Colonization by resistant micro-organism and infection related to health care*

Colonização por micro-organismo resistente e infecção relacionada ao cuidar em saúde

Colonización por microorganismo resistente e infección relacionada al cuidar en salud

Adriana Cristina de Oliveira[1], Fernanda Santiago Andrade[2], Mário Ernesto Piscoya Diaz[3], Robert Aldo Iquiapaza[4]

ABSTRACT

Objective: To identify risk factors for the development of colonization by resistant microorganisms (MR) and for infections related to health care (IRCS) in patients from the emergency room (SE) of a unit of Urgent Care (PA) in a hospital university. **Methods:** An epidemiological study of quantitative approach, conducted between August 2009 and March 2010, among adult patients of a SE in a PA unit of a university hospital in the city of Belo Horizonte, Minas Gerais. 254 patients were followed. **Results:** Of 254 total patients, 6.3% were colonized with MR and 11.4% developed IRCS. We identified the time spent in the SE > 9 days (OR = 28.7) and the presence of community infection (OR = 5) for colonization by MR and, for IRCS only the time spent in the SE > 5 days (OR: 19.8), as risk factors, which is common to both the colonization of the patient for MR and to IRCS. **Conclusion:** This study confirmed the inadequacy of the SE, whose priority should be the qualified primary attention, resolving and / or referring patients to a specialty unit.
Keywords: Cross infection; Emergency service, hospital; Risk factors; Drug resistance, microbial

RESUMO

Objetivo: Identificar os fatores de risco para o desenvolvimento de colonização por microrganismo resistente (MR) e para infecção relacionada ao cuidar em saúde (IRCS) em pacientes da sala de emergência (SE) de uma unidade de Pronto Atendimento (PA) em um hospital universitário. **Métodos:** estudo de abordagem quantitativa, epidemiológico realizado entre agosto de 2009 e março de 2010, entre pacientes adultos da SE de uma unidade de Pronto Atendimento de um Hospital Universitário da cidade de Belo Horizonte, Minas Gerais. Foram acompanhados 254 pacientes. **Resultados:** Do total de 254 pacientes, 6,3% foram colonizados por MR e 11,4% desenvolveram IRCS. Identificou-se o tempo de permanência na SE > 9 dias (OR=28,7) e a presença de infecção comunitária (OR=5) para a colonização por MR e, para as IRCS apenas o tempo de permanência na SE > 5 dias (OR:19,8), como fatores de risco, sendo este comum tanto à colonização do paciente por MR como para IRCS. **Conclusão:** Confirmou-se a inadequação da SE, cuja prioridade deve ser a primeira atenção qualificada, resolutiva e/ou o encaminhamento do paciente a uma unidade especializada.
Descritores: Infecção hospitalar; Serviço hospitalar de emergência; Fatores de risco; Resistência microbiana a medicamentos

RESUMEN

Objetivo: Identificar los factores de riesgo para el desarrollo de colonización por microorganismo resistente (MR) y para la infección relacionada al cuidar en salud (IRCS) en pacientes de la sala de emergencia (SE) de una unidad de Pronta Atención (PA) en un hospital universitario. **Métodos:** estudio de abordaje cuantitativo, epidemiológico realizado entre agosto del 2009 y marzo del 2010, entre pacientes adultos de la SE de una unidad de Pronta Atención de un Hospital Universitario de la ciudad de Belo Horizonte, Minas Gerais. Fueron acompañados 254 pacientes. **Resultados:** Del total de 254 pacientes, el 6,3% fueron colonizados por MR y el 11,4% desarrollaron IRCS. Se identificó el tiempo de permanencia en la SE > 9 días (OR=28,7) y la presencia de infección comunitaria (OR=5) para la colonización por MR y, para las IRCS apenas el tiempo de permanencia en la SE > 5 días (OR:19,8), como factores de riesgo, siendo éste común tanto a la colonización del paciente por MR como para IRCS. **Conclusión:** Se confirmó la inadecuación de la SE, cuya prioridad debe ser la primera atención calificada, resolutiva y/o el encaminamiento del paciente a una unidad especializada.
Descriptores: Infección hospitalaria, Servicio de urgencia en hospital, Factores de riesgo, Farmacorresistencia microbiana

