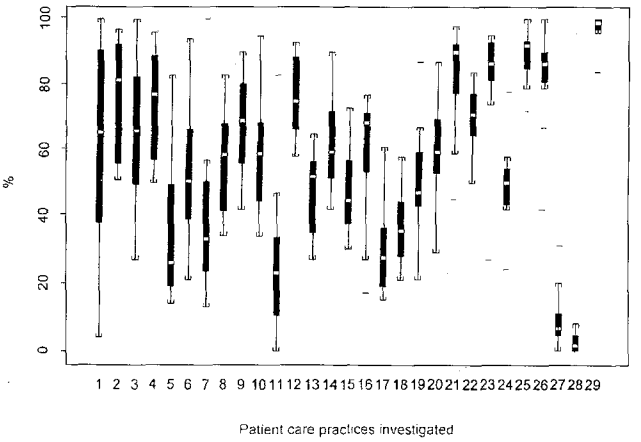

Fig. 1 Variability among countries of patient-care practices. Each box-and-whisker shows the distribution of a patient-care practice among different countries. The horizontal line in the interior of the box is located at the median of the data; the height of the box is equal to the interquartile range (IR), which is the difference between the third quartile (75% of all observations) and the first quartile (25% of all the observations) of the data; the whiskers (the dotted lines extending from the top and the bottom of the box) extend to the extreme values of the data or to a distance of $1.5 \times$ IR from the center, whichever is less. The taller the box, the wider the variability of the practice among countries

Discussion

Maintaining the highest level of compliance with preventive programs known to reduce the risk of nosocomial infections should be a goal for both ward staff and infection control officers. The present study provides information from more than 1000 European ICUs on compliance with infection control measures presently recommended in the literature. Compliance varied significantly by the type of practice studied. More than 80% of the respondents claimed that barrier precautions were used when appropriate, that aseptic techniques were applied for bronchial aspiration, and that i.v. lines were changed routinely within 72 h and more frequently when used for other than clear fluids. High compliance was found for perioperative chest physiotherapy for the prevention of postoperative pneumonia and for the use of closed urinary drainage systems.

Compliance with all other practices investigated was lower. Moreover, comprehensive programs adopting all the recommended preventive practices for specific infections were found to exist in a very low proportion of units: 39% for urinary tract infections, 31% for pneumonias, 22% for i.v. line infections, and 18% for antibiotic policy. It is not reassuring that the formal restrictive policies for the use of antibiotics rely upon "informal mutual consent" or "no uniform practice" in at least seven out of ten ICUs.

Over the last few years, the emergence of new scientific evidence has led to certain infection control measures being subject to discussion and modification (e.g., the optimal change interval for disposable humidifiers, intravenous infusion sets, and peripheral catheters) [6, 21, 22]. This could explain the wide variation in the adoption of these practices.

The multicenter–multicountry nature of the study and its effect on data quality should be taken into account when interpreting results: instructions were translated into several languages and interpreted by more than 1000 individuals. The actual effect on the quality of the data in this study is not known since data validation was not attempted. Moreover, information on practices was collected using a questionnaire (given that direct observation of practices was difficult to perform on a large scale); therefore, answers may merely reflect what physicians and nurses think should be done, rather than what is actually done.

Practice patterns are influenced by several factors, including uncertainty regarding optimal care, physicians' attitudes, values, tastes, habits, and characteristics, influences of professional leadership, practice setting, supply of health care resources, and by interventions aimed at modifying practice patterns [23].

The great variability observed by country for some of the 29 practices investigated offers some food for thought of the factors associated with the distribution of specific infection control measures. From the variability observed, it is clear that one of the strongest determinants of practice patterns is represented by the lack of clear-cut guidelines on specific issues. Recommendations become outdated very rapidly and thus should be updated regularly, in order to avoid the contradictory messages in the literature which promote the abandonment or the nonadoption of safe practices.

However, many controversial areas still exist. For instance, the use of sterile or nonsterile gloves for suctioning varied considerably within countries; recommendations on this issue published in the literature are not consistent. CDC, for instance, recommends the use of a sterile catheter and a new pair of gloves for suctioning, but they state that sterile gloves are not necessary [6]; others recommend sterile gloves for suctioning [24, 25]. However, to the best of our knowledge, no study has established the superiority of sterile gloves over non-sterile gloves.

