Progress report

Gastrointestinal instrumentation, bacteraemia, and endocarditis

This review has been stimulated by increasing interest in all aspects of infection related to gastrointestinal procedures, and by a recent case report suggesting a link between endocarditis and previous endoscopy. Many gastrointestinal procedures result in positive blood cultures, yet the risk of subsequent endocarditis is unknown, and no guidelines for its prevention have been formulated in the United Kingdom. While it may be necessary to give antibiotics to patients at risk, it is equally important not to over-react by giving expensive and potentially dangerous drugs unnecessarily to large numbers of patients.

We have reviewed the extensive literature in an attempt to seek answers to several inter-related questions: (1) Do gastrointestinal procedures cause endocarditis? (2) What is the incidence of bacteraemia after different procedures? (3) Are there any factors which may increase the risk of endocarditis? (4) Do antibiotics prevent endocarditis? (5) Which antibiotic regimens should be considered?

Do gastrointestinal procedures cause endocarditis?

A survey of 123 endoscopy units in USA revealed four poorly documented cases of endocarditis. The evidence implicating endoscopy as the cause of endocarditis in one British report is unconvincing, the patient also had an inguinal hernia repair. A patient with ulcerative colitis is reported to have developed endocarditis with Streptococcus faecalis on a bicuspid aortic valve after sigmoidoscopy (with biopsy) and barium enema. A patient known to one of us (SJE) developed Streptococcus faecalis endocarditis after sigmoidoscopy.

Large reviews of bacterial endocarditis have not implicated gastrointestinal procedures. About 1500 cases are estimated to occur in Britain each year; about half are caused by ‘viridans’ streptococci, presumably related mainly to dental disease and treatment; the risk in this context is small, as more than 2.7 million dental extractions alone are performed each year. Strep bovis and Strep faecalis account for about 12% of culture positive cases of endocarditis, which are more likely to be related to non-dental procedures. These forms of endocarditis, however, can occur spontaneously, and in patients with gastrointestinal pathology regardless of instrumentation. For example, 12 of 20 patients developing Strep bovis endocarditis in New York had an underlying gastrointestinal lesion, mainly neoplasm.

Most of the large reviews of endocarditis cover time periods before the recent huge growth in gastrointestinal endoscopy, but there is no evidence of a recent increase in endocarditis. Some surveys do suggest an increase in
the proportion of cases owing to bowel organisms, particularly amongst the elderly, but this is also denied. Current evidence suggests that gastrointestinal instrumentation is not a significant cause of endocarditis. This very rarity, however, and the delay in onset of endocarditis, might be masking an important if rare event. It is therefore prudent to remain vigilant.

**Bacteraemia after gastrointestinal procedures**

Many studies have documented the occurrence of bacteraemia after gastrointestinal procedures (Tables 1-6). Interpretation of the data is complicated by differences in patient selection, in timing of blood samples, and in precise culture techniques.

**Colon**

Colonic manipulation might be expected to cause bacteraemia, but findings vary. Positive blood cultures are unusual following rigid proctosigmoidoscopy (Table 1). One study reported an incidence of 9.5%, but this figure could not be reproduced when repeated in cirrhotic patients, who might be considered to be at greater risk. There is one report of gram negative septicaemia after rectal biopsy, but the patient also had a malignant gastric ulcer. A bacteraemia rate of 2% has been recorded after proctoscopy alone, and of 8% after proctoscopy and sclerotherapy; a similar rate was recorded after routine haemorrhoidectomy.

Positive blood cultures are reported with varying frequency after colonoscopy (Table 2); seven of 13 studies did not show bacteraemia.

The different frequency of positive cultures may result partly from differences in the number and timing of blood cultures in published reports. One group failed to show bacteraemia in 14 patients with infrequent sampling, but then found an incidence of 27% when they took multiple cultures during the procedure in a further 22 patients. One study of flexible sigmoidoscopy failed to show significant bacteraemia.

The incidence of bacteraemia after barium enema (Table 3) is probably similar to that after colonoscopy – reaching 23% in one study when multiple cultures were taken. There does not appear to be any correlation with radiographic findings, but the highest incidence at barium enema (and colonoscopy) occurs during maximum distension of the colon.

Breach of the mucous membrane, by biopsy or fulguration, does not seem to increase the risk.

With the exception of one report of persistence for six hours, most bacteraemias were short lived, with a high proportion due to anaerobic species. A case of *Clostridium perfringens* septicaemia is reported after a barium enema in a patient with acute leukaemia.

**Upper gastrointestinal tract**

Most studies report no bacteraemia during simple upper gastrointestinal endoscopy, or only rare and short-lived episodes (Table 4). Eight per cent of 200 cultures were positive in one study; in seven of these the bacteraemia persisted, so that cultures were positive at five and 30 minutes after the procedure. Biopsy sampling does not appear to increase the risk.
Table 1  *Bacteraemia after rigid sigmoidoscopy*

<table>
<thead>
<tr>
<th>First author</th>
<th>Patients studied</th>
<th>Incidence of bacteraemia (%)</th>
<th>Timing of blood cultures (minutes)</th>
<th>Organisms</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unterman 1957a</td>
<td>50</td>
<td>2</td>
<td>0, +15</td>
<td>Aerobacter aerogenes</td>
<td>—</td>
</tr>
<tr>
<td>Buchman 1960b</td>
<td>100</td>
<td>0</td>
<td>0, +15</td>
<td>—</td>
<td>Bacillus grown designated contaminant, 2 patients, polyp excised</td>
</tr>
</tbody>
</table>
| Le Frock 1973a | 200              | 9.5                          | 0, +5, +10, +15, +30              | Enterocci (II)  
  *Klebsiella pneumoniae* (3)  
  *Escherichia coli* (4)  
  *Bacteroides spp* (1) | No mixed growth  
  Pour plates – low levels of bacteraemia. None positive at 30 mins |
<p>| Engeling 1976a | 50               | 0                            | +1, +5, +15, +60                  | —         | Unable to reproduce Le Frock’s results in cirrhotic patients |</p>
<table>
<thead>
<tr>
<th>First author</th>
<th>Patients studied</th>
<th>Incidence of bacteraemia (%)</th>
<th>Timing of blood cultures (minutes)</th>
<th>Organisms</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rafoth 1975&lt;sup&gt;30&lt;/sup&gt;</td>
<td>52</td>
<td>0</td>
<td>During, +5, +30</td>
<td>—</td>
<td>22 patients given antibiotics beforehand</td>
</tr>
<tr>
<td>Craner 1975&lt;sup&gt;31&lt;/sup&gt;</td>
<td>12</td>
<td>0</td>
<td>During, +10</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Norfleet 1976&lt;sup&gt;32&lt;/sup&gt; (1)</td>
<td>40</td>
<td>0</td>
<td>+15, +60, +240</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Dickman 1976&lt;sup&gt;33&lt;/sup&gt;</td>
<td>52</td>
<td>6</td>
<td>At caecum ascending colon at biopsy +1, +5</td>
<td><em>E. coli</em> (1)</td>
<td>Positive in 2 patients with metastatic colonic cancer and 1 with perforation</td>
</tr>
<tr>
<td>Norfleet 1976&lt;sup&gt;34&lt;/sup&gt; (II)</td>
<td>60</td>
<td>0</td>
<td>+5, +10, +15</td>
<td><em>Bacteroides spp</em> (2)</td>
<td>—</td>
</tr>
<tr>
<td>Pelican 1976&lt;sup&gt;35&lt;/sup&gt; (1)</td>
<td>14</td>
<td>0</td>
<td>15 min intervals during, +60, +120</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(II) 22</td>
<td>27</td>
<td>1.5, 10, 15 during, +30</td>
<td>—</td>
<td>—</td>
<td>Importance of early blood cultures</td>
</tr>
<tr>
<td>Geraci 1976&lt;sup&gt;36&lt;/sup&gt;</td>
<td>36</td>
<td>15</td>
<td>not stated</td>
<td>—</td>
<td>Haemolytic streptococcus</td>
</tr>
<tr>
<td>Liebermann 1976&lt;sup&gt;37&lt;/sup&gt;</td>
<td>20</td>
<td>15</td>
<td>+10, +15, +20, +30, +1 late culture</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Coughlin 1977&lt;sup&gt;38&lt;/sup&gt;</td>
<td>35</td>
<td>0</td>
<td>10 minute intervals during, +10, +20, +30, +60, +120</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Hartong 1977&lt;sup&gt;39&lt;/sup&gt;</td>
<td>15</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Stray 1978&lt;sup&gt;40&lt;/sup&gt;</td>
<td>25</td>
<td>4</td>
<td>+5</td>
<td>—</td>
<td>Anaerobic lactobacillus</td>
</tr>
<tr>
<td>Daly 1979&lt;sup&gt;41&lt;/sup&gt;</td>
<td>9</td>
<td>11</td>
<td>+5, +30</td>
<td>—</td>
<td>Patient had colonic cancer</td>
</tr>
<tr>
<td>Byrne 1981&lt;sup&gt;42&lt;/sup&gt;</td>
<td>18</td>
<td>0</td>
<td>+5, +30</td>
<td>—</td>
<td>? contaminant</td>
</tr>
<tr>
<td>Goldman 1982&lt;sup&gt;43&lt;/sup&gt;</td>
<td>75</td>
<td>0</td>
<td>During, +8, +15</td>
<td>—</td>
<td>Flexible sigmoidoscope, 14/600 cultures positive – contaminants</td>
</tr>
</tbody>
</table>

