

CLINICAL EPIDEMIOLOGICAL STUDY ON HEALTHCARE ASSOCIATED INFECTIONS IN A REGIONAL EMERGENCY HOSPITAL FROM NORTHEASTERN ROMANIA

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ABSTRACT

Background: Healthcare associated infections (HAIs) represent one of the major issues of population health as it affects sick people, medical staff involved in providing medical care and non-medical supportive staff.

Methods: A longitudinal descriptive study on a total of 982 patients suffering from hospital-acquired infections was carried out between 2012-2017 at the "St. Mary" Emergency Children Clinical Hospital in Iasi, Romania.

Results: The extremely large range of clinical epidemiological results and analyzed statistics indicated a global incidence of HAIs of 0.57% (for an annual average flow of 28,685 discharged patients), with over unity variations in the risk departments. Most of these were mechanical ventilation related-infections, surgical plague related-infections and central venous catheter-related infections.

Conclusion: The results of our study are comparable to the data registered at the national level. Unlike developed countries, which are equipped with a much better monitoring system, in Romania, the incidence and prevalence data are undervalued, due to some dysfunctions in managing these infections with regards to terms of screening and reporting them. Therefore, it is imperative for HAIs to represent a constant professional priority among the duties of the entire medical staff in order to provide safety to the medical-surgical act and pediatric patient.

Key words: healthcare associated infections; nosocomial infections; epidemiology; pediatrics

INTRODUCTION

Healthcare associated infections (HAIs) represent a major issue of population health, generated by the medical practice and concerns not only sick people, but also the medical and non-medical supportive staff who ensure the functionality of the medical

units. The epidemiological process of HAIs is a complex one, since it is characterized by an etiological and clinical epidemiological polymorphism to which a series of risk, behavioral and social economic factors are added (1, 2, 3).

The current particularities of pediatric

HAIs are determined by a multitude of factors: young aged patients, prematurity / dysmaturity, state of immunodeficiency, alteration of the defense anatomical barriers, congenital malformations and/or associated pathologies, prolonged hospitalization, increase in the number of surgical procedures, multitude of diagnosis and therapeutic procedures some of which some are invasive, broad-spectrum antibiotics often unjustifiably administered, emergence of the phenomenon of bacteria multi-resistance to antibiotics. Health care-associated infections determine the increase of the average length of hospitalization and death rate, while the costs for medical assistance are extremely high (3, 4, 5).

MATERIAL AND METHODS

A retrospective, descriptive, longitudinal study was carried out on a group of 982 patients aged between 0-18 years, hospitalized at the “St. Mary” Emergency

Children Clinical Hospital in Iasi, Romania, between 2012-2017. The patients developed one or several health care-associated infections during their hospitalization period. This hospital has a capacity of 652 beds, with an annual average flow of 28,685 discharged patients and serves the North-Eastern region of Romania. Data extracted from the medical documents (observation charts, HAIs files, registers for hospital-acquired infections, statistical reports) were used to carry out this study. Written informed consent was obtained from all caregivers of patients involved and ethical approval for this study was obtained from the “St. Mary” Emergency Children Clinical Hospital Ethics Committee (21296/21.09.2018). Processing of the information material was done by correlating different demographical, etiological, clinical epidemiological parameters, while the interpretation of results was carried out by using classical epidemiological, statistical, mathematical and computerized methods.

RESULTS

Between 2012-2017, there were reported 982 cases of HAIs at the “St. Mary” Emergency Children Clinical Hospital, with an average of 163.67/year and an average rate of 0.53%/year (Table 1).

Table 1 Annual distribution of HAIs between 2012 – 2017

YEAR	2012	2013	2014	2015	2016	2017	TOTAL
Total							
HAI cases	160	157	132	115	214	204	982
Incidence rate (%)	0.55	0.54	0.44	0.38	0.76	0.75	0.57

During the first 2 years of the study, we registered an approximately equal number of HAIs, namely 160 and 157 cases, with an incidence rate of 0.55% and 0.54%

respectively. Subsequently, 132 and 115 cases were registered in 2014 and 2015 with an incidence rate of 0.44% and 0.38% respectively. A double rate of 0.76% was reported for the year 2016, with 214 cases registered. The explosive growth that took place in 2016 is explained by the great number of rotavirus infections (29 cases). These overlapped with the national epidemic of gastroenteritis with Rotavirus, which is usually specific to the cold season and with an increased infectiveness in young children.

The case weight of HAIs in the main departments of the hospital, place the Pediatrics Departments at the top (418 cases representing 42.5% of the total number of cases), followed by the Intensive Care Unit

(345 cases, 35.1%) and surgical departments (219 cases, 22.3%). The great number of cases in the Pediatrics Departments from 2016 (86 – 40.2%) and 2017 (73 - 35.7%) can also be explained by an ongoing national epidemic of rotaviruses and rubella in this period, emerging in non-vaccinated children (Table 2).

