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Critical Issues in the Clinical Management of Complicated Intra-Abdominal Infections

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Abstract

Intra-abdominal infections differ from other infections through the broad variety in causes and severity of the infection, the aetiology of which is often polymicrobial, the microbiological results that are difficult to interpret and the essential role of surgical intervention. From a clinical viewpoint, two major types of intra-abdominal infections can be distinguished: uncomplicated and complicated. In uncomplicated intra-abdominal infection, the infectious process only involves a single organ and no anatomical disruption is present. Generally, patients with such infections can be managed with surgical resection alone and no antimicrobial therapy besides perioperative prophylaxis is necessary. In complicated intra-abdominal infections, the infectious process proceeds beyond the organ that is the source of the infection, and causes either localised peritonitis, also referred to as abdominal abscess, or diffuse peritonitis, depending on the ability of the host to contain the process within a part of the abdominal cavity. In particular, complicated intra-abdominal infections are an important cause of morbidity and are more frequently associated with a poor prognosis. However, an early clinical diagnosis, followed by adequate source control to stop ongoing

contamination and restore anatomical structures and physiological function, as well as prompt initiation of appropriate empirical therapy, can limit the associated mortality.

The biggest challenge with complicated intra-abdominal infections is early recognition of the problem. Antimicrobial management is generally standardised and many regimens, either with monotherapy or combination therapy, have proven their efficacy. Routine coverage against enterococci is not recommended, but can be useful in particular clinical conditions such as the presence of septic shock in patients previously receiving prolonged treatment with cephalosporins, immunosuppressed patients at risk for bacteraemia, the presence of prosthetic heart valves and recurrent intra-abdominal infection accompanied by severe sepsis. In patients with prolonged hospital stay and antibacterial therapy, the likelihood of involvement of antibacterial-resistant pathogens must be taken into account. Antimicrobial coverage of *Candida* spp. is recommended when there is evidence of candidal involvement or in patients with specific risk factors for invasive candidiasis such as immunodeficiency and prolonged antibacterial exposure. In general, antimicrobial therapy should be continued for 5–7 days. If sepsis is still present after 1 week, a diagnostic work up should be performed, and if necessary a surgical reintervention should be considered.

Intra-abdominal infection is a frequent cause of morbidity. The prognosis greatly depends on the degree of intra-abdominal contamination, the severity of underlying disease, the immune response of the host and associated organ dysfunction.[1-3] Associated mortality rates vary from <1% to >60%.[4-6] Intra-abdominal infections differ from other types of infections in a number of ways, and these are the main reasons for the observed mortality differences. First, the spectrum of intra-abdominal infections is very broad: uncomplicated acute appendicitis and diffuse peritonitis caused by a perforated ischaemic bowel are both intra-abdominal infections but differ in terms of diagnosis, treatment and outcome. Secondly, the role of surgery in the management of patients with intra-abdominal infections is pivotal; it is generally considered to be a decisive factor for the outcome of patients with intra-abdominal infections. Thirdly, the microbiology and microbiological diagnosis are different in several aspects: (i) intra-abdominal infections are rarely monobacterial and not every microorganism involved can be identified in the laboratory by routine cultures;[7] (ii) the microbiology of intra-abdominal infections can easily be predicted in patients with community-acquired disease, provided they have not been exposed to antibacterials recently; and (iii) the pathogenicity of certain microorganisms cultured from intra-abdominal infections is not considered to be the same for every patient: fungal isolates from the upper gastrointestinal tract in an immunocompetent patient should not be treated, whereas the same isolate from a solid organ transplant patient with perforated diverticular disease should be. Finally, the clinical signs and symptoms of intra-abdominal infections often do not match the severity of the disease, leading to a delay between the start of symptoms and adequate management. Moreover, in some patients such as those sedated in intensive care units, the nonspecific symptoms of intra-abdominal infections may significantly delay adequate management of the disease.

The choice of an antimicrobial agent to treat patients with intra-abdominal infections is not difficult in the majority of patients (it should have a broad Gram-positive and Gram-negative coverage and also be effective against anaerobes) but, in some patient groups, the choice proves more difficult. As a significant number of intra-abdominal infections can be managed with (surgical) source control alone, it is more difficult to define patient groups who do need antimicrobial treatment and for how long.

