Hospital-Acquired Urinary Tract Infections: Results of a Cohort Study Performed in an Internal Medicine Department

Infecção do Tracto Urinário Adquirida no Hospital: Resultados de um Estudo de Coorte Realizado num Departamento de Medicina Interna

Maria João LOBÃO✉[1], Paulo SOUSA[2]

ABSTRACT

Introduction: Urinary tract infections are the most frequent healthcare associated infections, being related to both high costs and morbidity. Our intention was to carry out an epidemiological characterization of hospital acquired urinary tract infections that occurred in an internal medicine department of a Portuguese hospital.

Material and Methods: Retrospective cohort study (historic cohort). Data were analysed from a systematic random sample of 388 patients, representative of the 3492 admissions occurred in 2014 in that department.

Results: One in four patients underwent the placement of a bladder catheter [24.7% (n = 96); 95% CI: 20% - 29%], 36.5% (95% CI: 33% - 48%) of which in the absence of clinical criteria for that procedure. The global cumulative incidence rate for nosocomial urinary tract infections was 4.6% (95% CI: 2.5% - 6.7%). Most hospital acquired urinary tract infections (61.1%) were related to bladder catheter use. We quantified 3.06 infections / 1000 patient-days and 14.5 infections / 1000 catheter-days. Catheter associated urinary tract infection occurred at an early stage of hospitalization. The vast majority of patients (66.7%) that developed a catheter associated urinary tract infection were subjected to bladder catheter placement at emergency department. Seventy one per cent of catheter associated urinary tract infection occurred in patients that were subjected to bladder catheter placement without criteria.

Discussion: These results point to an excessive and inadequate use of urinary catheters, highlighting the need for judicious use taking into account the formal clinical indications. The incidence of catheter associated urinary tract infection is similar to what we found in other studies. Nevertheless we found a very high incidence density per catheter-days that may foresee a problem probably related to the absence of early withdrawal of the device, and to both bladder catheter placement and maintenance practices. A significant part of catheter associated urinary tract infection occurred in patients that had the bladder catheter placed in the emergency department, before the admission to the internal medicine ward, which highlights the need to assess the urinary catheterization practices in those departments.

Conclusion: The high rate of catheter associated urinary tract infection that occurred in the absence of bladder placement indication reinforces the need to implement prevention strategies that contemplate the reduction of its use. Emergency departments should be part of quality improvement projects in this area. Causes for the early onset of catheter associated urinary tract infection in this cohort should be investigated.

Keywords: Community-Acquired Infections; Cross Infection; Hospital Departments; Internal Medicine; Urinary Tract Infections

RESUMO

Introdução: As infecções urinárias são as infecções associadas aos cuidados de saúde mais frequentes, estando associadas a elevados custos e morbidade. Pretendeu-se efectuar uma caracterização epidemiológica das infecções urinárias adquiridas no Hospital ocorridas num serviço de Medicina Interna de um hospital português.

Material e Métodos: Estudo de coorte retrospectivo (coorte histórica). Analisaram-se os dados correspondentes a uma amostra aleatória sistemática de 388 doentes, representativa das 3492 admissões ocorridas, em 2014, nesse Serviço.

Resultados: Um em cada quatro doentes foi sujeito à colocação de uma sonda vesical [24,7% (n = 96); IC 95%: 20% - 29%], em 36,5% (IC 95%: 33% - 48%) dos casos na ausência de critérios clínicos. A taxa de incidência cumulativa global de infecções urinárias nosocomiais foi de 4,6% (IC 95%: 2,5% - 6,7%). A maior parte das infecções (61,1%) associou-se à utilização de um cateter vesical. Ocorreram 3,06 infecções por mil dias de internamento e 14,5 infecções por mil dias de algaliação. As Infecções urinárias associadas a cateter vesical ocorreram numa fase precoce do internamento. A grande maioria dos doentes que desenvolveram infecções urinárias associadas a cateter vesical (66,7%) foram algaliados no serviço de urgência. Setenta e um por cento das infecções urinárias associadas a cateter vesical ocorreram em doentes algaliados na ausência de critérios para o procedimento.

Discussão: Estes resultados apontam para um uso excessivo e inadequado de cateteres urinários, destacando-se a necessidade do uso criterioso tendo em conta as indicações clínicas formais. A incidência de infecção do tracto urinário associada ao cateter vesical foi semelhante à encontrada noutros estudos. No entanto, encontrámos uma densidade de incidência por dia de cateter muito elevada, o que permite antever um problema relacionado com ausência de retirada precoce do dispositivo ou com as práticas de colocação e manutenção da algália. Uma parte significativa das infecções associadas a cateter vesical ocorreu em doentes cuja colocação de cateter vesical ocorreu no serviço de urgência, antes da admissão na enfermaria de medicina interna, o que enfatiza a necessidade de avaliar as práticas de algaliação nesses serviços.

Conclusão: A elevada taxa de Infecções urinárias associadas a cateter vesical ocorrida na ausência de indicação para

algaliação, reforça a necessidade de implementação de estratégias de prevenção que contemplem a redução do número de algaliações. Os serviços de urgência devem ser integrados nos projectos de melhoria nesta área. As causas para a ocorrência precoce de infecções urinárias associadas a cateter vesical nesta coorte devem ser investigadas.

Palavras-chave: Infecção Hospitalar; Infecções Comunitárias Adquiridas; Infecções Urinárias; Medicina Interna

INTRODUCTION

Healthcare associated infection (HAI) is a public health concern on a global scale. In the set of all HAI, urinary tract infections (UTI) stand out because these are the ones that occur more frequently and are commonly related to the use of a medical device (bladder catheter).[1–4] Once analysed in a cumulative way, this infection represents significant morbidity for patients and high costs for health systems.[1,5–8] Hospital acquired urinary tract infections (HAUTI) are also the most frequent cause of secondary bacteraemia.[1,2,8] HAUTI can be avoided by using prevention strategies that have proved to be effective.[4–6,9]

Portugal is the European country with the highest rate of HAI (10.6%; CI 95%: 10.1% -11.0%).[10] The Program of Prevention and Control of Infections and Antimicrobial Resistance [*Programa de Prevenção e Controlo de Infeções e de Resistência aos Antimicrobianos* (PPCIRA)], which coordinates Portuguese HAI incidence studies, has been privileging bloodstream and surgical site infections as well as populations and contexts associated with a greater risk of HAI acquisition (adults and newborn intensive care units).[11] The departments of Internal Medicine are key services departments not only in the Portuguese health system, but also in other health systems throughout the world. However, there is scarce epidemiological information available for nosocomial UTI occurring in these departments. With this study, the authors aim to characterize HAUTI that arises during hospitalization in an Internal Medicine department of a Portuguese hospital, with particular focus on those that are associated with bladder catheter use.

MATERIAL AND METHODS

We performed a retrospective cohort study at the Internal Medicine Department of hospital de Cascais. This public district hospital belongs to the Portuguese National Health Service and serves an estimated population of 285 000 inhabitants. It produces about 30 600 hospitalization episodes per year. The department where this study was carried out has 93 of the total 277-inpatient beds.

We used a process of systematic sampling[12,13] to achieve a representative sample of the population admitted to that internal medicine ward during the period of 1th January 2014 to 31th December 2014 (n = 3492). We determined that the minimum number of patients to be included in the cohort would be 384.[14] All patients that met the following criteria were excluded from the cohort: i) chronic bladder catheter use; ii) transfer from another hospital; iii) admission diagnosis of community UTI or healthcare associated UTI; iv) transfer to another hospital during the hospital stay; and v) missing data.

