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Nosocomial infections in intensive care: results from the Belgian national surveillance, 1996-1998

by

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Abstract

In 1996 the Scientific Institute of Public Health – Louis Pasteur (IPH), in collaboration with the Belgian Society of Intensive Medicine and Emergency Medicine, started the national surveillance of pneumonia and bacteremia in intensive care units (ICU). From 1996 to June 1998, 101 hospitals participated during at least one quarter, and 64% of those participated more than one period. A total of 31 374 patients were included for analysis.

In 4.7% of the patients a pneumonia with onset later than 48 hours of ICU stay was registered. In 89% of those at least one ventilation day had preceded the infection (RR 10.4%). The number of ventilator-associated pneumonia was 19.0/1000 ventilation-days, varying from 11.9 in coronary surgery to more than 25 in neurosurgery, non-cardiac thoracic surgery, vascular surgery and transplantation. The predominant micro-organisms were Pseudomonas aeruginosa (18.0%), Staphylococcus aureus (17.7%) and Escherichia coli (12.6%).

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Bacteremia was reported in 2.4% of the patients. Forty per cent (N=301) of those were secondary to another infection site and 55% (1.3% of the patients) matched the CDC case definition of laboratory confirmed primary bloodstream infection (BSI). The device-adjusted BSI rate was 3.0/1000 catheter-days and varied between 1.5 in coronary surgery to 6.0 in neurosurgery. The predominant micro-organisms in BSI were Staphylococcus epidermidis (33.3%), Staphylococcus aureus (12.8%) and Enterococcus faecalis (7.1%).

Further analysis is needed to identify areas for prevention of ICU-acquired infections and to improve the inter-ICU comparability of infection rates according to the risk profile of the different ICU populations.

Key words

Nosocomial infections, bacteremia, surveillance, intensive care.

Introduction

Patients admitted to intensive care units (ICUs) have an increased risk of acquiring nosocomial infections due to the severity of their illness and to the frequent use of invasive devices and procedures. ICU-acquired pneumonia and bacteremia account for an important part of the overall increased mortality, morbidity and cost that are associated with nosocomial infections.

Surveillance of nosocomial infections (NI) has been shown to be an important tool in reducing NI rates if other conditions such as the use of surveillance results in decision-making and presence of one full-time infection control nurse per 250 beds were also fulfilled (1). The SENIC study showed that in hospitals with a very effective infection surveillance and control programme, pneumonia rates could be reduced by 27% and bacteremia rates by 35%. In hospitals with a moderately effective program these figures were 13% and 15% respectively.

In January 1996 the Scientific Institute of Public Health – Louis Pasteur (IPH), in collaboration with the Belgian Society of Intensive Medicine and Emergency Medicine, started with the national surveillance of pneumonias and bacteremias in ICUs of the Belgian acute hospitals. Through this surveillance, participating units are able to compare their crude and risk-adjusted infection rates to those of comparable units

in Belgium, to follow-up their rates in time, to interpret rates according to the profile of the local case-mix and to evaluate the local use of therapeutic procedures.

This paper reports the main results of the national surveillance from January 1996 to June 1998.

Methods

Data were collected according to a standardised protocol for all patients admitted to the ICU during a surveillance period of minimum three months and staying at least 24 hours in the ICU. Participation to the surveillance was voluntary (although financially stimulated since the end of 1997) and individual data were treated confidentially. A participating hospital was defined as a hospital that collected data during at least one surveillance period and sent a valid data file on floppy disk to the IPH.

Collected patient data included data at admission (such as the severity of illness measured by the SAPS II score (2) and the reason for admission), day-by-day data (such as central venous catheter and ventilator use), and data at discharge. Infection data included infection date, isolated micro-organism(s),13 diagnostic criteria for pneumonia and origin of the bacteremia. Resistance profiles were registered optionally.

The CDC definitions for nosocomial pneumonia and primary laboratory confirmed bloodstream infection have been applied during the data analysis using available infection data. ICU-acquired infection was defined as an infection with onset after 48 hours of ICU stay unless, for primary bacteremia, the relationship with catheter use was clearly established. Only first episodes of infections were considered for this analysis.

Crude infection rates were defined as the number of infections per 100 admissions. Device-adjusted rates were computed according to CDC recommendations (3) as the number of device-associated infections per 1000 device-days. For this calculation, infections with at least one day of device-use preceding the onset of the infections were considered. Rates were computed with their 95% exact confidence limits.

