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Original Article

Urinary infections in patients with spinal cord injury

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Study design: A retrospective study concerning urinary tract infections in spinal cord injury (SCI) patients.
Objectives: To check whether the regular (1/week) urine cultures allow a more accurate treatment of urinary tract infections in SCI patients compared to empiric treatment.
Setting: Ghent University Hospital, East-Flanders, Belgium.
Methods: Group 1: 24 tetraplegic patients; group 2: 22 paraplegic patients; group 3: 28 other polytrauma patients as controls. These groups were chosen as catheterisation and other voiding methods differ according to the underlying pathology.
Results: An average of four clinically significant episodes of bacteriuria were found for groups 1 and 2, while group 3 experienced very few urinary infections. The mean species turnover of the first two groups was 2. No statistically significant difference was found in antibiotic-resistance patterns of organisms isolated.
Conclusion: Despite different catheterisation techniques in para- and tetraplegic patients, we conclude that: (1) the number of episodes of clinical significant nosocomial urinary infections is not different; (2) the mean species turnover is the same; (3) because of the species turnover, the value of regular urine cultures for 'documented' treatment of clinical relevant urinary infections seems to be limited. So urine culture could be performed less frequently or only when therapy becomes mandatory; (4) No oral antibiotic with superior activity was found: treatment is best started empirically (after sampling for urine culture) and adjusted to the resulting antibiotic sensitivity screening.
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Introduction

Spinal cord injury (SCI) patients are known to be subjected to prolonged hospital stays for management of acute injuries and for rehabilitation after stabilisation. SCI is a risk factor for infection.[1,2] Hence, nosocomial infection rates are high especially during the acute hospitalisation period[3,4] with reports of a proportion of 25.8% of patients being significantly greater than that for non-SCI admissions. As described previously, bacteriuria is almost universal in patients with SCI and is often an asymptomatic colonisation, but will recur throughout their lives and can cause serious problems (eg bacteremia, calculi, pyelonephritis, renal failure, etc).

At the acute rehabilitation centre of the University Hospital in Ghent, Belgium, while respecting the consensus that bacteriuria should only be treated when symptoms or signs are present,[5] patients are screened by means of a urinary sediment and culture on admission and at least once a week to anticipate urinary infections. While evaluating the consecutive culture results per patient, we noticed a frequent change in the overall bacterial species. We first tried to confirm this phenomenon by closer surveillance of the results and evaluation of the catheterisation technique used according to the level of paralysis. Secondly, we looked if a previous culture result permits a guided instead of an empirical antibiotic treatment when treatment becomes clinically required.

Materials and methods

Setting

The University Hospital of Ghent, Belgium is a 1059 bed hospital that acts as a tertiary care centre. We

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analysed retrospectively the data of patients who were admitted for the first time to the acute rehabilitation centre in a 7-month period between October 1999 and April 2000.

Overall, 46 patients were enrolled in the study; 24 with tetraplegia and 22 with paraplegia. As a control group, 28 polytrauma patients without paralysis and without indwelling urinary catheters were selected. They were hospitalised in the same nursing department as the SCI patients, so being treated by the same doctors and specialised personnel (eg from nursing to rehabilitation therapy) and having the same risk factors related to the infrastructure (eg need for transportation, nursing techniques, etc) and environment. Patients with chronic indwelling catheters were not included in the study.

Bacteriology

Urine cultures were obtained using the clean catch technique for patients able to void spontaneously or at the time of intermittent cathaterisation as established by the rehabilitation unit protocol. For urine culture routinely, a biplate per sample consisting of blood agar (Trypticase™ Soy Agar W/5% Sheep Blood (TSA II™)) and a McConkey II agar (BD BBL™ Stacker™ Plate; Becton, Dickenson and Company, Sparks, MD 21152, USA) is inoculated with a sterile calibrated 1 μl loop. The plates are incubated overnight at 37°C ($\pm$1.5°C); colonies are counted and, if judged to be significant, identified following standard microbiological techniques.[6–8] For females, Kass criteria are respected ($\geqslant$100 000 CFU/ml), and for males more than 10 000 CFU/ml is considered significant if only one bacterial specimen is present. In the case of urinary catheterisation, lesser CFU/ml combined with a positive urinary sediment is also considered significant. Criteria for a positive urinary sediment were as follows: more than 25 leucocytes and more than 250 bacteria per microlitre (as determined by flow cytometry; UF-100, TOA Medical Electronics, Kobe, Japan).[9,10]

