The Characteristics of Acute Pyelonephritis in Geriatric Patients: Experiences in Rural Northeastern Taiwan

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Acute pyelonephritis causes hospitalization and is a commonly-ignored cause of death in geriatric patients. It has been well studied in young-adult populations but rarely in geriatric populations. The aim of our study was to analyze the characteristics of acute pyelonephritis in geriatric patients. The electronic admission records of a community hospital in northeastern Taiwan were retrospectively screened from July 1, 2003 to June 30, 2006. The basic characteristics, laboratory findings and infectious microorganisms of all subjects were evaluated. Sixty-five subjects (mean age 71.6 ± 4.9 years; range 65-84 years) and 73 admission records contributed by them were enrolled. These 65 subjects, including one who died in hospital, were predominantly female (52 subjects; 80%). Twenty-two subjects (33.8%) had co-existing diabetes mellitus, 9 subjects (13.8%) had co-existing tumors, and 19 subjects (29.2%) had a history of intra-abdominal surgery. The admission records revealed right kidney involvement (52.1%), co-existing urolithiasis (50.7%) and admission to wards of internal medicine (57.5%). Urological procedures were performed on 20 (27.4%) of all 73 admission records. Escherichia coli was the most common infecting microorganism (19.2% of all records; 42.4% of records with positive microorganism culture). Hemoglobin < 10 g/dl was a significant predictive factor for both hospital stay > 7 days and serum creatinine > 2.0 mg/dl (p = 0.003 and 0.002, respectively). Positive microorganism culture was also a significant predictive factor for hospital stays > 7 days (p < 0.001). In our geriatric patients with acute pyelonephritis, low hemoglobin levels implied co-existing renal insufficiency and prolonged hospitalization. Positive microorganism culture also implied prolonged hospitalization. ——— anemia; creatinine; geriatrics; hemoglobins; pyelonephritis.

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Received September 4, 2007; revision accepted for publication December 1, 2007.
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Acute pyelonephritis is well documented in young-adult populations. Anatomical anomalies such as vesicoureteral reflux correlate strongly with acute pyelonephritis in children (Jantunen et al. 2001; Lai and Ng 2003). In young or middle-aged adults, acute pyelonephritis correlates with several well-known risk factors such as female gender, co-existing diabetes mellitus, pregnancy, urinary incontinence, sexual behavior and urolithiasis (Nicolle et al. 1996; Hill et al. 2005; Scholes et al. 2005; Pertel and Haverstock 2006). In contrast, acute pyelonephritis has been relatively little evaluated in geriatric populations.

The geriatric population has grown to represent 7% of the total population in Taiwan and the country achieved the World Health Organization’s criteria for an aging society in 1993. At the end of 2006, the geriatric population accounted for 10.0% of the total Taiwanese population (Department of Statistics, Ministry of the Interior, R.O.C. 2006). In the West, studies from autopsies and chart reviews have revealed that acute pyelonephritis increases the risk of bacteremia and septic shock in geriatric inpatients, and is also a commonly-ignored cause of death in these patients (Gleckman et al. 1982; Gee 1993). In Taiwan, there is still little literature about acute pyelonephritis in geriatric populations. The aim of our study was to analyze the characteristics of acute pyelonephritis in a sample of geriatric patients from northeastern Taiwan.

METHODS

Population and subjects

Retrospective and descriptive analyses were performed. With the approval of the Institutional Clinical Ethics Committee of I-Lan Hospital, we collected electronic files of admission records in a community hospital from July 1, 2003 to June 30, 2006. Established since 1896, this community hospital is the oldest healthcare facility in northeastern Taiwan; it is located in Yilan County, a rural region comprising 12 townships, each with a population of less than 100,000. It serves as the main hospital with acute and intensive medical services in the north Yilan sub-region, which includes 6 townships and around 227,000 inhabitants. The geriatric population accounted for 12.3% of the total population of Yilan County at the end of 2006 (Department of Statistics, Ministry of the Interior, R.O.C. 2006). Being affiliated with a tertiary medical center in Taipei since 2001, the community hospital had 58 attending physicians at that time and provided over 30,000 outpatient visits and over 1,000 admissions (around 10,000 person-days) per month.