We considered many variables that were organized into five groups: i) demographic variables (gender, age, place of residence); ii) clinical variables (pressure ulcers category,[15] performance in activities of daily living (Barthel Index),[16,17] sphincter incontinence, nutritional risk category (NRS-2002),[18] diabetes mellitus, cancer, immunodeficiency, age adjusted Charlson comorbidity index[19,20]; iii) hospital admission variables (origin, principal diagnosis according to
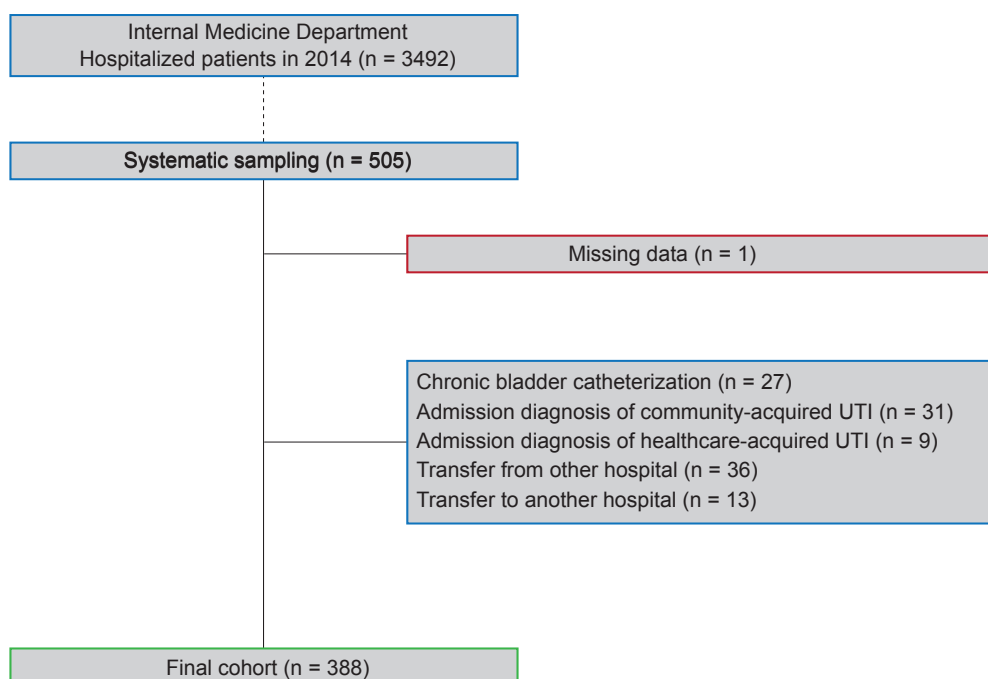

Figure 1 – Flow diagram of patients´ inclusion and exclusion in the study cohort

ICD-9-CM®, length of stay, death); iv) bladder catheterization variables (department of device placement, adequacy of placement, catheter-days); and v) infection variables (day of hospitalization at diagnosis, catheter day at diagnosis, microbiologic agent, selected antibiotic, number of antibiotic days, secondary bacteraemia related to HAUTI). We used the Centers for Disease Control (CDC) methodology to define the main outcome of this study (HAUTI, related or not to the use of a bladder catheter).

Data for all variables, namely exposure and outcomes, were retrospectively collected by indirect documentation in the year 2015.

We used the IBM® SPSS® Statistics Software, version 21 for Windows for statistical analysis. For both nominal and ordinal variables, counts were made and respective percentages were calculated. For numerical variables we calculated measures of central tendency (average and median) and dispersion (standard deviation, range of variation). CDC metrics were used to calculate urinary catheter utilization rate and incidence densities rates for catheter associated urinary tract infection (CAUTI) (for one thousand catheter-days and for one thousand patient-days). Where applicable, confidence intervals were calculated for a significance level of 5%.

The Ethics Committee of the Hospital where the study was conducted approved the research protocol.

RESULTS

The final number of patients included in this study cohort was 388, as shown in Fig. 1. The proportion of women in the study is slightly higher than that of men (51.3% *vs* 48.7%). The participants mean age was 79 years ± 17.1 (minimum - maximum interval: 20 - 99 years, IQR: 68 - 85 years). At admission, a significant proportion of patients had pressure ulcers (17%; 95% CI: 13% - 21%), some degree of dependence in activities of daily living (74%; 95% CI: 69% -78%) and sphincter incontinence (52.5%; 95% CI: 48% - 58%) (Table 1). The mean age-adjusted Charlson comorbidity index was 3.9 ± 2.2 points (95% CI: 3.6 - 4.1) (minimum - maximum interval: 0 - 11 points; IQR: 3 - 5 points).

The majority of patients were admitted from the emergency department (91.2%) (Fig. 2), most frequently due to pathologies included in respiratory (35.9%) and circulatory (29.1%) diseases group according to ICD9-CM® (Table 2). The length of stay was 9.26 days (± 5.8 days; 95% CI: 8.68 - 9.83 days). The mortality rate was 12.9% (95% CI: 10% – 16%).

