Factores de riesgo de Infección Nosocomial en una Unidad de Rehabilitación

Risk factors for Healthcare-associated Infection on a Rehabilitation Unit

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ABSTRACT

Objective: Ascertain healthcare-associated infection (HAI) prevalence and identify risk factors associated with a higher incidence of infection in a Rehabilitation Ward.

Materials and Methods: Two-year retrospective cohort study conducted in a post-acute Rehabilitation Ward of a tertiary-care, public, university-affiliated hospital. Demographic and clinical data were collected from electronic medical record. The assessment of risk factors was done by comparison of patients with or without HAI. Univariate and multivariate logistic regression analysis was used to identify risk factors.

Results: There were 262 admissions to the Rehabilitation Ward during the study period. One-hundred thirty-one HAIs were detected in 95 (36.3%) of the 262 patients. The most common infections were urinary tract infections (87.8% of all infections). An age-sex adjusted multivariate logistic regression model showed that urinary catheter, surgery in the last 30 days and length of stay ≥ 30 days were independent risk factors for HAI. Length of stay was associated with an increased odd of developing HAI (median length of 28 days for those without HAI, 35 days for those with only one HAI and 55 days for patients having ≥ 2 HAI). Only one patient died of infection.

Conclusions: HAI is a frequent complication in a post-acute Rehabilitation Ward. The logistic regression model identified patients with urinary catheter, surgery in the last 30 days and length of stay ≥ 30 days as having an higher risk for HAI, thereby being the main targets of surveillance and adoption of preventive measures.

Keywords: Healthcare-associated infection; rehabilitation ward; risk factors; urinary tract infection; urinary foley catheter.

RESUMEN

Objetivo: Determinar la prevalencia y los factores de riesgo de infección nosocomial en pacientes ingresados en una Unidad de Rehabilitación.

Material y Métodos: Estudio de cohorte retrospectivo de dos años realizado en una Unidad de Rehabilitación posaguda de un hospital público. La evaluación de los factores de riesgo se realizó mediante la comparación de pacientes con o sin infección nosocomial. Se utilizó un análisis de regresión logística univariado y multivariado para identificar los factores de riesgo.

Resultados: Hubo 262 ingresos a la Unidad de Rehabilitación durante el período de estudio. Se detectaron 131 infecciones nosocomiales en 95 (36,3%) de los 262 pacientes. Las infecciones más frecuentes fueron las del tracto urinario (87,8%). Un modelo de regresión logística multivariado ajustado por edad y sexo mostró que el catéter urinario, la cirugía en los últimos 30 días y la duración de la estancia ≥ 30 días fueron factores de riesgo independientes para infección nosocomial. La duración de la estancia se asoció con una mayor probabilidad de desarrollar una infección nosocomial (duración media de 28 días para aquellos sin infecciones, 35 días para aquellos con solo una infección y 55 días para pacientes con ≥ 2 infecciones). Solo un paciente murió de infección.

Conclusiones: La infección nosocomial es una complicación frecuente en una Unidad de Rehabilitación. El modelo de regresión logística identificó a los pacientes con catéter urinario, cirugía en los últimos 30 días y estadía ≥ 30 días con mayor riesgo de infección, por lo que son los principales objetivos de la vigilancia y adopción de medidas preventivas.

Palabras clave: Infección nosocomial; unidad de rehabilitación; factores de riesgo; infección del tracto urinario; catéter urinario.

INTRODUCTION

Healthcare-associated infection (HAI), also referred to as nosocomial infection or hospital acquired infection, is a common adverse event in care delivery and a major public health issue with an impact on morbidity, mortality, and medical costs. Reports about healthcare-associated infections (HAIs) in acute care departments are numerous, but there is few data regarding Rehabilitation Units.[1,2] These settings frequently include patients with severe clinical and functional impairments from trauma, neurological disorders, general deterioration (deconditioning) after a debilitating illness and prolonged stay in intensive care units, with high comorbidity burden and needing a long-term hospitalization with unavoidable exposure to infectious nosocomial risks.[1,2] A high number of patients in rehabilitation facilities are typically transferred from an acute care setting, where a high prevalence of multiple drug resistant organisms exists and so many nosocomial microorganisms previously acquired may spread to Rehabilitation Units.[2] Among patients admitted to these units, those with spinal cord injury seem to have a significantly higher rate of HAI.[3]

Studies found that HAIs prolong hospital length of stay and are associated with increase in medical costs.[3] In addition, HAIs occurring among hospitalized patients are often serious and may be life-threatening.[3] In Rehabilitation Units, HAIs might have a significant impact on adherence to and compliance with rehabilitation program and thereby decrease functional improvement.[3,4] Thus, improving the prevention and management of infections in Rehabilitation Units should be a goal for improving quality of healthcare. However, the prevalence and risk factors of HAI among inpatients admitted to Rehabilitation Units has not been thoroughly evaluated.