The purpose of this review is to provide insights in the classification and related aetiology of intra-abdominal infections in adult patients, management from a surgical point of view, and to provide guidelines for clinical practice. As the antimicrobial strategies for intra-abdominal infections generally are standardised, special emphasis is given to the issue of when to initiate antimicrobial agents, and dealing with enterococci, *Candida* species and resistance.

1. Microbial and Anatomical Considerations

The gastrointestinal tract contains a complex microflora which in healthy persons has a relatively stable composition. The mouth and oropharynx harbours about 200 different species, most of them anaerobes and streptococci. The stomach normally contains no commensals. The bacterial content increases when going further down the small intestine and the relative presence of anaerobes also increases. The anaerobic microorganisms are the dominant flora in the large intestine and form the colonisation barrier that protects against colonisation with transient, opportunistic microorganisms, such as *Pseudomonas* sp., *Candida* spp. and staphylococci.

The subdominant flora, consisting of the Enterobacteraceae, streptococci and enterococci, are a source of microorganisms commonly involved in infections. Several factors play a role in the complex homeostasis in the gastrointestinal microflora: local pH, interbacterial competition for colonisation, intestinal motility and gastrointestinal secretions. The use of broad-spectrum antimicrobial agents disturbs the anaerobic flora, disrupts the colonisation barrier and may lead to colonisation with antimicrobial-resistant pathogens.

The abdominal cavity is covered by the peritoneum, a mesothelial membrane. The region posterior to the peritoneal cavity is the retroperitoneum, which includes the kidneys, pancreas, great vessels, and posterior aspects of the duodenum and the ascending and descending colon. Precisely because of the many organs concerned, the causes of intra-abdominal infection are multiple.[2,8] Often the infection is not limited to the primary organ involved. Dissemination is facilitated as a result of the complex anatomic properties, the peritoneal fluid as the perfect vehicle for microbial spread, and diaphragmatic activity. Different causes of infection and varying degrees of contamination underscore the need for classification.

2. Definitions and Classification of Peritonitis and Intra-Abdominal Infection

Important differences between intra-abdominal infection and peritonitis exist. Whereas peritonitis refers to an inflammation of the peritoneal membrane alone, intra-abdominal infection is defined as an inflammatory reaction of the peritoneum in response to microorganisms, which results in a purulent exsudate in the peritoneal cavity.[9] However, because in the majority of patients peritonitis is caused by intra-abdominal infections, the two are often used interchangably.

Peritonitis is usually classified based on the cause of the inflammatory process, and is further differentiated into primary, secondary and tertiairy peritonitis. In primary peritonitis, no source from within the abdomen can be identified and no breach in the gastrointestinal tract is present. Three clinical conditions fall into this category: (i) spontaneous bacterial peritonitis, which is a typical complication in patients with liver cirrhosis and is considered to be the consequence of bacterial translocation through the bowel wall; (ii) continuous ambulatory peritoneal dialysis-related peritonitis, which occurs in chronic renal failure patients with an indwelling intraperitoneal catheter; and (iii) rare conditions such as streptococcal peritonitis that occurs in young female patients, accidental puncture of the gastrointestinal tract during abdominal paracentesis and culture negative neutrocytic ascites.

Secondary peritonitis is the most frequent form of peritonitis, and is the consequence of a local infectious process within the abdominal cavity, with or without a hollow viscus perforation, and can lead to diffuse peritonitis.

Tertiary peritonitis is an ill-defined entity, and is generally referred to as a persistent or recurrent peritonitis after initial adequate treatment for secondary peritonitis.

From a clinical point of view, two main categories can be identified within the group of intra-abdominal infection: ‘uncomplicated’ and ‘compli-

cated' intra-abdominal infection. In uncomplicated intra-abdominal infection, the infectious process is contained within a single organ, no anatomical disruption is present, and the majority of these patients can be managed with surgical resection alone and they do not need antibacterial therapy besides perioperative prophylaxis; acute appendicitis and cholecystitis are common examples. In complicated intra-abdominal infection, the infectious process proceeds beyond the organ that is the source of the infection, and causes localised peritonitis, also referred to as abdominal abscess, or diffuse peritonitis, depending on the abiltiy of the host to contain the process within a part of the abdominal cavity. These patients are the focus of this review, and as the pathogenesis, clinical presentation and treatment of primary and tertiary peritonitis differ substantially, these two entities fall outside the scope of this paper.

