Clinical and microbiological characteristics of hospital infections in the neonatal intensive care unit

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Abstract

Neonates hospitalized in intensive care units, are exposed to a higher risk of infectious complications. The research involved 52 neonates hospitalized in the Neonatal Intensive Care Unit (NICU), Chair and Clinic of Obstetrics and Perinatology over a span of one year. The incidence of hospital infections as well as etiological factors were analyzed. Clinically manifested hospital infections were diagnosed in 38.5% of babies with very low or extremely low birth weight, in boys twice as often as in girls. Generalised invasive infections prevailed; in most cases they were caused by Gram-negative rods, mainly *Klebsiella* spp.

Key words: hospital infections, neonate.

Introduction

Hospital infections pose a serious problem of contemporary medicine in the whole world, irrespective of the level of civilization development. Neonatal wards, where preterm neonates are treated, are especially difficult in respect of epidemiology. Despite complying with safety rules, the risk of neonatal infections in Neonatal Intensive Care Units (NICUs) shows upwards tendency.

The aim of this study was the clinical and microbiological analyses of hospital infections found in babies hospitalized in NICU.

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Material and methods

The research involved 52 neonates hospitalized within the space of one year in NICU, Clinic of Obstetrics and Perinatology, Pomeranian Medical University in Szczecin. Each child had its own infection registration card elaborated for the sake of the research. In case of clinical suspicion of infection (in different days of hospitalization), adequate materials were taken for microbiological analysis, namely: blood, cerebrospinal fluid, urine, bronchoaspirat (BAL), and swabs from: nasopharyngeal cavity, ear, intubation tube, anal orifice. Microbiological analysis was done in Chair and Department of Microbiology and Immunology, Pomeranian Medical University in Szczecin in accordance with valid procedures**.**

Results

Clinically manifested infections were diagnosed in 24 (46.2%) babies altogether. Most of them (20) were given birth by the caesarean section. In 4 cases, they were congenital **i**nfections, in 20 (38.5%) – acquired ones. Hospital infections were found in 13 male and 7 female neonates. All the children had either very low (8) or extremely low (12) birth weight. The prevailing infections were general infections/septicaemia and pneumonia. Two babies with diagnosed septicaemia died. Etiological factors of infections varied – both Gram-positive and Gram-negative microbes were isolated; Gram-negative rods from the family *Enterobacteriacae* were most numerous. In the microbiological tests performed successively, the same child had sometimes different microbes isolated, and negative inoculation results were obtained (from blood or cerebrospinal fluid). Detailed clinical and microbiological characteristics of infections were shown in *Tab. 1*.

***Table 1*. The profile of acquired infections in NICU over a span of one year**

No	Material	Sex	Birth weight (g)	Isolated microbes	Clinical forms of infections
1	blood, rectal swabs	m	1640	*Serratia liquefaciens,* *Serratia liquefaciens*	Septicaemia *
2	rectal swabs nasopharyngeal swabs	m	890	*Pneumocystis carini,* *Klebsiella pneumoniae* ESBL(-) *Klebsiella pneumoniae* ESBL(-)	Pneumocystis pneumonia
3	rectal swabs rectal swabs rectal swabs rectal swabs	m	985	*Pneumocystis carini,* *Staphylococcus haemolyticus* *Enterobacter cloacae* *Enterobacter cloacae*	Pneumocystis pneumonia
4	rectal swabs rectal swabs nasopharyngeal swabs nasopharyngeal swabs	m	1640	*Staphylococcus haemolyticus* *Pneumocystis carini* *Staphylococcus haemolyticus* *Staphylococcus haemolyticus* *Enterobacter cloacae*	Pneumocystis pneumonia
5	rectal swabs	f	600	*Klebsiella oxytoca* ESBL(+)	Generalised infection **
6	rectal swabs blood nasopharyngeal swabs	m	1470	*Klebsiella pneumoniae* ESBL(-) *Klebsiella pneumoniae* ESBL(-) *Serratia marcescens*	Septicaemia *
7	nasopharyngeal swabs nasopharyngeal swabs nasopharyngeal swabs nasopharyngeal swabs	f	890	*Serratia marcescens* *Serratia marcescens* *Serratia marcescens* *Serratia marcescens* *Enterobacter cloacae* *Pseudomonas aeruginosa*	Generalised infection **
8	rectal swabs blood	m	1270	*Klebsiella oxytoca* ESBL(-) *Serratia marcescens*	Septicaemia *
9	rectal swabs rectal swabs	m	1270	*Enterococcus faecium* *Candida albicans* *Klebsiella oxytoca* ESBL(+)	Generalised infection **
10	rectal swabs rectal swabs	m	985	*Enterobacter cloacae* *Klebsiella oxytoca* ESBL(-)	Cerebrospinal meningitis
11	rectal swabs rectal swabs rectal swabs	f	920	*Citrobacter freundii* *Klebsiella oxytoca* ESBL(-) *Klebsiella oxytoca* ESBL(-)	Generalised infection **
12	blood purulent secretion	m	1500	*Enterobacter cancerogenus* *Enterobacter cloacae*	Septicaemia * Skin infection
13	nasopharyngeal swabs blood rectal swabs rectal swabs	m	1000	*Staphylococcus haemolyticus* *Staphylococcus epidermidis* *Enterobacter cloacae* *Klebsiella oxytoca* ESBL(-)	Septicaemia *
14	nasopharyngeal swabs urine purulent secretion from conjunctiva	m	920	*Klebsiella pneumoniae* ESBL(+) *Klebsiella oxytoca* ESBL(+) *Streptococcus agalactiae* *Proteus* spp.	General infection ** Conjunctivitis
15	rectal swabs	m	750	*Klebsiella pneumoniae* ESBL(-)	Pneumonia
16	nasopharyngeal swabs nasopharyngeal swabs blood	f	540	*Stenotrophomonas maltophilia* *Stenotrophomonas maltophilia* *Candida albicans*	Septicaemia *
17	rectal swabs bronchoaspirat rectal swabs	f	580	*Candida albicans* *Stenotrophomonas maltophilia* *Enterobacter cloacae*	Pneumonia
18	rectal swabs	m	1250	*Escherichia coli*	Pneumonia
19	blood nasopharyngeal swabs rectal swabs rectal swabs	f	980	*Staphylococcus haemolyticus* *Klebsiella oxytoca* ESBL(+) *Pseudomonas aeruginosa* *Klebsiella oxytoca* ESBL(+) *Klebsiella oxytoca* ESBL(-)	Septicaemia *
20	nasopharyngeal swabs rectal swabs	f	1700	*Klebsiella pneumoniae* ESBL(+) *Klebsiella pneumoniae* ESBL(+)	Pneumonia