*E. coli* (1) *, Bacteroides fragilis*, *Enterobacter aerogenes*, *Clostridium innocuum*
<table>
<thead>
<tr>
<th>First author</th>
<th>Patients studied</th>
<th>Incidence of bacteraemia (%)</th>
<th>Timing of blood cultures (minutes)</th>
<th>Organisms</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Le Frock 1975</td>
<td>175</td>
<td>11</td>
<td>+1, +15, +30</td>
<td>Veillonella spp (1)</td>
<td>all cultures negative by 30 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>E. coli</em> (4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>Pseudomonas morgani</em> (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bacteroides spp (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>Klebsiella pneumoniae</em> (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Enterococcus (9)</td>
<td></td>
</tr>
<tr>
<td>Schimmel 1975</td>
<td>44</td>
<td>0</td>
<td>+5, +10, +20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schimmel 1975</td>
<td>(1)</td>
<td>8</td>
<td>During +15</td>
<td>Single culture of enterococcus considered contaminant. Failed to reproduce Le Frock’s results</td>
<td>6/8 had inflammatory bowel disease</td>
</tr>
<tr>
<td>Butt 1978</td>
<td>(2)</td>
<td>26</td>
<td>During 1, 5, 10, 15, and +30</td>
<td>Peptostreptococcus spp (3)</td>
<td>Only 1/6 patients with bacteraemia had colonic pathology</td>
</tr>
<tr>
<td>Butt 1978</td>
<td></td>
<td>8</td>
<td>During +15</td>
<td>Bacteroides spp (4)</td>
<td></td>
</tr>
<tr>
<td>Butt 1978</td>
<td></td>
<td>26</td>
<td>During 1, 5, 10, 15, and +30</td>
<td>Propionibacterium acnes</td>
<td></td>
</tr>
</tbody>
</table>
Table 4  Bacteraemia after upper gastrointestinal endoscopy

<table>
<thead>
<tr>
<th>First author</th>
<th>Patients studied</th>
<th>Incidence of bacteraemia (%)</th>
<th>Timing of blood cultures (minutes)</th>
<th>Organisms</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linne 1971(^{51})</td>
<td>40</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>Only one blood culture medium used</td>
</tr>
<tr>
<td>Shall 1974(^{52})</td>
<td>50</td>
<td>8</td>
<td>During. +5, +30</td>
<td>Neisseria perflava (2)</td>
<td>No anaerobic technique. Only 1 pour plate positive indicating low levels of bacteraemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Streptococcus salivarius</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Propionibacterium acnes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Streptococcus mitis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Staphylococcus epidermidis</td>
<td></td>
</tr>
<tr>
<td>Mellow 1976(^{53})</td>
<td>100</td>
<td>3</td>
<td>+10, (some +5 as well)</td>
<td>Enterococcus 'Diphtheroid'</td>
<td>Many with severe chronic liver disease. 3 immunosuppressed. 7 chronic renal failure. 7 contaminated endoscopes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Staphylococcus epidermidis</td>
<td></td>
</tr>
<tr>
<td>Leibermann 1976(^{57})</td>
<td>44</td>
<td>2</td>
<td>0, +5, +10, +15, +20, +30, + one late culture</td>
<td>Streptococcus pneumoniae</td>
<td>Positive at 10 mins only</td>
</tr>
<tr>
<td>Balth 1977(^{54})</td>
<td>200</td>
<td>8</td>
<td>+5, +30</td>
<td>Staphylococcus epidermidis (4)</td>
<td>2 patients had 'mixed' growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Streptococci: mitis (2), sanguis (2), mutans (1), 'microphilic' (2), anaerobic (1) Veillonella spp (1) Propionibacterium acnes (1) Staphylococcus aureus (3) Lactobacillus (2)</td>
<td></td>
</tr>
<tr>
<td>Stephenson 1977(^{55})</td>
<td>10</td>
<td>10</td>
<td>+5, +30</td>
<td>Viridans streptococcus</td>
<td>Endoscopes heavily contaminated</td>
</tr>
<tr>
<td>Stray 1978(^{40})</td>
<td>100</td>
<td>1</td>
<td>+5</td>
<td>Anaerobic lactobacillus</td>
<td></td>
</tr>
<tr>
<td>Daly 1979(^{41})</td>
<td>51</td>
<td>2</td>
<td>+5, +30</td>
<td>Staphylococcus epidermidis</td>
<td></td>
</tr>
<tr>
<td>Kirk 1979(^{56})</td>
<td>52</td>
<td>0</td>
<td>During. +15</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Byrne 1981(^{42})</td>
<td>50</td>
<td>2</td>
<td>+5, +30</td>
<td>Group D Streptococcus</td>
<td>All children. All under GA</td>
</tr>
<tr>
<td>Norfleet 1981(^{57})</td>
<td>53</td>
<td>2</td>
<td>+5, +10, +15</td>
<td>Acinetobacter spp</td>
<td>1 patient had dilatation of oesophagus</td>
</tr>
<tr>
<td>O'Connor 1982(^{58})</td>
<td>50</td>
<td>4</td>
<td>During. +5, +30</td>
<td>Streptoccci 'polymicrobial'</td>
<td>Low levels of bacteraemia. (Pour plate negative). Same organisms isolated from saliva</td>
</tr>
</tbody>
</table>
Most positive cultures are of upper respiratory tract commensals. Few of the studies document the dental health of their patients which might be critical. Endogenous infections should be differentiated from those arising from contaminated equipment, a problem which has been highlighted with oesophageal dilators; one study suggested that bacteraemia during endoscopic dilatation could be abolished by adequate sterilisation of the instruments.

There have been no prospective studies of bacteraemia after peroral small bowel biopsy. Two cases of gram negative septicaemia (Bacillus anitratum and aeromonas) occurred amongst 680 patients undergoing capsule biopsy, but the presence of intestinal perfusion catheters might have contributed. There is also a single report of Escherichia coli bacteraemia after small bowel biopsy using a Quinton multi-purpose biopsy tube, in a patient with bacterial overgrowth in the small bowel.

**Liver and Pancreas**

Patients with biliary stasis (particularly those with stones) often have infected bile. Both percutaneous and endoscopic cholangiography can provoke cholangitis and bacteraemia. Prospective studies report bacteraemia rates of 0–14% after endoscopic cholangiography (ERCP), Table 5. Clinical infection can usually be avoided if these diagnostic procedures are followed immediately by effective drainage. Endoscopic pancreateography may result in pancreatitis, and pseudocyst infection, particularly when inadequately disinfected equipment is used. Prospective studies of bacteraemia after percutaneous liver biopsy show rates of 3–13% with a wide variety of organisms.