3. Diagnosis of Intra-Abdominal Infection

3.1 Clinical Diagnosis

The diagnosis of intra-abdominal infection is based on the symptoms and clinical findings on presentation. Typically, the patient is admitted to the emergency room because of abdominal pain and a systemic inflammatory response, including fever, tachycardia and tachypnoea. On clinical examination there may be tenderness on palpation or even signs of peritoneal irritation such as rebound tenderness. Clinical examination of the abdomen is often helpful to determine the source of the intra-abdominal infection.

Diffuse abdominal pain and generalised (rebound) tenderness are often signs of complicated peritonitis, and appropriate action should be undertaken. Additional imaging techniques are not always indicated in these patients, as this may delay the definitive management, and these patients should be considered candidates for immediate surgery when they are properly resuscitated and stable, and if processes such as acute pancreatitis and ischaemia are excluded.

When an intra-abdominal infection affects a hospitalised patient, it involves the complication of a pre-existing disease or a surgical intervention. The most common problem in these patients is anastomic leakage of enteric anastomoses.

The course of nosocomial intra-abdominal infections is often atypical and may lead to considerable delay in recognition of the problem, especially in sedated patients. The clinician should suspect an infectious abdominal complication in patients who develop severe sepsis or septic shock after abdominal surgery.

3.2 Microbiological Diagnosis

Unlike the enormous microbial diversity of the gastrointestinal tract, the spectrum of bacteria isolated during peritonitis only represents a small part of its flora, suggesting that only a few pathogens are truly involved in infectious peritonitis. Table I gives an overview of the most common causative pathogens in intra-abdominal infections. Microbiological confirmation of intra-abdominal infection is inconsistent, even in patients with obvious contamination. In an analysis of 374 patients with secondary peritonitis, bacterial growth was absent in 25%, the infection was monomicrobial in another quarter, and in half of the patients peritonitis was polymicrobial.[1]

For community-acquired peritonitis, microbiological identification is of limited value as the encountered flora is generally susceptible to the recommended regimens. In addition, microbiological analyses often reveal mixed cultures, in which it is

Table I. Frequently isolated pathogens in complicated intra-abdominal infections

Gram-negative bacteria
Escherichia coli
Enterobacter spp.
Klebsiella spp.
Proteus spp.
Pseudomonas aeruginosa
Acinetobacter spp.
Gram-positive bacteria
Streptococci
Enterococci
Coagulase-negative staphylococci
Staphylococcus aureus
Anaerobe bacteria
Bacteroides spp.
Clostridium spp.
***Candida* spp.**

difficult to distinguish contaminants from true causative pathogens. Yet, in patients with complicated intra-abdominal infection, perioperative culturing is routinely performed, although it rarely has an impact on the management of the patient.[10] Recently, there have been several reports describing an increase in infections with antibacterial-resistant organisms in some parts of the world. Although there are no data about the prevalence of these organisms in intra-abdominal infections, or about the impact of this trend on the epidemiology of intra-abdominal infections, intraoperative cultures should be considered if there is a concern about the involvement of antibacterial-resistant organisms.

In hospital-acquired infections, intraoperative cultures are generally recommended, as there is a realistic probability that antimicrobial-resistant pathogens will be involved. Knowledge of susceptibility patterns of the organisms involved is useful to guide therapy as there might be a risk of inappropriate empirical coverage and clinical failure.[11] The empirically initiated regimen must be changed based on detection of antimicrobial-resistant pathogens in microbiologic cultures in order to improve outcomes.[12]

4. Treatment of Complicated Intra-Abdominal Infections

The treatment of intra-abdominal infections can have multiple aspects, depending on the severity of illness caused by the infection. The concept of source control applies to all patients with complicated intra-abdominal infections and the majority of them will also need antibacterial therapy. Apart from this, patients with complicated intra-abdominal infections may also need organ function support in case of severe sepsis or septic shock, and they may also benefit from other strategies used for patients with severe sepsis, such as drotrecogin alfa (recombinant human activated protein C), strict glycaemic control and corticosteroid administration.[13]

4.1 Source Control

In the context of intra-abdominal infections, source control is often thought of as the pure mechanical control of leaking content from the gastrointestinal tract, but the concept 'source control' consists of "all physical measures undertaken to eliminate a source of infection, to control ongoing contamination, and to restore premorbid anatomy and function".[14] All different aspects of this definition are important, but the elimination of the source and the control over ongoing contamination determine early and long-term success of the treatment. Restoration of anatomy and complete function can be performed in a delayed fashion when prolonging the surgical intervention may be harmful to the patient at the first operation.

