Hot Topics in Acute Care Surgery and Trauma

Francesco Piscioneri
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Luca Ansaloni *Editors*

Emergency Surgery for Low Resource Regions

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Hot Topics in Acute Care Surgery and Trauma

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Preface

The last 30 years have seen rapid advances in surgery. Not only has there been more knowledge gained about surgical pathology and its treatment through high-quality research, but also technological advancements have allowed better imaging, early diagnosis and more specialised operative equipment. The modern operating theatre is virtually space age compared to the operating environment of 30 years ago.

This progress has not been equitable. Low resource regions are disadvantaged owing to the discordance between low levels of education and training, high patient volumes and reduced access to sophisticated imaging and theatre. Most research and technology advances are aimed at the highly resourced institutions and services.

Unfortunately, this has resulted in a widening of the gap in surgical healthcare provision between well and poorly resourced regions. A global surgery approach aims to bring those advances in knowledge and technology to the lower resource regions in an efficient and sustainable manner so that other services are not disrupted.

This latter is very important in that any new initiative must not only be sustainable, but it must not create opportunity costs in other areas. There are many good projects around the world which deliver training, service and ongoing collaboration between highly resourced and low resource regions.

Most modern textbooks and related resources in surgery are aimed at those who have trained and worked in highly resourced regions. The aim of this work is to identify topics in emergency surgery that can be safely managed in low resource regions using the knowledge and techniques that are available in better resourced areas.

The chapter authors have been asked to look at current knowledge and management and then extrapolate it to areas that are less well resourced. This work is not meant to be a textbook of emergency surgery. The aim is to complement current textbooks and give guidance on how to manage those conditions in the lower resourced areas.

We welcome feedback and suggestions so that we may further improve the information provided here.

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Part I

Principles of Surgery

Role of Antibiotics in Surgery

1

Francesco Piscioneri

In surgical practice, antimicrobial therapy is administered in three types of situations—prophylaxis, adjunct to operative treatment, and as therapy.

Antibiotics are classified based on their mechanism of action, chemical structure, or spectrum of activity. Most target bacterial function or growth processes. With the advent of modern medicine and chemistry, most antibacterial products are semisynthetic modifications of natural compounds.

1.1 Antibiotic Prophylaxis

Prophylactic antibiotics are used more often to prevent infection of a surgical site (SSI). The principles include

1. Safety of agent and effects to patient
2. Little to no reliance on the agent for therapeutic purposes
3. A narrow spectrum of coverage of relevant pathogens
4. Understanding the target tissue concentration
5. Administration within 1 h of surgery and for a defined period thereafter

It is clear that most SSIs are caused by inoculation with gram-positive cocci. Thus, prophylaxis should be directed principally against staphylococci for clean cases and for high-risk clean-contaminated elective biliary and gastric surgery. In these circumstances, a first-generation cephalosporin is desirable with clindamycin reserved for penicillin-sensitive patients. In gastrointestinal surgery or contaminated situations, either a second-generation cephalosporin or a first-generation

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cephalosporin in combination with metronidazole is used. Vancomycin prophylaxis is appropriate in institutions with a high incidence of methicillin-resistant staphylococcus aureus (MRSA) infections.

The optimal time for antibiotic prophylaxis is administration within 1 h of incision with little to no benefit gained in SSI prevention if administered during or after the procedure. Exceptions to the former are in situations where there is evidence of infection and gross contamination. However, redosing every 2–3 h is recommended for agents with short half-lives (i.e., cefazolin). There is no evidence to support the use of antibiotics in the setting of catheters or drains. It should be remembered that antibiotics should not be used as a substitute for poor surgical technique.

Low resource regions should endeavor to develop their antibiotic guideline practices to complement local microbiome, resistance, and allergy patterns.

1.2 Therapeutic Use of Antibiotics

Antimicrobial therapy is the use of agents in the setting of established or highly suspected infection. It encompasses empirical or directed therapy.

Effective therapy with no toxicity is the goal. To achieve this, a careful but expeditious search for the infectious source is key. A clinical diagnosis is established after careful history and examination. Biochemical analysis may complement the clinical assessment. Of importance is the identification of lactic acidosis, leukopaenia, thrombocytopaenia, and left-shift-leucocytosis. This warrants empirical antimicrobial therapy while appropriate clinical specimens are obtained for microscopy and culture and other related analysis. It is important to consider wounds as a source and thus debridement and drainage compliments the commencement of antimicrobial therapy.

Directed antibiotic therapy is based on several interrelated factors. Though it is paramount to select agents that are directed against the microorganisms in question, it is desirable to narrow the spectrum of cover when clinically appropriate. Indiscriminate use of antibiotics carries significant risks that are not limited to cost, resistance, and drug toxicity. As anywhere else, it is essential to understand local antimicrobial resistance patterns when prescribing antimicrobials. Further to this, it is important to establish the mode of acquisition (hospital vs community) and its associated patterns when deciding on therapy. Patient factors such as allergy status, immunosuppression, hepatic and renal impairment, existing microorganism-drug-resistance (MDR), and comorbidities play a pivotal role in the antimicrobial prescription algorithm.

In some low resource regions, the lack of ability to assess titer levels and therapeutic drug assays narrows the decision of antibiotic prescription and rationalization. Thus, the value of a multidisciplinary approach (e.g., infectious/ tropical disease specialist) to caring for such patients is invaluable.

1.3 Summary

Antibiotics are a powerful tool in the treatment of infection. Their use is complementary and symbiotic. Local guideline formulation and a multidisciplinary model of care provide a supportive environment for these complex patients to limit risks of resistance, toxicity, and failure of therapy. All surgeons should be familiar (or have access to) with local antibiotic guidelines.

DVT Prophylaxis

2

Gajen Perinpanayagam

The burden of disease represented by venous thromboembolic (VTE) disease is significant, particularly in the hospitalized populations. Surgery itself represents a risk factor for VTE. A multi-modality approach achieves the best overall outcome.