This study aims to ascertain HAI prevalence and identify factors associated with a higher incidence of infection in a post-acute Rehabilitation Ward (RW).

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METHODS

Study setting

This study was performed at Centro Hospitalar Universitário de São João, a tertiary-care, public, university-affiliated hospital located in Porto, Portugal. The post-acute RW provides rehabilitation treatment to patients with traumatic or non-traumatic orthopedic or neurological pathologies or patients with deconditioning after a debilitating illness. Patients are admitted to this RW from one of the following sources: (1) directly from the community; (2) acute wards from other departments of this hospital; (3) other healthcare facility.

Study design

This was a retrospective cohort study of patients consecutively admitted to the RW between October 2017 and September 2019. Data were collected from electronic medical record and included demographic data (age and sex), previous functional status (according to modified Rankin scale), underlying diseases, date of admission, diagnosis on admission to the RW, location prior to admission (home, other hospital, other medical or surgical department), initial hospitalization length of stay (acute-care hospital), length of stay on the RW, occurrence of prior infection in the acute-care hospital, antibiotic treatment at the time of admission to the RW, diagnosis and type of HAI, isolated pathogens from cultures, prescribed antibiotics, use of invasive medical devices at admission (nasogastric feeding tube, percutaneous gastrostomy, peripheral or central venous catheter, urinary foley catheter, tracheostomy), severity of disability at the time of admission and discharge, measured by the modified Rankin scale (mR) and discharge destination. Data were collected on forms specifically designed for this study. As this is a retrospective study, with data collected only from electronic medical record, patients' consent was waived. This study was approved by the committee on research ethics at the institution in which the research was conducted.

Patients

All patients admitted to the post-acute RW for intensive physical rehabilitation during the study period were included in this study. No patients were excluded. Patients with HAI were analyzed as a group and compared with those without HAI.

Definition of Healthcare-associated infection

HAI is, according to the World Health Organization, any infection occurring during hospitalization, irrespective of the healthcare facility, which was not present or incubating at the time of admission.[5] HAI can affect patients in any type of setting where they receive healthcare and can also appear after discharge.[5] For the purpose of this study, the diagnosis of HAI was primarily assumed when explicitly expressed in patient's electronic medical records or discharge summaries the diagnosis of an infection first detected 48-hours or more after admission to the RW and associated antibiotic therapy. Infections present or incubating at the time of admission were not included. Posteriorly, infections identified by patient's electronic medical records or discharge summaries were validated using the Centers for Disease Control/National Healthcare Safety Network (CDC/NHSN) surveillance definitions.

Statistical analysis

SPSS statistics (version 25.0) was used for data analysis. Descriptive statistics are presented as mean±standard deviation or median (interquartile range, IQR) for normal and non-normally distributed continuous variables, respectively. For between-group comparisons we used the Student´s T-test or Mann-Whitney U-test, according to normality of data distribution. Categorical variables were presented as proportions and percentages and compared using the Pearson's chi-square test or Fisher exact test, as appropriate. Considering the binary dependent variable (with/without HAI), we performed a univariate logistic regression analysis to identify potential clinical predictors of infection. A stepwise logistic regression was used for a multivariate analysis of all the potential risk factors that proved significant in univariate analysis using $p<0.05$ as model entry criteria and $p>0.10$ for removal from multivariate model.

RESULTS

Clinical characteristics

During the 24-month study period, there were 262 admissions to the RW, mostly males (56.9%), with a mean age of 58.1±14.0 years. Most of the patients (92.7%) were previously independent in their daily activities (mR≤2). The most common reasons for admission were ischemic stroke (40.8%), hemorrhagic stroke (17.9%), spinal cord injury (13.0%), deconditioning (6.9%) and traumatic brain injury (5.3%). The median length of stay in the acute care hospital was 26 (15 – 44) days and in the RW was 30 (21 – 45) days. Most patients were transferred from the following departments: Internal Medicine (33.6%), Neurosurgery (21.0%), Neurology (20.2%), Orthopedic (7.2%) and Stroke Unit (3.8%). Seven patients were referred from the Physical Medicine and Rehabilitation outpatient clinic. The baseline characteristics of the study group are summarized on table 1.