Source control is based on three principles: drainage, debridement and restoration of anatomy and function. All three principles are important as such, but in the individual patient they can be applied independently and at different times.

4.1.1 Drainage

Drainage consists of evacuating the contents of an abscess. The efficiency of the drain used is very important: it should be sized adequately to allow complete evacuation of the abscess. If the abscess cannot be drained completely, source control will fail. The use of additional drains can be considered, but it should be kept in mind that some abscesses or infections cannot be drained adequately. In these instances, debridement of necrotic tissues or removal of gastrointestinal contents may be necessary.

Drainage of an abscess can be performed surgically or percutaneously, using ultrasound or CT scan.[15] The latter is preferred for most situations, provided that adequate drainage is possible and no debridement or repair of anatomical structures is necessary. Surgical drainage is indicated when percutaneous drainage fails or cannot be performed, for example when multiple abscesses are present.

4.1.2 Debridement

Debridement should consist of removing dead tissue and foreign material from the abdominal cavity. This can only be accomplished surgically, and the extent to which this should be done remains a controversial topic. Some surgeons favour a minimalist approach, which consists of removing dead tissue and using gauze to remove any pus present, whereas others promote an aggressive approach of high volume peritoneal lavage, and meticulously removing all fibrin adhering to the intestines or abdominal wall.[14]

4.1.3 Restoration of Anatomy and Function

Restoration of anatomy and function is the final step in the management of intra-abdominal infections, and as such, is often the goal of the surgical intervention. In most patients it can be established during the first operation, but in some patients it needs to be delayed until the condition of the patient allows for the sometimes lengthy procedure and until tissue healing is adequate. In some patients, this delay of a definitive procedure can take months and the patient may even be discharged home before reconstruction is finalised.

4.2 Antimicrobial Treatment

4.2.1 Antimicrobial Agents

The main objectives of antimicrobial therapy in the treatment of intra-abdominal infections are to prevent local and haematogenous spread and to reduce late complications.

It is important that the decision to start antimicrobial therapy is not taken too lightly and that its duration is defined from the start of the treatment. Although only limited data are available, it appears that the misuse of antimicrobials in this setting is enormous, resulting in unnecessary costs[16,17] and increased rates of resistance. In case of complications – mostly due to inadequate source control – this will unnecessarily impede achievement of appropriate therapy.

Patients with uncomplicated intra-abdominal infections undergoing surgery do not need antimicrobial therapy except from perioperative prophylaxis, and this decision should be made intraoperatively by the surgeon. When the focus of the infection is completely resectable and there is no associated peritonitis, no antibacterial treatment is necessary.

There are a number of clinical situations where antibacterial treatment should not be continued for more than 24 hours (table II).[18,19] This category represents a group of patients with minimal risks for infectious complications and that, therefore, needs neither prophylaxis alone nor therapy for established infection.[20]

Several schemes for antibacterial therapy have been proposed for the treatment of complicated intra-abdominal infection and none these has proven to be superior (table III). These infections always require coverage for both Gram-positive and Gram-negative bacteria, as well as a drug active against anaerobe bacteria. In case of prior antibacterial exposure or prolonged hospitalisation, a regimen including an antipseudomonal drug is recommended. Additionally, the choice of an antibacterial for a patient with an intra-abdominal infection – especially nosocomial infections – should always be based on knowledge of the local ecology and resistance patterns.

Table II. Conditions for which antibacterial therapeutics (>24 hours) are generally not recommended[18]

Traumatic and iatrogenic small and large bowel perforations operated on within 24 hours (including intraoperative contamination)
Gastroduodenal perforations operated on within 24 hours
Acute and gangrenous appendicitis without perforation
Acute and gangrenous cholecystitis without perforation
Transmural bowel ischaemia and necrosis without perforation or established peritonitis or abscess

4.2.2 Duration of Antimicrobial Therapy

In intra-abdominal infections managed with prompt surgical intervention and adequate source control, antibacterial therapy is generally recommended to continue for 5–7 days, although even shorter courses have been proposed.[9] As a guideline for clinical practice, antibacterial therapy for established infections can safely be stopped after resolution of clinical signs of infection.[19] Once symptoms such as fever and leucocytosis have disappeared, and the patient tolerates enteral feeding, recurrent infection is not likely to occur.[21]

For patients with persistent sepsis after 1 week of antibacterial therapy, such therapy should not merely be continued, as this frequently points to failed source control or another focus of hospital-acquired infection. In selected patients, prolonged antimicrobial therapy may be necessary; infected pancreatic necrosis is a typical example.