Table 2 HAIs department comparative distribution per year between 2012 – 2017

YEAR	PEDIATRICS		SURGERY		ICU		TOTAL
	No.	%	No.	%	No.	%	
2012	89	55.6	27	16.9	44	27.5	160
2013	75	47.8	20	12.7	62	39.5	157
2014	69	52.3	27	20.5	36	27.3	132
2015	26	22.6	20	17.4	69	60.0	115
2016	86	40.2	58	27.1	70	32.7	214
2017	73	35.7	67	32.8	64	31.3	204
TOTAL	418	42.5	219	22.3	345	35.1	982

The age group 0-1 year is extremely prone to developing HAIs (474 cases – 48.7%), with a range between 19.7% in 2012 and 24.9% in 2017, of which most were newborns.

An increased vulnerability in developing HAIs was also noticed in children aged 1-4 years (249 cases – 25.36%), caused by the immaturity of their immunity system.

Teenagers aged 10-14 years and over 15 years developed a HAI in a percentage of 9.17% and respectively, 10.38% (Table 3).

The distribution of HAIs cases by clinical entity in the entire hospital between 2012-2017 shows the greatest proportion is held by bacterial respiratory infections with multiple germs, most of them associated with mechanical ventilation-248 (25.2%), surgical plague infections-181 (18.4%), followed by cutaneous infections (most of them occur in cases of burn)-141 (14.3%), central venous catheter-related infections-135 (13.7%), urinary infections (post-catheterization bladder)-84 (8.5%), digestive infections-79, namely, 8.0% (most of them generated by

Rotavirus, which has a high infectiveness in children aged 1-5 years). The lowest figures were reported as being nosocomial septicemias-70 (7.1%) and other entities such as nosocomial measles-44 (4.4%), in the context of a national epidemic (caused by some dysfunctions in the vaccination program and the refuse of vaccination of some families). The dynamic evolution of different HAIs entities during our study is shown in Table 4.

By analyzing the etiology of HAIs between 2012-2017, we could notice a predominance of the infections generated by *Klebsiella Pneumoniae* (173 cases-17.61%), followed by infections caused by methicillin-resistant *S. Aureus* (MRSA) with 168 cases-17.1%, *Pseudomonas spp.* (132 cases-13.44%), *Acinetobacter baumannii* (96 cases-9.77%). The Rotavirus was isolated from 68 patients (6.92% from the total group of study) while the measles virus was isolated from 32 patients (3.25%).

By analyzing the correlation of the types of HAIs and etiology, it was concluded that mechanical ventilation-related respiratory infections - 248 (25.2%) were generated, in the largest proportion, by *Pseudomonas spp.* (41.4%), *Acinetobacter baumannii* (31%) and *Klebsiella pneumoniae + ESBL* (26.8%); surgical plague infections – 181 cases (18.4%) were generated by *Klebsiella pneumoniae + ESBL* (28%), *S. Aureus MRSA* (24.6%), *Pseudomonas spp.* (24.3%); central venous catheter-related infections - 135 (13.7%) were caused by *A. baumannii* (18.4%), *S. Aureus MRSA* (15.9%), *Klebsiella pneumoniae. + ESBL* (14.6%). Also, *S. Aureus MRSA* caused 28.3% of the cutaneous infections, most of them cases of superinfected burns (Table 5).

Table 3 HAIs distribution by age groups between 2012-2017

Age group	2012		2013		2014		2015		2016		2017		TOTAL No. (%)
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
0-1 year	79	19.7	93	23.2	58	14.5	71	17.7	100	24.9	73	35.78	474 (48.27%)
1-4 years	31	18.9	27	16.5	31	18.9	14	8.5	61	37.2	85	41.66	249 (25.36%)
5-9 years	19	33.9	9	16.1	9	16.1	7	12.5	12	21.4	11	5.39	67 (6.82%)
10-14 years	15	21.7	13	18.8	12	17.4	10	14.5	19	27.5	21	10.29	90 (9.17%)
Over 15 years	16	18.2	15	17.0	22	25.0	13	14.8	22	25.0	14	6.86	102 (10.38%)
TOTAL	160	20.6	157	20.2	132	17.0	115	14.8	214	27.5	204	20.77	982