It is important to appreciate that the main risk in patients with liver and pancreatic disease are those of acute clinical infection (cholangitis and septicaemia) rather than endocarditis.

**Factors which may increase the risk of endocarditis**

It is clear that endocarditis occurs extremely rarely after gastrointestinal procedures. It remains appropriate to assess whether some patients are more at risk, and whether particular bacteraemias are more dangerous.

While many patients with endocarditis give no history of previous dental procedures, it is accepted that these can result in endocarditis in patients with heart disease. The actual risk, however, is low— one estimate was one in 3000 extractions— despite the fact that bacteraemia may occur in up to 85% of patients undergoing dental extraction. The same patients may also experience transient bacteraemia during everyday life, after chewing food and cleaning teeth. What determines the development of endocarditis?

The duration and extent of bacteraemia may be important. Most positive cultures after gastrointestinal procedures are transient and where quantified by pour plate methods, they are also of low density. On the other hand instrumentation of the infected urinary tract often produces intense bacteraemia, but causes endocarditis only rarely.

The type of organism is also important. Escherichia coli is the commonest organism isolated from blood cultures in clinical practice, yet
<table>
<thead>
<tr>
<th>First author</th>
<th>Patients studied</th>
<th>Incidence of bacteraemia (%)</th>
<th>Timing of blood cultures (minutes)</th>
<th>Organisms</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lam 1977(^1) (1)</td>
<td>20</td>
<td>0</td>
<td>During, +15, +60, +360, +720, +1440</td>
<td>—</td>
<td>Failed cannulation</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>63</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siegel 1978(^2)</td>
<td>35</td>
<td>6</td>
<td>During, +5, +30</td>
<td>Alkaligenes faecalis (2)</td>
<td>Cannulation successful</td>
</tr>
<tr>
<td>Stray 1978(^3)</td>
<td>25</td>
<td>0</td>
<td>+5</td>
<td>E coli (3)</td>
<td>—</td>
</tr>
<tr>
<td>Parker 1979(^4)</td>
<td>50</td>
<td>14</td>
<td>During, +5, +10, +15, +20, after cannulation + 1 late culture</td>
<td>Staphylococcus epidermidis (3)</td>
<td>Staphylococcus also isolated from endoscope</td>
</tr>
<tr>
<td>Low 1980(^5)</td>
<td>101</td>
<td>0</td>
<td>+5, +10, after cannulation</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
Table 6  Bacteraemia associated with gastrointestinal procedures; summary of publications

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Bacteraemia total studies (no.)</th>
<th>Studies showing Maximum bacteraemia rate (%)</th>
<th>Total patients (no.)</th>
<th>Overall bacteraemia rate (%)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid sigmoidoscopy</td>
<td>2/4</td>
<td>9-5</td>
<td>400</td>
<td>5</td>
<td>No relation to biopsy or pathology. High incidence of enterococci in one study</td>
</tr>
<tr>
<td>Flexible sigmoidoscopy</td>
<td>0/1</td>
<td>0</td>
<td>75</td>
<td>0</td>
<td>14/600 cultures labelled as contaminant</td>
</tr>
<tr>
<td>Proctoscopy</td>
<td>1/1</td>
<td>2</td>
<td>50</td>
<td>2</td>
<td>Possible underestimate because of sampling times</td>
</tr>
<tr>
<td>Proctoscopy and injection sclerotherapy</td>
<td>1/1</td>
<td>8</td>
<td>50</td>
<td>8</td>
<td>Possible underestimate because of sampling times</td>
</tr>
<tr>
<td>Haemorrhoidectomy</td>
<td>1/1</td>
<td>8</td>
<td>36</td>
<td>8</td>
<td>Possible underestimate because of sampling times</td>
</tr>
<tr>
<td>Colonoscopy</td>
<td>7/13</td>
<td>27</td>
<td>409</td>
<td>5</td>
<td>Show importance of frequent sampling</td>
</tr>
<tr>
<td>Barium enema</td>
<td>2/3</td>
<td>23</td>
<td>253</td>
<td>10</td>
<td>Several positive cultures probably contaminants</td>
</tr>
<tr>
<td>Upper GI endoscopy</td>
<td>10/12</td>
<td>10</td>
<td>800</td>
<td>4</td>
<td>Importance of using sterile equipment</td>
</tr>
<tr>
<td>Endoscopic oesophageal dilatation</td>
<td>2/2</td>
<td>100</td>
<td>43</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>ERCP</td>
<td>3/5</td>
<td>14</td>
<td>294</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
there were only 14 reported cases of *E coli* endocarditis in the English language literature between 1945 and 1977. More than half of the cases of endocarditis are caused by Streptococcal species, yet 'viridans' streptococci are rarely isolated from blood cultures except in patients with endocarditis.

