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François Dubos
Marie Vanderborght
Anne-Laure Puybasset-Joncquez
Bruno Grandbastien
Francis Leclerc

Can we apply the European surveillance program of nosocomial infections (HELICS) to pediatric intensive care units?

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F. Dubos · M. Vanderborght ·
A.-L. Puybasset-Joncquez · F. Leclerc (✉)
Jeanne de Flandre Hospital, CHRU Lille, and Lille 2 University, Pediatric Intensive Care Unit,
Avenue E. Avinée, 59037 Lille cedex, France
e-mail: fleclerc@chru-lille.fr
Tel.: +33-3-20445982
Fax: +33-3-20444917

F. Dubos
Roger Salengro Hospital, CHRU Lille, Pediatric Emergency Unit and Infectious Diseases,
Lille, France

B. Grandbastien
Calmette Hospital, CHRU Lille and Lille 2 University, Clinical Epidemiology Unit,
Lille, France

Abstract *Objective:* To evaluate the applicability of the HELICS program [part of the "Improving Patient Safety in Europe" program aiming at controlling nosocomial infections (NI) through surveillance] in European pediatric ICUs. *Design and setting:* A comparison of HELICS and pediatric definitions of the main NI was performed. The adaptability of the HELICS questionnaire for pediatric patients was examined. Then a European survey was carried out by e-mail questionnaire to analyze NI surveillance programs. *Participants:* Units affiliated with the European Society of Paediatric and Neonatal Intensive Care or the French Groupe Francophone de Réanimation et Urgences Pédiatriques. *Measurements and results:* The main differences between adult and pediatric ICUs were the definition of ICU-acquired pneumonia, severity scores at admission, and scores of risk for NI. A total of 65 answers from 23 countries were collected. Among them 56 had a NI surveillance program that was of local origin for 64%. The most frequently collected NI were blood stream infections (91% of the units), catheter-related infections (88%), acquired pneumonia (86%), and urinary tract infections (77%). Definitions of NI had a local-based origin in 18% of cases, a regional-based or nation-wide origin in 21%, came from the Centers for Disease Control and Prevention in 38% and had multiple origins in 20%. Seventy-five percent of the units declared an interest in joining a European pediatric working group on NI within the European Society of Paediatric and Neonatal Intensive Care. *Conclusions:* The adaptation of the HELICS protocol for pediatric ICUs is necessary. Its application is largely wished and may be easily performed.

Keywords Nosocomial infections · Pediatric intensive care unit · Surveillance program · HELICS

Introduction

Nosocomial infections (NI) are an important concern in intensive care units (ICUs) and are associated with an increase in morbidity, mortality, length of stay, and costs of hospitalization [1–6]. In 1998 the European Parliament launched the Hospital in Europe Link for Infection Control through Surveillance project (HELICS) to built a common program for the monitoring of NI in the European Union (www.helics.univ-lyon1.fr; protocol, version 6.1 http://helics.univ-lyon1.fr/protocols/icu_protocol.pdf, accessed, 6 February 2007). This project included the standardization of definitions for each NI, a standardized collection of data, and the application of homogeneous procedures in adult ICUs. This program was proposed mainly by physicians working in adult ICUs, although it was mentioned that pediatric (PICUs) and neonatal ICUs (NICUs) could be included in the network. However, NI in pediatric units differ from that adult units by various characteristics (epidemiology, distribution of

infection sites, microorganisms) [1]. Incidence density for acquired-pneumonia, blood stream infection, and urinary tract infection in HELICS-ICUs are of 8.9, 3.9, and 5.4 per 1,000 patient-days, respectively (http://www.helics-lyon1.fr/documents/HELICS%20ICU%20statistical%20Report%202005.pdf, accessed 9 July 2007) compared with 2.9, 6.6 and 4.0/1000 patient-days respectively in PICUs [7].

The aim of this study was to evaluate the applicability of the HELICS program to PICUs and NICUs (a) by comparing definitions used in this HELICS program with those for children in the literature, and (b) by a standardized survey focusing on the current NI monitoring in European PICUs and NICUs affiliated to the European Society of Paediatric and Neonatal Intensive Care (ESPNIC) or Groupe Francophone de Réanimation et d'Urgences Pédiatriques (GFRUP).