The variation of device-adjusted rates was statistically examined using poisson regression with device-days as exposure-time. The alpha-error was kept at the 0.05 level. The quality of the data was assessed by

analysis of missing data, internally discordant data and probability of infection rates.

Results

Participation to the national surveillance

From January 1996 (except two last quarters) to June 1998, 101 hospitals and 150 ICUs participated during at least one surveillance quarter. Sixty four per cent of these hospitals participated to more than one period. Table 1 shows the number of participating hospitals by hospital size and year until June 1998.

Because merging between hospitals has decreased the denominators since 1997, the percentage of hospitals having participated at least once was re-estimated at 60% in June 1998.

TABLE 1

Number of participating hospitals in the national surveillance of nosocomial infections in intensive care units, by hospital size and year, January 1996 – June 1998

Hospital size (N of beds)	N	1996 (2 quarters)	1997 (4 quarters)	1998 (2 quarters)	Jan 1996-June 1998
< 200	77	6 (6%)	17 (22%)	11 (14%)	20 (26%)
200-499	103	37 (35%)	48 (47%)	39 (38%)	66 (64%)
≥ 500	19	12 (63%)	9 (47%)	4 (21%)	15 (79%)
Total hospitals	199	55 (27%)	74 (37%)	54 (27%)	101 (51%)
Total patients		9819	16 504	8950	35 273

N = total number of acute hospitals in category beginning of 1997;
percentages between brackets are relative to this total number

Description of the ICU population

A total of 35 273 patients were registered. Eleven per cent (3899 patients) was excluded because of low data quality, leaving 31 374 patients for the analysis.

Male patients represented 60% of the sample. The median age was 68 years. The average length of stay in ICU was 5.5 days, the mean SAPS II score was 30.8. Overall, 8.7% of the patients died in the ICU and an additional 1.4% was discharged with status DNR (do not reanimate). Eighteen per cent of the patients presented an infection at admission (lower respiratory tract infection 11%, bacteremia 2%, other 6%).

Nosocomial pneumonia

In 4.7% (95% CI 4.5-5.0) of the patients a pneumonia with onset later than 48 hours of ICU stay was registered. In 89% of those at least one ventilation day had preceded the onset of the infection (RR 10.4; 8.9-12.2). The crude pneumonia rate varied from 0.93% in patients without ventilation to 21.5% in patients with 5 days of ventilation or more. The number of ventilator-associated pneumonia per 1000 ventilation-days was 19.0/1000 ventilation-days, varying from 11.9 in coronary surgery patients to more than 25 in neurosurgery, non-cardiac thoracic surgery, vascular surgery and transplantation (table 2). Although the crude pneumonia rate varied significantly with SAPS II score categories, these differences were largely explained by higher ventilation use in severely ill patients.

TABLE 2
ICU-acquired pneumonia rates by severity of illness, admission type and type of surgery

Category	Total	% with NP > 48h		VUR	N VAP / 1000 VD	
Total	31374	4.7		386	19.0	
SAPS II score						
< 20	6449	1.5	£	173	15.1	£
20-39	15043	3.8	*	330	18.4	
40-59	4580	10.6	*	537	21.1	*
≥ 60	1824	11.8	*	688	17.9	
Admission type						
Medical, other than coronary	10606	5.9	£	420	17.8	£
Coronary care	5207	2.1	*	198	16.2	
Scheduled surgery	12050	3.3	*	369	18.0	
Unscheduled surgery	3598	10.1	*	500	23.9	*
Multiple traumata	2367	8.7	*	447	24.1	*
Prior surgery site						
Coronary surgery	4174	2.7	*	532	11.9	*
Other cardiac surgery	1265	5.2	*	549	17.8	
Other thoracic surgery	868	9.9	*	415	25.4	*
Other vascular surgery	1921	5.6		335	29.1	*
Abdominal surgery	3613	5.5	*	375	20.3	
Transplantation	104	7.8		385	25.8	
Neurosurgery	1267	10.3	*	532	25.8	*
Orthopaedic surgery	1521	3.8		309	23.2	
Other surgery sites	1335	3.7		363	19.5	

NP=nosocomial pneumonia; VUR=ventilation utilization rate (N of ventilation-days/1000 patient-days); VAP=ventilator associated pneumonia; VD=ventilation days; * significantly different from all other patients without condition or from reference category (£)

The predominant micro-organisms in ICU-acquired pneumonia were *Pseudomonas aeruginosa* (18.0%), *Staphylococcus aureus* (17.7%), *Escherichia coli* (12.6%), *Candida* spp. (12.1%) and *Enterobacter* spp. (9.5%).