m – male, f – female, * – positive blood culture, ** – negative blood culture

Discussion

Medical achievements of the last twenty years have increased the survival rate of premature and extremely low birth weight infants [1]. These babies always need prolonged hospitalization in an intensive care unit which, combined with the short pregnancy duration and low weight, is a factor contributing to the elevated risk of post-infectious complications [1]. Moreover, this is the group of patients whose own resistance is low, which additionally increases their susceptibility to infections.

As the result, the stay in NICU, diversity of the invasive diagnostic-therapeutic procedures, and infections acquired in a hospital may thwart the efforts of medical staff and dash parents' hopes for health and life of premature infants [2]. Both intrauterine infections and those acquired after childbirth are, at present, the most serious problem in neonatology – the one which, besides congenital defects and complications associated with prematurity and oxygen deficiency during labour, contribute greatly to perinatal mortality.

Various authors report on different incidence of hospital infections. It mainly depends on the level of newborns' maturity and applied therapeutic procedures as well as the centre publishing data. In the United States, the incidence of the acquired infections in neonates is estimated as 5.2-30.4%, and in Europe – 8-10% [3]. The incidence of infections in neonates treated in NICU increases to 17-25%, and is inversely proportional to gestational age and birth weight. In newborns with birth weight lower than 1 500 g, it is 5-32%, in babies weighing less than 1 000 g – up to 40%, and neonates born earlier than in the 25th week of pregnancy – even up to 46% [4].

According to Szczapa [5], in the group of premature infants treated in NICU, the percentage of infections is 15-25%, and in babies with birth weight below 1 500 g it is as much as up to 40%. Similar results were obtained in our research, where all neonates hospitalized in the NICU within the space of one year, were subjected to analysis, and 38.5% of hospital infections were found. They were observed in babies with very low (8) and extremely low (12) birth weight. According to other authors, the incidence of infections in NICU ranges from 2.7% to 24.6%, and mortality rate among septicaemic infants in these wards is estimated as 21% [6].

In NICU, infections are usually caused by Gram-positive bacteria (57-70%), and about 40% of infections are caused by coagulase-negative staphylococci. Infections with Gram-negative rods and fungi are less common, but they are responsible for greater number of deaths. In case of *Pseudomonas aeruginosa* mortality rate amounts to 75% [4].

During our research, sometimes a few potentially pathogenic microbes were isolated from a neonate. It happened in such cases that etiologic factor of infection could not be exactly determined. Most infections, however, were caused by Gram-negative rods, among them the strains producing β-lactamases with a wide substrate spectrum (ESBL). The above data have their reflection in the results presented by other authors [7,8]. Poland lacks a standardized system for monitoring the frequency and kind of acquired infections in hospitalized neonates; this is why data considering bacterial etiologic factors are so varied. Gadzinowski [9] and Zięba [10] report, however, on the prevalence of Gram-negative rods, including *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Coagulase-negative staphylococci place on the second position in these authors' reports. The basic reason why the resistant strains of Gram-negative rods spread in hospitals is hygienic neglect. These bacteria are very capable of living on human hand skin. What is more, they multiply rapidly in warm fluids. They spread on hands of medical staff members, on medical tools, and sometimes, but rarely by air. Also preventive use of ampicillin and cephalosporin contributes to the increased microbial colonization.

Infections caused by Gram-negative rods belong to the life-threatening ones. Through endotoxin production, not only can they considerably disturb the functioning of various organs, but also the whole systems with symptoms of septic shock, and, as a consequence, they can lead to neonatal death [11]. In the analyzed hospital unit, the following Gram-negative rods were identified and listed from the most to the least frequently occurring: *Klebsiella* spp*., Enterobacter cloacae, Serratia* spp. Based on the research conducted in Cracow, Kędzierska et al. [8] mention *Enterobacter cloacae* as the most frequently occurring, then *Escherichia coli,* and finally *Klebsiella pneumoniae* and *Serratia marcescens*.

In case of *Klebsiella* spp., the most commonly described mechanism of resistance is the production of β-lactamases with an extended substrate spectrum (ESBL), which are coded by plasmids. This phenomeon was also observed in our research. The presence of ESBL-producing *Klebsiella* clone in an intensive care unit poses a serious threat and therapeutic problem, as the plasmids can easily transfer between Gram-negative rods, and infections are likely to spread to other hospital units, and the use of β-lactam antibiotics in the therapy has its limitations. Such a situation always requires verification of the applied procedures, and strict sanitary routines in the unit.

Conclusions

Hospital infections in NICU were diagnosed in about 40% of neonates, more frequently in males. In most cases they were generalised invasive infections and pneumonia. The most common etiologic factors were Gram-negative rods including ESBL-positive strains of *Klebsiella* spp.

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