Screening tools and definitions

The electronic medical charts were queried in the Total Hospital Information Management System (THIMS; Solomon Solutions Service Ltd., 2002, Taipei, Taiwan, R.O.C.). We collected and reviewed the inpatient data of subjects aged 65 years or older with a diagnosis of acute pyelonephritis and related International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Acute pyelonephritis was defined as records showing evidence of pyelonephritis-related symptoms/signs such as fever, nausea, vomiting, costovertebral angle tenderness or flank pain, pyuria, and positive imaging studies on ultrasonography or computer tomography. We also retrieved information such as side of kidney involvement, history of intra-abdominal surgery, co-morbidities such as diabetes mellitus, tumors, urolithiasis, obstructive uropathy, and also the relevant laboratory findings. Details of infectious microorganisms in urine or blood cultures were obtained by reviewing electronic discharge summaries. Serum albumin levels, serum C-reactive protein (CRP) levels and history of urinary catheterization were not reviewed because of incomplete chart records.

The definitions of co-morbidities are as follows. Co-existing tumors included all kinds of malignancies. Intra-abdominal surgery included related operations involving the gastro-intestinal, hepato-biliary or genitourinary systems. White blood cell count, hemoglobin levels and serum creatinine levels were recorded at the beginning of admission. Co-existing urolithiasis included renal, ureteral or cystic stones. Co-existing obstructive uropathy included hydronephrosis, hydroureter or other image-proved urinary retention. Cultures included blood or urine samples. The urological procedures, which were performed by urologists, included extracorporeal shock wave lithotripsy (ESWL), trans-scopic lithotomy, percutaneous nephrotomy (PCN), intra-ureteral catheter retention (double J catheterization) and open lithotomy.

Statistical analyses

Data in the text and tables are expressed as means ±
Independent t-test, Chi-square test and Fisher’s exact test were performed using SPSS software (SPSS version 11.0, SPSS Inc., Chicago, IL, USA). The odds ratios (OR) and confidence intervals (CI) of variables were obtained using multivariable logistic regression analyses. A p value less than 0.05 was considered statistically significant (two-tailed tests).

RESULTS

During the 3-year study period, we screened 42,276 admission records, which accounted for 309,075 person-days. Three hundred and sixty-four admission records, contributed by 320 patients, were compatible with a diagnosis of acute pyelonephritis, and 73 (20.1%) of them were contributed by patients aged 65 years or older. These 73 admission records, contributed by 65 subjects (mean age 71.6 ± 4.9 years; range 65 to 84 years), were enrolled in the study. Two of these subjects were transferred to tertiary medical centers and one died in hospital. The mean frequency of admission of these 65 subjects was 1.14 times (from 1 to 4 times), and 59 had been admitted only once. The subjects were predominantly female (80%), with low proportions of co-existing diabetes mellitus (33.8%), tumor (13.8%) and intra-abdominal surgery history (29.2%) (Table 1). Four of the subjects with co-existing tumors had cervical cancer; three had colorectal cancer; one had lymphoma; and one had right gluteus liposarcoma.

The admission records showed involvement of the right kidney (52.1%), co-existing urolithiasis (50.7%) and admittance to wards of internal medicine (57.5%). Co-existing obstructive uropathy (35.6%), positive microorganism culture (45.2%) and urological procedures (27.4%) occurred in a minority of subjects (Table 2). Escherichia coli was the most common infecting microorganism (19.2% of all records; 42.4% of records with positive microorganism culture), followed by Klebsiella pneumoniae (8.2% of all records; 18.2% of records with positive microorganism culture). Two admission records revealed mixed infections, including one with Citrobacter

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>71.6 ± 4.9</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>13/52</td>
</tr>
<tr>
<td>Co-existing diabetes mellitus (yes/no)</td>
<td>22/43</td>
</tr>
<tr>
<td>Co-existing tumors (yes/no)</td>
<td>9/56</td>
</tr>
<tr>
<td>Intra-abdominal surgery history (yes/no)</td>
<td>19/46</td>
</tr>
</tbody>
</table>

The definitions of parameters are listed in Screening tools and definitions.