The average length of stay in patients with pneumonia was 19.6 days. Mortality associated with pneumonia was 30.3%.

Nosocomial bacteremia

Bacteremia was reported in 2.4% of the patients, corresponding to an incidence density of 4.2 bacteremias per 1000 patient-days. Forty per cent (N=301) of the bacteremia were secondary to another infection site: lower respiratory tract infections 20%, urinary tract infections 6%, surgical site infections 6% or other infection sites 8%. Fifty five per cent (N=404) of all bacteremia matched the CDC definition of laboratory confirmed primary bloodstream infection, which corresponded to 1.3% of the patients and 2.3 primary bacteremias per 1000 patient-days. Although only one third of the bacteremias (34.2%) was reported as catheter-associated, 93% of the bacteremias had at least one central venous catheter (CVC) – day before the onset of the bacteremia (RR 6.0%; 4.5-8.0). The device-adjusted bacteremia rate was 3.1 catheter-associated/1000 CVC-days and varied significantly according to the SAPS II score (table 3). It was significantly lower in scheduled surgery patients, coronary surgery and higher in trauma patients and neurosurgery. Other differences observed in the crude bacteremia rate according to admission type or surgery site were explained by CVC use.

The predominant micro-organisms in primary bacteremia were *Staphylococcus epidermidis* (33.3%), *Staphylococcus aureus* (12.8%), *Enterococcus faecalis* (7.1%), *Pseudomonas aeruginosa* (6.1%) and *Enterobacter aerogenes* (5.7%). The average length of stay was 21.9 days for primary bacteremia and 18.9 days for secondary bacteremia. Associated mortality was 27.6% and 38.0% respectively.

Discussion

Since 1996, 60% of the Belgian acute hospitals participated to the national surveillance for at least one surveillance period. However, an exact percentage is difficult tot calculate because of two reasons:

TABLE 3
Primary laboratory-confirmed bacteremia rates by severity of illness, admission type and type of surgery

Category	Total	% with BSI > 48h		CUR	N CAB/ 1000 CD	
Total	31374	1.3		729	3.1	
SAPS II score						
< 20	6352	0.3	£	610	1.4	£
20-39	14904	1.0	*	699	2.9	*
40-59	4548	2.9	*	828	3.9	*
≥ 60	1763	3.1	*	881	3.7	*
Admission type						
medical, other than coronary	10449	1.8	£	731	3.6	£
coronary care	5127	0.7	*	405	3.2	
scheduled surgery	11954	0.6	*	838	1.8	*
unscheduled surgery	3537	2.7	*	828	4.1	
Multiple traumata	2337	2.5	*	714	4.8	*
Prior surgery site						
coronary surgery	4159	0.6	*	914	1.5	*
other cardiac surgery	1261	0.9		885	1.9	
other thoracic surgery	859	2.0	*	778	3.8	
other vascular surgery	1896	1.2		780	2.8	
abdominal surgery	3575	1.8	*	889	3.5	
Transplantation	103	1.0		915	1.6	
Neurosurgery	1259	3.5	*	792	6.0	*
orthopaedic surgery	1491	1.2		741	3.3	
other surgery sites	1313	0.7		693	2.1	

N = number of patients in category; BSI = primary laboratory confirmed bloodstream infection; CUR = central venous catheter utilisation rate (N of CVC-days/1000 patient-days); CAB = catheter-associated BSI; CD = CVC-days; *significantly different from all other patients without condition or from reference category (£)

1) the lack of a clear definition of 'intensive care unit' in Belgium, necessary for the denominator of eligible hospitals and
2) the ongoing process of hospital merging in Belgium. The relative participation of small and mid-size hospitals increased in 1997 and 1998, while large hospitals participated less than in 1996. This observation may be partially due to the fact that the financial incentive for participation to the surveillance protocol introduced by the Ministry of Public Health in the last quarter of 1997 is a fixed rather than a hospital-size dependent amount.