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Corresponding Author: **Adriana Cristina de Oliveira**
R. Professor Alfredo Balena, 190/sala 200 – Santa Efigênia
Belo Horizonte - MG - Brasil – CEP. 30130-100
E-mail: adrianacoliveira@gmail.com

INTRODUCTION

The aim of Emergency Services at Emergency Care Units (ECU) is to offer immediate care to patients at imminent risk of death, guaranteeing initial qualified and problem-solving care and permitting patients' adequate referral in the Unified Health System (SUS)[1]. Thus, according to Ministry of Health Decree No. 312, issued on May 30th 2002, the maximum recommended stay of patients at this service is 24 hours[2].

In daily practice, due to the lack of and/or inexistence of vacant beds at Intensive Care Units (ICU), Emergency Rooms (ER) at ECU are overcrowded, so that patients are kept under intensive care, with highly invasive procedures and use of antimicrobials, longer than recommended[3,4]. In parallel, the importance of the emergence of resistant microorganisms (RM) and healthcare-associated infections (HAI) is highlighted.

The appearance of multi-resistant bacteria in the hospital environment has been progressive in recent decades, representing a challenge to public health all over the world. The problem can be explained by the indiscriminate and inadequate use of antimicrobials, whether in hospitals or in the community[5,6]. The situation is aggravated as these bacteria contribute to increase patients' morbidity and mortality and hospitalization costs, and mainly because of the reduced technological arsenal or lack of therapeutic options for treatment in view of some microorganisms that cause infection[7,8].

In addition, in emergency situations, non-observance and/or low conformity with infection control protocols/measures is verified, as the maintenance of patients' vital function is prioritized. Frequent overcrowding, absence of adequate distance between beds, work overload of clinical professionals and bad distribution of hospital resources increase the risk that patients will develop severe care-related complications[4].

Despite the profile of emergency room patients and this unit's characteristics, epidemiological surveillance has not been part of routine at health institutions. The fact can be explained by insufficient staff and lack of training, resources and even data and indicators to support the prioritization of emergency care, as an epidemiologically important unit to prevent and control HAI, reduce the dissemination of bacterial resistance and, mainly, guarantee care quality.

Another aspects that stands out in patient monitoring at the emergency room refers to the need to establish parameters for comparison and knowledge about the risk factors associated with the development of colonization and HAI, thus permitting the assessment of care quality at these units[4]. Thus, in view of the relevance of lack of research on the theme, this study aimed to identify the risk factors associated with the development of colonization by resistant microorganisms and healthcare-associated infections in patients at an Emergency Room of the Emergency Care Unit at a large University Hospital.

METHODS

A prospective epidemiological cohort study was developed between August 2nd 2009 and March 31st 2010 at the Emergency Room of the Emergency Care Unit at a University Hospital. This room is a unit of the Emergency Care Sector and offers nine beds for clinically and/or hemodynamically unstable patients or who need continuous monitoring, of external origin or forwarded from other sectors at the study hospital.

All patients admitted at the unit and who remained there for more than 24 hours were selected for the study. Thus, the sample included 254 patients.

A scientific initiation grantee from the Nursing undergraduate program who was trained for epidemiological surveillance collected the data. Epidemiological surveillance and monitoring of patients' evolution were accomplished daily. An instrument was adopted to collect patient data, including: identification; age; origin; time of stay at the ER, clinical severity index upon admission; patient type; community infection; infection from other hospital sectors; invasive procedures (mechanical ventilation, indwelling urinary and central venous catheter); colonization by RM during hospitalization; use of antimicrobials; HAI; outcome; daily evolution and infection records, according to the criterion of the National Healthcare Safety Network (NHSN)[9]. Data were obtained from the nursing records, patient files and microbiological test results.