VTE prophylaxis comes in three main forms: ambulation, chemical/pharmaceutical prophylaxis, and mechanical prophylaxis. These methods have synergistic effects. Patients who take regular antithrombotic medications for preexisting VTE or VTE risk factors represent a unique problem. In this population, a thorough assessment of each patient's preexisting risk factors, as well as those represented by their impending operation, needs to be made to decide when to stop their antithrombotic agents, and whether bridging therapy is required. As with many clinical decisions, cost-effectiveness of treatments has to be considered based on local circumstances.

2.1 Introduction

Virchow's triad underpins VTE pathophysiology. The clinical factors predisposing to VTE are immobilization, trauma, surgery, malignancy, and previous VTE. The nonclinical factors predisposing to VTE are age, obesity, infection, the immediate postpartum period, varicose veins, dehydration, hormone treatment, and thrombophilias. Post-thrombotic chronic venous disease is not often considered but can lead to deep venous obstruction or reflux, and the subsequent skin changes and ulceration can decrease quality of life and become quite costly over time.

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There is a low rate of appropriate VTE prophylaxis around the world, particularly for acutely ill patients. Education, hospital-wide protocols, VTE prevention audits, and clinical nurse specialists have all been shown to substantially increase the appropriate application of VTE guidelines. The risk profile for surgical patients and the associated treatments vary substantially for orthopedic and non-orthopedic procedures, and thus they will be discussed separately. There will be a brief outline of periprocedural management of anticoagulation and the cost-effectiveness of VTE prevention.

2.2 Non-Orthopedic Patients

In non-orthopedic patients, the most widely used tool for quantification of VTE risk is the modified Caprini risk assessment model from the American College of Chest Physicians (Table 2.1). The model has been validated for patients having general and abdominal/pelvic, including the critically ill among them.

One of the most important components in VTE prophylaxis decision-making is estimating the risk of bleeding. Major bleeding includes fatal bleeding, symptomatic bleeding in a critical region or organ, bleeding that causes a hemoglobin drop of ≥20 g/dL, and/or bleeding that necessitates transfusion of two or more units of packed red blood cells. The ideal method of risk assessment involves determining the patient's baseline risk of major bleeding based on the type of procedure (Table 2.2) they are having and then modifying that risk based on individual risk factors. In non-orthopedic surgical patients, the primary individual risk factors for major bleeding are bleeding as the cause for surgery; intracranial hemorrhage; development of moderate or severe coagulopathy; underlying bleeding disorder; or thrombocytopaenia. Patients at low risk (<2%) for major bleeding are those having uncomplicated general abdominal/pelvic, bariatric, vascular, and thoracic surgery. Those at high risk include patients having cardiac surgery and those with major trauma, particularly to do with the brain or spine, are considered to be at the highest risk. Also included in the high-risk category are patients in whom bleeding could be considered catastrophic such as neurosurgical patients in which thromboprophylaxis could cause spinal or intracranial hemorrhage. Mechanical prevention methods include interventions such as intermittent pneumatic compression (IPC), venous foot pumps (VFP), and graduated elastic compression (GEC) garments. Mechanical methods are thought to reduce the risk of VTE by increasing blood flow in the deep veins of the legs, inhibiting the venous stasis component of Virchow's triad. IPC increases endogenous fibrinolytic activity. Chemical prophylaxis includes drugs like vitamin K antagonists (VKA), low molecular weight heparin (LMWH), unfractionated heparin (UFH), oral factor Xa inhibitors/novel oral anticoagulants (NOAC), and fondaparinux.

The preferred options approach outlined in this chapter are consistent with the majority of reputed guidelines. It is important to note that the recommendations outlined are largely for patients at low risk for bleeding. Treatment approaches should be adapted according to the risk of major bleeding.

Table 2.1 Modified Caprini risk assessment model for VTE in general surgical patients

Risk score			
1 point	**2 points**	**3 points**	**5 points**
• Age 41–60 years • Minor surgery • BMI >25 kg/m^2 • Swollen legs • Varicose veins • Pregnancy or postpartum • History of unexplained or recurrent spontaneous abortion • Oral contraceptives or hormone replacement • Sepsis (<1 month) • Serious lung disease, including pneumonia (<1 month) • Abnormal pulmonary function • Acute myocardial infarction • Congestive heart failure (<1 month) • History of inflammatory bowel disease • Medical patient at bed rest	• Age 41–60 years • Minor surgery • BMI >25 kg/m^2 • Swollen legs • Varicose veins • Pregnancy or postpartum • History of unexplained or recurrent spontaneous abortion • Oral contraceptives or hormone replacement • Sepsis (<1 month) • Serious lung disease, including pneumonia (<1 month) • Abnormal pulmonary function • Acute myocardial infarction • Congestive heart failure (<1 month) • History of inflammatory bowel disease • Medical patient at bed rest	• Age ≥ 75 years • History of VTE • Family history of VTE • Factor V Leiden mutation • Prothrombin 20210A mutation • Lupus anticoagulant • Anticardiolipin antibodies • Elevated serum homocysteine • Heparin-induced thrombocytopenia • Other congenital or acquired thrombophilia	• Stroke (<1 month) • Elective arthroplasty • Hip, pelvis, or leg fracture • Acute spinal cord injury (<1 month)
Guide to interpretation:			
Surgical risk category		**Score**	**Estimated VTE risk in the absence of prophylaxis (%)**
Very low		0	<0.5
Low		1–2	1.5
Moderate		3–4	3.0
High		≥5	6.0

Table 2.2 Risk of major bleeding in non-orthopedic patients

Type of surgery	Risk of major bleeding (%)
General/abdominal/pelvic surgery	1
Bariatric surgery	<1
Plastic and reconstructive surgery	0.5–1.8
Vascular surgery	0.3–1.8
Cardiac surgery	5 (high risk)
Thoracic surgery	1
Neurosurgery	
• Craniotomy	1–1.5
• Spinal surgery	<0.5
Major trauma	3.4–4.7

(Source—Tables 2.1 and 2.2)

2.3 Very Low Thrombosis Risk

According to the Caprini model (Table 2.1), patients at very low risk of thrombosis are those with a score of 0 undergoing general/abdominal/pelvic surgery, or those with a score of 0–2 undergoing plastic/reconstructive surgeries. Examples include young, healthy patients having minor outpatient procedures: laser eye surgery, cataract removal, skin biopsy, benign breast biopsy, diagnostic endoscopy, nasal polypectomy, dilatation and curettage, colposcopy, or aspiration of joint effusion.

