Urinary Escheria coli Susceptibility Profiles and their Association with Community Antibiotic Use in Tasmania, Australia

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Bacterial resistance to antibiotics is increasing, but varies greatly in different geographical locations.

Antimicrobial use is considered the major factor driving this increase. The proportion of isolates not susceptible each month was assumed to have a binomial distribution determined by the proportion resistant and the number of isolates collected in the month.

Methods

- The susceptibility profiles of all urinary *E. coli* isolates between January 2010 and December 2012 in Tasmania were included; this was a population-based study.
- Susceptibility testing had been done using disc diffusion with CDS methodology, with the exception of 2011 & 2012 isolates from one laboratory, which were tested using EUCAST methodology.
- Isolates were classified as either “susceptible” or “not susceptible” (intermediate or resistant) to each antibiotic tested.
- Only the 1st isolate from each patient, each year was included in the analyses for geographical and temporal differences.
- The number of PBS-subsidised prescriptions for amoxycillin, amoxycillin-clavulanate and cephalexin in Tasmania each month was downloaded from the PBS website, and converted to defined daily doses (DDDs) per 1,000 population per day. This represents antibiotic use by concession card holders.

Results

- There were 42,691 isolates included in total; 32,920 isolates were included in the analyses for geographical and temporal differences.

Geographical differences

- Antimicrobial resistance levels were low and regional differences were small, although resistance to amoxycillin-clavulanate, cephalexin and norfloxacin was greater in the South than the North and Northwest of Tasmania (Table 1).

Temporal changes

- The proportion of *E. coli* isolates not susceptible to amoxycillin-clavulanate increased from 3.4% in 2010 to 4.2% in 2012 (*P*<0.01), but there was no increase in resistance to other antibiotics detected when analysed using linear regression.
- There was an increase in the proportion of *E. coli* isolates not susceptible to amoxycillin from 34.2% during Summer/Autumn to 36.1% during Winter/Spring (*P*<0.01) (Figure 1).
- Amoxycillin use increased from 2.07 DDDs per 1,000 population per day in Summer/Autumn to 2.79 in Winter/Spring (*P*<0.01) (Figure 1).
- The results of logistic regression models further evaluating the effect of season and lag in resistance after antibiotic use are shown in Table 2.

Recurrent isolates

- 7,653 patients had *E. coli* isolated on multiple occasions during the study.
- The proportion of *E. coli* isolates not susceptible to each antimicrobial tested increased with each episode (Figure 2).

Conclusions

- *E. coli* resistance to antimicrobials is lower in Tasmania than reported elsewhere in Australia, which may be due to Tasmania’s isolated geographical location.
- There was no increase in antibiotic resistance detected during this 3-year study, with the exception of minimal increase in amoxycillin-clavulanate resistance.
- An increase in amoxycillin use and resistance was identified during winter and spring, which may be due to treatment of respiratory tract infections.
- Increased resistance to amoxycillin and amoxycillin-clavulanate was seen following a 2-month lag after increased use of each of these antimicrobials.
- The increase in antimicrobial resistance in recurrent isolates is likely to be a result of antimicrobial treatment in patients with recurrent urinary tract infection.

Table 1. Susceptibility profile of urinary *E. coli* isolates in Tasmania.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Proportion Not Susceptible (South)</th>
<th>Proportion Not Susceptible (North)</th>
<th>Proportion Not Susceptible (Northwest)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxycillin</td>
<td>35.7%</td>
<td>33.8%</td>
<td>35.6%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Amoxycillin-clavulanate</td>
<td>4.6%</td>
<td>3.6%</td>
<td>2.2%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cephalexin</td>
<td>3.6%</td>
<td>3.4%</td>
<td>2.7%</td>
<td>0.01</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>1.9%</td>
<td>1.9%</td>
<td>1.4%</td>
<td>0.03</td>
</tr>
<tr>
<td>Norfloxacin</td>
<td>4.0%</td>
<td>2.4%</td>
<td>1.7%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Trimethoprim</td>
<td>14.7%</td>
<td>13.5%</td>
<td>14.2%</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table 2. Logistic regression models assessing season and lag in resistance after antimicrobial use.

<table>
<thead>
<tr>
<th>Outcome: Amoxycillin resistance</th>
<th>Odds Ratio</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season (peak July)</td>
<td>1.17</td>
<td>1.09-1.26</td>
</tr>
<tr>
<td>Amoxycillin use, 2-month lag</td>
<td>1.12</td>
<td>1.06-1.17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Amoxycillin-clavulanate resistance</th>
<th>Odds Ratio</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxycillin-clavulanate use, 2-month lag</td>
<td>1.26</td>
<td>1.04-1.52</td>
</tr>
<tr>
<td>Amoxycillin-clavulanate use, 3-month lag</td>
<td>1.17</td>
<td>0.97-1.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Cephalexin resistance</th>
<th>Odds Ratio</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season (peak July)</td>
<td>1.17</td>
<td>0.99-1.38</td>
</tr>
</tbody>
</table>

*Methods for Logistic Regression:

- Season was transformed from month of year (1 to 12) into a sine wave taking on values between -1 and +1, with the peak in July and nadir in January to represent anticipated increased risk associated with winter months.
- The number of isolates not susceptible each month was assumed to have a binomial distribution determined by the proportion resistant and the number of isolates collected in the month.
- The outcome variable was the proportion of isolates not susceptible to the antimicrobial each month.
- Predictors assessed included: time, season, antimicrobial use (DDDs per 1,000 population per day) in the same month, and antimicrobial use 1, 2 and 3 months prior.

References


Figure 1. Amoxycillin use and *E. coli* resistance to amoxycillin.

Figure 2. Antimicrobial resistance in recurrent *E. coli* isolates.