One in four patients underwent bladder catheter placement [24.7% (n = 96); 95% CI: 20% - 29%]. We found that 36.5% of patients (n = 35; 95% CI: 33% - 48%) did not meet criteria for that procedure (Fig. 2). The greatest number of urinary catheter insertions occurred in the Emergency department (n = 58, 60.4%), prior to admission to the Internal Medicine department. The number of catheter-days varied between 1 and 25 days, being the mean 7.9 ± 5.57 days. In total, we accounted 759 urinary catheter days. The

bladder catheter utilization rate was 21.2% [(759/3591) x 100].

In this cohort, the overall cumulative incidence rate of nosocomial UTI was 4.6% (95% CI: 2.5% - 6.7%). More than half of identified UTI occurred in relation to urinary catheter use (61.1%). The overall cumulative incidence of CAUTI was 2.8% (95% IC: 1.1% - 4.4%).

There were 3.06 infections per thousand patient days and 14.5 infections per thousand catheter days (Fig. 2). CAUTI diagnosis occurred early during the hospital stay (median of inward days: 4 days, IQR: 3 - 8 days; median day of bladder catheter: 3 days, IQR: 3 - 11 days). The vast

Table 1 - Characterization of the study cohort regarding sociodemographic and clinical variables

Variable	Nº (%) (n = 388)
Gender	
Female	199 (51.3%)
Male	189 (48.7%)
Age	
< 34	17 (4.4%)
35 - 49	27 (7.0%)
50 - 64	56 (14.4%)
65 - 79	108 (27.8%)
80 - 94	170 (43.8%)
> 95	10 (2.6%)
Place of residence	
Home	330 (85.1%)
Nursing home	57 (14.7%)
Chronic care Hospital (RNCCI)§	1 (0.3%)
Pressure ulcers category	
None	322 (83.0%)
I	24 (36.4%)
II	17 (25.8%)
III	19 (28.8%)
IV	6 (9.1%)
Performance in activities of daily living category*	
Independence	101 (26.0%)
Slight dependence	8 (2.1%)
Moderate dependence	49 (12.6%)
Severe dependence	118 (30.4%)
Total dependence	112 (28.9%)
Sphincter incontinence	184 (47.4%)
Nutritional risk category**	
Low risk	286 (73.7%)
High risk	102 (26.3%)
Diabetes mellitus	75 (19.3%)
Cancer	65 (16.8%)
Immunosuppression	35 (9.0%)

§ RNCCI: Integrated National Continuing Care Network; * Barthel Index; ** NRS-2012
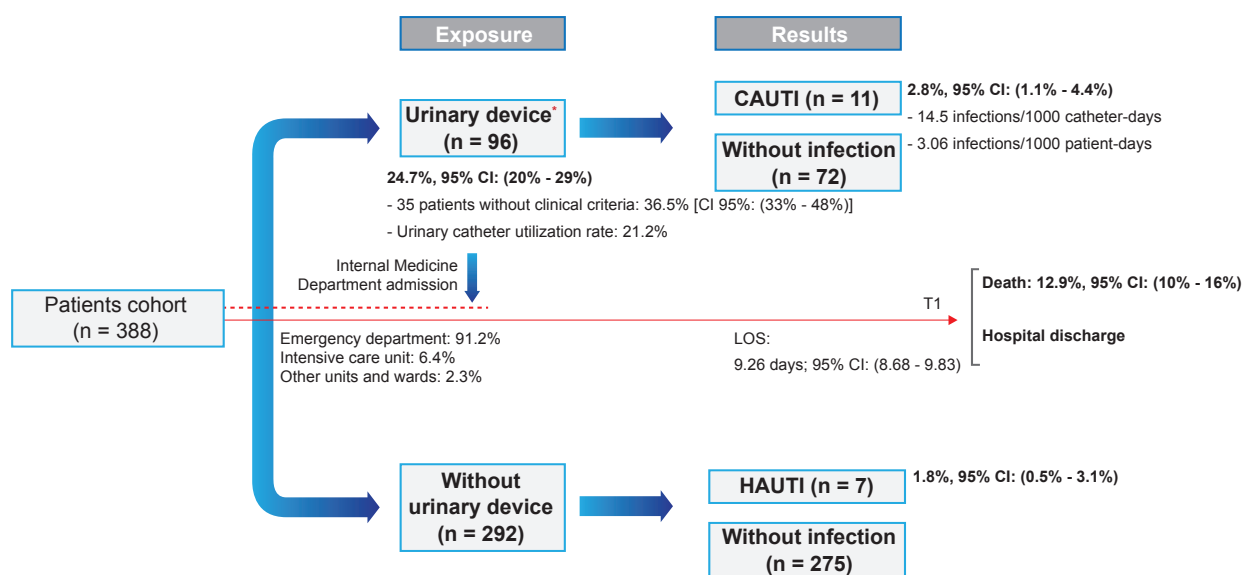
Figure 2 – Representative diagram of the study design and obtained main results

