# URINARY TRACT INFECTIONS (UTIs) AFTER UROGENITAL PROCEDURES AND RELATED OUTCOMES AND COSTS: ANALYSIS OF DATA FROM THE NATIONAL HOSPITAL INFORMATION SYSTEM

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## BACKGROUND

Healthcare-associated infections (HAIs) are infections that appear within 48 hours after admission to the hospital or are present at admission in a patient who was transferred from another acute care hospital (1). Hospital UTIs are associated with invasive procedures affecting the urinary system; 75-80% of UTIs are associated with the use of bladder catheters and 5-10% are associated with other manipulations of the urinary tract (e.g., cystoscopy) (2). The duration of catheterization is the main risk factor for the development of UTIs (2). Other risk factors are open circuit drainage, errors in the handling of the bag or catheter, the performance of other invasive procedures (cystoscopy, surgery urology), female sex and old age (2).

## OBJECTIVE

The objective of this study was to evaluate at the national level the proportion of acute inpatient hospitalizations with UTIs after urogenital procedures and the associations between UTIs after urogenital procedure and in-hospital mortality, length of stay (LOS) and costs using real world data.

## METHODS

### Data sources and study population

This retrospective study was based on the Italian National Hospital Information System (HIS). In particular, the analysis was carried out using the Hospital Discharge Database, which collects information related to all admissions to public and private hospitals in Italy.

We selected all patients with acute inpatient hospitalizations that occurred between January 1, 2010, and December 31, 2014, with at least one of the following urogenital procedures in the main or secondary fields: nephrostomy (ICD-9-CM codes: 55.02, 55.03, 55.04, 55.82, 55.93), transurethral removal of obstruction from ureter and renal pelvis (ICD-9-CM 56.0x), ureteroscopy (ICD-9-CM 56.31, 56.33), dilation of ureteral meatus (ICD 9 CM 56.91), ureteral catheterization (ICD-9-CM 59.8x), ultrasonic fragmentation of urinary stones (ICD-9-CM 59.95), and extracorporeal shockwave lithotripsy [Eswl] of the kidney, ureter and/or bladder (ICD-9-CM 98.51). We excluded admissions of patients who were not Italian residents, admissions of patients aged <18 or >100 years, admissions in day hospitals and rehabilitation centres and long-term admissions. The patients' clinical histories were defined by retrieving specific conditions and procedures recorded in the index admission and in all hospitalizations that occurred during the previous 2 years, as commonly performed in the operational protocols of the National Outcome Evaluation Program. The Charlson comorbidity index (CCI) was also calculated for each patient by summing the assigned weights for all comorbid conditions evaluated in the index admission and in all hospitalizations that occurred during the previous 2 years (3).

### Study outcomes

The presence of infection was verified through the presence of a primary or secondary diagnosis of a UTI. UTIs were identified according to the presence of primary or secondary diagnosis of pyelonephritis (ICD-9-CM 590.00, 590.01, 590.10, 590.11, 590.80, 590.81); urinary tract infection, site not specified (ICD-9-CM 599.0); other post-operative infection (ICD-9-CM 998.59); other infection due to medical care (ICD-9-CM 999.3); cystitis (ICD-9-CM 595.xx); and urethritis (ICD-9-CM 597.xx). It was assumed that the infection occurred subsequent to the urogenital procedures. A further sensitivity analysis was performed considering UTIs defined as only the presence of a Hospitalization cost was estimated according to the national diagnosis-related group (DRG) tariffs of reimbursement (4).

### Statistical analysis

The associations between the presence of a UTI and the outcomes considered in the analysis were assessed both unadjusted using the Mann–Whitney unpaired test for continuous variables and Pearson's Chi-square test for categorical variables and after adjusting for potential confounding factors using different models for each outcome. The association between in-hospital mortality and the presence of a UTI was evaluated using a logistic regression model; a generalized linear model with a log link function and a negative binomial distribution was used to estimate the association between the length of stay and the presence of a UTI (5, 6); finally, a generalized linear model with a log link function and a gamma distribution was used to estimate the association between the mean hospitalization cost and the presence of a UTI (7). To control for confounding variables, each measure of association was adjusted for age, sex and a list of comorbidities selected by a stepwise procedure using thresholds of p=0.05; a sensitivity analysis was performed with the CCI scores grouped into three categories (≤ 1, 2-3, ≥ 4) as confounders in each model. Two-tailed p-values < 0.05 were considered statistically significant, and all statistical analyses were conducted with SAS University Edition 9.4 (Cary, NC, USA).

## RESULTS

We identified 272,133 patients with acute inpatient admissions who underwent a urogenital procedure during 2010-2014. In total, 60.8% of the patients were males. The mean age of the entire sample was 58.9 years (SD 16.1 years).