Table 4 HAIs clinical entities between 2012-2017

Clinical entities	2012		2013		2014		2015		2016		2017		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Septicemias	6	3.8	11	7.0	11	8.3	7	6.1	21	9.8	14	6.8	70	7.1
Respiratory infections	51	31.9	47	29.9	34	25.8	29	25.2	47	22.0	40	19.6	248	25.2
Digestive infections	0	0.0	11	7.0	2	1.5	1	0.9	31	14.5	34	16.6	79	8.0
Urinary infections	10	6.3	9	5.7	16	12.1	5	.3	17	7.9	27	13.2	84	8.5
Cutaneous infections	23	14.4	16	10.2	15	11.4	17	14.8	33	15.4	37	18.1	141	14.3
Central venous catheter-related infections	25	15.6	32	20.4	26	19.7	14	12.2	22	10.3	16	7.8	135	13.7
Surgical plague infections	39	24.4	22	14.0	26	19.7	35	30.4	31	14.5	28	13.7	181	18.4
Others (measles)	6	3.8	9	5.7	2	1.5	7	6.1	12	5.6	8	3.9	44	4.4
TOTAL	160		157		132		115		214		204		982	

Table 5 The etiology of HAIs between 2012-2017

Etiological agent	2012		2013		2014		2015		2016		2017		Total	
	No.	%	No.	%	No.	%	No	%	No.	%	No.	%	No.	%
<i>Pseudomonas spp.</i>	18	11.3	25	15.9	18	13.6	20	17.4	28	13	23	11.2	132	13.44
<i>Klebsiella spp.</i> + ESBL	29	18.1	30	19.1	29	22.0	27	23.5	38	17.7	20	9.8	173	17.61
<i>Enterococcus spp.</i>	7	4.4	6	3.8	6	4.5	8	7.0	7	3.2	12	5.8	46	4.68
<i>S. aureus MRSA</i>	28	17.5	18	11.5	24	18.2	20	17.4	46	21.5	32	15.6	168	17.1
<i>Proteus mirabilis</i>	4	2.5	4	2.5	2	1.5	1	0.9	4	1.8	2	0.9	17	1.73
<i>Acinetobacter spp.</i>	18	11.3	26	16.6	12	9.1	18	15.7	9	4.2	13	6.3	96	9.77
<i>Serratia spp.</i>	2	1.3	3	1.9	2	1.5	0	0	4	1.8	4	1.9	15	1.52
<i>E. coli + ESBL</i>	7	4.4	11	7.0	12	9.1	4	3.5	13	6.1	13	6.3	60	6.1
<i>Candida spp.</i>	14	8.8	16	10.2	6	4.5	3	2.6	8	3.7	10	4.9	57	5.8
<i>Stenotrophomonas spp.</i>	2	1.3	2	1.3	3	2.3	7	6.1	9	4.2	5	2.4	28	2.85
<i>Enterobacter spp.</i>	14	8.8	12	7.6	12	9.1	3	2.6	6	2.8	10	4.9	57	5.8
Rotavirus	2	1.3	2	1.3	2	1.5	2	1.7	29	13.5	31	15.1	68	6.92
Measles virus	15	9.4	2	1.3	2	1.5	2	1.7	2	0.9	9	4.4	32	3.25
Other etiologies	0	0	0	0	0	0	0	0	11	5.1	20	9.8	31	3.15
TOTAL	160		157		132		115		214		204		982	

DISCUSSIONS

In developed countries, the prevalence of HAIs is between 3.5% and 12% (6). In the European countries the European Centre for Disease Prevention and Control (ECDC) calculated an average prevalence of 7.1% and estimates that 4.131.000 of patients are affected by approximately 4.544.100 episodes of HAIs every year (7). In 2002 in the USA the estimated incidence rate was 4.5% with 1.7 million affected patients (9.3 infections to 1.000 patients/day) (8). In a European multicenter study, in the intensive care units the rate of infected patients is 51%, most of these being HAIs. Approximately 30% of the

patients from the intensive care units suffer at least one episode of HAIs. The high frequency of HAIs is associated with invasive medical devices use, especially that of central venous catheters, urinary catheters and ventilators (6, 8).

On the contrary, restricted and most often, low-quality data regarding hospital-acquired infections come from the average and underdeveloped countries. Nevertheless, a recent analysis of WHO concluded that HAIs are more frequent in the areas with limited resources than in the developed countries (6). The frequency of infections related to the use of central venous lines and mechanical

ventilators or of other invasive devices can be nineteen times greater than the frequency registered in Germany and USA (6).

A meta-analysis conducted by a group of ECDC experts on HAIs in Pediatrics (9), emphasized that in the 29 EU countries the study took place, hospitalized children were registered in 1356 departments from 618 hospitals, where most of the children were hospitalized in general pediatrics departments (n = 8298; 48%), neonatology departments (n=4467, 26%), ICU neonatology (n=2283, 13%), pediatric surgery departments (1437.8%) and ICU pediatrics (788.5%). Most of the children were aged under 12 months, newborns prevailing - 5587 (34%) and babies aged 1-11 months: 4024 (25%). There were registered 770 cases of HAIs in 726 children, which corresponds to a prevalence of 4.2%.