Data were obtained from culture analyses and a sensitivity test to the following profiles: Oxacillin-resistant *Staphylococcus aureus, Staphylococcus epidermidis* and *Staphylococcus* sp.; Vancomycin-resistant *Enterococcus* sp.; *Streptococcus pneumoniae* resistant to Penicillin or Ceftazidime or Ceftriaxone or Cefotaxime; *Pseudomonas aeruginosa* resistant to Ciprofloxacin or Levofloxacin or Gatifloxacin or Imipenem or Meropenem or Ceftazidime or Piperacillin; *Acinetobacter* sp., *Enterobacter* sp. and *Klebsiella* sp. resistant to Imipenem or Meropenem or Ceftriaxone or Cefotaxime; *Escherichia coli* resistant to Ceftazidime or Ceftriaxone or Cefotaxime or Ciprofloxacin or Levofloxacin or Gatifloxacin; *Citrobacter* sp. *Serratia* sp. *Proteus* sp. *Providencia* sp. *Morganella* sp. resistant to Ceftazidime or Ceftriaxone or Cefotaxime.

To classify the severity of patients' clinical condition, the *Average Severity Index Score* (ASIS)[10] was adopted, a renowned international classification of clinical severity. Patients were assessed and classified upon

admission to the surveillance unit, in the categories: A – In postoperative phase, not demanding intensive medical or nursing care, with discharge from hospitalization unit in up to 48 hours. B – Physiologically stable, demanding nighttime prophylactic observation without medical or nursing care. C – Physiologically stable, demanding intensive nursing care and monitoring. D – Physiologically unstable, demanding intensive medical and nursing care with frequent needs for treatment reassessment and adjustment. E – Physiologically unstable, in coma or shock or requiring cardiopulmonary resuscitation or intensive medical and nursing care and frequent reassessment.

Data were types and processed in Statistical Package for the Social Sciences (SPSS) software, version 13.0. Descriptive statistics and bivariate logistic regression were used to characterize patients and possible risk factors for colonization by resistant microorganisms and HAI, and multivariate logistic regression to verify the risk factors associated with RM colonization and HAI. Approval for the research was obtained from the Ethics Committee, in compliance with National Health Council Resolution 196/96 [11] (Protocol No. 267/2003).

RESULTS

Emergency Room patient characteristics

During the study period, 254 patients were monitored, 144 (56.7%) of whom were male, with a mean age of 61.3 years and a mean stay at the Emergency Room of 5.8 days. Most were clinical patients (95.7%), from the community (61%) and with ASIS C (69.3%) and E (18.1%) (Table 1).

Table 1. Distribution of all patients followed (n=254), according to study variables at the Emergency Room of a University Hospital – Belo Horizonte – 2010

Variables	Category	N	%	P-value *
Sex	Male	144	56.7	0.43
	Female	110	43.3	
Age	Mean (years)	61.3	-	0.00
Origin	Other hospital sectors	17	6.7	0.00
	Community	155	61.0	
	Observation room	35	13.8	
	Other hospital	47	18.5	
Stay at ER	Mean (days)	5.8	-	0.00
	Minimum	1	-	
	Maximum	24	-	
Average Severity Index Score (ASIS)	A	0	0.0	0.00
	B	10	3.9	
	C	176	69.3	
	D	22	8.7	
	E	46	18.1	
Patient type	Clinical	243	95.7	0.04
	Surgical	11	4.3	
Community infection	No	172	67.7	0.32
	Yes	82	32.3	
Infection from other hospital sectors	No	243	95.7	0.04
	Yes	11	4.3	
Invasive procedure	No	84	33.1	0.66
	Yes	170	66.9	
Patient colonized by RM during hospitalization	No	238	93.7	0.06
	Yes	16	6.3	
Antimicrobial use for non-hospital infections	No	88	34.6	0.65
	Yes	166	65.4	
Hospital infections	No	225	88.6	0.11
	Yes	29	11.4	
Outcome	Discharge to other unit	190	74.8	0.00
	Deaths	60	23.6	
	Hospital transfer	2	0.8	
	Hospital discharge	2	0.8	

(*) P-value for Chi-square test of equality of proportions for categorical variables, or t-test equal to zero for continuing variables.