Susceptibility testing is only performed on bacteria considered significant. Repetitive isolates are not re-tested within a 14-day period. For Gram negatives, the primary antibiotic sensitivity screening consists of ampicillin, cotrimoxazole, nitrofurantoin, cefuroxime, gentamicin, colistin, temocillin and quinolones. For multiresistant strains (less than two susceptibilities left in the primary antibiotic sensitivity screening), amikacin, piperacillin, ceftriaxone, ceftazidime, aztreonam and imipenem are tested. For *Pseudomonas aeruginosa*, we test gentamicin, tobramycin, amikacin, ciprofloxacin, piperacillin, ceftazidime and imipenem. Ampicilin, methicillin, cotrimoxazole, doxycycline, fusidic acid, vancomycin, rifampicin, gentamicin and quinolones are tested in case of staphylococci. Disk diffusion (Antimicrobial Susceptibility Test Discs, Oxoid Limited, Wade Road, Basingstoke, Hampshire RG24 8PW, England) is used according to the Kirby Bauer method[11] and NCCLS-criteria.[12]

Definitions

All positive urine cultures were analysed. The following definitions are used throughout the text: an 'episode' is a period of positive urine cultures (clinically significant or not) with the same microorganism starting more than 48 h after admission. 'Species turnover' is a change in the causative microorganism. An infection was defined to be nosocomial when it occurred more than 72 h after admission. In case a patient was already infected on admission, an episode was only taken into account if there was a complete recovery of the previous one (negative culture and negative urinary sediment).

Statistical analysis

The Kruskal–Wallis test was used for calculation of significance (Medcalc, Mariakerke, Belgium). A significant difference was accepted for $P<0.05$.

Results

The age distribution was comparable for all the three groups and ranged from 16 to 77 years with a mean age of 42 years for all the three groups and comparable ranges. Male/female ratios were as follows: 3.8, 2.7 and 2.1 for tetraplegic, paraplegic and polytrauma patients, respectively. Of the 46 patients included, half of them (mostly males) had positive urine cultures when admitted to the rehabilitation unit: nine tetraplegic, 11 paraplegic (nine males, two females) and three polytrauma patients. Only episodes after a full recovery of these infections were included in the study.

Characteristics of the study population are presented in Table 1. Mean hospitalisation periods were 136, 125 and 80 days for groups 1, 2 and 3, respectively. This is a statistically significant difference between groups 1 and 2 versus group 3 ($P<0.05$). The main catheterisation technique differed according to the underlying pathology: in tetraplegic patients 11 out of 24 received only catheterisation by nursing staff; in paraplegic patients 16 out of 22 performed intermittent self-catheterisation. The remaining patients switched from one technique to another during the study (eg from catheterisation by nursing staff to self-catheterisation). All of the polytrauma patients could void spontaneously.

During hospitalisation in the rehabilitation unit, there was a significant difference in the number of episodes of a positive urinary culture between the three groups (Table 1). The median number of episodes for tetraplegics, paraplegics and polytrauma patients were 4, 4 and 0, respectively. Few polytrauma patients ever had urinary infections during their acute hospitalisation: only three patients during the study period.

The mean species turnover for the para- and tetraplegics was 2. This means that, on average, the causative bacteria change twice.

For the catheterisation technique, a standard protocol is followed. We mobilised the hospital infection control team to check whether there were striking differences between the technique of self-catheterisation and

Table 1 Characteristics of the study population

Parameter	*Tetraplegic patients (n = 24)*	*Paraplegic patients (n = 22)*	*Control group (n = 28)*
Males/females (ratio)	19/5 (3.8)	16/6 (2.7)	19/9 (2.1)
Mean age in years (range)	41 (16–65)	42 (26–67)	42 (17–77)
Days in rehabilitation centre	136 (62–209)*	125 (82–170)*	80 (48–112)*
Positive culture at admission (males/females)	9/0	9/2	3/0
Main catheterisation technique	a	b	c
Nosocomial episodes of significant bacteriuria	4 (1–7)*	4 (2–5)*	0
Mean species turnover	2 (1–4)*	2 (1–4)*	—

Data are presented as mean and 95% confidence interval unless otherwise stated
*Statistical significant difference ($P<0.05$) of tetraplegic and paraplegic patients versus control group
[a]Intermittent catheterisation by nursing staff
[b]Intermittent catheterisation by the patient
[c]Spontaneous voiding

Table 2 Most frequent organisms isolated ($n = 126$)

Organism	*Overall (%)*	*Tetraplegic patients (%)*	*Paraplegic patients (%)*
K. pneumoniae	25	27	23
P. mirabilis	13	14	12
E. coli	10	8	14
P. aeruginosa	9	6	12
Total Gram negatives	88	89	86

catheterisation by the nursing staff that could explain the described phenomenon and to check if there was a colonisation of the materials (oil, disinfectant) used for catheterisation either by the patients or the nurses. They found neither differences nor any colonisation.