Compared to our study, which reports a sub unitary prevalence, the average prevalence in Europe was of 2-10.4%, while Poland, Finland and Cyprus registered a prevalence above the superior limit of 95% CI for the total population, whereas in the Czech Republic and Italy the registered prevalence was below the inferior limit of the average. The departments with the highest prevalence values were PICU (5%) and NICU (7%), followed by neonatology departments (5%), pediatric surgery departments (4%) and general pediatrics departments (1.8%) (9).

Most of the HAIs registered in children with less favorable McCabe scores, hospitalized in NICU or PICU, were subjected to invasive medical devices use and present children who were hospitalized for a longer duration. In the same study, it is emphasized that the blood flow infection (septicemia) was the most frequent type of HAI (44.6%), followed by inferior respiratory tract infections (22.2%), gastrointestinal infections (8,3%), eye, ear, nose and throat

infections (7.1%), urinary tract infections (4.8%) and surgical plague infections (4.4%). The blood flow infection was the most frequent type of HAI in all the age groups except the age group 5-10 years, in which the inferior respiratory tract infections were the most frequent. The urinary tract infections were less frequent in newborns, but they contributed to a tenth of the HAIs in the other age groups, while the plague infections were more frequent in older children. Compared to newborns, children over the age of 11 months had a lower risk of developing HAIs (9).

Of the involved microorganisms, 343 (88%) illnesses were caused by bacteria, 28 (7%) by fungi and 21 (5%) by viruses. Enterobacteriaceae were the most frequently isolated microorganisms (113 - 15%), then coagulase negative staphylococci (most frequently encountered in newborns and babies) and *Staphylococcus aureus*, while 19% of the cases of *S. aureus* isolation were resistant to methicillin (MRSA). 44% of the isolated Enterobacteriaceae were resistant to third generation cephalosporins and 9% were resistant to carbapenems. Rotaviruses were the most frequently identified (13 of 21 isolated cases); other identified viruses were involved in every other case: cytomegalovirus, HIV, herpes simplex virus, norovirus, syncytial respiratory virus (9).

Another multicenter comparative study carried out over five years in Italy and Brazil, highlighted the fact that blood flow infections represented 45.4% of the total number of cases of HAIs in the pediatrics departments (10). The cumulative incidence of HAIs was of 3.6% of the total number of hospitalizations in the ICU. Most frequently isolated pathogenic agents were Enterobacteriaceae, then *Pseudomonas aeruginosa* and *Staphylococcus aureus* MRSA. The independent factors associated with HAIs were the geographical region,

previous antibiotic-based treatment, transplant, major surgical interventions and colonization with an MDR strain (10).

Another study carried out in Brazil on the infantile population, showed that the most frequently pathogenic agents involved in HAIs with MDR Gram-negative bacteria were: *A. baumannii* - 7 cases (17%); *Stenotrophomonas maltophilia* - 7 (15%); *Enterobacter* spp. - 7 (15%) and *K. pneumoniae* - 7 (15%). Of the Gram-negative but non-MDR pathogenic agents, the following were identified: *P. aeruginosa* in 22 cases (41%), *A. baumannii* - 14 (26%) and *K. pneumoniae* - 8 (15%) (11).

Our study has some limitations. Firstly, the data was collected from a single regional hospital, over a short time period (6 years). Despite the results of our study being similar to those on the European level, a broader analysis over a longer period of time and a comparative study between pediatric profile hospitals in the region and a cross-border area would be more useful for clinicians and epidemiologists, in order to make them able to prescribe the best targeted and accurate treatment and avoid the emergence of hospital resistant strains.

CONCLUSIONS

From the multitude of clinical epidemiological and statistical data analyzed, it has revealed that the global incidence of

HAIs in the “St. Mary” Emergency Children Clinical Hospital in Iasi, between 2012-2017 was of 0.57%, with variations between 0.38 % and 0.76%, which was under the average of Romania (1-2%) and significantly under the average of Western countries and USA (5-10%). Although annual global incidences are sub unitary at the level of the hospital, the increased-risk departments (ICU and NICU, Oncology, surgical departments: Burn center, Urology) registered far more over unitary incidence rates (12.7%-60%). The most numerous ones were the respiratory infections, most of them related to mechanical ventilation (25.2%), surgical plague infections (18.4%), followed by central venous catheter-related infections (13.7%), all of which have an etiology of multiresistant germs with epidemiological risk, such as *Klebsiella pneumoniae* + ESBL (17.61% of the cases), *S. Aureus* MRSA (17.1%), *Pseudomonas* spp. (13,44%). The most affected was the age group 0-1 year (48.27%).

In Romania, healthcare-associated infections are undervalued due to the dysfunctions of the clinical epidemiological monitoring system and their reporting. Therefore, it is unequivocally compulsory for healthcare-associated infections screening to become a constant professional priority of the entire medical staff to achieve better results in the future.

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