Healthcare-associated infections

One-hundred thirty-one HAIs were detected in 95 (36.3%) of the 262 patients admitted to the RW. Seventy patients had 1 infection, seventeen patients had 2 infections each, six patients had 3 infections each, 1 patient had 4 infections and one patient had 5 infections during the stay in the RW (table 2).

One hundred and fifteen HAIs corresponded to urinary tract infection (UTI) (87.8%), eight to respiratory tract infections (6.1%), five to surgical wound infections (3.8%). There was one osteomyelitis, one pseudomembranous colitis and a bacteriemia.

In most UTIs (n=100, 87%), a pathogen was identified; Escherichia coli and Klebsiella pneumoniae were responsible for more than one-half of all isolated organisms. Pathogens responsible for the HAI, stratified by source, are shown in table 3. The microorganism responsible for osteomyelitis was not identified.

Predictors of Healthcare-associated infection

In univariate analysis we found that transfer from a surgical department, surgery in the last 30 days, spinal cord injury, occurrence of prior HAI at an acute care setting, presence of urinary foley catheter, presence of peripheral venous catheter, number of medical devices ≥ 2, presence of nasogastric tube and length of stay ≥ 30 days were all associated with HAI. A stepwise age-sex adjusted multivariate logistic regression model showed that urinary foley catheter (OR=5.4; 95% CI 2.2-13.4), surgery in the last 30 days (OR=2.5; 95% CI 1.1-6.1) and length of stay ≥ 30 days (OR=2.1; 95% CI 1.1-3.9) remained as independent risk factors for development of HAI in the RW. Univariate and multivariate logistic regression models are summarized in table 4.

Table 1. Baseline characteristics of patients on admission to the post-acute RW

CHARACTERISTICS	POPULATION STUDY (N=262)
Sex, n (%)	
Female	113 (43.1%)
Male	149 (56.9%)
Age in years, mean±SD	58.1±14.0
Previous modified Rankin scale, n (%)	
≤ 2	243 (92.7%)
> 2	19 (7.3%)
Provenience, n (%)	
Internal Medicine Department	88 (33.6%)
Neurosurgery Department	55 (21.0%)
Neurology Department	53 (20.2%)
Orthopedic Department	19 (7.2%)
Stroke Unit	10 (3.8%)
Other Hospital Departments	28 (10.7%)
Physical and Medicine Rehabilitation outpatient clinic	7 (2.7%)
Other Healthcare Facility	2 (0.8%)
Reasons for admission, n (%)	
Ischemic stroke	107 (40.8%)
Hemorrhagic stroke	47 (17.9%)
Spinal cord injury	34 (13.0%)
Deconditioning	18 (6.9%)
Traumatic Brain Injury	14 (5.3%)
Polyneuropathies	12 (4.6%)
Polytrauma	4 (1.5%)
Inferior limb fracture	4 (1.5%)
Inferior limb amputation	4 (1.5%)
Central Nervous System infection	3 (1.1%)
Other cause	15 (5.7%)
Length of stay in the acute care hospital in days, median (IQ)	26.0 (15.0-44.0)
Prior infection in the acute care hospital, n (%)	141 (53.8%)
Modified Rankin scale on admission, n (%)	
≤ 2	7 (2.7%)
> 2	255 (97.3%)
Presence of medical devices on admission, n (%)	102 (38.9%)
Number of medical devices on admission, n (%)	
0	160 (61.1%)
1	66 (25.2%)
≥ 2	36 (13.7%)
Medical devices on admission, n (%)	
Urinary foley catheter	64 (24.4%)
Nasogastric feeding tube	24 (9.2%)
Percutaneous endoscopic gastrostomy	2 (0.8%)
Peripheral venous catheter	56 (21.4%)
Central venous catheter	3 (1.1%)

Outcomes

In six patients who developed HAI (2.3%), the rehabilitation program had to be suspended due to transfer to another department; one of these patients died due to severe hospital acquired pneumonia and the other five returned to the RW after receiving adequate treatment. The outcome for the remaining 261 patients was as follows: 117 (44.8%) were discharged to home, 75 (28.7%) were discharged to a Rehabilitation Center or a Private Hospital to continue an inpatient rehabilitation program, 61 (23.4%) were discharged to other facilities for chronic care and 8 (3.1%) were discharged to another department of the hospital for an acute problem and survived. Patients with at least one HAI had worse functional outcome at discharge, with mR >2 (87.4% vs 68.9%%, p=0,001). The stay in the RW was significantly longer in patients with infection than in patients without infection [41.0 (28.0-57.0) vs 28.0 (16.0-37.0) days, p<0.001]. Length of stay was associated with an increased odd of developing HAI (median length of 28.0 (16.0-37.0) days for those without HAI, 35.0 (26.0-53.25) days for those with only one HAI and 55.0 (46.0-70.5) days for patients having two or more HAI).