The optimal product for disinfecting the catheter site has not been conclusively determined and this probably affects practice patterns. While several microbiological studies on the efficacy of different antiseptic products have been conducted, only one clinical trial has been reported in the literature on the comparative efficacy of povidone-iodine 10%, alcohol 70%, and aqueous chlorhexidine 2% in preventing central catheter-associated infections; the results of this study indicate chlorhexidine to be the most effective product [26]. Meatal care represents another controversial issue in the infection control literature. Given the biological plausibility of a measure aimed at reducing meatal colonization, several authors attempted to investigate the efficacy of daily antimeatal disinfection for the prevention of urinary tract infections, but none of these studies was able to demonstrate any benefit [27, 28]. The variability observed for changing intravenous sets after each blood infusion and breathing circuits every 48–72 h can be attributed to the lack of a clear agreement in the literature on this issue. CDC advocates changing intravenous sets after each infusion of blood and every 24 h for TPN [6]; other authors currently recommend a less conservative approach, suggesting that a change every 24–48 h is safe both for blood and TPN [22].

Other interesting clues can be drawn from the analysis of the factors associated with substandard care. The SENIC study pointed out that the availability of an infection control nurse (ICN) and of infection control physicians was associated with more strict compliance with recommended practices and with a consistent reduction in the incidence of nosocomial infections [12]. Accordingly, our study showed that units located in hospitals where an ICN had been appointed reported fewer at-risk patient-care practices than ICUs located in hospitals where ICNs were lacking.

In conclusion, our study showed that the diffusion of safe practices for preventing nosocomial infections is far from satisfactory, even in a priority hospital area such as intensive care. Relevant and documented European guidelines should be translated into clear instructions for safe clinical practice, and the ICU staff should be made aware of the essential infection control measures as well as of unnecessary costly practices, some of which were reported in almost half of the units. The availability of at least one ICN in each hospital should also be strongly advocated.

Appendix (Members of the EURO.NIS Study Group)

EURO.NIS Project coordinator: Jacques Fabry, Centre Hospitalier Lyon Sud, Unite d'Hygiene et Epidemiologie, Lyon, France

National coordinators and researchers: Belgium: Raf Mertens (Institut d'Hygiene et d'Epidemiologie, Bruxelles); *Denmark:* Ole Bent Jepsen (Statens Seruminstitute, Copenhagen); *France:* Serge Gottot (Faculte Xavier-Bichat, Department de Santé Publique, Paris), Jean Carlet (Hôpital Saint Joseph, Service de Réanimation, Paris); *Germany:* Franz Daschner (Klinikum der Albert Ludwigs Universität, Klinikhygiene, Freiburg);

Greece: Olga Paniara-Liaropoulos (Evangelismos Hospital, Department of Microbiology, Athens); *Ireland:* Rosemary Hone (Mater Misericordiae Hospital, Dublin), Conor T. Keane (St. James Hospital, Dublin); *Italy:* Rita Melotti (Ospedale Policlinico Sant'Orsola-Malpighi, Istituto di Anestesiologia-Rianimazione, Bologna), Maria Luisa Moro (Istituto Superiore di Sanità, Roma); *Luxembourg:* Margaret Hemmer (Centre Hospitalier du Luxembourg, Service d'Anesthesie Réanimation, Luxembourg); *The Netherlands:* Jacob Dankert (University of Amsterdam, Department of Microbiology, Amsterdam); *Portugal:* Elaine Pina (Ministerio de Saude, Gabineto do Secretario de Estado da Administracio de Saude, Lisboa); *Spain:* Miguel Angel De La Cal (Hospital Universitario de Getafe, Unidad de Cuidados Intensivos, Getafe, Madrid), Miguel Carrasco (Universidad Autonoma de Madrid, Centro Universitario de Salud Publica, Madrid); *Sweden:* Lars Burman (Statens Bakteriologiske Laboratorium, Stockolm); *Switerzland:* Anne Delachaux (Service d'Anestesiologie et de Réanimation, Hôpital Cantonal, Fribourg); *United Kindgom:* Graham A.J. Ayliffe (Dudley Road Hospital, Hospital Infection Research Laboratory, Birmingham), Barry Cookson (Public Health Laboratory Service, Division of Hospital Infections, London), Linda Taylor (Public Health Laboratory Service, Division of Hospital Infections, London); *OMS-Europe:* Anne Marie Worning (Quality of Care and Technologies Programme, World Health Organization, Copenhagen, Denmark).