For non-orthopedic surgical patients at very low risk of VTE, the prophylaxis of choice is early and frequent ambulation. The majority of patients in this group are able to mobilize promptly after surgery, substantially reducing their risk of VTE. For exceptional circumstances in which these patients are unable to ambulate, the recommendation is mechanical prophylaxis in the form of GEC garments, VFP, or IPC. Adequate hydration is also important in this group.

2.4 Low Thrombosis Risk

Patients who are at low risk (Table 2.2) for VTE include those with a modified Caprini score of 1–2 undergoing general/abdominal/pelvic surgery, or those with a score of 3–4 undergoing plastic/reconstructive surgeries. Examples include patients having: minor elective abdominal/pelvic surgery such as appendicectomy or laparoscopic cholecystectomy; minor thoracic surgery such as diagnostic thoracoscopy or video-assisted biopsy; minor vascular procedures such as vein ablation; and elective spinal surgery such as spinal fusion. For non-orthopedic surgical patients at low risk of VTE, the prophylaxis of choice is mechanical. In these patients, the risk of VTE is sufficiently high to justify the use of prophylaxis, but not enough to warrant the risk of bleeding that comes with pharmacological methods. Pharmacological prophylaxis may be indicated for patients at low risk of major bleeding with individual risk factors for VTE.

2.5 Moderate or High Thrombosis Risk

Patients who are at moderate risk for VTE include those with a modified Caprini score of 3–4 undergoing general/abdominal/pelvic surgery, or those with a score of 5–6 undergoing plastic/reconstructive surgeries. Examples include those patients undergoing major gynecological or urological surgery, major cardiac or thoracic surgery, bariatric surgery, ankle fracture repair, neurosurgical procedures, or who have sustained non-extensive trauma which does not involve the central nervous system.

High-risk patients include those with a modified Caprini score of 5 or more undergoing general/abdominal/pelvic surgery, or those with a score of 7–8 undergoing plastic/reconstructive surgeries. Examples include patients undergoing: extensive abdominal/pelvic, thoracic surgery, distal colorectal resections, or pelvic exenteration; major trauma procedures, particularly when they involve the brain or spine; acute spinal cord injuries; and cancer surgery.

For non-orthopedic surgical patients at moderate or high risk of VTE with low bleeding risk, the prophylaxis of choice is pharmacological. In selected patients for whom the risk of VTE is particularly high (multiple risk factors, surgery for active malignancy), a multimodal approach using chemical and mechanical prophylaxis is recommended. In these patients, a combination of mechanical prophylaxis such as IPC or GEC with chemical prophylaxis such as LMWH or UFH confers greater protection against VTE than either method on its own.

For non-orthopedic surgical patients at high risk of bleeding, those who have a contraindication to pharmacologic prophylaxis, or those in whom bleeding would have catastrophic consequences (neurosurgical procedures), mechanical prophylaxis alone is recommended. In this group of patients, it is recommended adding, or switching to, a form of chemical prophylaxis as soon as the bleeding risk had adequately dropped, and/or adequate hemostasis has been achieved.

2.6 Timing of Initiation

For those patients in whom VTE prophylaxis is indicated and the bleeding risk is low, mechanical methods should be instituted just prior to surgery while pharmacological agents should ideally start 2–12 h prior to surgery (depending on the pharmacokinetics of the agent chosen). The timing, particularly for pharmacological prophylaxis, should be adjusted on an individual basis according to risk factors, and the type of prophylaxis being used. An exception to this recommendation lies in the use of neuraxial anesthetic, particularly indwelling epidural catheters, or the requirement for a spinal puncture. In these patients, there should be consultation with local anesthetic expertise, with the usual practice being to avoid preoperative pharmacologic agents in these patients, and withholding postoperative administration until 6–8 h after epidural catheter removal.

2.6.1 Duration

Around the world VTE prophylaxis appears to be prescribed for an average of 10 days, however variability in the definition, or interspersed periods of immobility may justify a longer course of prophylaxis. This is particularly important given that VTE risk does not disappear on discharge/ambulation but can continue for weeks after surgery. In patients who undergo major abdominal/pelvic surgery, particularly for active malignancy, there is evidence for VTE prophylaxis with LMWH for 10–28 days post-surgery.

2.6.2 Dosing

For dosing requirements and timing of commencement, refer to product label statements, manufacturer's recommendations, and local guidelines.

LMWH is recommended as the default pharmacologic agent of choice for VTE prophylaxis. There are a number of preparations of LMWH and none have a proven advantage over the others.

2.6.3 Enoxaparin

In patients without cancer, use 40 mg subcutaneously, 2 h prior to abdominal surgery, or 12 h prior to all other surgeries. Following this, use 40 mg subcutaneously, daily, 2–72 h postoperatively once hemostasis is achieved and the bleeding risk is acceptable. In patients with cancer, use 20 mg subcutaneously, 2–4 h prior to surgery, or 40 mg subcutaneously, 10–12 h prior to surgery. Recommence 40 mg subcutaneously, daily, 6–12 h after surgery.

2.6.4 Dalteparin

Use 5000u subcutaneously, 12 h prior to surgery and restarting the same dose daily, following surgery, once hemostasis is achieved and the bleeding risk is acceptable.