Methods

Adaptability of NI definitions and HELICS questionnaire to pediatric patients

The definitions of NI proposed by the HELICS working group for blood stream NI, acquired pneumonia, catheter-related infection, and acquired urinary tract infection (www.helics.univ-lyon1.fr/helicshome.htm) were compared to the definitions of NI used in PICUs and NICUs. These definitions were retrieved by a specific PubMed database research. All references available between 1988 and 2004 were analyzed that used the key-words "nosocomial bacteremia" or "catheter related infections" or "nosocomial urinary tract infection" or "nosocomial pneumonia" or "ventilator-associated pneumonia" and "children." A cross-checking was also performed with related references of the relevant articles to search for articles not identified by our first database research. The HELICS questionnaire was scrutinized to determine the items poorly adapted to neonates or children admitted to an ICU.

Design of the survey

A European investigation of NI surveillance system was conducted in 2004 by e-mailing a standardized questionnaire validated by the scientific committee of the ESPNIC to each ICU affiliated to the ESPNIC and GFRUP (see Electronic Supplementary Material). The questionnaire contained 11 items that required simple yes/no answers, to determine the characteristics of the ICUs, the characteristics of their NI surveillance system, the knowledge of the HELICS network, and the interest in participating in a further European network for NI surveillance in PICUs and NICUs.

The two levels of surveillance proposed in the HELICS network were retained in our questionnaire. The "unit-based" surveillance (level 1) is the minimal dataset to be collected (only for patients with NI), adapted to a prolonged follow-up. The "patient-based" surveillance (level 2) requires the collection of risk factors of NI for each patient, infected or not, who stayed more than 2 days in the unit. Optional modules can be combined with level 2 (level 2 + options) to determine the standardized infectious ratio for each site of NI (http://helics.univ-lyon1.fr/protocols/icu_protocol.pdf).

Data collection and analysis

Each center was contacted twice by e-mail (in February and June 2004). The completed questionnaires were reported in a standardized Excel file and analyzed with the Epi-Info 6.04 software (Centers for Disease Control and Prevention, CDC). Results are expressed in percentages rounded off to the nearest integer.

Results

Homogeneity of the definitions

Our PubMed research identified 234 references between 1988 and 2004: 13 were considered as relevant. The definitions of NI [1–4, 8, 9], hospital-acquired blood stream infections [1–4, 8–11], catheter-related infections [1–4, 8, 9, 12–14] and acquired urinary tract infections [8, 15, 16] used in PICUs and NICUs mainly follow the CDC criteria [8] and were in accord with the HELICS definitions (see Electronic Supplementary Material). The definition of hospital-acquired pneumonia in children [5, 17], updated in 2002 by the CDC pneumonia definition [18], differed from the one used for adults in the HELICS program and is as follows [19]. Nosocomial pneumonia is defined as pneumonia developing after at least 3 days of hospitalization or occurring within 7 days after hospital discharge. Ventilator-associated pneumonia is defined as occurring at least 48 h after initiation of mechanical ventilation. Radiographic evidence of pneumonia is considered a new or progressive infiltrate consistent with infection (interstitial, bronchial, alveolar), consolidation, cavitation, abscess or pneumatocele. In children aged under 1 year:

- Radiographic evidence of pneumonia
- Plus worsening gas exchange (oxygenation desaturation episodes, increased oxygen requirement, or increased ventilation requirement)

- Plus at least three of the traits from the clinical and vital signs categories.
- Clinical
  - Cough
  - Wheezing, rales, or rhonchi
  - Apnea, tachypnea, nasal flaring with retraction of chest wall or grunting
  - New onset of lower respiratory tract secretions, change in character of secretions, or increase in the quantity of secretions or suctioning requirements
- Vital signs
  - Temperature instability with no other recognized cause
  - Bradycardia or tachycardia appropriate for age.

