International Orthopaedics (SICOT) (2001) 25:55–59
DOI 10.1007/s002640000176

ORIGINAL PAPER

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Urinary infection after orthopedic procedures

Accepted: 7 June 2000 / Published online: 17 January 2001

Abstract We have investigated prospectively the incidence of urinary tract infection (UTI) in 5320 orthopaedic patients. There were 74 UTIs (1.39%). Enterobacteriaceae was the most frequent etiological agent. Each infection increased the length of stay in hospital by more than 8 days. Statistically independent risk factors for the development of urinary infection were a preoperative stay of more than 4 days, inadequate preoperative preventive measures, central venous catheterization and urinary catheterization. Sex, age, or type of surgery had no statistical influence on the development of infection.

Résumé Nous avons étudié prospectivement 5320 patients hospitalisés pendant plus de 2 jours. Les entérobactéries furent les agents étiologiques principaux parmi les 74 infections urinaires (1.39%). L'infection urinaire a prolongé l'hospitalisation de plus de 8 jours. Les facteurs de risque retrouvés pour l'infection urinarie sont: une hospitalisation préopératoire de plus de 4 jours, des mesures préventives préopératoires insuffisantes, la cathéterisation veineuse centrale, et la cathéterisation vésicale. Le sexe, l'âge ou le type de chirurgie n'ont pas montré de signification statistique.

Introduction

The incidence of deep and superficial wound infection has decreased dramatically in orthopaedic surgery over the past four decades as a consequence of modern antibiotic prophylaxis [3, 4,12]. Urinary tract infection (UTI) is the second most common hospital-based infection, accounting for more than one-third of infections acquired whilst in hospital with an incidence of 25–28% [19]. The risk of mortality is increased by a factor of 3 in patients with a UTI, and there is an increased risk of metastatic infection around joint replacements, although the statistical significance of this incidence remains controversial [1, 6,21].

There has been a decrease in the incidence of urinary infections during recent decades, partly due to improved nursing techniques with closed catheterization systems [9, 16,17]. Systemic antibiotic administration for wound infection prophylaxis also reduces the incidence of urinary infection [16]. There has been a change in the pattern of infective agents with increasing incidence of enterococci and yeasts [19]. Regression studies have demonstrated that female sex, number of days of urinary catheterization, and inappropriate catheter management are important risk factors. In a previous 2-year prospective study of our orthopaedic patients [3] the incidence of urinary infection was 2.2%; however, many of these patients had been managed with open catheterization systems and no systemic prophylactic antibiotics.

The purpose of this study was to analyse the current incidence of UTI, to further investigate the risk factors and to suggest ways of reducing urinary infections in orthopaedic patients.

Materials and methods

A total of 5320 orthopaedic patients above the age of 10 years with a post-operative stay of more than 2 days were treated in our hospital between 1991 and 1996. Of these, 1617 (30.4%) underwent fracture osteosynthesis, 1388 (26.1%) hip arthroplasty, 596 (11.2%) knee arthroplasty, 340 (6.4%) different joint arthrodeses and 1379 (25.9%) underwent other surgical procedures. Ninety-eight pieces of information were prospectively recorded for each patient by the staff of the Preventive Medicine Department independently of the surgical staff.

According to our treatment protocols, parenteral antibiotic prophylaxis is adequate when started preoperatively and continued for a maximum of 48 h after elective orthopaedic surgery and for

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5–7 days after operations in a potentially contaminated surgical field. The omission, delayed administration, or the prolonged use of antibiotics is considered inappropriate treatment. Wide-spectrum antibiotics are used: first generation cephalosporin with cefazolin (or vancomycin in cases of beta-lactam allergy) for elective surgery, and the same antibiotic associated with an aminoglycoside (gentamicin or tobramicin) for contaminated surgery.

Our protocols also include a urine analysis performed on every patient at 48–72 h after surgery or after removal of a urinary catheter. If the analysis shows indication of infection (pH>7, bacteriuria, pyuria, leukocyturia, significant hematuria, proteinuria or positive nitrites) or if the patient has urinary symptoms (dysuria, frequency, urgency and/or suprapubic pain), or if there is a fever of unknown origin, a quantitative microbiological urine culture is performed. A diagnosis of urinary infection is made if >100,000 colony-forming units/ml (CFU/ml) are cultured. The culture is repeated if >10,000 CFU/ml but <100,000 CFU/ml are grown. Urinary infection is discounted if <10,000 CFU/ml are grown.

The data were filed in an electronic database (Dbase IV; Ashton Tate, USA) and analysed with a computerised statistical package (SPSS, Statistical Package for Social Sciences; SPSS, USA). Infected and uninfected cases were compared using Pearson's chi-square test for qualitative variables and Student's *t*-test for quantitative variables. A step-wise logistic regression analysis was performed to evaluate significant independent risk factors for urinary infection. Quantitative variables (age, preoperative stay, and urinary, central venous and peripheral venous catheterization times) were processed to establish "cut-point" values separating high and low risks of infection.