2.6.5 Tinzaparin

Use 4500u subcutaneously, 12 h prior to surgery and restarting the same dose daily, following surgery, once hemostasis is achieved and the bleeding risk is acceptable.

2.6.6 Unfractionated Heparin

Low dose heparin is a viable alternative to LMWH and is the recommended agent in the setting of renal insufficiency. Give 5000u subcutaneously, at least 2 h prior to

surgery and restarting the same dose, twice daily, following surgery once hemostasis is achieved and the bleeding risk is acceptable.

All patients having LMWH or UFH should have regular monitoring of their platelet counts to detect heparin-induced thrombocytopaenia (HIT) as early as possible. Heparin-based agents are contraindicated in all patients with active HIT or a history of HIT.

2.7 Orthopedic Patients

In orthopedic patients, the risk of VTE is significant and is related to both procedure and patient-related factors. Procedure-related factors include type of anesthesia, the likelihood of immobilization, postoperative casting, and extent/duration of surgery. Patient-related factors include age >75 years, poor ambulation prior to surgery, obesity, and cardiovascular disease.

With orthopedic operations, the risk of VTE is highest for patients who have total hip/knee arthroplasties, hip fracture surgeries, hip fractures for conservative management, pelvic fractures, and multiple fractures resulting from severe trauma. The lowest risk procedures are foot/ankle fractures, and surgery or arthroscopy of tibial/shoulder/elbow. Spinal and epidural anesthetics can reduce thromboembolism in patients undergoing hip and knee surgery but other mechanical methods should also be used.

2.8 Total Hip/Knee Arthroplasty and Hip Fracture Surgery

For patients in whom the risk of bleeding is low, many surgeons advocate for the use of combined prophylaxis with a pharmacological agent in conjunction with GEC garments or IPC. The preferred agent for these patients is LMWH or one of the NOACs (non-vitamin K antagonist oral anticoagulants), particularly rivaroxaban or apixaban. In patients having hip fracture surgery, LMWH is the preferred option.

In patients with significant renal impairment, unfractionated heparin is preferred however if patients cannot tolerate subcutaneous injections, warfarin can be used. This should be continued for 10–14 days.

Aspirin is not suitable as a single agent for VTE prophylaxis but in particularly low-risk patients, it can be used after 5 days of rivaroxaban. For patients at high risk of bleeding, or in whom chemical prophylaxis is contraindicated, use mechanical methods, ideally IPC. GEC garments can be used; however, IPC has been shown to be more effective. Specific to patients with fractures, if there is a delay in surgery, recommend starting prophylaxis with LMWH or IPC as close to the time of fracture as possible.

2.9 Timing of Initiation (for Hip/Knee Surgery)

With regards to the timing of administration, LMWH and UFH should not be given close to the time of surgery with current recommendations being 12 h or more preoperatively and postoperatively. Mechanical prophylaxis should be used just prior

to surgery and continued until hospital discharge or full ambulation. In the case of combined prophylaxis, pharmacological agents can be added as soon as adequate hemostasis has been achieved, usually 12–72 h postoperatively. Factor Xa inhibitors and VKA should be started no earlier than 8–12 h postoperatively.

2.9.1 Duration

In patients with total hip/knee arthroplasty or hip fracture surgery, VTE prophylaxis is recommended for a minimum of 10–14 days and should ideally be continued for a total of 35 days. Prophylaxis should certainly be continued at least until patients are discharged home and/or ambulating fully.

In patients whom mechanical prophylaxis is being used in place of chemical prophylaxis due to bleeding risk, it should be continued for as long as tolerated by the patient, and be replaced with pharmacologic prophylaxis as soon as it is safe to do so.

2.9.2 Dosing

For dosing requirements and timing of commencement, refer to product label statements, manufacturer's recommendations, and local guidelines.

2.9.3 Enoxaparin

In total hip arthroplasty give 30 mg subcutaneously, twice daily or 40 mg, once daily, started at least 12 h before, or after surgery. For total knee arthroplasty use 30 mg subcutaneously every 12 h, started at least 12 h before, or after surgery. Please note that dose adjustment is advised with obesity and/or renal insufficiency.

2.9.4 Unfractionated Heparin

Use 5000u subcutaneously twice daily. Again, dose adjustment is advised with obesity.

2.9.5 Warfarin

Patients should be commenced on 5 mg orally, once daily, 12–24 h after surgery. The target INR should be a range between 2 and 3, therefore many patients will need adjusted dosing.

2.9.6 Rivaroxaban

Use 10 mg orally, once daily, 6–10 h after surgery.

2.9.7 Apixaban

Use 2.5 mg orally, twice daily, 12 h after surgery.

2.10 Lower Extremity Injuries Requiring Immobilization

In most patients with lower extremity injuries requiring immobilization, use LMWH. In younger patients without significant risk factors, VTE prophylaxis can be avoided all together if early ambulation is feasible. If prophylaxis is given, it should be continued for the duration of immobilization.

2.11 Multiple Trauma

In patients without intracranial bleeding in whom hemorrhage has been controlled, use LMWH initiated within 36 h of injury. In the subset of these patients in whom anticoagulation is precluded, use IPC. Patients who receive LMWH or IPC should continue treatment until they are fully ambulant. The routine use of IVC filters is not recommended in patients without proof of DVT.

2.12 Pregnancy and VTE Prophylaxis

The risk of venous thromboembolism (VTE) is increased in all trimesters of pregnancy, and especially in the postpartum period. Although most women do not require prophylaxis, those who are considered to be at the greatest risk are generally targeted for VTE prevention.

Antepartum pharmacologic prophylaxis is considered for patients with a history of a single idiopathic, pregnancy-associated, or estrogen-associated VTE, and in those with a history of multiple VTEs, regardless of the cause. Pharmacologic prophylaxis is also considered for patients with a known thrombophilia and a history of VTE and for patients with certain “high risk” thrombophilias plus a family history of VTE.