Special attention should be given to intra-abdominal infections with involvement of *Candida* spp. and *Staphylococcus aureus*. These microorganisms are a frequent cause of recurrent infection, especially when accompanied by bloodstream infection, facilitating haematogenous spread and metastatic infectious foci.[22,23] For these indications, therapy should be continued for at least 2–3 weeks. Methi-

cillin-susceptible *S. aureus* is covered by all recommended regimens (table III). Methicillin-resistant strains of *S. aureus* are relatively uncommon causes of intra-abdominal infections. These infections may require more prolonged antibacterial therapy, because of the possibility of infectious metastatic foci, and the lesser bactericidal activity and higher minimum inhibitory concentrations for glycopeptides. With continuous infusion of vancomycin, target concentrations are more stable and more rapidly achieved, whereas the frequency of adverse drug events decreases.[24] Newer antibacterial agents active against resistant Gram-positive bacteria such as linezolid or tigecycline appear to be promising. In the treatment of intra-abdominal infection, their clinical benefit compared with glycopeptides remains unproven.

4.2.3 Who Needs Enterococcal Coverage?

The clinical relevance of enterococci in intra-abdominal infections has been an ongoing matter for discussion.[19,25-27] Not all patients with peritonitis need coverage against enterococci, but when these microorganisms are involved, inappropriate empirical therapy may result in higher fatality rates, as pointed out in a study on enterococcal bacteraemia.[28] Several trials on community-acquired peritonitis have compared regimens active against enterococci with regimens that are less active against the isolated strains.[29-31] None of these trials was able to demonstrate a beneficial effect in covering the *Enterococcus* spp. involved. Therefore, routine coverage against enterococci is not considered necessary in patients with community-acquired peritonitis. However, the chance of enterococcal involvement in complicated intra-abdominal infection may be greater, as well as their clinical relevance in this particular disease entity. Although hard evidence is lacking, reasonable indications for enterococcal coverage include the presence of septic shock in patients previously receiving prolonged treatment with cephalosporins, immunosuppressed patients at risk for bacteraemia, the presence of prosthetic heart valves and recurrent intra-abdominal infection accompanied by severe sepsis.[26,32-34]

Table III. Proposed empirical antimicrobial therapy schemes for the treatment of complicated intra-abdominal infection

Monotherapy
β-Lactam/β-lactamase inhibitor
amoxicillin/clavulanic acid
piperacillin/tazobactam
ticarcillin/clavulanic acid
Carbapenems
ertapenem
imipenem/cilastatin
meropenem
Other
tigecycline
Combination therapy
Cephalosporin-based
cefuroxime + metronidazole
third- or fourth-generation cephalosporin + metronidazole
Quinolone-based
ciprofloxacin + metronidazole
Aminoglycoside-based
aminoglycoside + clindamycin
Other
aztreonam + metronidazole

4.2.4 Intra-Abdominal Candidiasis

The incidence of *Candida* spp. involvement in intra-abdominal infections depends on the presence of predisposing factors like immunodeficiency or prolonged exposure to antibacterials. Candidal peritonitis may occur in patients with peritoneal dialysis or following major abdominal surgery or trauma. The incidence of *Candida* spp. involvement in peritonitis varies depending on the source. Some authors found *Candida* spp. to be the leading or second most frequently isolated pathogen in secondary or tertiary peritonitis.[5,35,36] In a study of 120 patients with secondary peritonitis, *Candida* spp. were present in only 12% of the cases, ranking seventh.[37] Also, *Candida* spp. are a predominant pathogen in infected severe acute pancreatitis and are associated with high mortality.[38,39] The high risk for candidiasis in patients with intra-abdominal contamination has led to an increased use of antifungal prophylaxis. In a placebo-controlled trial it was demonstrated that prophylaxis with fluconazole reduced the rate of intra-abdominal candidiasis in high-risk surgical patients.[40] Although this study focussed solely on patients with gastrointestinal perforations and anastomotic leakage, this finding is often generalised to other patients with complicated intra-abdominal conditions.

Routine treatment for *Candida* spp. isolated following fast and uncomplicated repair of an intra-abdominal perforation is not recommended in otherwise healthy patients without a septic profile. Surgical source control implying repair of perforations and elimination of contaminated peritoneal fluids or infected necrosis is essential in the treatment of intra-abdominal candidiasis.[41,42] Prompt surgical intervention should be accompanied by pharmacological therapy either with fluconazole or amphotericin B.[43] Intra-abdominal candidiasis therapy should always be continued for 2–3 weeks.