Table 2. Demographic characteristics of 73 admission records by subjects with acute pyelonephritis.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean hospital stay (days)</td>
<td>7.9 ± 6.4</td>
</tr>
<tr>
<td>Mean white blood cell (counts/ul)</td>
<td>13,660.0 ± 6,656.1</td>
</tr>
<tr>
<td>Mean hemoglobin (g/dl)</td>
<td>11.8 ± 2.1</td>
</tr>
<tr>
<td>Mean serum creatinine (mg/dl)</td>
<td>1.7 ± 1.0</td>
</tr>
<tr>
<td>Result of hospitalization (discharge/transferal/expire)</td>
<td>70/2/1</td>
</tr>
<tr>
<td>Side of kidney involvement (left/right/bilateral)</td>
<td>26/38/9</td>
</tr>
<tr>
<td>Positive microorganism culture (yes/no)</td>
<td>33/40</td>
</tr>
<tr>
<td>Co-existing urolithiasis (yes/no)</td>
<td>37/36</td>
</tr>
<tr>
<td>Co-existing obstructive uropathy (yes/no)</td>
<td>26/47</td>
</tr>
<tr>
<td>Section of admission ward (internal medicine/urology/other)</td>
<td>42/29/2</td>
</tr>
<tr>
<td>Received urological procedures (yes/no)</td>
<td>20/53</td>
</tr>
</tbody>
</table>

The definitions of parameters are listed in Screening tools and definitions.
plus *Streptococcus* and one with *Escherichia coli* plus *Streptococcus* (Table 3).

The age and gender distributions of subjects are shown in Fig. 1. The peaks are located at 70-74 years for males and 65-69 years for females. There were no statistically significant differences between the mean ages of males and females (male: 72.0 ± 5.0 years; female: 71.4 ± 5.0 years, \( p = 0.722 \) by independent \( t \)-test) at the time of contracting acute pyelonephritis.

Multivariate regression analyses showed that co-existing urolithiasis correlated significantly with obstructive uropathy (OR = 4.373, 95% CI = 1.534 – 12.463, \( p = 0.006 \)). Positive microorganism culture correlated significantly with long hospital stay (> 7 days) (OR = 6.889, 95% CI = 2.443 – 19.424, \( p < 0.001 \)). Anemia (hemoglobin < 10g/dl) was a significant predictive factor for both renal insufficiency (serum creatinine > 2.0 mg/dl) and long hospital stay (OR = 7.999, 95% CI = 2.164 – 29.573, \( p = 0.002 \); OR = 10.997, 95% CI = 2.222 – 54.425, \( p = 0.003 \), respectively). In this study, long hospital stay correlated insignificantly with age, gender, results of hospitalization, side of kidney involvement, diabetes mellitus, tumor, urological procedures, section of admission ward, urolithiasis and obstructive uropathy (\( p > 0.05 \)).

### DISCUSSION

In the West, advanced age is considered a risk factor for hospitalization, and acute pyelonephritis is one of the important causes of hospital mortality in elderly patients (Efstathiou et al. 2003; Ramakrishnan and Scheid 2005). In our hospital, all the geriatric patients (65 years or older) diagnosed with acute pyelonephritis had been hospitalized for treatment instead of being kept in outpatient clinics because of payment from National Health Insurance and underlying risks. Therefore, in order to minimize selection bias, the subjects in this study comprised all the geriatric patients visiting our study hospital because of acute pyelonephritis.

The results show that co-existing urolithiasis correlated significantly with obstructive uropathy. However, neither urolithiasis nor obstructive uropathy was related to long hospital stay, which might imply the severity of acute pyelonephritis.

### TABLE 3. The list of infectious microorganisms.

<table>
<thead>
<tr>
<th>Microorganisms</th>
<th>Count in records (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No growth after cultures</td>
<td>40 (54.8)</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>6 (8.2)</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>14 (19.2)</td>
</tr>
<tr>
<td><em>Morganella</em></td>
<td>1 (1.4)</td>
</tr>
<tr>
<td><em>Staphylococcus</em></td>
<td>1 (1.4)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>1 (1.4)</td>
</tr>
<tr>
<td><em>Proteus</em></td>
<td>2 (2.7)</td>
</tr>
<tr>
<td>Other bacteria</td>
<td>4 (5.5)</td>
</tr>
<tr>
<td>Fungus/yeast</td>
<td>2 (2.7)</td>
</tr>
<tr>
<td>Two microorganisms or more</td>
<td>2 (2.7)</td>
</tr>
</tbody>
</table>

\%, percentage of all 73 admission records.

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![Graph showing age distribution of subjects according to gender.](image)  
**Fig. 1.** Age distribution of subjects according to gender.
Our results are consistent with those of an Italian study (Rollino 2007), which also showed that mortality from acute pyelonephritis is low when the condition is treated early and managed aggressively.