Women who are hospitalized antenatally for nondelivery reasons, the same criteria for pharmacologic thromboprophylaxis should be used as in the outpatient setting.

Women in whom the decision is made to administer pharmacologic prophylaxis, heparin-based regimens are safer than oral anticoagulants. Therefore, low molecular weight heparin rather than unfractionated heparin is recommended provided the patient does not have renal insufficiency.

Postpartum VTE prophylaxis is initiated when a history of prior VTE (single or multiple) regardless of the provoking factor (transient or persistent) and in a subset of patients with inherited thrombophilia without a personal history of VTE. In such a situation, thromboprophylaxis should be continued for 6 weeks to 3 months. Following the cesarean section, thromboprophylaxis is continued until the patient is ambulatory.

2.13 Periprocedural Management of Antithrombotic Therapy and Bridging Anticoagulation

The periprocedural management of anticoagulants in patients requiring surgery is a very common problem. Decision-making in these patients requires careful balancing of risk of VTE when anticoagulation is ceased with the risk of bleeding during, and after, surgery. In reality, two decisions are required: firstly, whether the patient's longstanding anticoagulation needs to be ceased prior to surgery; and secondly whether temporary, or bridging, anticoagulation is needed in the perioperative period.

At present, there is no validated scoring system for the risk of bleeding related to procedures. One proposed mechanism is the use of a two-tiered system separating procedures into high and low bleeding risk. Procedures classified as high-risk are major operations lasting >45 min, vascular procedures, cardiothoracic procedures, major orthopedic surgeries, prostate/bladder surgery, and extensive cancer operations. Low-risk procedures include most operations less than 45 min, diagnostic gastrointestinal procedures, dental procedures, dermatological procedures, and ophthalmological surgeries.

If bridging therapy is being administered, usually in the form of therapeutic-dose LMWH, the final dose should be administered 24 h prior to the procedure. In the case of intravenous heparin as bridging therapy, the infusion should be ceased 4 h prior to the procedure. In terms of resuming bridging therapy, following minor procedures, LMWH should be recommenced within 24 h assuming adequate hemostasis has been achieved. For major surgery, or procedures at high risk of bleeding, there are three suggested options:

- delaying LMWH for 2–3 days after surgery,
- using low-dose LMWH within 24 h of the procedure,
- avoiding bridging therapy altogether if the VTE risk for the patient allows it.

2.14 Summary

Patients at highest risk of VTE include patients who are critically ill, patients with cancer or stroke, and patients with multiple risk factors for VTE including pregnancy, heart failure, myocardial infarction, old age (>75 years), previous VTE, prolonged immobility, renal failure, obesity, and inherited or acquired hypercoagulable states.

Special populations require an individualized approach to thromboprophylaxis during acute hospitalization. These include patients with heparin-induced thrombocytopenia, patients undergoing neuraxial anesthesia, patients with stroke or cancer, patients who are traveling for extended periods, and patients who are pregnant.

Each institution should develop a formal strategy for the prevention of VTE. This should aim to increase compliance while maintaining an equitable health care delivery system.

Nutrition in Surgical Patients

3

Francesco Piscioneri

Malnutrition is relatively common in surgical patients and is an important part of surgical care. It is associated with higher infection rates, extended hospital stays, and increased morbidity and mortality.

The role of nutritional support is to bridge the division between catabolism and anabolism with the goal to minimise protein breakdown thus preserving lean body mass, promoting protein synthesis, and optimising immune responses.

3.1 Components of Nutrition

The basic components are

- Water
- Carbohydrates
- Fats
- Proteins
- Vitamins
- Minerals and trace elements.

3.2 Nutritional Assessment

Factors to be considered include body weight, body mass index, serum proteins, immunocompetence, and nitrogen balance. Greater than 20% loss of weight is associated with higher morbidity and mortality.

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Basic requirements to be factored in

- 25 kcal/kg/day
- protein 1.5–2 g/kg/day (not included in calorie count)
- carbohydrate—aim for 70% of caloric requirements
- lipid—upto 30% of caloric requirement
- These figures may need to be greatly increased in patients under stress (e.g. Burns, ICU patients).

3.3 Malnutrition Prior to Surgery

Many patients present with pre-existing features of malnutrition.

- Lack of food—quality, neglect, alcohol and drug abuse, elderly patients
- Swallowing difficulty—dysphagia from a variety of causes including tumour, achalasia, oesophagitis, corrosive stricture
- Vomiting—mechanical obstruction, psychological, toxins
- Diarrhoea—infective (e.g. cholera), inflammatory (e.g. Crohn's disease)
- Malabsorption—short gut syndrome, pancreatic insufficiency, chronic biliary obstruction, mucosal (coeliac disease), small bowel fistula.

This is further compounded by the fact that emergency patients are often kept fasting for several days whilst being evaluated and waiting for surgical treatment. It is important that a nutritional assessment is carried out on admission and a plan is put in place to minimise the impact of further nutritional depletion.

3.4 Post-operative Malnutrition

Any delay in returning to a normal diet risks malnutrition. This also applies to multiple trauma patients. Patients who have had surgery to the digestive tract are especially at risk as it may take many days for intestinal recovery to be sufficient to allow adequate nutritional intake. Other patients to consider are those where there has been extensive surgery or damage to the oral cavity and may not be able to take food by this route for an extended period of time.

Hypercatabolic patients are also at risk. They need a high caloric replacement. These include patients with ongoing sepsis and those with extensive burns.

3.5 Pathophysiology

Glucose stores are consumed within the first 24 h. After that muscle breakdown commences.

In the first 3 days, there is significant weight loss due to water, sodium, and protein loss. After this time the rate of catabolism slows down. Daily nitrogen losses go from about 10 g per day to approximately 4 g per day over the next few weeks.

Fat gradually becomes the major supplier of energy replacing glucose. The brain and the red blood cells still require glucose which is produced from amino acids by gluconeogenesis in the liver.