Table 2. Distribution of 254 patients according to RM colonization status and selected characteristics, at the Emergency Room of a University Hospital – Belo Horizonte, 2010

| Variables | Category | Colonization by RM | | |
		No (%) n=238	Yes (%) n = 16	P-value Chi-square test
Sex	Female	105(44.1)	5 (31.3)	<0.01
	Male	133(55.9)	11(68.8)	
Age (median)		59.9	60.2	
Origin	Community	141(61.3)	9 (56.3)	
	Other hospital sectors	17(7.1)	0 (0)	
	Other hospital	43(18.1)	4 (25)	
	Observation room	32 (13.4)	3 (18.8)	
Patient type	Clinical	229(96.2)	14 (87.5 %)	
	Surgical3	9 (3.8)	2 (12.5)	
Clinical severity	A	0(0)	0(0)	
	B	10 (4.2)	0 (0)	
	C	163(68.5)	13 (81.3)	
	D	21(8.8)	1 (6.3)	
	E	44(18.5)	2 (12.5)	
Stay (days) at ER	1-4	133 (55.9)	1 (6.2)	<0.01
	5-8	67 (28.2)	4 (25)	
	9 and +	38 (15.9)	11 (68.8)	
Use of invasive procedures	No	82 (34.5)	2 (12.5)	<0.01
	Yes	156 (65.5)	14 (87.5)	
Community infection	No	168(70.6)	4 (25)	<0.01
	Yes	70 (29.4)	12 (75)	
Infection from other hospital sector	No	227(95.4)	16 (100)	
	Yes	11 (4.6)	0(0)	
Outcome	Discharge	183(76.8)	11 (68.7)	
	Death	55 (23.1)	5 (31.3)	

In the patient group, 170 (66.9%) used some type of invasive procedure, distributed as follows: 74 (43.5%) central venous catheter, 156 (91.8%) indwelling urinary catheter and 111 (65.3%) mechanical ventilation.

In addition, 82 (32.3%) displayed community infection upon admission to the ER and 166 (65.4%) used therapeutic antimicrobials during their hospitalization.

As for patient outcomes, 190 (74.8%) were transferred to other hospital sectors, 60 (23.6%) died, 2 (0.8%) were discharged and 2 (0.8%) were transferred to another hospital.

Among the patients who died, 5 (8.3%) were colonized and 9 (15%) suffered from HAI, showing similarity between the two groups. Their mean stay before death ranged between 5 and 21 days.

Patients colonized by resistant microorganisms

Among all 254 patients, 16 (6.3%) were colonized by RM. *Acinetobacter baumannii* (37%), followed by *MRSA*

(18.5%) and *Pseudomonas aeruginosa* (11.1%) stood out as colonizing microorganisms.

In the colonization, the following were also detected: VRE, extended-spectrum beta-lactamase (ESBL) producing *Klebsiella pneumoniae*, *Klebsiella pneumoniae* RM/ESBL, *Klebsiella pneumoniae* carbapenemases (KPC), *Enterobacter cloacae, Enterobacter sp., Staphylococcus haemolyticus, Staphylococcus epidermidis MR* and *Staphylococcus homini*, each of which represented 3.7%.

The risk factors for colonization by a resistant micro-organism were sex, time of stay at the emergency room, use of invasive procedures and presence of community infection, with statistical significance at $p < 0.01$ (Table 2).