DISCUSSION

Our study showed that patients admitted to this post-acute RW experienced a high rate of HAI. Over one third developed at least one HAI, with urinary tract, respiratory tract and surgical wound infections being the most common HAIs in patients admitted for post-acute rehabilitation, as described in previous studies.[1,4,6,7] Longer hospitalization, indwelling urinary catheter and prior surgery were all associated with increased odds for HAI.

Incidence of HAI of up to 36.2% was twice that reported by Mylotte *et al*. 2000 (16.5%), Golliot *et al*. 2001 (15.9%) and Tinnelli *et al*. 2011 (15%).[1,4,6] This difference might be due to variations in type of study (retrospective vs prospective) and different criteria for HAI definition.

The most common infection in this cohort, by far, was UTI, which accounted for 87.8% of all HAIs identified, which is in agreement with previous studies in similar settings.[2,4,7,8] Given the burden of UTI in these facilities, further critical evaluation of the impact, risk factors, and prevention of this problem should be a priority.

Controlling HAIs may include three strategies: surveillance, prevention and early treatment. These infections can be prevented to a large extent by instituting careful surveillance of bacterial infections, improving hand hygiene, limiting antibiotics overuse and unnecessary invasive procedures.[9] Defining a priori risk factors for HAI can help identify high-risk patients for HAI who need stricter preventive measures and active surveillance of symptoms development. We identified that indwelling urinary catheter, prior surgery and prolonged length of stay were all associated with an increased risk for HAI during the hospitalization at the RW.

Recent surgery and indwelling urinary catheter are significant risk factors for HAI and these findings are consistent with previous studies.[6,10,11] Surgery and anesthesia result in a variety of metabolic and endocrine responses, which result in a generalized state of immunosuppression in the post-operative period.[12] The severity of immune disorders is proportional to the extent of surgical trauma and depends on several factors, including the baseline condition requiring surgical treatment, coexisting infections, and impaired nutritional status.[13] It can take a couple of weeks for the immune system to fully recover. In our study, 21.8% of rehabilitation inpatients had undergone surgery in the previous month and 33.7% of the patients who developed at least one infection had undergone surgery in the previous month.

Indwelling catheters are a well-described key source of infection in the general medical population.[11] Patients admitted to RW due to spinal cord injury, stroke and traumatic brain injury, are more likely to need an urinary catheter placement than other hospitalized patients; their high incidence of bladder dysfunction increases the likelihood of being catheterized.[14] Also limited mobility secondary to hemiparesis, paraparesis or tetraparesis impairs the ability to transfer to the toilet

NUMBER OF INFECTIONS PER PATIENT	FREQUENCY (%)
0 infections	167 (63.7%)
1 infection	70 (26.7%)
Urinary tract infection	63
Surgical wound infection	3
Respiratory tract infection	3
Bacteriemia	1
2 infections	17 (6.5%)
2 urinary tract infections	12
1 urinary tract infection + 1 respiratory tract infection	3
1 urinary tract infection + 1 surgical wound infection	1
1 urinary tract infection + 1 osteomyelitis	1
3 infections	6 (2.3%)
3 urinary tract infections	4
2 urinary tract infections + 1 surgical wound infection	1
2 urinary tract infections + 1 pseudomembranous colitis	1
4 infections	1 (0.4%)
4 urinary tract infections	1
5 infections	1 (0.4%)
3 urinary tract infections + 2 respiratory tract infections	1

Table 2. Total number of infections per patient during the stay in the RW

Table 3. Bacteriology of the HAI, by the main sources, occurring among patients admitted to the RW

ORGANISM	NUMBER OF ISOLATES FROM INDICATED SOURCE			
	Urinary tract (115)	Respiratory tract (8)	Surgical wound (5)	Bloodstream (1)
Escherichia coli	39			
Klebsiella pneumoniae	23			
Proteus mirabilis	10			
Pseudomonas aeruginosa	11			
Enterococcus faecalis	5			
P. aeruginosa + K. pneumoniae	1			
E. coli + K. pneumoniae	3			
Morganella morganii	1			
Enterobacter aerogenes	1			
Citrobacter freundii	1			
Enterobacter cloacae	1			
Serratia mascescens	1			
Streptococcus agalactiae	1			
Klebsiella oxytoca	1			1
S. aureus		1	1	
S. aureus + K. pneumoniae		1	1	
P. aeruginosa + Morganella morganii		1		
E. aerogenes + P. mirabilis		1		
S. aureus + S. warneri			1	
Microorganism not identified	16	4	2	