After 3 weeks of starvation, the brain adapts using the fat-derived ketones as an energy source.

3.6 History and Examination Findings

History

- Weight loss/gain
- Presence of chronic diseases
- Infection
- Details of current hospitalisation
- Medications
- Allergies and food intolerances
- Evidence of decreased dietary intake
- Gastrointestinal dysfunction
- Metabolic demands

Examination

- Height and weight
- Muscle wasting
- Head and neck—dentition, hair loss, temporal wasting, conjunctival pallor, angular stomatitis, thyromegaly
- Extremities—evidence of peripheral neuropathy, tetany, loss of subcutaneous fat, oedema of sacrum and ankles
- General—ascites, evidence of heart failure, pressure ulcers, ecchymoses

3.7 Laboratory Tests

There are some simple laboratory investigations that can help in the assessment of malnutrition.

- Serum albumin below 35 g/L
- Lymphocyte count below 1–1.2 $\times 10^9$
- Serum transferrin below 100–200 mg/dL
- Cholesterol levels consistently below the patient's normal range
- Iron studies
- Serum electrolytes and glucose levels.

3.8 Routes of Administration of Nutrition

These can be classified as either enteral or parenteral.

The enteral route is preferred as it utilises the body's natural absorptive and digestive surfaces. It has reduced complications and is simpler, safer, and cheaper than parental support. Enteral feeding includes oral, nasogastric, gastrostomy, jejunostomy, or variations of these.

Parenteral refers to all nutrition entering via an intravenous route, the main form being total parenteral nutrition (TPN).

Access for enteral feeding may require surgical approach if a feeding gastrostomy or jejunostomy is required. This can be done laparoscopically or open. TPN is best administered by a central venous line. A peripherally inserted central catheter (PICC) is also an option.

3.9 Components of Nutrition

Enteral feeds are the simplest to prepare. They can range from a simple home-made diet that can be administered in either solid or liquid form, to prepared commercial formulations that contain all the nutritional requirements in an easily digestible format. These have the advantage of maintaining the integrity of the intestinal mucosa. They are easy to maintain and look after both in hospital and at home.

Parental feeds are highly specialised. The access points need special care so as to avoid any risk of infection. Feeds need to go into a large vein and have to be carefully calculated in order that nutrients are given correctly and safely. This is a highly specialised area and needs experienced and trained physicians to manage the service. As the bowel is not utilised, there is a risk of intestinal mucosal atrophy as a result. It is also a very expensive alternative. Hence, parenteral feeding is only used when the enteral route is not available.

3.10 Complications

Enteral nutrition has the least complications.

- Tube will displace requiring reinsertion
- Hyperosmolar diarrhoea
- Nausea, vomiting
- Dyspepsia
- Risk of refeeding syndrome

TPN has a higher complication profile.
Insertion problems include

- Air embolism, haematoma, subclavian artery puncture
- Pneumothorax, haemothorax
- Brachial plexus injury, phrenic nerve injury
- Catheter malposition, thromboembolism

Metabolic and other complications

- Dehydration/overhydration
- Alkalosis/acidosis
- Hyperlipidaemia
- Hypocalcaemia/hypercalcaemia
- Hypoglycaemia/hyperglycaemia
- Coagulation defects
- Cholestasis
- Refeeding syndrome
- Infective complications

3.11 Refeeding Syndrome

This refers to pathological shifts of fluids and electrolytes that may occur in malnourished patients receiving artificial refeeding whether it be enteral or parenteral. Hormonal and metabolic changes can lead to severe complications. The syndrome is typified by hypophosphataemia.

During refeeding there is increased insulin and increased secretion of glucagon. This leads to stimulation of protein, fat, and glycogen synthesis. Potassium, magnesium, and phosphate are taken up into the cells with a corresponding fall in serum levels. Water follows by osmosis.

Patients at highest risk are the chronically malnourished and those who had had very little energy intake for more than 10 days. It is important to be aware of refeeding syndrome and to recognise at-risk patients as the condition is avoidable.

In at-risk patients, refeeding is started with low levels of calories, amino acid supplementation, and progressive correction of fluid and electrolytes.

3.12 Monitoring

Patients can be monitored both clinically and by laboratory studies.

Laboratory studies include the standard electrolyte and blood screens including liver function tests, acid and base balance, as well as vitamin assays.

Clinical monitoring is also very useful. This includes weight gain, and functional measures such as strength, coordination, and exercise tolerance.

3.13 Summary

Surgical patients are at risk of nutritional depletion and malnutrition. This is especially so in patients admitted to the intensive care unit as they are often very ill and have severe metabolic derangements.

It is important to be aware of which patients are a nutritional risk very early in their admission and interventions should be put in place to decrease these risks.

The enteral approach should always be used where possible leaving TPN as the final option.

Careful attention to nutrition is achievable at all levels of care if the problem is recognised early.

Critically Ill Surgical Patients

4

Francesco Piscioneri

This chapter does not aim to cover Surgical Critical care but rather look at how the surgeon can optimise the care of the more critically ill patients. There will be a discussion on monitoring of critically ill surgical patients and the final part will discuss the importance of sepsis in surgical patients.

4.1 Optimisation of High-Risk Patients

With the ageing of the population, there is an increase in significant comorbidities. More and more complex procedures are being offered to elderly patients. Those with multiple conditions and advanced systemic illness are more susceptible to complications even with minor surgical procedures.

There are several grading systems to help determine at-risk patients. The most well-known is the American Society of Anaesthesiologists (ASA) classification for operative risk assessment. This classification stratifies patients into five categories (Table 4.1).

Major surgery has multiple effects on organ systems which can in some cases lead to multi organ dysfunction syndrome (MODS). The underlying causes are tissue ischaemia and the body's stress response.