For any acute illness, long hospital stay may result from complications in the general condition of patients, the high cost of medical services and the underlying risk of nosocomial infections (Eveillard et al. 1998; Vaque et al. 1999). In our study, long hospital stay (>7 days) was a significant predictive factor for positive microorganism culture. Previous or empirical use of antibiotics may be responsible for this by causing microbial resistance. Therefore, it is logical that hospital stay would be prolonged in order to complete another course of a different antibiotic. Resistant strains of microorganisms also grew positively in samples cultured after prescriptions for empirical antibiotics. This also explains the low positive culture rate in our study (45.2% of all admission records). A similarly low positive culture rate was found in another British study (Gujral et al. 2003). A European study showed that resistant microorganisms correlated highly with empirical antibiotics in patients with acute pyelonephritis (Efstathiou et al. 2003). An American 5-year epidemiological study revealed that the standard regimen for acute pyelonephritis had been shifted due to increasing resistance of microorganisms (Czaja et al. 2007). Infection by antibiotic-resistant microorganisms is an international problem, and there is a continuing need to discuss and improve the proper use of antibiotics.

Urologists also had a role in caring and related consulting services for the subjects with acute pyelonephritis. In our study, urologists shared 39.7% of hospitalization services and all relevant procedures. Our result differed from those of a previous report from the United Kingdom, which suggested that most acute pyelonephritis cases could be treated only by medical physicians (Gujral et al. 2003). The visiting behavior of rural inhabitants may have been responsible for the difference. Being affiliated to a rural community hospital, both urologists and medical physicians must provide primary outpatient/inpatient care instead of simple referrals. The role of specialists in rural health care is interesting and indicates an area for further investigation.

Among our geriatric subjects, we found that long hospital stay was a significant predictive factor for anemia instead of renal insufficiency, which a local metropolitan study viewed as a risk factor for bacteremia or poor prognosis in patients with acute pyelonephritis (Hsu et al. 2006). We found that subjects with serum creatinine >2.0 mg/dl had longer hospital stays than those with serum creatinine ≤2.0 mg/dl. However, this was not statistically significant (8.7 ± 6.0 vs 7.7 ± 6.6 days; p = 0.565 by independent t-test). We considered that both anemia and renal insufficiency implied health complications in our geriatric subjects, such as chronic renal disease, impaired nutritional status or underlying blood loss. Western studies have considered anemia to be a risk factor for co-morbidities such as disability and falls that cause prolonged hospitalization of geriatric inpatients (Maraldi et al. 2006; Dharmarajan et al. 2007). Uncorrected anemia in inpatients also caused mortality, long hospital stay and low therapeutic efficacy (Spence 2007). The progress of acute pyelonephritis is more complex in geriatric patients than in younger patients, which could explain why diabetes mellitus, a poor-prognosis factor in young-adult patients with acute pyelonephritis, impacted insignificantly on our geriatric subjects.

**Study limitations**

The sample size in our study was limited, though it was inevitable that geriatric patients constituted only a small percentage of all acute pyelonephritis patients. The high negative culture rates (54.8% of all admission records) may affect the distribution of microorganisms and imply partially inadequate culture sampling (i.e., collecting blood or urine cultures after prescribing empirical antibiotics). Screening with ICD-9-CM codes may underestimate the counts of some parameters and co-morbidities. Incomplete chart records are a major limitation of retrospective analyses. Details of characteristics of subjects such as nutritional status, presence or absence of vesicoureter-
al reflux, body mass index and urinary catheterization were limited in our study, although the positive correlation between long-term urinary catheterization and pyelonephritis has been documented (Reid et al. 1982; Warren et al. 1994; Warren 1997; Efstatiiou et al. 2003). Also, evidence from a rural community hospital may underestimate the actual incidence of acute pyelonephritis in the surrounding region; some inhabitants with acute pyelonephritis may visit smaller local hospitals for hospitalization because they are nearer, instead of opting for advanced care. A similar phenomenon has been reported in a nationwide study of American hospitals (Foxman et al. 2003). However, such relatively evidence-based reports are still absent in Taiwan. Further prospective analyses or nationwide studies are warranted in the future.

In summary, the characteristics of geriatric patients with acute pyelonephritis are apparently more complicated than those of young adult patients. In geriatric patients with acute pyelonephritis, low hemoglobin levels may imply co-existing renal insufficiency and prolonged hospitalization. Positive microorganism culture may also imply prolonged hospitalization. Co-existing diabetes mellitus, urolithiasis and obstructive uropathy impacted insignificantly on prolonged hospitalization in these geriatric patients.

Acknowledgments

The authors thank Miss Pei-Yi Yang and her colleagues in Information Technology Services, I-Lan Hospital, for their technical assistance.

References