References

1. Craven D, Steger KA, Barber TW (1991) Preventing nosocomial pneumonia: state of the art and perspectives for the 1990s. Am J Med 91 [Suppl 3B]: 44S–53S
2. Nichols RL (1991) Surgical wound infections. Am J Med 91 [Suppl 3B]: 54S–64S
3. Stamm WE (1991) Catheter-associated urinary tract infections: epidemiology, pathogenesis and prevention. Am J Med 91 [Suppl 3B]: 65S–71S
4. Maki DG (1989) Pathogenesis, prevention and management of infections due to intravascular devices used for infusion therapy. In: Bisno Al, Waldvogel FA (eds). Infections associated with indwelling medical devices. American Society for Microbiology, Washington, DC, pp 161–177
5. Weinstein RA (1991) Epidemiology and control of nosocomial infections in adult intensive care units. Am J Med 91 [Suppl 3B]: 179S–184S
6. Centers for Disease Control (1981) Guidelines for prevention and control of nosocomial infections. US Department of Health and Human Services, Centers for Disease Control, Atlanta, GA
7. Centers for Disease Control (1986) Guidelines for handwashing and hospital environmental control. Am J Infect Control 14: 110–129
8. Centers for Disease Control (1986) Guidelines for prevention of surgical wound infections. Am J Infect Control 14: 71–80
9. Anonymous (1988) Resource list for standards and guidelines related to infection control practice. Am J Infect Control 16: 38A–43A
10. Ducel G, Haxhe JJ, Tanner F, Zumofen M (1979) Practical guide to the prevention of hospital-acquried infections. World Health Organization, Geneva
11. Celentano DD, Morlock LL, Malitz FE (1987) Diffusion and adoption of CDC guidelines for the prevention and control of nosocomial infections in US hospitals. Infect Control 8: 415–423
12. Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, Hooton TM (1985) The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol 121: 182–205
13. Wenzel RP, Thompson RL, Landry SM, Russel BS, Miller PJ, Ponce de Leon S, Miller GB Jr. (1983) Hospital-acquired infections in intensive care unit patients: an overview with emphasis on epidemics. Infect Control 4: 371–375
14. Donowitz LG, Wenzel RP, Hoyt JW (1982) High risk of hospital-acquired infection on the ICU patient. Crit Care Med 10: 355–357
15. Daschner FD, Frey P, Wolff G, Baumann PC, Suter P (1982) Nosocomial infections in intensive care wards. A multicenter prospective study. Intensive Care Med 8: 5–9
16. Chevret S, Hemmer M, Carlet J, Langer M and the European Cooperative Group on Nosocomial Pneumonia (1993) Incidence and risk factors of pneumonia in intensive care units. Intensive Care Med 19: 256–264
17. Inglis L (1992) Infection control in intensive care units: UK National Survey. Br J Anaesth 68: 216–220
18. Norusis MJ (1986) SPSS/PC for the IBM PC/XT/AT. SPSS, Chicago, IL
19. Armitage P (1973) Statistical methods in medical research. Blackwell Scientific, Oxford, pp 34–43
20. Williamson DF, Parker RA, Kendrick JS (1989) The box plot: a simple visual method to interpret data. Ann Intern Med 110: 916–921
21. Craven DE, Connolly MG, Lichtenberg DA, Primeau PJ, McCabe WR (1982) Contamination of mechanical ventilators with tubing changes every 24 or 48 hours. N Engl J Med 306: 1505–1509
22. Maki DG, Botticelli JT, Thielke TS (1987) Prospective study of replacing administration sets for intravenous therapy at 48- vs 72 hour intervals. 72 hours is safe and cost-effective. JAMA 258: 1777–1781
23. Eisenberg JM (1985) Physician utilization. The state of research about physicians' practice pattern. Med Care 23: 461–483
24. McLaughlin AJ (1983) Manual of infection control in respiratory care. Little, Brown, Boston, MA, pp 91–92
25. Palmer MB (1984) Infection control. A policy and procedure manual. Saunders, Philadelphia, PA, pp 125–126
26. Maki DG, Ringer M, Alvarado CJ (1991) Prospective randomised trial of povidone-iodine, alcohol, and chlorhexidine for prevention of infection associated with central venous and arterial catheters. Lancet 338: 339–343
27. Burke JP, Garibaldi RA, Britt MR, Jacobson MA, Conti M, Alling DW (1981) Prevention of catheter-associated urinary tract infections. Efficacy of daily meatal care regimens. Am J Med 70: 655–658
28. Classen DC, Larsen RA, Burke JP, Alling DW, Stevens LE (1991) Daily meatal care for prevention of catheter-associated bacteriuria: results using frequent applications of polyantibiotic cream. Infect Control Hosp Epidemiol 12: 157–162