Tissue ischaemia is related to decreased blood volume both due to the underlying condition and the effects of surgery. The stress response is caused by the release of cytokines and other vasoactive substances which would reduce blood flow to susceptible organs such as the gut. Tissue ischaemia also has the added effect of releasing further cytokines as a result of anaerobic metabolism.

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Table 4.1 ASA grading of operative risk

ASA grade	Description	Estimated mortality
I	Normal, healthy	0.06–0.08%
II	Mild systemic disease and no functional limitations	0.27–0.4%
III	Moderate to severe systemic disease that results in some functional limitation	1.8–4.3%
IV	Severe systemic disease that is functionally incapacitating and a constant threat to life	7.8–23%
V	Moribund; poor 24 h survival with or without surgery	9.4–51%

All this results in end organ dysfunction which if prolonged leads to susceptibility to infection and higher morbidity and mortality.

Surgical optimisation aims to reduce morbidity by improving blood flow and oxygen delivery to the organs of the body.

4.2 Goals of Optimisation

The aim is to try to achieve normal cardiac output. Patients with severe cardiac disease may not be able to achieve this.

A haemoglobin level greater than 10 g/dL is required for optimal oxygen transport. Levels above 15 g/dL are associated with increased blood viscosity and resistance to flow thus not improving oxygen delivery.

Similarly, with pulmonary function the aim is to achieve an optimum oxygen saturation.

Tight control of blood sugar levels in critically ill patients leads to reduced mortality, decreased serious complications, and reduced length of stay in hospital.

4.3 Clinical Application of Optimisation

There are two main groups of high-risk patients. These include those undergoing major surgery as well as those with significant cardiorespiratory and/or systemic disease. Unfortunately, many patients fall into both of these groups.

These patients are then carefully scrutinised by history and examination and investigations to help identify the specific clinical risks. Consultation with specialist physicians may be necessary to help with optimisation of acute and chronic medical conditions as well as drug therapies. In the emergency situation, there may not be time for this to occur.

There are several parts to the process of optimisation.

- Use of monitoring devices (such as central venous lines, arterial blood pressure monitoring, pulse oximetry) to assess and manage cardiac function, tissue perfusion, and oxygen delivery.

- Improving cardiac output by careful fluid loading (increases preload) and/or inotropes (to increase myocardial contractility). It is also very important to control the heart rate and aim for sinus rhythm.
- Oxygen saturation is maximised by treatment directed at any underlying respiratory conditions. Techniques include physiotherapy, treatment of chest infections, bronchodilators, and corticosteroids for bronchospasm and related diseases. All patients should have appropriately monitored oxygen therapy.
- Ensure an adequate haemoglobin concentration, preferably above 10 g/dL by use of blood transfusions.
- Stabilisation of other systemic conditions such as diabetes, renal failure, and coagulation disorders.
- Arrange for ICU or HDU admission either pre- and/or post-surgery.
- Careful attention to analgesia requirements as pain can augment the stress response to surgery.

4.4 Issues in Low Resource Regions

There are significant resource issues such as lack of HDU and ICU facilities. There may also be the lack of expert anaesthetic care to help recognise and determine the treatment of systemic illnesses.

Care needs to be taken when fluid loading patients as this may precipitate cardiac failure if done too aggressively.

The role of the surgeon becomes more expanded as there is a requirement to recognise the at-risk patient, institute preoperative optimisation, ensure the patient has close monitoring during surgery, and is carefully monitored post-operatively. It is critical that careful attention to fluid balance and oxygen delivery as well as management of other systemic problems is carefully controlled in the first 48 h post-surgery as this is when patients are at greatest risk of dying.

4.5 Overview of Sepsis

The body normally releases chemicals such as inflammatory mediators and white blood cells in response to infection. Sepsis is when response becomes amplified and out of control leading to changes that can damage organ systems.

If it progresses to septic shock (a dramatic fall in blood pressure), death may occur. Early treatment of sepsis with appropriate antibiotics and aggressive fluid therapy improves chances of survival.

Sepsis may occur in anyone, but some groups are more susceptible. These include

- The very young
- The very old
- Pregnant women

- Immunocompromised individuals
- People with chronic conditions such as diabetes, renal failure, and respiratory disease.

4.6 History of Sepsis Classification

The term Systemic Inflammatory Response Syndrome (SIRS) was introduced in the early 90s to describe the clinical syndrome of sepsis, independent of cause. Some of these patients then progressed to severe sepsis, septic shock, and eventually Multiple Organ Dysfunction Syndrome (MODS).

Whilst it is important to understand the underlying pathophysiological changes that occur, it is very difficult to determine which patients will progress beyond SIRS.

The qSOFA score has been more recently introduced in order to help recognise those patients with sepsis who may have significant deterioration.

The three elements are

- Systolic BP less than or equal to 100
- Respiratory rate greater than or equal to 22
- Glasgow Coma Score less than or equal to 14

Each of these scores one point and a score of two or more close to the onset of sepsis indicates a greater risk of death or prolonged stay in the intensive care unit.

4.7 Septic Shock

Septic shock is far more likely to cause death than sepsis alone;

To confirm septic shock the patient must have presumed or confirmed infection plus both of the following;

Systolic blood pressure that can only be maintained above 65 MM HG by use of inotropes or vasopressors;

Lactate level above 4 mmol/L in spite of adequate fluid replacement

4.8 Treatment

Early aggressive treatment is required in order to enhance the chances of survival. Patients need close monitoring, usually in an Intensive Care Unit setting.

High-dose broad-spectrum intravenous antibiotics should be commenced immediately until sensitivities for specific organisms can then be used for more targeted antibiotic therapy. Intravenous fluid resuscitation should be instituted as soon as possible plus vasopressors support if there is persistent hypotension.

The role of surgery is for source control which includes drainage of abscesses and removal of infected and necrotic tissue. The patient should be optimised as

much as possible prior to surgery although this may not always be possible. It may be necessary for repeated surgical procedures to be performed in order to get complete control of the septic source.

