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Nosocomial infections in neonatology clinic and neonatal intensive care unit

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Summary

Aim: Nosocomial infections (NI) in a neonatal intensive care unit (NICU) and neonatal clinic were evaluated during a one-year-period.

Material and Method: 314 newborns were investigated for nosocomial infections. Local ethics committee approval was given for this study. Nosocomial infections was defined using the CDC criteria.

Results: Nosocomial infections developed in 53% of 127 patients (58% with culture positivity) in the NICU and in 2.6% of 187 patients (all with a negative culture) in the neonatal clinic. In total, (NICU plus neonatal clinic), NI developed in 23% of hosptalized patients. Nosocomial infections rate was 42.3% and in terms of patient days, NI rate was 14/1000 patient-day. When evaluated separately, NI developed in 53.5% of patients admitted in NICU and in 2.6% of neonatal clinic patients. Also, NI rates were 17.9/1000 patient-day in NICU and 1.6/1000 patient-day in the neonatal clinic. Patients with NI stayed at the hospital for 73.6±47.8 day in NICU and for 16.0±6.7 day in the neonatal clinic. Nosocomial infections developed on the 29.4±30.9th d in NICU and on the 7.6±2.9th day in the neonatal clinic. In NICU, in terms of 128 NI episodes, the NI related mortality was 8.5%. 16.1% (n: 11) of the patients with NI died. They died on the 56.7±50.2nd day of admission and on the 25.8±10.2nd day second after NI diagnosis. There was no mortality in neonatal clinic patients.

Conclusions: Our NI rates were slightly higher than the developed countries and lower than the developing countries. *(Turk Arch Ped 2011; 46: 293-8)*

Key words: Diagnosis, intensive care unit, newborn, nosocomial infection

Introduction

In USA, the rates of nasocomial infections (NI) in Neonatal Intensive Care Units (NICU) range between 1.8% and 39.8% according to the National Surveillance System (NNIS) (1,2). In different countries, the rates of NI in NICUs have been reported to range between 8.4% and 57.7% (3-10). Patient hospitalization days have been reported to range between 8,9 and 29.8 NE/1000 patient day (3,7,8). In a multi-center study performed in Greece in 1999, the rate of NE in the NICU was found to be 30.3% (9). In a study performed in the Children's Hospital in Iran between 1999 and 2004, the rate of NE in the NICU was found with the highest value (40%). In our neonatology clinic, it was found to be 2.6% (10). There are few studies about NE in newborns in our country and different rates have been reported. In a study performed in the NICU in Marmara University in 2001, the rate of NE was found to be 16,1/1000 patient day according to patient hospitalization days (11). In a study performed in Uludağ University Medical Faculty in 2003 where only culture results were evaluated, the rate of NI was found to be 12%. In İzmir, the frequency of confirmed sepsis was found to be 9.1% in newborns (12,13). In a multi-center surveillance study performed by the Turkish Neonatology Association, the frequency of sepsis raged between 2.2% and 17% (14). In our country, the rate of NE was reported to be in a wide range (2-66%) in newborns (15).

There are few studies related to the frequency of NE in neonatology clinics and NICUs in our country (2,11). In addition, no study could be found evaluating the rate of NI considering hospitalization times and the mortality rate according to birth weight. In this study, it was aimed to evaluate the frequency of NI in patients hospitalized in the Neonatology Clinic and NICU (including birth weight and relations with hospitalization times) and the mortality rate.