The bacteria found in the blood after procedures on the large bowel are not prominent in the spectrum of organisms which cause endocarditis. When enteric organisms are grown from blood cultures, they are usually assumed to be clinically relevant; however, they may sometimes be contaminants of the technique. The bacteria cultured from the blood after upper gastrointestinal procedures are often respiratory tract commensals, with a higher propensity to cause endocarditis. It is not clear whether such bacteraemias are more intense or dangerous than those which occur in daily life.

The adherence properties of bacteria may be relevant. Incubation of punch biopsies of human and canine valves in standardised solutions of bacteria showed enterococci to be the most adherent, followed by Streptococci and Staphylococci. Gram negative organisms (except Pseudomonas) were only weakly adherent. It may be relevant that these studies used gram positive organisms isolated from patients with endocarditis, but gram negative organisms derived elsewhere.

**Heart disease is believed to be a risk factor for endocarditis.** About half of the patients who develop endocarditis, however, have no previous cardiac lesion, and others have lesions— for example, bicuspid aortic valve, and mitral leaflet prolapse— which may be easily overlooked on routine examination. These facts have major implications for any policy of antibiotic prophylaxis. There are no conclusive data to support the reasonable suspicion that patients with prosthetic valves, and those who have previously suffered endocarditis, are at greater risk.

**Do antibiotics prevent endocarditis?**

Despite widespread belief in the value of antibiotic prophylaxis in patients with valvular heart disease, and despite the falling prevalence of rheumatic heart disease in Western countries, the incidence of endocarditis has remained fairly constant. This suggests that prophylaxis has not been practised appropriately, or that it is irrelevant.

The effectiveness of antibiotic prophylaxis has been tested in a rabbit model. Sterile vegetations are induced by cardiac catheterisation, and endocarditis is produced by injection of bacteria. The experimental model has been criticised; bacteria loads are higher than in any clinical situation; the vegetations are produced before bacteraemia, and rabbits metabolise antibiotics differently; the presence of a catheter is artificial (but might mimic a prosthetic valve). Furthermore, these experiments have been performed with a single strain of Streptococcus which is moderately resistant to penicillin.

In fact there is no evidence that antibiotics prevent clinical endocarditis in man, even in the context of dental extraction where prophylaxis is widely recommended— if not universally practised. A controlled trial would require vast numbers, and many clinicians would consider it unethical to withhold prophylaxis.
Which antibiotic regimens should be considered?

It is not difficult to test the type and dosage of antibiotics required to produce blood levels sufficient to kill the strains of bacteria against which prophylaxis is sought. Such studies have not been performed specifically for gastrointestinal procedures, and recommendations are being made on more general principles.

Many authoritative bodies have addressed the question. The American Heart Association (AHA), revised their recommendations in 1977. No evidence was given to justify their suggestion that 'gastrointestinal instrumentation (presumably referring mainly to colonoscopy) was implicated in the aetiology of enterococcal endocarditis'. This report concluded that upper gastrointestinal endoscopy (without biopsy), percutaneous liver biopsy, procto-sigmoidoscopy, and barium enema did not justify prophylaxis in 'most patients' with underlying heart disease, but made an exception of patients with prosthetic valves.