Post-operative and total hospitalisation times were not included in the risk factor analysis as they are cause as well as the consequence of infection.

Results

There were 74 urinary infections with an incidence of 1.39%. This accounted for 28% of the total hospital-acquired infections. Forty were caused by Enterobacteriaceae and 27 by gram-positive cocci. The average length of stay before symptomatic urinary infection was 16 days; 20.4±4.2 days for Enterobacteriaceae and 10.4±1.7 days for other bacteria. Thirty-four of these infections were treated with quinolones (27 with norfloxacin), 13 with cephalosporins, and 6 with penicillins. The mean duration of treatment was 7 days. Postoperative hospitalisation and the total hospitalisation period in patients with urinary infection compared with non-infected patients can be seen in Table 2.

Bivariate analysis

The differences in qualitative variables between patients with and without urinary infection are presented in Table 1. There is no difference in the incidence of infection with regard to sex, emergency or elective surgery, type of surgical procedure and preoperative preparation; whereas there is a statistically significant difference in the incidence of infection in relation to adequate antibiotic prophylaxis, urinary catheterization and the requirement for a central intravenous catheter.

Table 1 Differences in qualitative variables between patients with and without urinary infection (*i.v.* intravenous)

Qualitative variables	Without urinary infection (%)	With urinary infection (%)	*P*	Odds ratio (95% confidence interval)
Sex				
Male	99	1	Non-significant	–
Female	98.4	1.6		–
Emergency surgery	97.8	2.2	Non-significant	–
Planned surgery	98.8	1.2		–
Surgical procedure				
Fracture osteosynthesis	97.9	2.1	Non-significant	–
Arthrodeses	99.1	0.9		–
Knee arthroplasty	99.5	0.5		–
Hip arthroplasty	98.7	1.3		–
Other	99.7	0.3		–
Clean surgery	98.7	1.3	Non-significant	–
Contaminated surgery	97.7	2.3		–
Preoperative preparation				
None	96.3	3.7	Non-significant	–
Proper	98.8	1.2		–
Improper	97.7	2.3		–
Antibiotic prophylaxis				
Adequate	99.2	0.8	<0.01	1.91 (1.13–3.23)
Improper	98.4	1.6		
When admitted to hospital:				
No infection	98.6	1.4	Non-significant	–
Infection	98.7	1.3		–
No urinary catheterization	99.5	0.5	<0.0001	8.47 (4–18)
Urinary catheterization	95.6	4.4		
No central i.v. catheter	98.8	1.2	<0.0001	8.04 (3.2–20.22)
Central i.v. catheter	91.4	8.6		
No peripheral i.v. catheter	98.9	1.1	Non-significant	–
Peripheral i.v. catheter	98.4	1.6		–

Table 2 Differences in quantitative variables between patients with and without urinary infection

Quantitative variables	Without urinary infection (means ± SD)	With urinary infection (means ± SD)	*P*	Difference of arithmetical means (95% confidence interval)
Age (years)	56±1	66±3	0.235	Non-significant
Length of surgery (min)	111±60	112±57	0.429	Non-significant
Preoperative hospitalization (days)	6.1±0.1	12.3±1.7	0.000	5.95 (3.8–8.1)
Postoperative hospitalization (days)	17±1	39±3	0.000	22.5 (19.2–25.8)
Total hospitalization (days)	23±0.2	50±4	0.000	26.9 (22.5–31.4)
Duration of vesical catheterization (days)	3.9±0.2	13.6±3.8	0.000	–
Duration of central intravenous catheterization	6.7±0.9	16.5±5.7	Non-significant	–
Duration of peripheral i.v. catheterization	4±0.2	6.4±1.3	Non-significant	–

Table 3 Urinary infection: multiple logistic regression analysis

Variable	Coefficient	Standard deviation	Statistical significance	Odds ratio	95% confidence interval
Preoperative hospitalization (>4/<4 days)	1.511	0.507	0.002	4.53	1.67–12.2
Vesical catheter (1–4 days/no catheter)	1.117	0.498	0.02	3.06	1.16–8.0
Vesical catheter (>4 days/no catheter)	3.276	0.481	0.000	26.5	10.3–67.9

The differences in quantitative variables between patients with and without infection are seen in Table 2. Patients with infections are slightly older, but this difference is not significant. There are also no significant differences in relation to the length of surgery or the duration of central or peripheral venous catheterization. However the length of preoperative hospitalisation ($P<0.001$) and the length of time of urinary catheterization ($P<0.001$) are associated with an increased incidence of infection.

Multivariate analysis (multiple logistic regression analysis)

Only two variables have a statistically significant influence on the development of urinary infection (Table 3); preoperative hospitalisation of more than 4 days, and urinary catheterization. A urinary catheter retained for 1–4 days is a significant risk factor, but it is of particular significance if retained for more than 4 days. The incidence of infection in catheterised patients rises from 3–4% in the 1st 4 days to 22% after the 5th day.