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Material and Method

In this study, nasocomial infections which occurred in the patients hospitalized in the NICU (15 beds) and Nenotology Clinic (5 beds) were examined. The Neonatology Clinic is a ward where a care of level 1 is given to the babies after they are taken from the NICU (a care of level 2 and 3) and before they are given to the mother. 68 of 128 infants hospitalized in the NICU who were found to have NI and 5 of 187 infants hospitalized in the Neonatology Clinic who were found to have NI were included in the study (a total of 73 infants). All patients with a diagnosis of NI were included in the study independent of the culture result. In all hospitalized patients considered to have nosocomial infection, urine, sputum, cerebrospinal fluid, wound place, catether and endotracheal aspirate (in patients receiving ventilator treatment) cultures in addition to blood culture were obtained. For blood samples BACTEC peds plus/F (BD, Sparks, MD) culture bottles were used. Tracheal aspirate fluid (TAF) samples were cultivated on 5% sheep blood agar and eosin methylene blue (EMM) agar plates. When >105 colonies (cfu)/ml were found in the tracheal aspirate culture, the result was considered to be a positive growth. However, the diagnosis of nosocomial pneumoniae was made using "Centres for Diseases Control and Prevention"(CDC) criteria which also considered this colonization. Automatized Phoenix culture system was used to determine the microorganism and antibiotic sensitivity and written reports prepared in line with NCCLS recommendations were evaluated. The clinical findings, culture results, radiological and laboratory data of the patients who were diagnosed as nosocomial infection were recorded daily by the specialist of pediatric infectious diseases seperately, but these results were not evaluated in this study. Nosocomial infections were defined based on the CDC criteria (16-18). The patients hospitalized in the NICU and Neonatology Clinic were divided into four groups according to their birth weight; <1000 grams: extremely low birth weight, 1001-1500 grams: very low birth weight, 1501-2500 grams low birth weight and >2501 grams: normal birth weight. The frequency of NI was determined according to these groups. No other statistical evaluation was made in the study except for figures and percent values. Approval was obtained from Uludağ University Medical Faculty Ethics Committee for the study (ethics committee letter dated 03/04/2008 with the number 2008-5/12).

Results

NI developed in 68 (53%) of 127 patients hospitalized in the NICU and in 5 (2.6%) of 187 patients hospitalized in the Neonatology Clinic. In some patients, multiple NI attacks and/or culture growths were determined. In a total of 68 patients determined to have NI in the NICU, 128 NI attacks (1.88 attacks per patient) and 134 culture growths were found (approximately 2 growths per patient and approximately one growth per attack). In 58.5% (75/128) of 128 attacks, laboratory confirmed NI (culture positivity) was found. In 5 patients found to have NI in the Neonatology Clinic, a total of 5 NI attacks developed, but no growth occured in cultures.

In the NICU and Neonatology Clinic, NI developed in 73 of 314 patients (23%) totally. The rate of NI was found to be 42.3% (133/314) by hospitalization of 100 patients and 14/1000 patients day by 1000 patients days. The rate of NI by 1000 patient days was found to be 17.9/1000 patient days in the NICU and 1.6/1000 patient days in the Neonatology Clinic. Hospitalized patients and the patients who developed NI in the NICU and Neonatology Clinic are shown in Table 1.

When all NI attacks were considered in the NICU, the diagnosis of NI was made at the 29.4±30.9th day of hospitalization. The demographic properties and some other values of the patients hospitalized in the NICU and Neonatology Clinic who developed NI are shown in Table 2a and 2b.

Among the 314 patients who were hospitalized in the NICU and Neonatology Clinic in a one-year period, 11 of 68 patients who developed NI were lost (a mortality rate of 16.1%). The mortality rate in patients who did not develop NI in the same period (n=246) and who were lost after the first 48 hours which was considered as a criterion for development of NI (n=20) was found to be 8.1% (20/246). According to this, the mortality rate attributed to NI was calculated to be 8% in deaths which occured after 48 hours.

Discussion

Advances in neonatology and development of new life support techniques and treatment samples have caused an increase in survival rates especially in very low birth weight preterm infants in years. As a result of increase in survival rates, NI is still a significant problem in these infants who have

Table 1. Hospitalized patients in the NICU and Neonatology Clinic

					Mortality rate	
Birth weight (grams)	Hospitalize d patients n/N (%)	NI attack n/N (%)	Patients who developed NI n/N (%)*	NI negative n/N (%)	NI positive n/N (%)	Total n/N (%)
≤1000	28/314 (9)	22/28 (79)	9/28 (32)	18/19 (95)	5/9 (56)	23/28 (82)
1001-1500	32/314 (10)	45/32 (141)	19/32 (59)	6/13 (46)	1/19 (5)	7/32 (22)
1501-2500	81/314 (26)	35/81 (43)	23/81 (28)	12/58 (22)	1/23 (4)	13/81 (16)
≥2501	173/314 (55)	31/173 (18)	22/173 (13)	9/151 (6)	4/22 (18)	13/173 (8)
Total	314 (100)	133/314 (42)	73/314 (23)	45/241 (19)	11/73 (15)	56/314 (18)

*: Two patients who were hospitalized in the Neonatology Clinic and who developed NI had a birth weight of 1501-2500 g and three patients had a birth weight of >2501 g.