In the whole study period, 7.0% of patients with acute inpatient admissions had UTIs (95% CI: 6.9% - 7.4%) (Table 1). Patients with UTIs had a higher in-hospital mortality rate (1.2% vs. 0.9%; p = 0.0004), a longer length of stay (10.8 days vs. 6.8 days; p < 0.0001) and higher hospitalization cost (€ 4,673.6 vs. € 3,809.5; p < 0.0001) than patients without UTIs. Our analysis shows that there is no significant difference in in-hospital mortality between patients with and without UTI (OR adjusted for age, gender and comorbidities 0.95; p = 0.5106) (Table 2), but there is a strong association between in-hospital mortality and the diagnosis of a post-operative infection (OR adjusted for age, gender and comorbidities 2.42; p = 0.0075) (Table 3). Moreover, our study indicated that the presence of a UTI is associated with a prolonged hospital stay and elevated mean hospitalization costs (Table 2); when we considered only post-operative infections as the exposure, the increases in the length of stay and mean cost for patients with post-operative infections compared with those without post-operative infections were even greater (Table 3).

**Table 1: Proportion of admissions with UTIs by year and for the whole period of analysis**

| Year | UTIs | Total | Prop. (%) | 95% CI |
|---|---|---|---|---|
| **2010** | 3,596 | 52,385 | 6.9% | (6.6% – 7.1%) |
| **2011** | 3,665 | 52,920 | 6.9% | (6.7% - 7.1%) |
| **2012** | 3,859 | 54,095 | 7.1% | (6.9% - 7.4%) |
| **2013** | 3,999 | 55,208 | 7.2% | (7.0% - 7.5%) |
| **2014** | 4,046 | 57,525 | 7.0% | (6.8% - 7.2%) |
| **Total** | 19,165 | 272,133 | 7.0% | (6.9% - 7.4%) |

**Table 2: Associations between UTI and in-hospital mortality, length of stay and hospitalization cost**

| | | Univariate model | | | Multivariable model 1 * | | | Multivariable model 2 ** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **In-hospital mortality** | **%** | **OR** | **95% CI** | **p value** | **OR** | **95% CI** | **p-value** | **OR** | **95% CI** | **p value** |
| w/o infection | 0.93 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | 1.19 | 1.28 | 1.11 - 1.46 | 0.0005 | 0.95 | 0.83 - 1.10 | 0.5106 | 1.01 | 0.88 - 1.17 | 0.8441 |
| **LOS** | **Mean LOS** | **IRR** | **95% CI** | **p value** | **IRR** | **95% CI** | **p-value** | **IRR** | **95% CI** | **p value** |
| w/o infection | 6.8 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | 10.8 | 1.60 | 1.58 - 1.62 | <0.0001 | 1.50 | 1.48 - 1.51 | <0.0001 | 1.54 | 1.53 - 1.56 | <0.0001 |
| **Hospitalization costs** | **Mean cost** | **β** | **95% CI** | **p value** | **β** | **95% CI** | **p-value** | **β** | **CI** | **p value** |
| w/o infection | € 3,810 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | € 4,674 | 1.23 | 1.21 - 1.24 | <0.0001 | 1.19 | 1.18 - 1.21 | <0.0001 | 1.21 | 1.20 - 1.22 | <0.0001 |

* Adjusted for age, gender and comorbidities
** Adjusted for age, gender and CCI

**Table 3: Associations between post-operative infections and in-hospital mortality, length of stay and hospitalization cost**

| | | Univariate model | | | Multivariable model 1 * | | | Multivariable model 2 ** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **In-hospital mortality** | **%** | **OR** | **95% CI** | **p value** | **OR** | **95% CI** | **p-value** | **OR** | **95% CI** | **p value** |
| w/o infection | 0.95 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | 3.65 | 3.95 | 2.10 - 7.44 | <0.0001 | 2.42 | 1.26 - 4.66 | 0.0079 | 2.45 | 1.28 - 4.68 | 0.0067 |
| **LOS** | **mean LOS** | **IRR** | **95% CI** | **p value** | **IRR** | **95% CI** | **p-value** | **IRR** | **95% CI** | **p value** |
| w/o infection | 7.0 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | 24.6 | 3.51 | 3.20 - 3.86 | <0.0001 | 2.79 | 2.56 - 3.04 | <0.0001 | 2.93 | 2.96 - 3.20 | <0.0001 |
| **Hospitalization costs** | **Mean cost** | **β** | **95% CI** | **p value** | **β** | **95% CI** | **p-value** | **β** | **CI** | **p value** |
| w/o infection | € 3,866 | 1 | - | - | 1 | - | - | 1 | - | - |
| w infection | € 8,686 | 2.25 | 2.07 - 2.44 | <0.0001 | 1.90 | 1.75 - 2.05 | <0.0001 | 1.98 | 1.83 - 2.15 | <0.0001 |

* Adjusted for age, gender and comorbidities
** Adjusted for age, gender and CCI

## CONCLUSIONS

In this study we demonstrated that the presence of UTI after a urogenital procedure is associated with a prolonged hospital stay and elevated mean hospitalization costs. The study may help advance out understanding of the outcomes and costs related to UTIs after urogenital procedures in the Italian context.

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