The AHA recommendations about antibiotics were complex and difficult to follow. For upper gastrointestinal procedures they recommended large doses of penicillin or vancomycin or erythromycin. For procedures likely to produce bacteraemia involving bowel organisms, they recommended ampicillin or penicillin with gentamicin or streptomycin or vancomycin. ERCP was not specifically discussed; any prophylaxis would presumably have to be directed against both enteric and upper respiratory organisms. These AHA recommendations have been criticised as too stringent; they are impracticable, and compliance is likely to be poor. A survey of endoscopy units in the USA in 1979 indicated wide policy variations; only a minority routinely used antibiotics with many different regimens. One member of the AHA Committee subsequently wrote a paper entitled 'antimicrobial prophylaxis of bacterial endocarditis; prudent caution or bacterial overkill?', concluding that the dangers and complexity of parenteral regimens ruled them out. He recommended single injections of procaine penicillin and streptomycin, but also stated that oral penicillin would be sufficient – with erythromycin as an alternative. It is likely, however, that a substantial failure rate exists, even with penicillin. These ideas have been further simplified by Shanson who advised a single oral dose (or perhaps two doses) of amoxycillin. This regimen has been recommended for all dental surgery, regardless of cardiac status.

No group has formally questioned the AHA recommendations for 'enterococcal' prophylaxis. These are costly, unpleasant, and time consuming. Furthermore, one study showed that even this regimen did not necessarily produce bactericidal blood levels of antibiotics.

PROBLEMS WITH ANTIBIOTICS

Endocarditis is a serious condition but antibiotics can have serious side effects. Penicillin can provoke anaphylaxis (even after oral administration). The risk is estimated as 0·015 to 0·04%, with a mortality rate of about 10%. The potential is common to most types of penicillin, with some cross-reaction with cephalosporins. Sensitivity screening is impractical, as most affected patients give no relevant history, and skin testing is of unproven value. The other antibiotics
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recommended by the AHA can have other serious side effects.

Drugs recommended for upper respiratory tract organisms are relatively inexpensive, but 'enterococcal' regimes are costly, particularly if drugs have to be given parenterally (which may mean hospital admission).

**Conclusion**

We have found few clear answers to the questions which we posed. It is plain, however, that the risk of developing endocarditis after gastrointestinal procedures must be extremely small and that there are major problems in recommending antibiotic prophylaxis, let alone implementing it.

Different attitudes can be struck. One view might be that prophylaxis should be given to all patients with underlying heart disease undergoing a procedure known to provoke bacteraemia. Logically, this should include procedures not previously considered risky – for example, barium enema – and would involve careful screening of all patients for asymptomatic cardiac lesions. As about half of the patients who contract endocarditis are not known to have heart disease beforehand, it could be argued that all patients should be protected (as has been suggested for dental patients). Such a policy, however righteous, would involve considerable inconvenience, and cost, and some unnecessary risk from antibiotic complications.

The evidence, or lack of it, would equally allow of the conclusion that no prophylaxis need be recommended, as neither the risk of endocarditis nor the effectiveness of prophylaxis have been established. We incline toward the latter view, and consider that no one can be held at fault for omitting antibiotic prophylaxis. Some may feel that patients with severe heart disease, prosthetic valves, or previous endocarditis, should be protected if possible; at present this is a matter for individual judgement.

Further prospective studies of this problem are necessary.

**FOOTNOTE**

Since we submitted this article, the Working Party of the British Society of Antimicrobial Chemotherapy has published its own recommendations for the prophylaxis of infective endocarditis. The Working Party noted poor compliance with the AHA regimens, and felt that gastrointestinal instrumentation did not require prophylaxis, except in patients with prosthetic valves. They recognised that the risk of developing endocarditis in such patients was probably no greater than in other susceptible patients, but advised prophylaxis, because the consequences of infection were probably more serious. The regimen suggested is directly primarily against faecal streptococci.

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