Table 2a. The demographic properties of the patients who were diagnosed as NI in the NICU

	N=68 n/N (%)	Mean ± SD (change range)
Gender		
Female	38 (55.8)	
Male	30 (44.1)	
Birth weight (grams)		2016±975 (720-4600)
≤1000	9 (13.2)	
1001-1500	19 (27.9)	
1501-2500	21 (30.8)	
≥2501	19 (27.9)	
Gestational age (weeks)		33.9±3.9 (26-40)
≤27	2 (2.9)	
28-31	24 (35.2)	
32-36	23 (33.8)	
≥37	19 (27.9)	
Hospitalization time (days)	median 67	73.6±47.8 (4-225)
The first day when NI was determined	median 8.5	11.8±10.7 (3-73)
The day when NI was determined	median 25.2	29.4±30.9 (3-195)
Hospitalization days after NI		
In patients who survived	median 33	45.9±33.0 (7-120)
In patients who died	median 16	25.8±10.2 (1-95)
Mortality rate		
By NI time	11 (8.5)	
By patient who developed NI	11 (16.1)	
Day of death (by hospitalization time)	median 42	56.7±50.2 (4-157)

Table 2b. The demographic properties of the patients who were diagnosed as NI in the Neonatology Clinic

	N=5 n/N (%)	Mean±SD (değişim aralığı)
Gender		
Female	2 (40)	
Male	3 (60)	
Birth weight (grams)		2788±943 (1800-4100)
1501-2500	2 (40)	
≥2501	3 (60)	
Gestational age		37.6±1.5 (36-39)
32-36	2 (40)	
>37	3 (60)	
Hospitalization time (days)	median 20	16.0±6.7 (6-21)
The day when NI was determined	median 9	7.6±2.9 (4-11)
Hospitalization days after NI	median 10	8.4±4.3 (1-12)
Mortality rate	0	-

long hospitalization times (2). The frequency of NI in NICUs have been reported to range between 1.8% and 74.3% in different sources (1,2) (Table 3). The rates of NI have been reported to be 4.8-22/1000 patient days, when evaluated by 1000 patient days in NICUs (19). The frequency of NI in NICUs shows an inverse relation with birth weight and the developmental level of the country. NI rates in NICUs in different countries are shown in Table 3. When comparing the rates found in different studies, the way of calculation of the rates should be considered. The rates of nosocomial infections can be reported as the rate of patients who developed NI (the number of patients who developed NI/all hospitalized patients x 100), NI rate (the number of NI/all hospitalized patients x 100) or NI rate by 1000 hospitalization days (the number of NI/total hospitalization days x 1000) in a given period. To make an accurete comparison between hospitals or units the same rates should be compared.

In our country, there are few published studies conducted considering CDC criteria related to NI in children maily in NICUs. In a surveillance study performed in Marmara University NICU in 2001, it was reported that NI developed in 11.3% of hospitalized patients and the rate of NI by patient days was reported to be 16.1/1000 patient days (11). In another study performed in Uludağ University Medical Faculty, the rate of NI with only culture positivity was found to be 6.3% in the NICU between September 1997 and April 2000 (30). However, it should be kept in mind that these data include only culture positive NI rates. In our study, the rate of NI in the whole Pediatric Clinic in 2007 was found to be 20.7%, the rate of NI in the NICU and Neonatology Clinic by hospitalization of 100 patients was found to be 42.3 and the rate of NI by patients days was found to be17.9/1000 patients days. The rates found in our study were slightly lower compared to developing

Table 3. The rates of NI in NICUs in different countries

Country	General NI rate (%)	NI rate (for 1000 patient days)	Reference
USA	1.8-39.8	8.9	10.11.20
Europe	7		21
Spain	74.3	27	22
Germany		28.6	23
Brazil	57.7	29.8	24
South America	8.4	6.2	22
South Korea	44.6		25
Taiwan	11.4-17.5		15.26
Greece	30.3		27
Iran	2.9	2.6	28
Turkey			
İstanbul		16.1	29
İzmir	9.1		13
16 centers	6.4 (2.1-17)		14
Bursa		17.9	*

*The data of our study

countries except for Iran, relatively higher compared to developed countries and slightly lower than or comperable to the rates found in another study performed in our country. Our data were evaluated considering CDC criteria for NI and can be considered reliable in this aspect. NI rates in our Neonatology Clinic was found to be much lower compared to the NICU as expected (1.6NI/1000 patient days).

