Original Research Article

Device-associated pneumonia of very low birth weight infants in Polish Neonatal Intensive Care Units

Jadwiga Wójkowska-Mach [a,*], T. Allen Merritt [b], Maria Borszewska-Kornacka [c],
Joanna Domańska [d], Ewa Gulczyńska [e], Marek Nowiczewski [e], Ewa Helwich [f],
Agnieszka Kordek [g], Dorota Pawlik [h], Paweł Adamski [i]

[a] Chair of Microbiology, Jagiellonian University Medical College, Krakow, Poland
[b] Division of Neonatology, Loma Linda University Children's Hospital, Loma Linda, CA, USA
[c] Clinic of Neonatology and Intensive Neonatal Care, Warsaw Medical University, Warsaw, Poland
[d] Institute of Theoretical and Applied Informatics of Polish Academy of Sciences, Gliwice, Poland
[e] Clinic of Neonatology, Polish Mother's Memorial Hospital-Research Institute, Lodz, Poland
[f] Clinic of Neonatology and Intensive Neonatal Care, Institute of Mother and Child, Warsaw, Poland
[g] Department of Neonatal Diseases, Pomeranian Medical University, Szczecin, Poland
[h] Clinic of Neonatology, Jagiellonian University Medical College, Krakow, Poland
[i] Institute of Nature Conservation, Polish Academy of Sciences, Krakow, Poland

ARTICLE INFO

ABSTRACT

Purpose: Late-Onset Pneumonia (LO-PNEU) is still the most important complication associated with the hospitalization of infants with very low birth weight (<1501 g). The purpose of this paper is to summarize the results of an ongoing surveillance program defining LO-PNEU as associated or not associated with respiratory support in the NICU and distribution of causative pathogens from the Polish Neonatology Surveillance Network (PNSN).

Materials and methods: Surveillance of infections was conducted in the years 2009–2011 at six Polish NICUs.

Results: The incidence was 3.1/1000 NICU patient days (pds). The mean gestational age and birth weight among infants with LO-PNEU were significantly lower. The VAP incidence was of 18.2/1000 NICU pds for mechanically ventilated (MV) infants, while the rates for those receiving only CPAP were as low as 7.7/1000 NICU pds. MV significantly increased the risk of PNEU, but MV or CPAP for <10 days did not increase the risk of LO-PNEU. Significantly associated with LO-PNEU was the use of central or peripheral venous catheters and total parenteral nutrition for longer periods.

Microorganisms isolated in cases of LO-PNEU were Gram-positive cocci (53.5%) and Gram-negative rods, with predominating *E. coli*. Non fermentative bacilli were significantly more frequent in cases of VAP than in other cases.

Conclusions: Observed incidence rates associated with VAP and CPAP-PNEU, were higher than in other national surveillance systems and expressing the feasibility of lowering the risk of LO-PNEU and increasing patient safety. The incidence of pneumonia was found to be lower when using CPAP as compared to using MV.

© 2015 Medical University of Bialystok. Published by Elsevier Sp. z o.o. All rights reserved.

1. Introduction

Many premature infants require endotracheal intubation because of respiratory distress syndrome or when other pulmonary conditions in both term and preterm infants result in hypoxic respiratory failure. Endotracheal intubation and mechanical ventilation are associated with risks of respiratory tract colonization and infection, resulting in pneumonia. These latter cases may be nosocomial, and may or may not be accompanied by a systemic infection with positive blood cultures and changes in chest x-rays interpreted as "pneumonia".

These patient-related, or infection-control complications may result from altered host responses, especially in premature infants, and from a large bacterial "load" resulting in airway and lung

parenchyma infection [1]. The presence of an endotracheal tube and the duration of mechanical ventilation have been associated with the highest risk of ventilator associated pneumonia (VAP) [2,3], and the intubation procedure may itself significantly increase this risk [2]. In the United States, the National Healthcare Safety Network (NHSN) implemented in 2002 a specific definition to be used for the surveillance of all healthcare-associated pneumonias, including (but not limited to) ventilator associated pneumonia [4]. In Poland, similar surveillance of infections occurring in different types of intensive care units has been systematically collected over the last several years [5,6]; however, there have been no reports on the epidemiology of respiratory infections in Polish Neonatal Intensive Care Units (NICUs) in order to establish effective or achievable infection control measures designed to prevent or minimize VAP. The purpose of this paper is to summarize the results of an ongoing surveillance program defining Late-Onset Pneumonia (LO-PNEU) associated with respiratory support in the NICU and to associate these findings with established risk factors for the identification and distribution of causative pathogens from the Polish Neonatology Surveillance Network (PNSN). One of the purposes of this surveillance program was to have uniform definitions, specimen acquisition, and culturing techniques for uniform infection surveillance so that VAP could be systematically reported.

