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# Dynamic Practice Guidelines for Emergency General Surgery

Committee on Acute Care Surgery, Canadian Association of General Surgeons

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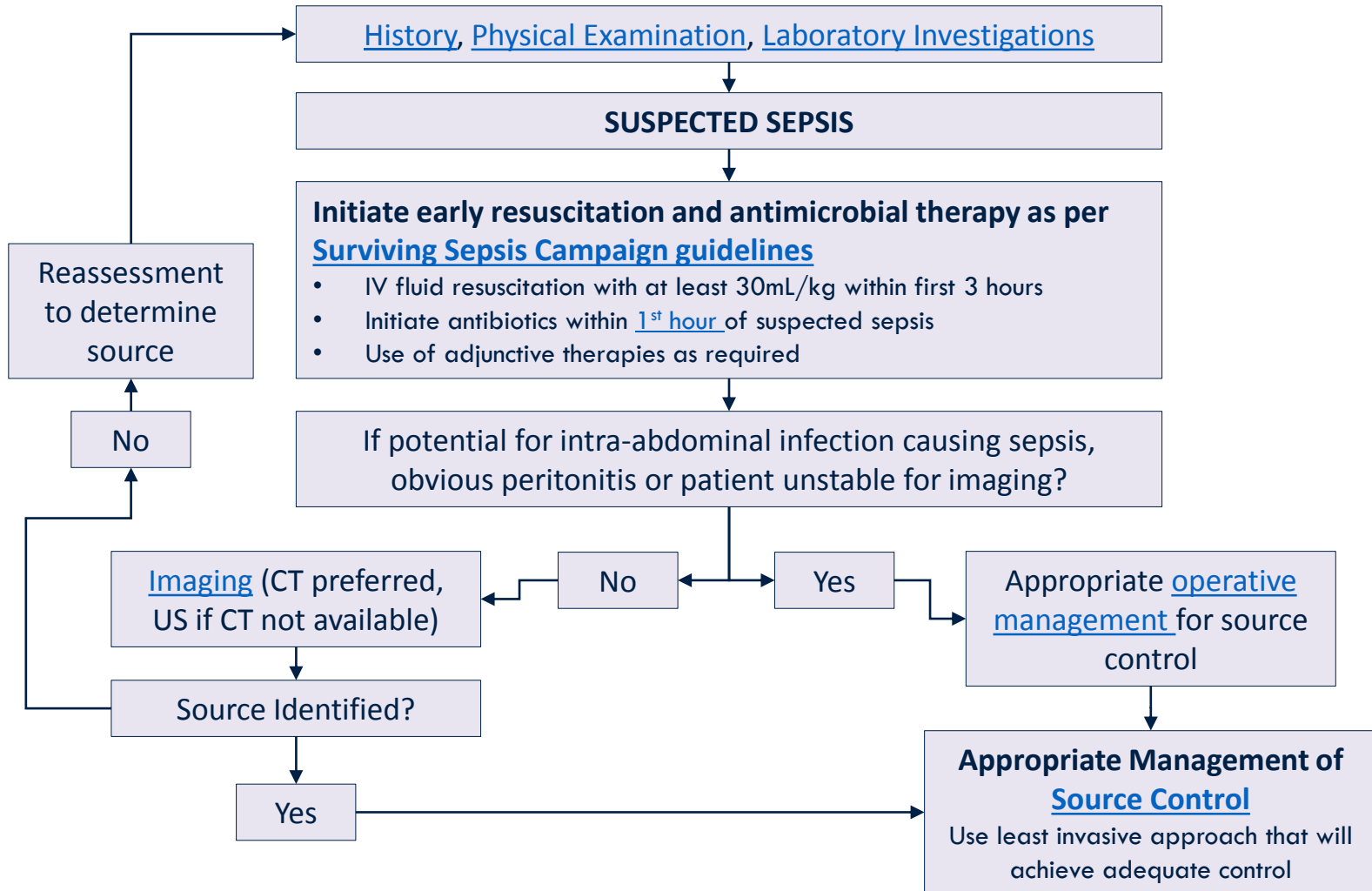
## RESUSCITATION AND SOURCE CONTROL

Dynamic Practice Guidelines for Emergency General Surgery

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# RESUSCITATION AND SOURCE CONTROL



## Definitions:

- Sepsis: Life-threatening *organ dysfunction* caused by a dysregulated host response to infection; a systemic inflammatory response to a new infection
  - Organ dysfunction may be represented by an increase in Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score of  $\geq 2$  points
  - Quick SOFA (qSOFA) may be used to identify suspected infection or high-risk patients

## qSOFA (Quick SOFA) Criteria

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- Respiratory rate  $\geq 22$ /min
  - Altered mentation
  - Systolic blood pressure  $\leq 100$ mmHg
-

## Definitions:

- Systemic inflammatory response syndrome (SIRS): a multisystem response that can result from infectious (localized or general) or non-infectious causes (e.g. trauma, burns, pancreatitis)
  - **NB:** SIRS criteria remain clinically established and continue to serve in identifying sepsis along with newer definitions<sup>1</sup> (i.e. SOFA)

## Systemic Inflammatory Response Syndrome (SIRS)

Two or more of:

Temperature  $>38^{\circ}\text{C}$  or  $<36^{\circ}\text{C}$

Heart rate  $>90/\text{min}$

Respiratory rate  $>20/\text{min}$  or  $\text{PaCO}_2 <32\text{mmHg}$

WBC  $>12$  or  $<4$ , or  $>10\%$  immature bands

<sup>1</sup>Daniels, Nutbeam and Berry, 2016 [BMJ Best Practice Guidelines](#)  
Singer, Deutschman, Warren-Seymour, et al. 2016 [JAMA](#)

## Definitions:

- Septic shock: subset of sepsis where underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality
  - Persistent hypotension requiring vasopressors to maintain MAP  $>65$ mmHg, and serum lactate  $>2$ mmol/L despite adequate volume resuscitation
- Patients with suspected sepsis can be stratified according to risk of severe illness or mortality based on [guidelines](#) from UK National Institute for Health and Care Excellence (NICE)
- Source control: all physical measures undertaken to eliminate a source of infection, to control contamination, and to restore pre-morbid anatomy and function

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Daniels, Nutbeam and Berry, 2016 [BMJ Best Practice Guidelines](#)

Singer, Deutschman, Warren-Seymour, et al. 2016 [JAMA](#)

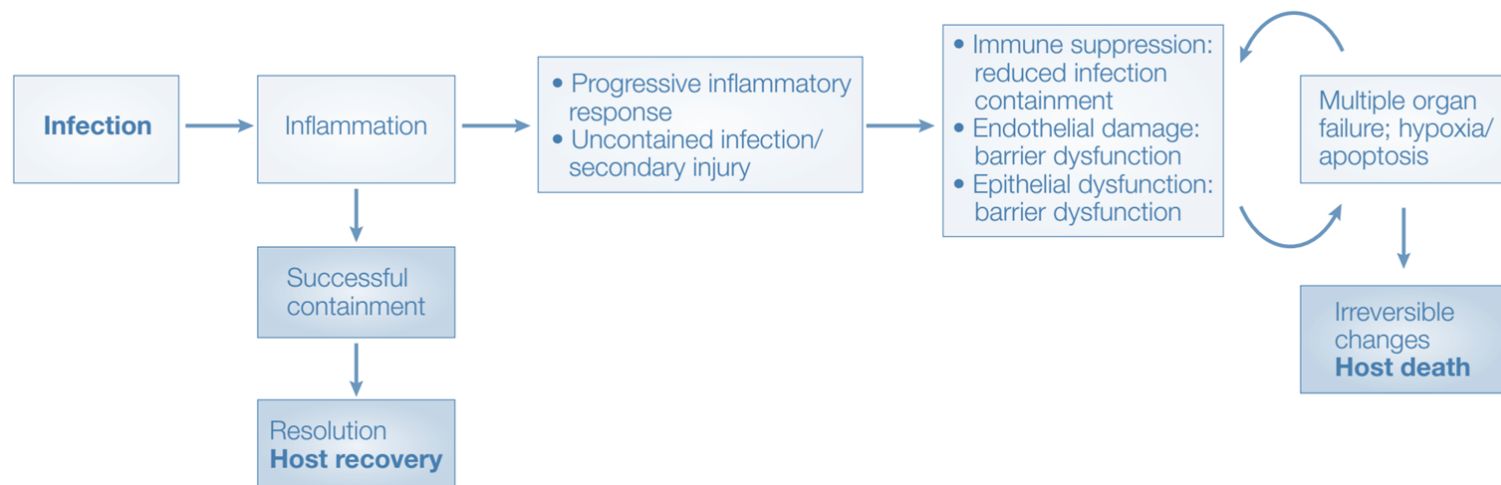
Costantini TW, et al. Sepsis. In: Britt LD, Peitzman AB, eds. *Acute Care Surgery*. 2012; 160-169

## Etiology

- Causative agents vary significantly depending on region, hospital size, season and type of unit (e.g. neonatal, transplantation, oncology, hemodialysis units)
  - *E. coli* remains the most prevalent pathogen causing sepsis
- Pathogenic organisms are identified in only 1/2 of cases of sepsis
- Relative frequencies of source of infection:
  - Respiratory (45-60%)
  - Bloodstream (20%)
  - Abdomen (26%)
  - Skin (14%)
  - Urinary tract (12-20%)

## Pathophysiology

- In sepsis, a pathogen incites a substantial host inflammatory response, activating both the complement and coagulation cascades
- Responses are essential in eradication of the pathogen, but are also capable of creating major damage against the host





**Routine history, physical examination, and laboratory studies** will identify most patients with suspected intra-abdominal infection for whom further evaluation and management is warranted (Grade 2-A)<sup>1</sup>

## History of Presenting Illness



- Assess for risk factors of sepsis:
  - Underlying malignancy
  - Age >65 yrs.
  - Immunocompromised state
  - Alcoholism
  - Diabetes mellitus
  - *Other risk factors include:* recent surgery, compromised skin integrity, indwelling lines/catheters, IV drug abuse, pregnancy
- Assessing the risk for an adverse outcome in patients is important in optimizing selection of source control and antimicrobial therapy<sup>1</sup>

Daniels, Nutbeam and Berry, 2016 [BMJ Best Practice Guidelines](#)

<sup>1</sup>Mazuski, Tessier, May, et al., 2017 [Surgical Infection Society Revised Guidelines](#)

**Routine history, physical examination, and laboratory studies** will identify most patients with suspected intra-abdominal infection for whom further evaluation and management is warranted (Grade 2-A)<sup>1</sup>

## Physical Examination



- Signs commonly associated with sepsis include:
  - High or low temperature
  - Tachycardia, hypotension
  - Tachypnea, low oxygen saturation
  - Acutely altered mental status
  - Poor capillary refill, ashen appearance, cyanosis
  - Decreased urine output
  
- Perform focused physical examination

# RESUSCITATION + SOURCE CONTROL

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|                     |  |
|---------------------|--|
| <b>CBC</b>          | <ul style="list-style-type: none"><li>• Elevated or decreased WBC (&gt;12, or &lt;4) or normal WBC with &gt;10% immature forms</li><li>• Low platelets – thrombocytopenia can arise in severe sepsis</li></ul>                       |
| <b>Electrolytes</b> | <ul style="list-style-type: none"><li>• Hyper K<sup>+</sup> may be precipitated by renal failure or lactic acidosis</li><li>• Extended electrolytes (Ca, Mg, Phos) should be ordered</li></ul>                                       |
| <b>Urea, Cr</b>     | <ul style="list-style-type: none"><li>• Elevated in circumstances of renal dysfunction</li></ul>   |
| <b>LFTs</b>         | <ul style="list-style-type: none"><li>• Elevated – sepsis can originate from hepatic or perihepatic sources; sepsis can also compromise hepatic blood flow</li></ul>   |
| <b>INR/ aPTT</b>    | <ul style="list-style-type: none"><li>• May be prolonged – if prolonged, consider DIC</li></ul>  |
| <b>Lactate</b>      | <ul style="list-style-type: none"><li>• Elevated – levels &gt;2 associated with worse prognosis</li><li>• Denotes tissue hypoperfusion</li></ul>   |
| <b>Glucose</b>      | <ul style="list-style-type: none"><li>• Elevated – due to stress response or altered glucose metabolism</li><li>• Attempt to maintain normoglycemia, as hyperglycemia is associated with increased morbidity and mortality</li></ul> |
| <b>Blood Cx.</b>    | <ul style="list-style-type: none"><li>• May be positive for organism</li><li>• Attempt to draw cultures prior to administration of antibiotic</li></ul>  |

Table adapted from: Daniels, Nutbeam and Berry, 2016 [BMJ Best Practice Guidelines](#)

## Imaging



- Imaging studies should be chosen based on the clinical presentation and presumed source of infection.
- **CT scan** is the imaging of choice to determine the presence of an intra-abdominal infection and its source (Grade 2-A)<sup>1</sup>
  - Does require transfer of potentially unstable patient and therefore benefit should be weighed against risk<sup>2</sup>
    - Further diagnostic imaging is unnecessary in patients with obvious signs of diffuse peritonitis and in whom immediate surgical intervention is to be performed (Grade 3-B)<sup>1</sup>
- Localizing source

<sup>1</sup>Solomkin, Mazuski, Bradley, et al., 2010 [IDSA Guidelines](#)

<sup>2</sup>Daniels, Nutbeam and Berry, 2016 [BMJ Best Practice Guidelines](#)

## Management



### General Recommendations for Sepsis

#### Surviving Sepsis Campaign – International Guidelines for Management of Sepsis and Septic Shock, 2016<sup>1</sup>

- **Regarding fluids:**
  - Initiate resuscitation and treatment immediately
  - Administer **at least 30mL/kg** of IV crystalloid within the first 3h for sepsis-induced hypotension (strong recommendation, low quality of evidence (QOE))
  - Continue to reassess hemodynamic status to determine need for additional fluids
  - If inadequate response to resuscitation, target a mean arterial pressure of **65mmHg** for patients requiring vasopressors (strong recommendation, moderate QOE)
- **Regarding antibiotics:**
  - Initiate broad-spectrum antibiotics as soon as possible (strong recommendation, mod QOE)
- **Regarding adjuncts:**
  - Transfusion if hemoglobin <70g/L (strong recommendation, high QOE)
  - Control glucose to maintain serum glucose >6.1 and <10mmol/L (strong recommendation, high QOE)
  - Initial vasopressor of choice is norepinephrine (levophed)

<sup>1</sup>Rhodes, Evans, Alhazzani, et al., 2016 [Surviving Sepsis Campaign Guidelines](#)

## Management

### Timing of Antimicrobial Therapy



#### Empiric Antibiotic Treatment Reduces Mortality in Severe Sepsis and Septic Shock from First Hour<sup>1</sup>

- Retrospective cohort study; 165 intensive care units in Europe, the US, and South America participating
- N=28,150 of patients with severe sepsis and septic shock
  - N=17,990 for those who received antibiotics with data available on timing included in analysis
- Adjusted for sepsis-severity score, **hospital mortality increased from 24.6% in patients receiving antibiotics within first hour to 33.1% in patients with >6hr delay**

| Time to 1 <sup>st</sup> Antibiotics | Hospital mortality |
|-------------------------------------|--------------------|
| 0-1 hrs                             | 32%                |
| 1-2 hrs                             | 28.1%              |
| 2-3 hrs                             | 28.6%              |
| 3-4hrs                              | 29.8%              |
| 4-5 hrs                             | 32.5%              |
| 5-6 hrs                             | 36.6%              |
| >6 hrs                              | 39.6%              |

<sup>1</sup>Ferrer, Martin-Loeches, Phillips, et al., 2014 [Crit Care Med](#)

## Management



### Type of Antimicrobial Therapy

- Use antimicrobial regimens that have activity against aerobic gram-negative Enterobacteriaceae, aerobic gram-positive cocci, and obligate anaerobes typically found in the GI tract<sup>1</sup>
  - Coverage of enteric anaerobes may not be essential in pts. with an upper GI source<sup>1</sup>

### Common GI Tract Bacteria

| Gram-negative bacilli   | Gram-positive cocci  | Anaerobes  |
|---|--|--|
| <ul style="list-style-type: none"><li>• Enterobacteriaceae:<ul style="list-style-type: none"><li>• <b><i>Escherichia coli</i></b></li><li>• <i>Citrobacter sp.</i></li><li>• <i>Klebsiella sp.</i></li><li>• <i>Proteus sp.</i></li><li>• <i>Enterobacter</i></li></ul></li><li>• <i>Pseudomonas aeruginosa</i></li></ul> | <ul style="list-style-type: none"><li>• <i>Streptococcus sp.</i></li><li>• <i>Enterococcus sp.</i></li></ul> | <ul style="list-style-type: none"><li>• <i>Bacteroides sp.</i></li><li>• <i>Clostridium sp.</i></li><li>• <i>Peptostreptococcus sp.</i></li><li>• <i>Prevotella sp.</i></li><li>• <i>Eubacterium sp.</i></li><li>• <i>Bifidobacterium sp.</i></li><li>• <i>Porphyromonas sp.</i></li><li>• <i>Lactobacillus sp.</i> (upper GI)</li></ul> |

<sup>1</sup>Mazuski, Tessier, May, et al., 2017. [Surgical Infection Society Revised Guidelines](#)  
La Terre, Colardyn, Delmée, et al., 2006. [Acta Chir Belg](#)  
Bohnen, Solomkin, Dellinger, et al., 1992. [Arch Surg](#)

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## Management

### Type of Antimicrobial Therapy



| Type of therapy                            | For mild to mod. infxn   | For severe infections  |
|--|--|--|
| <b>Single agent</b>                        |  |  |
| β-lactam/β-lactamase inhibitor combination | <ul style="list-style-type: none"><li>• Ampicillin/sulbactam, ticarcillin/clavulanic acid</li></ul>                              | <ul style="list-style-type: none"><li>• Piperacillin/tazobactam</li></ul>  |
| Carbapenem                                 | <ul style="list-style-type: none"><li>• Ertapenem</li></ul>  | <ul style="list-style-type: none"><li>• Imipenem/cilastatin, meropenem</li></ul>   |
| <b>Combination regimen</b>                 |  |  |
| Cephalosporin based                        | <ul style="list-style-type: none"><li>• Cefazolin or cefuroxime, plus metronidazole</li></ul>                                    | <ul style="list-style-type: none"><li>• Third/fourth-generation cephalosporin (cefotaxime, ceftriaxone, ceftizoxime, ceftazidime, cefepime) plus metronidazole</li></ul> |
| Fluoroquinolone based                      | <ul style="list-style-type: none"><li>• Ciprofloxacin, levofloxacin, moxifloxacin, or gatifloxacin, plus metronidazole</li></ul> | <ul style="list-style-type: none"><li>• Ciprofloxacin plus metronidazole</li></ul>   |
| Monobactam based                           |  | <ul style="list-style-type: none"><li>• Aztreonam plus metronidazole</li></ul>   |

Table adapted from: Solomkin, Mazuski, Baron et al., 2003. [Clin Infect Dis](#)



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## Management

### Type of Antimicrobial Therapy



| Type of Infection                            | Example   | Selection of Antibiotic |                              |                               |
|--|---|-------------------------|------------------------------|-------------------------------|
|  |   | Coverage                | Antibiotic                   | If PCN allergic               |
| <b>Community Acquired IAI: Uncomplicated</b> |   |                         |                              |                               |
| Uncomplicated                                | <ul style="list-style-type: none"><li>Non-perforated appendicitis</li></ul>   | Enteric GNB, anaerobes  | Cefazolin plus metronidazole | Gentamicin plus metronidazole |
| Perforation without established infection    | <ul style="list-style-type: none"><li>Gastric/ duodenal/ traumatic bowel perforation with source control 12-24hrs</li></ul> | GPC, GNB, +/- anaerobes |                              |                               |

Table adapted from: Doyle, Nathens, Morris, et al., 2011. [Best Practice in General Surgery](#)

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## Management

### Type of Antimicrobial Therapy



| Type of Infection                          | Example   | Selection of Antibiotic                       |   |                            |
|--|---|---|---|----------------------------|
|  |   | Coverage                                      | Antibiotic  | If PCN allergic            |
| <b>Community Acquired IAI: Complicated</b> |   |   |   |                            |
| Mild-to-moderate                           | <ul style="list-style-type: none"><li>Perforated appendicitis</li><li>Perforated diverticulitis</li></ul>                     | Enteric GNB, anaerobes                        | Cefazolin + metronidazole                                     | Gentamicin + metronidazole |
| Severe                                     | <ul style="list-style-type: none"><li>Septic shock, critically ill patient</li><li>New organ failure</li></ul>                | Enteric GNB, anaerobes, possibly enterococcus | Ceftriaxone + metronidazole; consider piperacillin-tazobactam |                            |
| Other risk factors for treatment failure   | <ul style="list-style-type: none"><li>Age &gt;70</li><li>Immunosuppressed</li><li>Delayed/inadequate source control</li></ul> |   |   |                            |