or bedside commode, increasing the likelihood of catheter placement for nursing convenience.[14] Speech and language impairment as well as cognitive limitations affect the ability to communicate their need to urinate, which may be used as a justification for catheter placement.[11] This risk increases the longer the catheter remains in place.[10,15] The potential consequences of catheter-associated urinary tract infection include pain or discomfort, physical damage to the urethra, pyelonephritis, kidney failure, spread of infection to bloodstream (bacteriemia), increased use of antibiotics, increased hospital length of stay, and even patient death.[16] Therefore, catheters should only be placed in patients who require them for monitoring of fluid status due to a concurrent medical condition or in those with acute bladder obstruction or retention.[14] Other patients should be managed without indwelling catheters with careful attention to bladder dysfunction using other methods of bladder drainage when necessary such as intermittent catheterization.[14] To further minimize the risk to patients and to prevent colonization by bacteria that might potentially be pathogenic, it is important to perform a correct aseptic non-touch technique for catheterization so that the key parts of the catheter are not contaminated.[11]

We found that longer duration of hospitalization on the RW was associated with an increased incidence of HAIs. On one hand, this might reflect more complex clinical conditions with an increased suscepti-

Table 4. Univariate and multivariate analysis of potential risk factors associated with development of HAI.

Variables	OR [95% CI]	Adjusted OR [95% CI]
Sex	0.82 [0.49 – 1.36]	*
Age ≥ 60 years	1.37 [0.83 – 2.28]	*
Transfer from a surgical department	1.73 [1.01 – 2.96]	0.87 [0.39 – 1.91]
Surgery in the last 30 days	2.89 [1.58 – 5.27]	2.54 [1.06 – 6.09]
Spinal cord injury	5.01 [2.27 – 11.09]	1.56 [0.56 – 4.34]
Prior HAI at an acute care setting	2.25 [1.33 – 3.79]	1.62 [0.86 – 3.06]
Urinary foley catheter	8.64 [4.54 – 16.43]	5.43 [2.20 – 13.42]
Peripheral venous catheter	3.03 [1.65 – 5.56]	1.50 [0.61 – 3.70]
Nasogastric tube	3.29 [1.38 – 7.85]	2.19 [0.72 – 6.65]
Number of medical devices ≥ 2	6.97 [3.11 – 15.61]	0.99 [0.24 – 4.04]
Length of stay ≥ 30 days	3.02 [1.79 – 5.11]	2.10 [1.13 – 3.89]

Legend: OR: odds ratio; 95% CI: 95% confidence intervals. *Age-sex adjusted model.

bility to infections, higher rate of manipulation of indwelling catheters. On the other hand, we cannot exclude reverse causality whereby increased length of stay is not the cause but the consequence of HAI. HAIs can affect the adherence to and ability to participate in a rehabilitation program and thus delay functional recovery and induce a prolonged length of stay to achieve the established clinical and functional goals.

Finally, it should be noted that the outcome for patients with HAI in the present study was good. The relevant question in examining morbidity from infection would be HAIs interfering with the patient´s rehabilitation program. In 6 patients (2.3%), the rehabilitation program had to be suspended due to patient transfer to another department for specialized care of HAI. There was only one death attributable to HAI, probably due to higher proportion of HAI being uncomplicated UTIs with more favorable prognosis. Besides that, patients with at least one HAI showed worse functional outcome, as also reported by Myllote *et al.* (2001).[3] Myllote *et al.* (2001) found that older age, prior hospital length of stay and occurrence of HAI were predictive variables of a lesser increase in Functional Independence Measure score between admission and discharge; of these, HAI was the only one having the potential to be modifiable following admission to the Rehabilitation Unit.[3]

In summary, healthcare-associated infections, especially UTI, are a frequent complication in a RW and seems to be associated with longer length of hospitalization and poorer functional outcome. Patients with urinary foley catheter, prior surgery and prolonged length of rehabilitation unit stay are at increased risk for infection during the hospitalization at the RW. The observations reported in this study support the need to develop specific programs for the surveillance, prevention and care of infections in Rehabilitation Units. However, this study has some limitations. This was a single-center retrospective study performed in a post-acute RW in a public, university-affiliated hospital whereby results and conclusions should not be extrapolated to different rehabilitation settings.

CONFLICTS OF INTEREST
No conflicts of interest related to the manuscript have been reported by the authors.

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ETHICAL ASPECTS
All participants submitted a consent form to be included in this study.

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