Hospitalization times in nosocomial infections

Generally, patients with a diagnosis of NI stay longer in the hospital compared to the patients without a dignosis of NI (16,21,27,28,31). In a study performed in 2002 in Italy, the hospitalization time of the patients with a diagnosis of NI was shown to be 2 weeks longer compared to the patients without a diagnosis of NI in the NICU (21). In a study performed in Spain in 2000, the mean hospitalization time in the NICU was reported to be 17 days (30,5 days in patients with NI and 9 days in patietns without NI) (22). In a study performed in Brazil between 1993 and 2002, the hospitalization time in patients with a diagnosis of NI in the NICU was found to be 38,1 days for patients weighing <1000 grams, 31.4 days for patients weighing 1001-1500 grams, 15.1 days for patients weighing 1501-2500 grams and 11.6 days for patients weighing >2500 grams; the mean hospitalization time in patients with a diagnosis of NI was reported to be 19,4 days (3). In our study, the hospitalizaiton time in the patients with a diagnosis of NI was found to be approximately 67 days in the NICU and 20 days in the Neonatology Clinic. When the patients with a diagnosis of NI in the NICU were evaluated according to birth weight, patients weighing <1000 grams stayed in the hospital for 90,8 days, patients weighing 1001-1500 grams stays in the hospital for 73 days, patients weighing 1501-2500 grams stayed in the hospital for 41.4 days and patients weighing ≥2500 grams stayed in the hospital for 40.8 days. In Turkey, the mean hospitalization time in patients with a diagnosis of NI in Marmara University Pediatric Clinic was found to be 36,7 days (29). The longer hospitalization time found in the NICU in our study was attributed to the fact that our unit was a third degree unit where risky pregnancies were referred and the infants were born pretermly and stayed longer in the hospital because of additional complications.

The time of development of nosocomial infections

In many studies, most patients were found to be diagnosed as NI after the second week of hospitalization (28,32). In Canada, it was found that NI developed on the 19th day of hospitalization in infants with a birth weight of <1500 grams and on the 15th day in infants with a birth weight of >1500 grams in the NICU (20).

In a study performed in a NICU in South Korea, the diagnosis of NI was generally made on 15-18th days (5). In a study performed in a NICU in South America in 2001, the mean time when the first attack of infection was found was reported to be the 17±14th day (6). In our study, the diagnosis of NI was made between the 9th and 26th days depending on the type of infection and NI was found on the 29.4th day of hospitalization in the NICU and on the 7.6th day in the Neonatology Clinic. According to these results the time of development of NI in our study was found to be slightly later, but comparable compared to other studies. When only the first NI attacts were evaluated in our study, the mean day when the first NI attack was developed in the NICU was found to be earlier (11.8±10.7 days). In our country, no other study related to NI in children and hospitalization times was found. Therefore, no discussion was made.

NIs by birth weight

Many studies have shown that as the birth weight gets lower and the gestational week gets younger, nasocomial infections increase (21). In Japan, the rate of NI was found to be 25.2% in infants with a birth weight of <1000 g, 8.4% in infants with a birth weight of 1000-1500 g and 3.7% in infants with a birth weight of >1500 g in the NICU in the years of 2002-2003 (33). In a study performed in 2002 in Italy, the rate of NI was reported to be 48% in infants with a birth weight of <1500 g (21). In Canada, the frequency of NI was found to range between 6.7% and 74.5% in infants with a very low birth weight and between 0.1% and 17% in infants with high birth weight in the NICU between the years of 1996 and 1997 (20). In a surveillance study performed in Germany between the years of 1994 and 1995, 61% of NIs were found to develop in patients with a birth weight of <1500 g (34). In another study performed in a NICU in Germany between the years of 2000 and 2005, it was observed that 73% of NIs developed in patients with a birth weight of <1000 g, although the number of these patients was the lowest (23). In Turkey, no study investigating the frequency of NI according to birth weight in NICUs was found. In our study, 17.1% of NIs were found to develop in patients with a birth weight of <1000 g, 3.1% of NIs were found to develop in patients with a birth weight of 1001-1500 g, 25.7% of NIs were found to develop in patients with a birth weight of 1501-2500 g and 21.8% of NIs were found to develop in patients with a birth weight of ≥2500 g in the NICU. According to this, although the infants with a birth weight of <1500 g constituted 19% of all hospitalized infants, they constituted approximately half of NIs (52%). This rate was found to be lower compared to the rate reported in Germany.