4.2.5 Antimicrobial Resistance in Intra-Abdominal Infections

The clinical value of antimicobial agents is being threatened by the emergence of increasingly resistant microorganisms. Selective pressure favouring resistant strains arises from misuse and overuse of antimicrobials.[44] With regard to community-acquired intra-abdominal infections, however, these microorganisms only have a modest importance. The problem of resistance is more prominent in the hospital setting and hence a pertinent issue in complicated intra-abdominal infections. Over the past 2 decades, a striking increase in the emergence of resistance has been observed in Gram-negative and Gram-positive bacteria, as well as a shift towards less susceptible *Candida* spp.[45,46] Infections caused by resistant pathogens lead to enlarged resources use, increased comorbidity and possibly mortality.[47-50] Worse outcomes associated with such infections are due to the non-coverage of causative microorganisms by the empirically initiated regimen. Delayed initiation of appropriate antimicrobial therapy leads to significantly higher fatality rates.[51,52] In cases of healthcare-associated intra-abdominal infection, the empirical regimen must take into account risk factors supporting the likelihood of resistant pathogens, such as intensive care unit admission, colonisation with resistant microorganisms, prolonged hospitalisation and antimicrobial exposure.[53-55] Knowledge of the local ecology is, therefore, important since resistance patterns may differ substantially between regions or even between hospitals.

5. Recommendations

The antimicrobial management of complicated intra-abdominal infection requires consideration of several topics, each of which might influence the outcome. Fundamental issues to be taken into account are listed in table IV.

Table IV. Seven fundamental questions to guide antimicrobial management in complicated intra-abdominal infection

Is adequate source control achieved?	Surgical source control is essential. Without adequate drainage or debridement and restoration of anatomic structures, antimicrobial therapy will not be effective, will be administered for a prolonged time period and, hence, will unnecessarily lead to increased antimicrobial resistance
Is antimicrobial therapy for >24 hours indicated?	See table II for conditions for which therapeutic antibacterials (>24 hours) are generally not recommended[18]
Is there a need to cover hospital acquired microorganisms, e.g. *Pseudomonas aeruginosa* or resistant pathogens?	In case of substantial length of hospitalisation and/or prior antibacterial therapy, a regimen with antipseudomonal activity is recommended. Coverage against resistant pathogens, known from local ecology, is recommended in the presence of specific risk factors such as intensive care unit admission, colonisation with resistant organisms, prolonged hospitalisation and antibacterial exposure[53,54]
Should *Enterococcus* spp. be covered?	Yes, where septic shock is present in patients previously receiving prolonged treatment with cephalosporins, immunosuppressed patients at risk for bacteraemia, the presence of prosthetic heart valves and recurrent intra-abdominal infection with severe sepsis[26]
Is antifungal prophylaxis indicated?	Antifungal prophylaxis can be considered in cases of gastro-intestinal perforations, anastomotic leakage or severe acute necrotising pancreatitis[43]
Is the empirical regimen active against the isolated organisms from healthcare-associated intra-abdominal infection?	Inappropriate antimicrobial regimens must be changed in order to improve clinical outcomes[12]
How long should antimicrobial therapy be continued?	Generally, antibacterial therapy should be continued for 5–7 days if clinical signs of infection have disappeared. Source control must be questioned in the case of persistent sepsis (>7 days). Established intra-abdominal candidiasis should be treated for 2–3 weeks[43]

6. Conclusion

Complicated intra-abdominal infections are an important cause of morbidity and are associated with a poor prognosis. In complicated intra-abdominal infections, surgical intervention should be supported by effective antimicrobial management to prevent local and haematogenous spread, and to reduce late complications. Prompt initiation of appropriate empirical therapy can limit the associated mortality. Maintaining a balance between achieving a high index of appropriate therapy on one hand, and minimising the use of broad-spectrum antibacterials and related emergence of resistance on the other hand, is important. Therefore, the patients' profile should be checked for risk factors for the involvement of enterococci, *Candida* spp. or hospital-acquired bacteria such as *Pseudomonas aeruginosa* or resistant pathogens. In general, antimicrobial therapy should be continued for 5–7 days. If sepsis is still present after 1 week, a diagnostic work up should be performed and if necessary a surgical reintervention should be considered.

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