Table 2 - Study Cohort Principal diagnosis classification according to ICD9-CM®

Principal Diagnosis	n	%
Diseases of the respiratory system	137	35.3
Diseases of the circulatory system	113	29.1
Diseases of the digestive system	39	10.1
Neoplasms	24	6.2
Infectious and parasitic diseases	17	4.4
Diseases of the blood and blood-forming organs	16	4.1
Endocrin, nutrional and metabolic diseases and immunity disorders	13	3.4
Diseases of the genitourinary system	12	3.1
Diseases of the skin and subcutaneous tissue	6	1.5
Injury and poisoning	4	1.0
Diseases of musculoskeletal system and connective tissue	3	0.8
Diseases of nerve system and sense organs	2	0.5
Symptoms, Signs and ill-defined conditions	1	0.3
Mental disorders	1	0.3
Total	388	100

majority of patients who developed CAUTI were subjected to the procedure at the Emergency department (66.7%). Eight of the 11 CAUTI we have found (71.2%) occurred in patients that did not meet the criteria for the procedure. Only three patients developed secondary bloodstream infection, which corresponds to a cumulative incidence rate of 0.7% (95% CI: 0% - 2%).

CAUTI involved agents present a greater resistance profile, which requires the use of broad-spectrum antibiotics (Table 3). Five in eleven CAUTI infections (45%) were due to multiresistant agents. The rate of carbapenem use was 22.2%. Regarding all infections, we found that in the majority of cases (61.1%) the antibiotic choice was guided by antimicrobial susceptibility tests. On average, each patient completed 6.75 days of antibiotic (± 1.79 days).

DISCUSSION

With this study it was possible to quantify and characterize the nosocomial urinary tract infections that occurred in patients admitted to an Internal Medicine Department of a Portuguese hospital. The importance of research in this area is unequivocal since these infections constitute the most frequent healthcare associated infections[1,21–24] and are associated with high morbidity, mortality[1] and costs for health systems.[25]

Internal Medicine wards are essential and transversal to Portuguese hospitals. Patients admitted to them usually present advanced age and high complexity if we consider morbidity and dependence in daily living activities, as evidenced by the demographic and clinical characterization of the cohort of this study. Several studies have given

Table 3 - Infectious agent involved in CAUTI and HAUTI

Infectious agent	HAUTI	CAUTI	N
Acinetobacter baumanii	0	1	1
E. coli ESBL+[§]	0	4	4
E. coli	4	5	9
Enterococcus faecium	1	0	1
Klebsiela pneumoniae	1	1	2
St. aureus methicillin sensitive	1	0	1
Total	7	11	18

§ HAUTI: hospital-acquired urinary tract infection; CAUTI: catheter-associated urinary tract Infection; ESBL+: extended spectrum beta-lactamase

particular importance to the elderly population, since it is the population at higher risk for the occurrence of adverse hospital events, of which infection is highlighted.[26–31] The results of the present investigation may also contribute to HAUTI knowledge in this age group population.

In this study, the urinary catheterization rate was 24.7% (95% CI: 20% - 29%). In addition, 36.5% (95% CI: 33% - 48%) catheter placements occurred without formal indication for the procedure. These results point to an excessive and inadequate use of urinary catheters, similar to that verified in a prevalence study carried out in another Portuguese Internal Medicine ward. The authors of that study found a urinary catheterization rate of 20%, considering that in 25% of cases it would not be indicated.[32] In this context it is very important to emphasise the need for judicious use of urinary catheters taking into account the formal clinical indications (acute urinary retention; need for accurate measurements of urinary output in critically ill patients; to assist in healing of open sacral or perineal wounds in incontinent patients; to improve comfort for end of life care if needed; patients requiring prolonged immobilization).[1]