2. Materials and methods

An Electronic database created as the result of continuous prospective targeted surveillance of infections was used in the study. Between 1 January 2009 and 31 December 2011, six Polish NICUs participated in the Polish Neonatology Surveillance Network (PNSN) to ascertain continuous prospective guided surveillance of respiratory (and other) infections among infants receiving respiratory support. The PNSN is a prospective national surveillance system for the most relevant infections in very low birth weight infants (VLBW, birth weight < 1500 g) in Poland. Details of the following variables were collected for all VLBW newborns: birth weight and gestational age, gender, multiple pregnancy, type of delivery and information of the situation in time of delivery, for example chorioamnionitis, general status of newborns by Apgar score: at 1 and 5 min and Critical Risk Index for Babies (CRIB) and others. The PNSN recorded severe infections, including necrotizing enterocolitis observed at the time of hospitalization: from admission to discharge, transfer or death. Participation in PNSN is voluntary and confidential. Utilization of data collected in PNSN for the scientific purpose was approved by the Bioethics Committee of Jagiellonian University Medical College – no. KBET/221/B/2011. All data entered into the electronic database and analyzed during the preparation of this article were previously anonymized and de-identified. Those data were obtained under routine diagnostic procedures performed during patients' hospitalization. According to Polish law, the use of the data for scientific purpose does not demand patients' agreement or even information that data are collected in the anonymized database.

All cases of Late-Onset Pneumonia (LO-PNEU) were registered in reference to the time of symptom onset and the form(s) of respiratory support being provided to the infant. "Pneumonia" cases in these NICUs were defined according to Gastmeier et al. [7] as neonates with very low birth weight (VLBW) when they had signs of pneumonia diagnosed >72 h after birth [7].

Ventilator associated PNEU (VAP) and Continuous Positive Airway Pressure (CPAP) associated PNEU (CPAP-PNEU) was defined as PNEU with mechanical ventilation (MV) or CPAP use in the 48 h preceding the onset of the infection [7].

2.1. Description of the population

This surveillance included 1695 newborns. Analyses of the influence of selected factors for the risk of PNEU were based on the group surviving three or more days. The intubation utilization ratio was 0.25 for MV and 0.18 for CPAP (measures the present of total patients days in which a high-risk device – MV or CPAP – was used, calculated by dividing the number of ventilator days by the number of patient days). Tracheo-bronchial secretions, nasopharyngeal aspirates and blood cultures were collected for culture and assessment for infection in infants depending upon their mode of respiratory support. Microbial (bacteria and fungi) species identification was determined in laboratories associated with each NICU.

For the evaluation of the differences between the means for the infants under surveillance (those with VAP and CPAP PNEU) versus infants with early-onset symptoms, a one-way analysis of variance (ANOVA) with the least significant difference (LSD) test and the Tukey test were applied. A chi-square test for independence was used for the assessment of the frequency of infections in the infant groups. A Generalized Linear Model was applied to assess the significance of differences between positive cultures for coagulase-negative staphylococci, or Enterobacteriaceae and/or other microorganisms and birth weight, gestational age, length of hospitalization prior to the onset of initial symptoms and device use for respiratory support. The statistical analysis based on comparison of the frequencies of pneumonia with different etiology between patients with/without MV or CPAP. Analyses were conducted with Parsons' chi square test or likelihood ratio – when the data structure did not fulfill the demands of the Parsons chi square. Analysis of the join impact of devices was done with Generalized Linear Model technique. Due to dychotomic character of both – dependent and independent variable model was conducted for binominal distribution of effect and logit linked function. All analysis were provided using the open source library SciPy and with SAS JMP® 9.03 SAS; the assumed significance level was $p < 0.05$.

Polish NICU data (regarding central venous catheterization, intubation and CPAP) were compared with those of the German NeoKISS (German Krankenhausinfektionen Surveillance System) [8], which is a comprehensive surveillance of infections in German NICUs and is generally comparable to the Polish data.

3. Results

There were 287 episodes of LO-PNEU diagnosed in Polish NICUs, with an incidence of 3.1/1000 NICU pds. The most frequently observed symptoms of PNEU were: worsening of gas exchange (96%), new radiographic findings of progressive infiltrates in one or both lungs (79%) and a documented increase in pulmonary secretions with an increased need for suctioning (76%). An elevated C-reactive protein was found in 85.4% of the infants identified as having pneumonia. Demographic data are presented in Table 1. The mean gestational age and birth weight among infants with LO-PNEU were significantly lower; however, PROM, cesarean section and gestations with twins or triplets did not influence the risk of PNEU. Females were less likely to develop LO-PNEU (odds ratio OR 0.6464, 95% confidence interval CI 0.4943–0.8453) than males. The initiation of trophic feeding was an independent factor in the reduced risk of LO-PNEU (OR 0.6406, 95%CI 0.4871–0.8425).

The Apgar scores at 1 min after birth were statistically lower (0–4) in the group of infants with LO-PNEU (OR 1.9474, 95%CI 1.4727–2.5751). Similarly, the 5 min Apgar scores were lower (scores <7) (OR 3.6263, 95%CI 2.532–5.1935) among infants developing LO-PNEU. CRIB scores elevated from 5 to 15 indicating