Discussion

The risk factors of urinary infection after orthopaedic surgery are difficult to analyse and its low incidence requires the study of a large population of patients. This series is large and covers more than 6 years.

Urinary infection is the most frequent infective complication in orthopaedic surgery after superficial wound infection, and represents in our series 28% of hospital-acquired infections. Similar figures have been published by EPINE (Estudio de Prevalencia de Infección Nosocomial en España) [17], a multicentre study, and by other authors using closed urinary drainage systems [5]. The instance of urinary infection after joint replacement reported in the literature may be as high as 32.6% [8], and has been reported as 10.4% after multilevel spinal instrumentation [20]. The incidence of UTI associated with the use of antiseptic-impregnated catheters is slightly lower [19]. The distribution of etiological agents in our hospital is similar to that in other series.

Urinary infection is a consequence of bacteriuria, and in catheterised patients 25–50% of bacteriurias are caused by contamination during the introduction of a urinary catheter [18]. Bacteria multiply in the drainage system and reach 10,000 CFU/ml after 24–48 h. In our series the most important risk factor for infection was catheterization. The use of a catheter for a period of 1–4 days increases the incidence of infection by a factor of 3 and its use for more than 4 days increases the incidence by a factor of 26. Catheters should therefore be removed, if possible, after 4 days, and appropriate protocols for the introduction and removal of catheters are essential.

Prophylactic antimicrobials are recommended when the catheter is removed (nitrofurantoin) or during short periods of catheterization (norfloxacin). A higher incidence of infection is seen in patients who develop urinary retention and the alpha-blocker prazosin has been recommended as an adjunct in the prophylaxis of postoperative urinary infection [15].

Newer urinary catheterization systems associated with antiseptics (either in the bag or in the catheter) do not seem to decrease the incidence of bacteriuria significant-

Table 4 Theoretical incidence of urinary infection if risk factors could be controlled

Duration of vesical catheterization	Preoperative hospitalization	Number of patients (%)	Incidence of urinary infection (%)	Number of urinary infections diagnosed	Theoretic number of expected urinary infections (if risk factors controlled)	Number of avoided urinary infections (if risk factors controlled)
<4 days	<4 days	2905 (55%)	0.4	12	12	0
<4 days	>4 days	2250 (42%)	1.5	35	9	26
>4 days	<4 days	59 (1%)	4.3	3	0.2	2.8
>4 days	>4 days	106 (2%)	23.1	24	0.4	23.6
Whole series	–	5320 (100%)	1.39	74	22	52

ly. Postoperative management with straight catheterization protocols has not shown a difference when compared with indwelling catheterization protocols [2, 7, 14]; however, the incidence of urinary retention and infection is significantly higher with the former. Intermittent catheterization after total joint replacement is more time-consuming and more expensive [10], and is associated with a higher incidence of urinary retention and bladder distention [11]. It does not reduce the incidence of infection [10, 11], and thus has no advantages when compared with an indwelling catheter.

The second significant risk factor in this series was the length of preoperative stay. When this is greater than 4 days the incidence of urinary infection is increased by a factor of 4.5. We know of no previous description of this risk factor in the orthopaedic literature. Perineal and periurethral colonisation with more pathogenic hospital-resident bacteria increases with time. Microorganisms from other patients are transmitted by staff or by the patient. Decreasing the length of preoperative stay [13], which is easily accomplished with elective orthopaedic patients, can simply control this factor. However, shortening the length of preoperative stay in trauma patients is difficult due to co-morbid conditions and local administrative factors.

If both the preoperative stay and the period of urinary catheterization had been less than 4 days in all patients, urinary infection would only have developed in 22 patients, compared with 74 (Table 4), and the incidence of infection would have decreased by 70%.

Inadequate antibiotic prophylaxis increases the incidence of urinary infection by a factor of 1.91. Broad-spectrum antibiotics are used for wound infection prophylaxis, cefazolin or vancomycin, and in open fractures or infected surgical areas gentamicin or tobramicin. These antimicrobials are also effective against the habitual contaminants of the urinary tract; and thus when they are omitted this secondary beneficial effect is lost. Their abuse, with excessively prolonged administration, may produce selective-resistant strains, particularly with multi-resistant gram-negative organisms.

Sex, age, and type of surgery, which have previously been described as risk factors for the development of urinary tract infection, have no statistically independent influence on the incidence of infection in this series. The incidence of urinary infection is, of course, different in relation to different surgical procedures. The development of a urinary infection in our series increased the average length of stay in hospital by 8.5 days. Thus urinary infection caused 630 extra days spent in hospital. If both the preoperative stay and the length of urinary catheterization were less than 4 days, 440 days in hospital would have been saved.

Urinary infection is the second most common hospital-acquired infection in orthopaedic surgical patients. The effects on all aspects of management of these patients are very expensive; and everything should be done to reduce the incidence. Simple measures such as a decrease in preoperative stay, ensuring adequate prophylactic antibiotic management and reducing the period of urinary catheterization may significantly reduce this incidence.

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