Recent prevalence European and American data have shown that bladder catheter was used by 17.5% of patients in 66 European hospitals[33,34] and by 23.6% of patients in 183 US hospitals.[33,35] In this cohort, for every 100 days of hospitalization, approximately 21 were bladder catheterization days (urinary catheterization rate: 21.2%). Data from the National Healthcare Safety Network (NHSN) for the year 2013 indicate rates of 15% for medical wards in the USA.[36]

It should be noted that in this study 71.2% of CAUTI occurred in patients who did not meet criteria for bladder catheter placement. This data reflects event occurrence that could have been avoidable. It has a real impact on the patients and the health system, in terms of morbidity, length of stay and antibiotic therapy days. The overuse of bladder catheters in patients admitted to internal medicine wards should be avoided in accordance with the international literature.[1,2,23]

In this study, the incidence rate of nosocomial UTI was 4.6% (95% CI: 2.5% - 6.7%). Most of the identified infections occurred in patients with a bladder catheter (61.1%), less than what is reported in the literature (80%).[37,38] The CAUTI incidence rate found (2.8%, C 95%: 1.1% - 4.4%) was lower than in some published studies report.[37,39] However, when we evaluate incidence density per catheter days, the value found of 14.5 infections per thousand catheter-days was much higher what the National Healthcare Safety Network (NHSN) reported for medical wards for the year of 2013 (1.5 infections per thousand days of catheter).[36] These data may foresee a problem probably related to the absence of device early withdrawal, and to both bladder catheter placement and maintenance practices. This idea is further substantiated by the evidence that in this cohort of patients CAUTI occurred early during the hospitalization. This fact is against what might be expected, since it is recognized that the most important factor for CAUTI development is the number of days of bladder catheterization.[1,2,40] We consider that these data deserve a particular attention, giving the possibility of further investigation that can guide eventual infection prevention strategies in this area and in medical wards in particular.

One of CAUTI concerns is related to secondary bloodstream infection, a more serious problem that can seriously and negatively affect patient prognosis.[1] In the cohort we found a cumulative incidence of secondary bloodstream infection of 0.7% (95% CI: 0% - 2%), lower than the 2% - 4% described in the international literature.[1,2]

We must highlight that a significant part of CAUTI occurred in patients that had the bladder catheter placed in the emergency department, before the admission to the internal medicine ward. Other authors have shown that the setting of bladder catheter placement is an important risk factor for the development of CAUTI.[37] Although we did not ascertain the statistical significance of these data in our study, it will be worth to further assess the urinary catheterization practices in emergency departments and also integrate such assessment with joint development projects with internal medicine departments. Such projects seem to be crucial to improve the quality of practices, including the adoption of prevention bundles as described in the literature.[1,41]

Finally, a particular attention should be given to the high rate of multidrug-resistant infection in CAUTIs that determined the use of broad-spectrum antibiotics such as carbapenems. Urinary drainage systems are often reservoirs for multidrug resistant bacteria and a source of transmission to other patients.[1] This data reinforces, once again, the absolute need for rational and careful use of bladder catheters.

The present study concerns data from a single centre and, therefore, its goal is not to directly generalize its results. As it is an historical cohort, it was not possible to include variables that could not be collected from patient´s clinical records, namely those related to bladder catheter insertion and maintenance techniques, whose importance has been stressed in the literature as it negatively impacts CAUTI occurrence.

CONCLUSION

A significant part of the HAUTI identified in this study occurred in patients without indication for bladder catheter placement. A significant part of those infections were due to multidrug resistant bacteria, which require the use of broad-spectrum antibiotics.

These data reinforce the need to develop and implement strategies to prevent this type of hospital infection, where minimizing the use of this medical invasive device is of major importance. The inclusion of emergency services in joint intervention plans is mandatory, not only because they are the departments from which most of the patients admitted to other medical departments come from, but also because they are the place where the greatest number of unnecessary bladder catheters is found.

The data from this study are a contribute to a better epidemiological characterization of a public health problem, with a particular focus on a type of department that is transversal to hospitals and serves a highly complex population, taking into account its age and comorbidities profile.

PEOPLE AND ANIMALS PROTECTION

The authors declare that the Ethics Committee of the Hospital where the study was conducted approved the research protocol. The described procedures were followed according to the Helsinki Declaration of the World Medical Association.

CONFIDENTIALITY OF DATA

The authors declare having followed the protocols in use at their working center regarding patient's data publication.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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