Then, bivariate analysis, relating the colonization by a resistant microorganism variable with *sex, time of stay at the emergency room* (1 to 4 days, 5 to 8 days and ≥9 days), *use of invasive procedures and community infection,* it was ascertained that only community infection (OR=7.2) and time of stay at the ER ≥9 days (OR=38.50) con-

Table 3. Distribution of study variables according to presence or absence of healthcare-associated infection in patients at the Emergency Room of a University Hospital – Belo Horizonte - 2010

Variables	Category	IRCS		P-value
		No (%) n=225	Yes (%) n = 29	
Sex	Female	100(44.4)	10 (34.5)	
	Male	125(55.6)	19 (65.5)	<0.01
Origin	Community	138(61.3)	17 (58.6)	
	Other hospital sectors	17(7.6%	0 (0)	
	Other hospital	40 (17.8)	7 (24.1)	
	Observation room	30 (13.3)	5 (17.2)	
Patient type	Clinical	217(96.4)	26 (89.7)	
	Surgical3	8 (3.6)	3 (10.3)	
Clinical severity	A	0 (0)	0 (0)	
	B	10 (4.4)	0 (0)	
	C	157(69.8)	19 (65.5)	
	D	21 (9.3)	1 (3.4)	
	E	37 (16.4)	9 (31)	
Stay (days) at the ER	1 to 4	133 (59.1)	1 (3.5)	
	5 to 8	60 (26.7)	11 (38)	
	9 and more	32 (14.2)	17 (58.5)	<0.01
Community infection	No	154(68.4)	18 (62.1)	
	Yes	71 (31.6)	11 (37.9)	<0.01
Infection from other hospital sector	No	215(95.6)	28 (96.6)	
	Yes	10 (4.4)	1 (3.4)	
Colonization by RM	No	216 (96)	22 (75.9)	
	Yes	9 (4)	7 (24.1)	<0.01
Invasive Procedures	No	82 (36.4)	2 (6.9)	
	Yes	143(63.6)	27 (93.1)	<0.01
Outcome	Discharge	174(77.3)	20 (69)	
	Death	51(22.7)	9 (31)	

tinued statistically significant (p<0.01) for colonization by resistant micro-organisms.

In the multivariate analysis, *time of stay at the emergency room of 9 days or more* and *community infection* continued as risk factors for patient colonization by resistant microorganisms.

Healthcare-associated infection in emergency room patients

Healthcare-associated infections were notified in 29 (11.4%) patients, with pneumonia (38.3%) as the most frequent, followed by sepsis (23.5%), urinary tract infection (20.6%) and cardiovascular system infection (8.9%).

The remaining infections (surgical site infection, skin infection and eye infection, ear, nose, mouth or throat) each represented 2.9% of all HAI.

Data in Table 3 show the distribution of the study variables according to the presence or absence of healthcare-associated infection in emergency room patients and the p-value for the Chi-square test of association with selected characteristics.

The mean age of patients with healthcare-associated infections was 60.7 years, 65.5% were male and 93.1% used invasive procedures (Table 3).

In bivariate analysis, the *healthcare-associated infection development* variable was separately related with *sex, time of stay at the* ER (1 to 4 days, 5 to 8 days and ≥ 9 days),

community infection, colonization by RM and *use of invasive procedures*. Only the time of stay at the ER between 5 and 8 days (OR=24.38) and ≥ 9 days (OR=7.65), presence of colonization by resistant microorganism (OR=7.63) and use of invasive procedures (OR=7.74) were statistically significant for the development of HAI (p <0.01). In the multivariate analysis, only the time of stay between 5 and 8 days (OR=19.8) and ≥*9 days* (OR=69.2) showed statistical significance and continued as a risk factor for the development of HAI.

DISCUSSION

In this study, time of stay superior to nine days and community infection diagnoses were identified as factors associated with the risk of RM colonization, while only time of stay of more than five days served as a risk factor for the development of HAI in patients at an ER. Colonization is a problem inherent in critically ill patients and a constant public health concern, as it entails severe economic, social and political consequences[12,13].

The rate of patients colonized with RM during their stay at the ER remained below that of other studies, which reported percentages between 12.98% and 54.3%[13,14]. In bivariate as well as multivariate analysis, colonization by resistant microorganisms was associated with the patient's admission to the ER with community infection and to time of stay at the unit ≥9 days. No studies were found, however, that highlighted the relation between community infection and colonization by RM. Various studies appoint the prolonged hospital stay variable as a risk factor for HAI and for colonization by resistant bacteria at different hospitalization units. As a result of the similarity between the ER and other high-risk units, the same variable (hospital stay) also shows the same epidemiological important independently, as a behavior observed at other units[4,15].

