Microbiology of Intra-Abdominal Infections: Pathogens, Work-up, and Antimicrobial Susceptibility

Prepared by: Andrew Walkty and James Karlowsky

Introduction
An intra-abdominal infection may be defined as a disease process caused by micro-organisms (usually bacteria and/or fungi) that is situated in the abdominal cavity. Intra-abdominal infections can be considered as either uncomplicated, where the infectious process involves only a single organ and no anatomical disruption is present, or complicated [1,2]. Complicated intra-abdominal infections are characterized by extension of the infection beyond the source organ and into the peritoneal space, resulting in diffuse peritonitis or abscess formation [1]. Intra-abdominal infections may be further classified into those that are community-acquired and those that are health care-associated. Community-acquired intra-abdominal infections include gastroduodenal perforation, ascending cholangitis, cholecystitis, appendicitis, and diverticulitis with or without perforation [1]. In contrast, health care-associated intra-abdominal infections occur more than 48 hours after hospital admission, and include anastomotic leaks, perforations, and abscesses that develop as a consequence of surgery [1]. The distinction between community-acquired and health care-associated intra-abdominal infection is important, because the pathogens involved may differ [1,2].

Microbiology of Intra-abdominal Infections
The normal flora of the human gastrointestinal tract is complex, consisting of hundreds of species of facultative and anaerobic bacteria [1]. In the upper small bowel the flora are relatively sparse, but the number and variety of bacterial species encountered progressively increases with movement towards the colon [1,3]. Obligate anaerobes including Bacteroides fragilis represent the predominant colonic flora. Of the facultative organisms present in the colon, Escherichia coli is the most common. The normal colonic flora also consists of enterococci, streptococci, and various members of the family Enterobacteriaceae [1,3].

Intra-abdominal infection can occur from a breach in the mucosal integrity at some point along the gastrointestinal tract or secondary to local anatomical or functional abnormalities (e.g., biliary tract obstruction) [3]. Not surprisingly, the predominant pathogens in community-acquired intra-abdominal infections are members of the family Enterobacteriaceae (especially E. coli) and anaerobes (especially B. fragilis) [1,3]. Facultative gram-negative bacteria (e.g., E. coli) are thought to be responsible for early mortality associated with intra-abdominal sepsis, while anaerobes (e.g., B. fragilis) in combination with facultative organisms are important for abscess formation [3,4]. Hence, in the treatment of intra-abdominal infections, particularly those arising from the lower gastrointestinal tract, antimicrobial coverage of both E. coli and B. fragilis is important [1,2]. Note that the range of pathogens isolated from patients with health care-associated intra-abdominal infections and/or those that have received previous antimicrobial therapy is broader, and may also include resistant gram-negative bacteria, Enterococcus spp., Pseudomonas aeruginosa, methicillin-resistant Staphylococcus aureus, and yeasts [1,2].

Specimen Collection and Work-up in the Microbiology Laboratory
The submission of specimens for aerobic and anaerobic culture from patients with mild to moderate community-acquired intra-abdominal infections is considered optional in recent intra-abdominal infection clinical practice guidelines [1,2] (Table 1). Several publications have found that the routine submission of specimens for culture in low risk patients does not clearly alter patient management or outcome [1,2,5-8]. When patients go on to develop infectious complications, the bacteria isolated at the time of the initial surgery do not always predict the subsequent responsible pathogens [5,6]. Further, the microbiology associated with community-acquired intra-abdominal infections is predictable (as above) [1,2]. Specimens for culture should be obtained from higher risk patients, particularly those with health care-associated intra-abdominal infections who have been hospitalized for more than 5 days, are severely ill, and/or have received previous antimicrobial therapy [1,9].

Regarding the type of specimen to submit, fluid or pus collected at the time of surgery or an abscess drainage procedure is ALWAYS preferred over a swab [10]. Commercial rayon or dacron swabs (e.g., M40 swabs, eSwabs) are the specimen collection device of last resort because they hold a small volume of specimen (maximum 150 µL). In addition, anaerobes on swabs die upon exposure to air. Fluid or pus (up
to 50 mL) should be placed in a sterile container and promptly submitted to the microbiology laboratory [10]. Related to the polymicrobial nature of many intra-abdominal infections, multiple anaerobes may be recovered on culture. Anaerobe isolate identification is time consuming and labor intensive, and the clinical utility for an individual patient is often minimal (especially given the prolonged turn-around-time for results) [10]. Hence, work-up of anaerobes recovered from an intra-abdominal site of infection is limited to the predominant morphotypes present, with an emphasis on the more pathogenic species (e.g., B. fragilis, Clostridium perfringens) [Figure 1] [11].

Antimicrobial Susceptibility of Bacteria Commonly Recovered from Intra-abdominal Infections

The antimicrobial susceptibility of E. coli and B. fragilis group clinical isolates obtained from patients at the Health Sciences Centre is presented in Figures 2 and 3, respectively. E. coli isolates in Winnipeg generally remain susceptible to third generation cephalosporins, aminoglycosides, imipenem, and piperacillin-tazobactam. For anaerobic coverage, metronidazole, imipenem, and piperacillin-tazobactam demonstrate excellent in-vitro activity versus B. fragilis group isolates. Note that susceptibility of E. coli may vary between hospitals in Winnipeg. For institution specific antimicrobial susceptibility data, the reader is referred to the site specific DSM antibiograms, which can be accessed on-line at: http://www.dsmanitoba.ca/professionals/microbiology.html.

Table 1. Guidelines for Submission of Intraperitoneal Infection Specimens to the Clinical Microbiology Laboratory for Aerobic and Anaerobic Culture

<table>
<thead>
<tr>
<th>Acquisition Location for Intraperitoneal Infection</th>
<th>Specimen to Collect and Culture Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital-acquired (i.e., infection developed &gt;5 days post-admission)</td>
<td>Aspirate; tissue or fluid collected during surgery. Request aerobic culture and anaerobic culture. Clearly describe specimen source as “intraperitoneal infection” in clinical details section on microbiology requisition.</td>
</tr>
<tr>
<td>Community-acquired, high severity</td>
<td>Aspirate; tissue or fluid collected during surgery. May request aerobic culture and, if appropriate, anaerobic culture. Clearly describe specimen source as intraperitoneal infection in clinical details section on microbiology requisition.</td>
</tr>
<tr>
<td>Community-acquired, mild to moderate severity</td>
<td>Culture optional, as infectious agents are predictable.</td>
</tr>
</tbody>
</table>

Figure 2. Antimicrobial Susceptibility of 163 E. coli Systemic Isolates Obtained from Patients at the Health Sciences Centre, 2011

Figure 3. Antimicrobial Susceptibility of 70 B. fragilis Group Wound Isolates Obtained from Patients at the Health Sciences Centre

Key Points:
- Facultative gram-negative bacteria (especially E. coli) and anaerobes (especially B. fragilis) are the most common pathogens causing intra-abdominal infections.
- When submitting a specimen from an intra-abdominal infection for culture, a sample of infected fluid or pus is ALWAYS preferred over a swab.
- The microbiology laboratory work-up of anaerobes recovered from an intra-abdominal infection is directed at identifying the key anaerobic pathogens which may be involved in the disease process.

Figure 1. Work-up of Anaerobic Bacteria Recovered from an Intra-abdominal Source of Infection (e.g., Abdominal Abscess)

Data obtained from the ongoing CANAEROBES study (Zhanel et al., personal communication)
References: