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Surgical Treatment
Evidence-Based and Problem-Oriented
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surgery

Management of secondary peritonitis

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Reports on surgical treatment of peritonitis were available at the beginning of the century (Mikulicz 1889; Krönlein 1885; Körte 1892). *Kirschner* was among the first who demonstrated a reduction in mortality rate by surgical treatment from 80–100% to about 60% in 1926. However, there were doubts that the drainage of the peritoneal cavity is "physical and physiological impossible" (Yates 1905). Since 1926, mortality in peritonitis has decreased to an average of 30–40% with the development of new operative techniques, the introduction of antibiotics and intensive care treatment.

Definition, pathogenesis, and epidemiology

Peritonitis is defined as inflammation of the peritoneum, which may be caused by pathogens or non-pathogenic factors, e.g., barium enema.

Peritonitis is often synonymously used for intra-abdominal infection or intra-abdominal sepsis in the literature. In fact, the three most widely confused terms are contamination, infection and sepsis. Contamination means the presence of bacteria in normal sterile tissue without any host reaction. Infection is the presence of bacteria in normal sterile tissue with local host response (inflammation), clinically evident. Sepsis is the systemic response to local infection. Peritonitis may be caused by traumatic perforation of the bowel, anastomotic dehiscence, translocation of germs, inflammation or perforation of hollow viscus, e.g., appendicitis or colonic diverticulitis.

Peritonitis can be classified into primary, secondary or tertiary peritonitis.

- *Primary* bacterial peritonitis refers to spontaneous bacterial invasion of the peritoneal cavity. This mainly occurs in infancy and early childhood, in cirrhotic patients and immunocompromised hosts.
- *Secondary* bacterial peritonitis describes peritoneal infections secondary to intraabdominal lesions, such as perforation of the

hollow viscus, bowel necrosis, nonbacterial peritonitis, or penetrating infectious processes.

- *Tertiary* peritonitis, a less well-defined entity, is characterized by persistent or recurrent infections with organisms of low intrinsic virulence or with predisposition for the immunocompromised patient. It usually follows operative attempts to treat secondary peritonitis and is almost exclusively associated with a systemic inflammatory response.

Clinically peritonitis is often classified either as local or as diffuse. Local peritonitis refers to loculi of infection, usually walled-off or contained by adjacent organs, whereas diffuse is synonymous with generalized peritonitis, that is spread to the entire cavity.

The incidence of secondary peritonitis is difficult to assess. Intra-abdominal infections are found to occur in 25% of patients with multiple organ failure in surgical ICU. Peritonitis was present in 8% of all cases in a large necropsy series.

Mortality of peritonitis correlates with the severity of disease, which is usually assessed by the APACHE II/III score, even though this is not a specific peritonitis score. APACHE III score correlates with the development of multiple organ dysfunction syndrome. Specific peritonitis scores do exist, however, one example being the Mannheim Peritonitis Index (MPI). At least four prospective studies have confirmed that not only the MPI was as efficient as APACHE II in predicting the short term risk of mortality of a patient with peritonitis, but as well, this is one of the easiest scoring systems to apply and it can be calculated during operation whereas APACHE II score requires 24 hours and it is more or less organ specific, but the MPI has not yet gained wide acceptance. However, no score can predict the outcome of peritonitis in an individual patient.

The pathogens normally detected in peritonitis are gram-negative, e.g., E. coli, and anaerobes, e.g., Bacteroides fragilis.

When peritonitis persists, however, other pathogens may be isolated, e.g., pseudomonas aeruginosa, Enterobacter, Enterococci spp. Antimicrobial resistance of operative flora may correlate with postoperative infection. The impact of the type of

pathogens in outcome has changed since the early eighties. Today it is known that the immune response mounted against the invading pathogens is the decisive element for outcome. When the inflammatory response gets out of control, multi organ failure will ensue and surgery can no longer limit the immune response, emphasizing the need for timely operation in suspected peritonitis, the mainstay of treatment.

Factors affecting prognosis are age, fecal peritonitis, metabolic acidosis, blood pressure, pre-operative organ failure, serum albumin, New York Heart Association cardiac function status, malnutrition, malignoma, cause of infection, site of origin of peritonitis, number of organs involved in multi-organ-failure (MOF).

Diagnosis

The diagnosis of peritonitis is supported by clinical signs, e.g., abdominal pain and tenderness, nausea, vomiting, diminished intestine sounds, fever, shock, and diagnostic tests, e.g., abdominal x-ray, chest x-ray, ultrasound and CT scan. Ultrasound may be positive in up to 72%, CT in up to 82%. Leukocytes and C reactive protein may be altered but are not direct signs of peritonitis.

Antibiotic therapy

Antibiotics most commonly used for treatment of sepsis have insufficient activity to eliminate pathogens that commonly cause surgical sepsis. Regimens with little or no activity against facultative gram-negative rods or anaerobic gram-negative rods are not considered acceptable. Acceptable antimicrobial regimens are carbapenems and newer chinolones (e.g., Imipenem-cilastin) or combinations, e.g., antianaerobes plus aminoglycoside, antianaerobes plus third generation cephalosporins or chinolones, or clindamycin plus monobactam. Community-acquired infections of mild to moderate severity can be treated with Cefoxitin, Cefotetan, Cefmetazole, Ticarcillin-clavulanic acid.

Routine culture of the sites of infection seems worthwhile and empirical therapy should be as comprehensive as possible and should cover all potential pathogens.

Conditions that do not require prolonged antibiotic therapy are early acute appendicitis, acute suppurative appendicitis, simple acute cholecystitis, simple dead bowel, gastroduodenal ulcer perforation, traumatic enteric perforations. Antibiotics are routinely given for 5–7 days for generalized peritonitis. Antimicrobial agents should be continued until temperature and white blood cell count are within normal limits. Duration of antimicrobial therapy in postoperative peritonitis should not be longer than 7 days. Persistent clinical signs of fever or leukocytosis should prompt a search for a drainable focus of infection in the abdomen or treatable site elsewhere. (Grade A, B and C)

Surgical Treatment

The decision on the recommended procedure depends on the grading of the intra-abdominal infection: contamination, infection or sepsis.

In cases of contamination (example: nonperforated appendicitis without pus in the abdominal cavity seen early), treatment consists of appendectomy and lavage. Antibiotic therapy may not be necessary. In the case of infection (example: acute perforation of appendicitis with local pus and inflammation), treatment consists of the resection of the bowel plus intra-abdominal lavage and closure of the abdomen. In case of sepsis (example: perforated diverticulitis of the sigma accompanied by local and systemic infection) treatment includes source control, lavage and a short course of antibiotics (< 5 days).

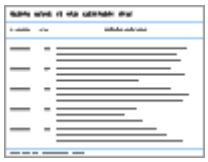

Table I

Control of the infectious focus in laparotomy on demand (more...)

Table I

Control of the infectious focus in laparotomy on demand

Site of infectious focus	surgical management
Stomach	Resection or excision/suture
Duodenum	Excision/suture or resection
Small bowel	Resection with primary anastomosis or enterostomy or suture
Large bowel	Resection with Hartmann procedure or primary anastomosis
Appendix	Appendectomy
Gall bladder	Cholecystectomy
Biliary tree	Drainage and/or resection

In most cases of intra-abdominal infections the basic operative procedure is the Relaparotomy on demand which encompasses control of the infectious focus and intra-abdominal lavage. Close postoperative monitoring of the patient and laparoto it organ dysfunction or signs of sepsis indicate persistent abdominal infection follows immediate Closure of the abdomenDuring the operation the infectious source is closed (sutured), or resected, or exteriorized and irrigation or mechanical cleansing clear remaining bacteria and adjuvants, e.g., blood. Table 1 demonstrates the surgical management of source control in laparotomy on demand.

Source Control

The term source control can be defined as those physical measures undertaken to eradicate a focus of infection, to eliminate ongoing microbial contamination, and to render the local environment inhospitable to microbial growth and tissue invasion.

It is impossible to drain the free peritoneal cavity in peritonitis. Drains designed to remove bacteria and fluid are never effective in free peritonitis unless peritoneal lavage is used. Drains are effective only if their purpose is to evacuate abscesses, establish controlled fistulas, or offer a preferential pathway for the escape of visceral secretions after extensive damage to pancreas or biliary tree.

Intraoperative peritoneal lavage, although well entrenched in modern surgical practice, has not yet demonstrated that the clinical mortality is decreased. No absolute proof exists that the addition of antibiotics to intraoperative lavage is increasing the survival rate. (Grade B and C)

Intestinal re-anastomosis is in most instances not performed in peritonitis.

There is a trend in the literature to make a stoma in cases of anastomotic dehiscence and peritoneal infection. While there is general agreement that on-table bowel preparation and primary anastomosis is safe in the presence of localized peritonitis, its use in the presence of generalized peritonitis is controversial and most surgeons opt for a Hartmann's procedure in this situation. (Grade B and C)

Removal of necroses and fibrin may be more a technical problem. There are possible benefits of surgically removing adjuvants by radical debridement, but this may not translate into better survival. Aggressive debridement is still debated controversially and may not be recommended. (Grade B and C)

There is increasing evidence that laparoscopy may play a definite role in patients with peritonitis. In patients with generalized peritonitis as a result of perforated diverticular disease treatment by laparoscopy and peritoneal lavage was successful. However, laparoscopic management of generalized peritonitis needs further assessment. (Grade C)

Continuous postoperative peritoneal lavage

Several large bore drains are inserted into the abdomen for continuous postoperative irrigation. This procedure may prevent recurrent injuries due to surgery but may not be as effective to cleanse the abdominal cavity than planned relaparotomy. The indications for continuous postoperative peritoneal lavage are not yet well defined. The assessment of lavage fluid allows only conclusions about the general condition of the abdominal cavity and does not distinguish between persisting peritonitis and failed control of septic focus (Grade B and C).

Advanced open operative treatment of peritonitis

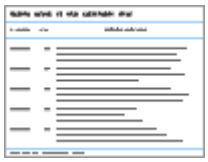

Table II

Indications for advanced open operative procedures

Table II

Indications for advanced open operative procedures

•1 Patient in critical condition (hemodynamic instability) precluding definitive repair
•2 Excessive peritoneal edema

- 3

  No definite source control

- 4

  Incomplete debridement of necrotic tissue

- 5

  Uncertainty about the viability of remaining bowel

- 6

  Uncontrolled bleeding

- 7

  Massive abdominal wall loss

However, in cases of severe diffuse peritonitis without control of focus laparotomy on demand may not be advocated. Table 2 shows indications for advanced operative technique which were developed to treat severe peritonitis.

The goals of advanced open operative treatment of peritonitis are:

- 1

  To eliminate the source that delivers infectious agents into the peritoneal cavity (Source control or repair)

- 2

  To clean the abdominal cavity from microorganisms, toxins, adjuvants (purge)

- 3

To reverse the adverse effects of increased intra-abdominal pressure (decompress)

- 4

  To ensure that the infectious focus remains closed, the abdominal cavity purged and decompressed (control or quality assurance).

There are basically three different types of advanced open operative procedures, the Staged Abdominal Repair (STAR) (Etappen-lavage, planned relaporatomy) where the decision to plan a relaparotomy is made at the initial operation for intraabdominal infection and this initial (or index operation) is not a planned re-operation, and the open or mesh abdominostomy, which are both frequently combined with relaparotomies, either planned or on demand.

Open abdominostomy generally defined as a laparotomy without re-approximation and suture of the abdominal fascia. Synonyms are abdomen left open, controlled open drainage, dorsoventral lavage, l'évisceration controllée, l'évisceration ouverte, la paroi ouverte, laparostomie d'irrigation, laparostomy.

Mesh abdominostomy is defined as laparotomy without re-approximation and suture closure of the abdominal fascia. The fascial gap is covered with a mesh consisting of various artificial materials or mobilized skin. Synonyms are laparostomy, Olgivie method, l'évisceration couverte, open abdomen, chirurgie iterative, planned relaparotomy, open fascia — skin closed, open-closed technique, medial myocutaneous advancement technique.

Material used to cover the abdominal wound and is not attached to fascia includes polyurethane foam or plastic tent. Meshes were consisting of polypropylene, polyglycolic acid, nylon, silastic, nylon stockings, latex tubes, simple infusion bag or other material. Underneath retention sutures have been used in attempts to close the gap between the fascial edges.

STAR Abdominostomy - Planned relaparatomy

This procedure consists of multiple planned relaparotomies with staged re-approximation and final suture closure of the abdominal fascia utilizing a zipper, a mesh with zipper or suture, an artificial burr, a slide fastener (Ethizip,) or simply sutures. Synonyms: programmed relaparotomy, scheduled re-exploration, planned relaparotomy, planned re-operation, sequential abdominal re-exploration, temporary abdominal closure, “Etappenlavage”, open abdomen, open packing, and open management with Marlex mesh and zipper.

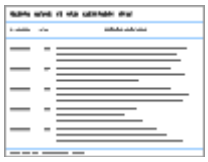

Table III

Complications in advanced open operative procedures (more...)

Table III

Complications in advanced open operative procedures for the treatment of peritonitis

Type of complication	Open abdominostomy	Mesh abdominostomy	STAR (planned relaparotomy) abdominostomy
Intraoperative hemorrhage	12%	6%	1%
Recurrent intra-abdominal infection	23%	15%	8%

Type of complication	Open abdominostomy	Mesh abdominostomy	STAR (planned relaparotomy) abdominostomy
Wound infection after final closure	100%	82%	8%
Abscess formation after final closure	22%	29%	0%
Fistula formation	16%	10%	5%
Hernia formation after abdominostomy	96%	68%	7%
Mortality	41.7%	39.1%	28.1%

The rates of intraoperative hemorrhage, recurrent intra-abdominal infection, abscess formation and wound infection after final closure, fistula formation, hernia formation after abdominostomy differ among the advanced open peritonitis procedures. However, the mortality rates are comparable. (Table 3) (Grade C)

Conclusion

Until a convincing controlled trial is performed the role of advanced operative strategies for intra-abdominal infection will continue to be controversial. There is a lack of prospective studies comparing the methods for advanced operative treatment and standard treatment. The results of reported studies are compared with the author's own results in the past or with those in earlier reports in the literature. So most of the

evidence for the surgical treatment of peritonitis comes from case series, non-randomized historic cohort studies (Grade C). There are only few studies where results are reported from non-randomized concurrent cohort studies (Grade C) or from randomized controlled studies (Grade A and B).

There is no difference in mortality when advanced operative procedures are compared to standard procedure. Clear indication for the use of procedures is missing. It is not yet decided which is the best material to cover the gap between the opened abdominal fascia in advanced open procedures.

The treatment of choice in most cases of intra-abdominal infection is the relaparotomy on demand. In certain cases with diffuse peritonitis advanced open surgical operations may be recommended.

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