In Brazil, it is estimated that between 5% and 17% of hospitalized patients catch some kind of infection[5,10]. These infections are even higher when referring to patients who need intensive care, representing 20% to 40% of all infections at a hospital[4,12-14]. At the ER under analysis, 11.4% of hospitalized patients developed HAI.

As verified in this research, other studies have demonstrated that the use of invasive procedures, a frequent situation in intensive care patients, increased the risk for infection development. Besides, according to some publications, colonization by resistant microorganisms is a risk factor associated with HAI[4,6,14,16]. In this study, the use of invasive procedures and colonization by RM were considered risks for the development of HAI in bivariate logistic regression only.

The microorganisms that were most frequently involved in colonization cases were *Acinetobacter baumannii, followed by* MRSA and *Pseudomonas aeruginosa, in line with the main organisms isolated from ICUs. As to the most prevalent infection sites among the emergency room patients, the distribution of these infections per specific site is similar to those described at ICUs, given the patients' severity and, mainly, the invisible profile of these organisms, which has been ascertained as a characteristic ER and ICU patients have in common*[16].

Time of stay at the ER ≥ 5 days was the main risk factor associated with HAI, with statistical significance in both bivariate and multivariate analyses. When comparing ER time of stay between 1 and 4 days with the group between 5 and 8 days and ≥9 days, it was verified that the latter is at an even higher risk of developing HAI, almost 70 times (OR=69.2) higher, while the group between 5 and 8 days reveal a risk almost 20 times higher when comparing both groups with patients who stay at this unit for 4 days or less. Other studies also identified the length of hospital stay as a risk factor for HAI[7,8,14-15]. In view of the above, if Ministry of Health Recommendations were followed, i.e. patients' stay at this unit for less than 24 hours, it is verified that most HAI at the ER could be avoided.

The 23.6% mortality rate can be considered high, although lower than records in an earlier study at the same unit, which registered a mortality rate of 59.6%. The analysis of deceased patients revealed that 5 (8.3%) were colonized with RM and 9 (15%) suffered from HAI. The risk these infections entail possibly worsened these patients' clinical situation, which may have enhanced complications and even death. This high mortality rate represents difficulties to compare the findings, as mentioned earlier, due to the lack of research at emergency rooms of emergency care units[10,12,16].

Concerning ICU mortality, a study showed 10.6% of deaths among 244 monitored patients, with 31.2% among patients who developed HAI. Despite the similarity between the ER and the intensive care unit, given the patients' profile, clinical condition and use of invasive procedures, it was verified that the mortality rate and its association with HAI was higher in the present study[16].

CONCLUSION

Length of stay at the ER ≥ 9 days and presence of community infection were identified as risk factors for colonization by resistant microorganisms. For the development of HAI, only length of stay at the ER > 5 days was considered a risk factor. The most frequently involved microorganisms in colonization cases were *Acinetobacter baumannii*, followed by *MRSA* and *Pseudomonas aeruginosa.* As a result of RM colonization and the development of HAI, complications like the high

mortality rate represent an additional concern at the emergency room.

In view of the study findings and the observed similarity between patient severity, length of stay beyond recommendations for this unit, overcrowding, the quantitative human resource shortage and mainly the outcome of emergency room patients concerning colonization by resistant microorganisms and the occurrence of infections among high-risk units, the importance of epidemiological surveillance is ascertained for infections at this unit. Also, criteria for comparison need to be established, as well as

care quality indicators that enhance the implementation of policies to adapt the physical structure, human resources and to adopt basic practices to control infections and the dissemination of resistant microorganisms.

This study also offers data that support reflections, evidencing the urgent need for discussions on institutional and public health policies. Also, the cost-benefit of such severe patient care and risk guidelines at a unit should be reassessed, with a view to complying with and setting immediate parameters for clinical decision making, and not for the length of patient stay.

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