The crude ICU-acquired pneumonia incidence rate of 4.7% is difficult to interpret by lack of comparable incidence data in Europe. The EURONIS study (1991) that used a different case definition found for Europe (11 countries) 11.8% presumptive pneumonias and 3.4% definite pneu-

monias, not excluding infections with onset before 48 hours. In one Belgian hospital, these figures were 12.8% and 7.4% respectively (4). Another European study, the European Sepsis Project, reported 420 ICU-acquired pneumonias in 3337 patients (12.6%) (5). As in the Belgian surveillance, both studies only included patients staying more than 24 hours in the ICU. Even if pneumonia occurring before 48 hours are included in the Belgian surveillance figure, and CDC criteria are not applied to the data, the Belgian surveillance still yielded a much lower crude pneumonia rate (6.6%), indicating that the sensitivity of reporting and/or used case definitions are largely different. Contrarily to the lower rate compared to European data, the device-adjusted VAP rate was generally higher than the one reported in the National Nosocomial Infection Surveillance (NNIS) system in the US (6). For example, in medical ICUs, the NNIS device-adjusted VAP rate was 8.5 VAP/1000 ventilation-days, compared to 17.8 in Belgian ICU patients admitted for (non-coronary) medical reasons, with a comparable ventilator utilisation rate (470 and 420 respectively). A more sensitive case definition for device-associated infection in the Belgian surveillance may account for this difference. However, we preferred to use this case definition to limit the number of ICUs with zero infection rates and thus to enhance the value of inter-hospital comparisons. The 2 most predominant pathogens found in nosocomial pneumonia, *S. aureus* and *P. aeruginosa*, were the same as those reported in another Belgian, as well as in the EURO-NIS and EPIC studies (4, 7).

For the comparison of the bacteremia figures, data from the Belgian national surveillance of hospital infections (NSIH) from 1992-1996 were used (8). The predominant micro-organisms in primary bacteremia were comparable to those reported in the NSIH system (data from re-analysis of primary BSIs reported in ICU, 1992-1996): *S. epidermidis* (33.3% vs. 29.1% in 1992-1996), *S. aureus* (12.8% vs. 12.7%), *E. faecalis* (7.1% vs. 5.3%), *P. aeruginosa* (6.1% vs. 5.3%). The previously reported increasing trend in Belgium in the proportion of bloodstream infections with *Enterobacter aerogenes* also seemed to be confirmed (2.9% in 1992-1996 vs. 5.7%). The incidence density of 4.2 bacteremias (secondary included) per 1000 patient days was also very similar to the figure of 3.9 found previously in Belgian ICUs and thus confirmed a 5.5 to 6 fold higher rate of nosocomial bacteremia in ICUs compared to the hospital-wide figure (0.7/1000 patient-days). The higher mortality associated with secondary bacteremia compared to primary bacteremia was also previously observed. Contrarily to the crude pneumonia rate, the crude primary BSI incidence rate of 1.3% compared well to the figure of 1.5% reported

in the European Sepsis Study (5). The device-adjusted bacteremia rate was generally lower in Belgium than in the NNIS system, but this difference may be explained by a much higher central venous catheter use in Belgium, that may be linked to a different definition of 'central line'. For example, in NNIS medical units the device-adjusted bacteremia rate was 6.1 with a central line use of 0.5 central-line days/patient-day, compared to 3.6 and 0.7 in Belgium. The fact that the device-adjusted BSI rate still varied significantly with the SAPS II score indicated that further adjustment of the BSI rate should be made for inter-hospital comparisons in Belgium. The comparisons of the results of the national surveillance of nosocomial infections in Belgian ICUs with those of other incidence studies ans surveillance systems highlight the importance of using exactly the same case definitions and methods. The introduction of European standardised surveillance methods would clearly facilitate international benchmarking. At the national level however, the large size of the national database will allow to refine the inter-ICU comparability of infection rates according to the case-mix of the different ICUs. Moreover, further study of the risk factors of NI and of the impact of the different therapeutic procedures on the infection rates is needed in order to identify areas of improvement of infection control in the ICUs.

Samenvatting

In 1996 startte het Wetenschappelijk Instituut Volksgezondheid – Louis Pasteur, in samenwerking met de Belgische Vereniging voor Intensieve Zorgen en Urgentiegeneeskunde, de surveillance van nosocomiale pneumonieën en bacteriëmieën in de intensieve zorgen (I.Z.) eenheden. Van 1996 tot juni 1998 (status op 15 september 1998) namen 101 ziekenhuizen deel aan ten minste één periode van drie maanden, en 64% hiervan nam deel aan meer dan één periode. In totaal kwamen 31.374 patiënten in aanmerking voor de analyse.