Of a total of 126 significant urinary isolates, as expected, the majority of the infections were caused by Gram negatives (overall 88%; tetraplegics 89%; paraplegics 86%), mainly *Klebsiella pneumoniae*, *Proteus mirabilis* and *Escherichia coli* (Table 2).

Table 3 indicates the resistance patterns for oral antibiotics most frequently used as empiric therapy.

Discussion

As expected, polytrauma patients (our control group) experience very few urinary tract infections in contrast to the other groups.

In para- and tetraplegic patients, we usually found one pathogen responsible for significant bacteriuria compared to patients with chronic indwelling catheters, in which the biofilm is complex and consists of two to five species of organisms.[13]

Concerning the types of organisms causing urinary tract infections, figures are very similar to those found in the literature for patients with chronic indwelling catheters,[13,14] only *K. pneumoniae* being more highly represented in our population. In contrast to other reports,[3] MRSA is found in only 2% of the cultures. As in patients with chronic indwelling catheters,[13] there is a trend towards more resistant isolates in tetraplegic patients, but not in the other groups. This phenomenon could be because of previous therapy, but we had no sufficient data for further investigation.

A number of the SCI patients arrive at the unit with a clinically significant urinary tract infection. No data regarding this phenomenon were collected and these episodes were not included in the figures of this study.

As to the catheterisation technique, patients can perform intermittent catheterisation themselves without increasing the risk for infections. The programme followed in our hospital to learn this technique therefore fulfils the standard requirements of hygiene. As soon as possible, patients are trained to assess self-catheterisation. The catheterisation technique is not the explanation for the species turnover. Materials for catheterisation and nursing staff as a source of contamination are excluded in our hospital after this

Table 3 Susceptibility pattern to oral antibiotics of the most frequent isolated organisms (percentage susceptible)

Antibiotic	*Ampicillin*		*Cotrimoxazole*		*Nitrofurantoin*		*Cefuroxime*		*Quinolones*	
Group	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*	*1*	*2*
K. pneumoniae	0	15	39	77	72	69	56	69	50	77
P. mirabilis	67	71	89	57	0	0	100	86	100	86
E. coli	0	50	0	63	60	100	60	88	60	88

Group 1: tetraplegic patients; group 2: paraplegic patients

survey. There is no difference between para- and tetraplegic patients in number of significant episodes and species turnover.

The reason for this frequent change in the pathological organism causing urinary infections needs to be further investigated. A possible explanation could be changes occurring in the urethral flora. The place of origin of these organisms causing infections needs to be clarified. Probably, they are present in residential flora in the fossa navicularis and are introduced into the urinary tract, despite disinfection, whenever catheterisation occurs. That would also explain why there is no difference in infection frequency between self-catheterisation and catheterisation by the nursing staff.

Since organisms causing positive episodes in para- and tetraplegic patients frequently change and polytrauma patients experience very few urinary tract infections, screening procedures once a week are not useful in nonurgent pathologies. As indicated in patients with chronic indwelling catheters,[13] it is best to start therapy when clinically indicated, after taking samples for culture, and adjust to antibiotic sensitivity screening later on. One can start treatment empirically: cefuroxime or a fluoroquinolone seem to be the best oral antibiotics to start.

Conclusions

For SCI patients hospitalised in our acute rehabilitation centre, despite different catheterisation techniques in paraplegic and tetraplegic patients, we conclude that:

(1) the number of episodes of clinical significant nosocomial urinary infections is not different;
(2) the mean species turnover is the same;
(3) because of the species turnover, the value of regular urine cultures for 'documented' treatment of clinical relevant urinary infections seems to be limited. So urine culture could be performed less frequent or only when therapy becomes mandatory and
(4) no oral antibiotic has superior activity. Cefuroxime and fluoroquinolones are acceptable first choices. Adjusting therapy to the resulting antibiotic sensitivity screening is obviously necessary.

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