Mortality rate

The mortality rate related to nosocomial infections is multi-factorial. It is closely related to the patient properties, the area of infection, the etiologic agent and the appropriateness of initial ampirical antibiotherapy. In a study performed in Egypt in the Pediatric Intensive Care Unit in 2005, the general mortality was found to be higher in patients with NI compared to the patients without NI (52% and 30.1%, resepctively) (35). However, the patients in the NICU were not evaluated in this study. This was explained by the severity of underlying diseases of the patients admitted to the intensive care unit. “National Institude of Child Health and Human Development” stated that the mortality rate

in infants with NI was 18% and the mortality rate in the general NICU was 7% (27). In a study performed in the NICU in 2002 in Italy, the general mortality rate was found to be 7.1% and the mortality rate was found to be higher in patients with a diagnosis of NI (12.7) and in patients with microbiologically confirmed sepsis (16.6%) compared to the patients without infection (5.8%), but the difference was not statistically significant (21). The mortality rates in patients with a diagnosis of NI in the NICU was reported to be 17% in a multi-center study performed in Europe between 1996 and 1997 and 10.3% in Japan in the years between 2002 and 2003 (2.1% in patients without NI) (31,33). In a study performed in Canada in 1996-1997, the mortality rate was found to be markedly higher in patients with a diagnosis of NI (8.5%) compared to the patients without a diagnosis of NI (1.3%) among patients with a birth weight of >1500 g in the NICU, but the mortality rates were found to be 8.7% and 8.6% in patients with and without NI, respectively among patients with a birth weight of <1500 g (20). In a study performed in Germany, the mortality rate was found to be 8.1% in the patients hospitalized in the NICU; when classified according to birth weight, the mortality rate was found to be 15,2% in patients with a birth weight of <1000 g and 2,8% in patients with a birth weight of 1000-1499 (23). In our country, there are few studies which evaluated mortality rates. In a study performed in İzmir, the mortality rate in confirmed sepsis in newborns was found to be 16%. In a multi-center study performed by the Turkish Neonatology Association, the mortality rate related to sepsis in 100 cases of sepsis was reported to be 24.4 (13,14). In a study performed in Ege University NICU in 2001 where only blood flow infections were evaluated, the mortality rate was found to be 15.9% in patients with a diagnosis of blood flow infection in the study group which was mostly composed of preterm infants (2). In our study, the mortality rate was found to be 8.6% in patients with a diagnosis of NI in the NICU by NI attack and 16.1% per patient in patients with a diagnosis of NI in the NICU. The general mortality rate in the NICU in our study was found to be comparable (8.6%) with the other studies performed in other centers in our country and the rates of other countries (12.7%, 17%) in the literature (21,31). In our study, the mortality rates in NI in the NICU was found to be comperable to the rates found in developed countries (8.5-18%). Among infants with nosocomial infection, 55.5% of the infants with a birth weight of <1000 g, 5.2% of the infants with a birth weight of 1001-1500 g, 4,5% of the infants with a birth weigth of 1501-2500 and 5.2% of the infants with a birth weight of >2500 g were lost. The high mortality rate in patients with a low birth weight may be due to the fact that these patients are lost in the first days of life because of preterm delivery and complications. (In this article, general mortality rates were discussed, but mortality rates by the causative agent and the type of nosocomail infection were not discussed in detail).

The mortality related to NI in children is approximately 11% (36). In the above-mentioned studies related to nosocomial infections, general crude mortality rates were given. In a 7-year study performed in USA in a NICU, the mortality rate related to NI was found to be 9-13%. Special mortality rates in different risk groups in Turkey could not be reached. However, when the mortality rate in patients without NI was considered, the mortality rate related to NI was found to be 8% in deaths which occured after 48 hours. Our mortality rates related to NI were found to be slightly lower than but comperable to the rates of other countries.

Conclusively, NIs continue to be a significant problem worldwide. Evaluation of continuing active surveillance in later years and comparison with previous values will give information about the success which will be achieved on this subject.

Conflict of interest: None declared.

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