Table adapted from: Doyle, Nathens, Morris, et al., 2011. [Best Practice in General Surgery](#)

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## Management

### Type of Antimicrobial Therapy



| Type of Infection                | Example  | Selection of Antibiotic                               |   |   |
|----------------------------------|--|---|---|---|
|                                  |  | Coverage  | Antibiotic  | If PCN allergic   |
| <b>Healthcare Associated IAI</b> |  |   |   |   |
| Mild-to-moderate                 | <ul style="list-style-type: none"><li>Anastomotic leak</li><li>Postoperative abscess</li><li>Hospitalized &gt;5d</li></ul> | Enteric GNB (drug-resistant), anaerobes, enterococcus | Piperacillin-tazobactam; consider ceftriaxone + metronidazole | <ul style="list-style-type: none"><li>Vancomycin + gentamicin + metronidazole</li><li>Carbapenem + vancomycin</li></ul> |
| Severe                           | <ul style="list-style-type: none"><li>As above with shock/critically ill patient</li></ul>                                 |   | Piperacillin-tazobactam                                       |   |

Table adapted from: Doyle, Nathens, Morris, et al., 2011. [Best Practice in General Surgery](#)

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## Management

### Type of Antimicrobial Therapy



| Type of Infection    | Example   | Selection of Antibiotic |  |                            |
|----------------------|---|-------------------------|--|----------------------------|
|                      |   | Coverage                | Antibiotic   | If PCN allergic            |
| <b>Biliary Tract</b> |   |                         |  |                            |
| Mild-to-moderate     | <ul style="list-style-type: none"><li>Acute calculous cholecystitis</li><li>Ascending cholangitis</li></ul> | Enteric GNB             | Cefazolin;<br>consider<br>ceftriaxone ±<br>metronidazole | Gentamicin                 |
| Severe               |   |                         | Piperacillin-tazobactam                                  | Ertapenem, ±<br>vancomycin |

Table adapted from: Doyle, Nathens, Morris, et al., 2011. [Best Practice in General Surgery](#)

## Management

### Recommendations for Intra-Abdominal Infections



#### Surgical Infection Society Guidelines on the Management of Intra-Abdominal Infections<sup>1</sup>

- Use a source control procedure to remove infected fluid and tissue and to prevent ongoing contamination in patients with IAI\* (Grade 1-A)
- Undertake source control within 24h of diagnosis of IAI; more urgently in patients with sepsis or septic shock (Grade 2-B)
- Use the least invasive approach that will achieve adequate source control, at least on temporary basis (Grade 1-B)
  - Consider use of alternative/ temporizing approaches to source control in patients with major physiologic instability, those with diffuse infections and ongoing bowel ischemia who are considered at higher risk for initial source control failure (Grade 2-B)

\*Except in patients where there is clear evidence that a non-interventional approach is associated with good clinical outcome

<sup>1</sup>Mazuski, Tessier, May, et al., 2017. [Surgical Infection Society Revised Guidelines](#)

## Management

### Recommendations for Intra-Abdominal Infections



#### Basic Principles of Source Control<sup>1</sup>

1. Drainage
2. Debridement and device removal
3. Decompression
4. Restoration of anatomy and function

#### Surgical Infection Society Guidelines on the Management of Intra-Abdominal Infections<sup>2</sup>

- Use abbreviated laparotomy and temporary abdominal closure techniques:
  - If closure of the abdomen would create meaningful intra-abdominal pressure
  - If the patient's physiologic reserve is severely compromised
  - If there is inability to achieve adequate source control with initial procedure
  - If there is plan for 2<sup>nd</sup> look laparotomy due to mesenteric ischemia (Grade 1-B)
- Do not use routine planned re-laparotomy in higher risk patients with severe peritonitis when adequate source control can be obtained at the time of the index procedure; treat such patients with on-demand rather than scheduled re-laparotomy (Grade 1-B)

<sup>1</sup>Costantini TW, et al. Sepsis. In: Britt LD, Peitzman AB, eds. *Acute Care Surgery*. 2012; 160-169

<sup>2</sup>Mazuski, Tessier, May, et al., 2017. [Surgical Infection Society Revised Guidelines](#)