In children aged 1–12 years:

- Radiographic evidence of pneumonia
- Plus at least three criteria below from the clinical, vital signs, and laboratory categories
- Clinical
  - Cough
  - Wheezing, rales, or rhonchi
  - Apnea, tachypnea, nasal flaring with retraction of chest wall, or grunting
  - Worsening gas exchange (oxygenation desaturation episodes, increased oxygen requirement, or increased ventilation requirement)
  - New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements
- Vital signs
  - Temperature of $> 38.4\,^{\circ}C$ or hypothermia ($< 36.5\,^{\circ}C$) with no other recognized cause
- Laboratory
  - Peripheral white blood cell count $> 15{,}000/mm^3$ with $> 10\%$ bands, or white blood cell count $< 4{,}000/mm^3$.

Adaptability of the HELICS questionnaire

Most of the items of the HELICS questionnaire can be applied in children, except two: (a) adult severity scores (Simplified Acute Physiology Score II, Acute Physiology and Chronic Health Evaluation II) and (b) the scores for risk of developing an NI (PN/BAC risk score) which are inadequate for children.

Fig. 1 European map with the number of responses from each country (65 responses from 23 countries)

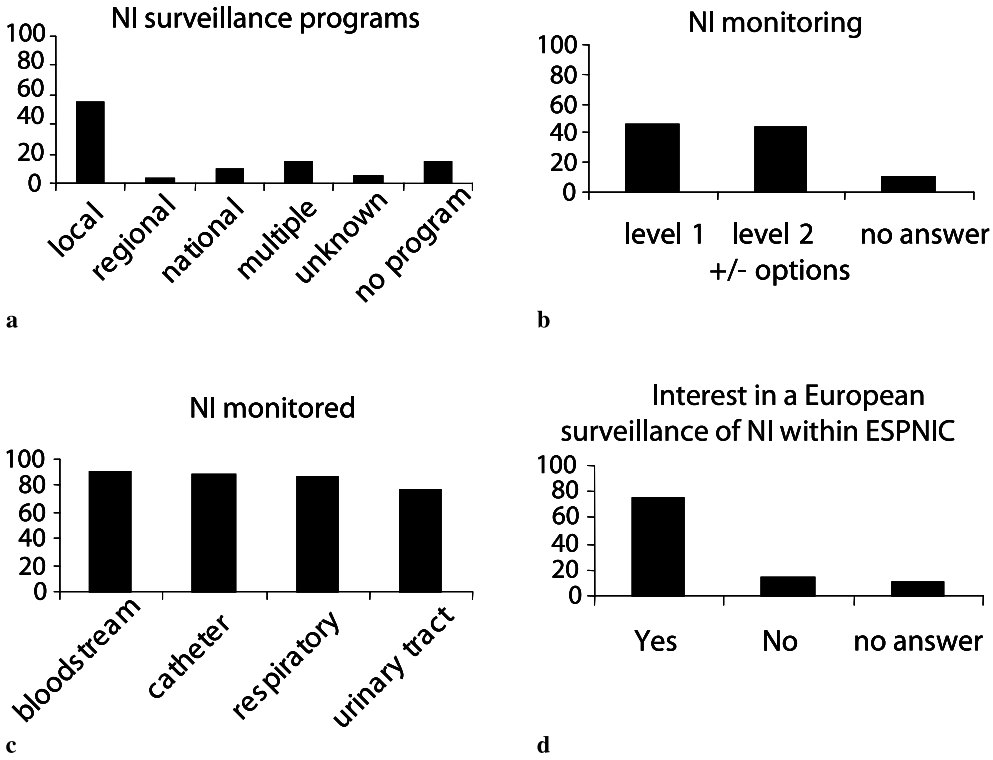

Fig. 2 Results of the survey. **a** Types of nosocomial infection (*NI*) surveillance program in each center. **b** Type of NI monitoring considering levels defined in the HELICS program. **c** NI monitored in each center. **d** Interest of the centers in joining a European surveillance of NI within the ESPNIC