Bij 4,7% van de patiënten werd een pneumonie geregistreerd die optrad na meer dan 48 uur verblijf op de I.Z.-afdeling. Negenentachtig procent van de pneumonieën hadden minstens één dag ventilatie in de voorgeschiedenis (RR 10,4). Het aantal ventilator-geassocieerde pneumonieën bedroeg 19,0/1000 ventilatiedagen en varieerde van 11,9 in coronaire heelkunde tot meer dan 25 voor neurochirurgie, niet-cardiale thoracale heelkunde, vasculaire heelkunde en transplantatie. De frequentst geïsoleerde micro-organismen waren *Pseudomonas aeruginosa* (18,0%), *Staphylococcus aureus* (17,7%) en *Escherichia coli* (12,6%).

Het bacteriëmiecijfer bedroeg 2,4%. Hiervan was 40% secundair aan andere infectielokalisaties, en 55% (of 1,3/100 I.Z.-opnames en 2,3/1000 patiëntdagen) beantwoordde aan de C.D.C.-definitie van 'laboratory-confirmed primary bloodstream infection'. Het gecorrigeerd bacteriëmiecijfer bedroeg 3,0 catheter-geassocieerde bacteriëmieën/1000 catheterdagen en varieerde van 1,5 voor coronaire heelkunde tot 6,0 voor neurochirurg-

iepatiënten. De frequentst geïsoleerde micro-organismen in primaire bacteriëmieën waren *Staphylococcus epidermidis* (33,3%), *Staphylococcus aureus* (12,8%) en *Enterococcus faecalis* (7,1%).

Er is diepgaand onderzoek nodig om de mogelijkheden voor preventie van I.Z.-verworven infecties te identificeren en de vergelijkbaarheid van de infectiecijfers tussen de verschillende I.Z.-eenheden verder te verfijnen volgens het risicoprofiel van de verschillende I.Z.-populaties.

Sleutelwoorden

Nosocomiale infecties, bacteriëmieën, surveillance, intensieve zorgen.

Résumé

En 1996, l'Institut Scientifique de la Santé Publique – Louis Pasteur, en collaboration avec la Société Belge de Médecine Intensive et de Médecine d'Urgence, a démarré une surveillance des pneumonies et bactériémies nosocomiales dans les Unités de Soins Intensifs (USI). De 1996 à juin 1998 (état au 15 septembre 1998), 101 hôpitaux ont participé au moins une fois à une période de surveillance de trois mois, dont 64% a participé à plus d'une période. Au total, 31.374 patients ont été inclus dans l'analyse.

Chez 4,7% des patients, une pneumonie ayant débuté après 48 heures de séjour dans l'USI a été enregistrée. Dans 89% de ces pneumonies, il y avait au moins une journée de ventilation dans l'anamnèse (RR:10,4). Le nombre de pneumonies associées à la ventilation atteignait 19,0/1000 journées de ventilation et variait de 11,9 en chirurgie coronaire à plus de 25 en neurochirurgie, en chirurgie thoracique non-cardiaque, en chirurgie vasculaire et en transplantation. Les micro-organismes les plus fréquemment isolés étaient *Pseudomonas aeruginosa* (18,0%), *Staphylococcus aureus* (17,7%) et *Escherichia coli* (12,6%).

Le taux de bactériémie était de 2,4%. Quarante pour cent étaient secondaires à d'autres localisations d'infection, et 55% (ou 1,3 par 100 admissions en USI) répondaient à la définition du CDC du 'laboratory-confirmed primary bloodstream infection'. Le taux corrigé de bactériémie était de 3 bactériémies associées à un cathéter/1000 journées de cathéter et variait de 1,5 en chirurgie coronaire à 6,0 en neurochirurgie. Les micro-organismes les plus fréquemment isolés dans des bactériémies primaires étaient *Staphylococcus epidermidis* (33,3%), *Staphylococcus aureus* (12,8%) et *Enterococcus faecalis* (7,1%).

Une analyse approfondie est nécessaire afin d'identifier les possibilités de prévention des infections acquises en USI et d'affiner la comparabilité des taux d'infection entre les USI en fonction du profil de risque des différentes populations de soins intensifs.

Mots-clés

Infections nosocomiales, bactériémie, surveillance, soins intensifs.

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