Results of the survey

Sixty-five answers from 23 different countries (Fig. 1) were collected from the 250 ICUs affiliated to ESPNIC or GFRUP (response rate 26%). Among these ICUs 32% were issued from general hospitals and 74% from university hospitals. Six were neonatal (9%), 25 pediatric (39%), 28 both neonatal and pediatric (43%), and 6 specialized ICUs (9%). Fifty-six ICUs had an NI surveillance program (87%), mainly (64%) constituted locally (Fig. 2a). The monitoring of NI was a unit-based surveillance (level 1) for 26 ICUs (46%), a patient-based surveillance (level $2 \pm$ options) for 25 ICUs (44%; Fig. 2b). The NI surveillance concerned blood stream infections in 91% of ICUs, catheter infections in 88%, acquired pneumonia in 86%, and urinary tract infections in 77% (Fig. 2c). Among the 65 ICUs 28% had heard about HELICS, and 88% thought that a European surveillance program of pediatric NI could be useful. Forty-nine ICUs (75%) declared an interest in participating in a specific ESPNIC network for a European surveillance of NI (Fig. 2d). Among the 49 ICUs interested in joining a European pediatric network 42 had already their own program of surveillance.

Discussion

This study suggests that the HELICS protocol needs to be modified for its application in PICUs by taking into account some pediatric specificities, and pediatricians working in ICUs seem to be interested in joining a European surveillance network of NI. The most important differences between adult and pediatric ICUs regard the definition of hospital-acquired pneumonia, severity scores and scores of risk for developing NI.

The diagnostic criteria of hospital-acquired pneumonia should be adapted to patient's age. Criteria used in the HELICS program for hospital-acquired pneumonia are based on a CDC definition initially proposed for any patient (whatever the age). The CDC definition has since been modified according to infant and children specificities [18]. Separate criteria have been identified for children aged under 1 year, 1–12 years, and over 12 years. Children over 12 years of age must fulfill the same criteria as adult patients (http://helics.univ-lyon1.fr/protocols/icu_protocol.pdf). In contrast, more clinical criteria are required for the diagnosis of hospital-acquired pneumonia in younger patients (see above) [19]. Infants aged under 1 year with radiographic evidence of pneumonia must have worsening gas exchange and at least three clinical criteria. Fever or leukocyte modifications are not necessary. Children aged between 1 and 12 years with radiographic evidence of pneumonia must have three clinical or laboratory criteria. However, laboratory evidence of bacterial infection not related to another source [5] may be substituted for one clinical criterion to satisfy the new CDC definition [18]. These definitions could be easily included in the HELICS

program to adapt it to children. The severity scores should also be adapted to ages. Predictive scores of mortality or organ dysfunction have been validated and could be easily used: Pediatric Risk of Mortality [20] score, Pediatric Index of Mortality [21], Pediatric Logistic Organ Dysfunction score [22], Clinical Risk Index for Babies [23].

Some risk factors for developing an NI have been identified for children. A Pediatric Risk of Mortality greater than 10 at admission was associated with a higher risk of developing an NI [24]. A score for risk of developing NI (Pediatric Nosocomial Infection Risk), validated for the first 14 days of hospitalization, has also been developed [25]. This includes intrinsic (severity score) and extrinsic factors (presence of invasive devices) that may contribute to the development of NI. Therefore considering these pediatric particularities could facilitate the participation of PICUs in the HELICS project.

Most units (86%) already had their own NI surveillance protocol, but with wide variations in methods one center to the other. This may be an argument for implementing a common surveillance program. The main weakness in this study is the low response rate (26%), as is common in such surveys [26]. It may constitute a selection bias since units that answered were probably those interested in the NI surveillance. The true number of monitoring programs and the interest for joining a European working group may thus have been overestimated. This work at least suggests an interest of pediatricians for a standardized NI monitoring in PICUs such as HELICS program offers: 88% of ICUs thought that a common European surveillance program could be useful, and 75% would be interested in joining a specific working group within the ESPNIC. Adaptations of the HELICS protocol are needed to become suitable for PICUs; this could be easily performed. Most investigated PICUs were interested in joining a European surveillance program of NI.

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