Supportive care such as renal dialysis and/or ventilatory support may also be required.

4.9 Implications for Low Resource Regions

Sepsis which proceeds to septic shock has a high mortality rate. Best outcomes occur with early recognition and early aggressive therapy. This is where the surgeon has the greatest role to play.

Overview of Basic Surgical Techniques

5

Francesco Piscioneri

This chapter will cover the following topics;

- Asepsis, antisepsis, and disinfection
- Wound Healing
- Control of Bleeding

5.1 Asepsis, Antisepsis, and Disinfection

Asepsis—freedom/absence from infection or prevention of contact with microorganisms

Aseptic technique—where surgical instruments, air, drapes, gloves, and gowns are free from microorganisms

Antisepsis—the process of prevention of sepsis by inhibition or destruction of agents

Disinfection—the process of killing microorganisms using chemical, mechanical, or thermal techniques.

5.2 Surgical Site Infection (SSI)

A *surgical site infection* is an *infection* that occurs after *surgery* in the part of the body where the *surgery* took place.

10–15% of all hospital-acquired infections

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60% at the incision site
Lead to significant morbidity and mortality with increased hospital stay and costs

5.3 Surgical Wound Classification

Clean/Class I—Uninfected operative wound in which no inflammation is encountered.

Clean-contaminated/Class II—Any operative wound in which the respiratory, alimentary, or genito-urinary tracks are opened without contamination.

Contaminated/Class III—Open fresh accidental wounds. Operations with a major break in sterile techniques. Gross contamination or major spillage.

Dirty-infected/Class IV—This includes traumatic wounds with devitalised tissue and those that involve existing clinical infection or perforated viscera. Organisms involved were present in the operative field before the operation.

5.4 Operative Factors

Skin Asepsis
- Surgical scrub
- Preoperative shaving
- Preoperative skin prep
- Antimicrobial prophylaxis

Surgical Contamination
- Instrument/equipment Sterilisation
- Foreign material—Surgical drains
- Surgical technique—Poor haemostasis, dead space obliteration, tissue trauma
- Surgical Hand Scrub—Bactericidal agent, contains emollient, rapid action can be used repeatedly

Antiseptic Agents
- Rapid action
- Broad spectrum, safe
- Alcohol, chlorhexidine, Iodine, Iodophores
- Denaturation of protein, disruption of cell wall

Disinfection
- This is broadly defined as the cleaning of something with a chemical so as to destroy or reduce the population of microorganisms. Sterility is a subset of this. There are many agents available for this purpose.

5.5 Wound Healing

A wound is a break in the continuity of any body tissue caused by injury or surgery.

There are four stages of normal wound healing;

- haemostasis
- inflammation
- formation of granulation tissue
- wound maturation

Haemostasis—At the time of injury there is transient vasoconstriction, activation of the clotting cascade, and platelet aggregation. A haemostatic plug forms completing haemostasis.

Inflammation—Occurs in the first 24–48 h. Local tissue activation factors need to mobilise white cells into the wound area to deal with the damaged tissue and any bacteria. An inflammatory exudate forms. The wound appears red, warm, painful, and swollen.

Granulation tissue—This starts to form at 2–5 days. Endothelial cell proliferation leads to formation of new blood vessels. Fibroblast proliferation leads to the laying down of collagen. In the skin edges, basal cells produce new epithelial cells which migrate across the surface of the wound creating a new epithelium over the collagen based scar tissue.

Maturation—commences at day 5 and continues for months. Remodelling and realignment of the collagen fibres leads to a gradual strengthening of the scar. In the first 6 months the scar tissue appears dark because of increased vascularity and by this time it has achieved at least 60–80% of its final wound strength. Over the next 12–18 months the scar contracts, becomes lighter, and achieves approximately another 20% of strength.

Wound healing can occur by first or second intention.

Primary union (first intention) applies to most surgical wounds. There is minimal tissue loss/contamination and the divided edges are reapproximated without tension. The edges are held together by sutures, metal clips, tapes, or tissue glue.

Secondary union occurs when there is a more extensive defect and the edges cannot be reapproximated. There is more necrotic tissue and contamination than in primary wounds. Wound contraction plays a major role in the secondary union. Granulation tissue is usually quite abundant. If the skin defect is significant and a long healing time is expected, application of a split skin graft directly over the defect will significantly reduce healing time and lead to a better quality result.

5.6 Impaired Healing

Factors that cause impaired healing can be either systemic or local.

Local Factors
- infection
- local ischaemia
- foreign body
- malignancy

Systemic Factors
- poor nutritional status
- steroid therapy
- cancer chemotherapy
- ionising radiation
- malignancy
- diabetes
- elderly

5.7 Wound Management

All wounds should be thoroughly cleaned, necrotic tissue and debris removed, and haemostasis secured. Surgical wounds are best managed by primary closure. If the wound has irregular edges, wound excision and primary closure can be performed if there is minimal contamination.

Wounds requiring extensive debridement should be left open initially and can have delayed primary closure (usually at 3– 5 days) if the wounds remain clean. If there is extensive skin loss, grafting (either primary or delayed) is required.

Special attention needs to be placed on high-velocity missile injuries. These create complex cavities with severe tissue damage and major contamination. These wounds need to be aggressively treated with debridement, antibiotics, and anti-tetanus prophylaxis. These wounds are best left open in the early stages of treatment.

5.8 Wound Closure

In order for wound healing to occur efficiently and with minimal scarring, wound edges need to be approximated effectively and efficiently. Sutures have been around for a long time and are still the mainstay of treatment.

Sutures can be classified as;

- natural/synthetic
- absorbable/non-absorbable
- monofilament/braided

Sutures are available in varying diameters, strengths, and different types of needles.

It is important to select the correct suture to suit the intended purpose.

Sutures have traditionally been made from natural materials because of simple manufacturing techniques and availability. Unfortunately, these materials often cause unwanted tissue reactions and can have a lower strength. Synthetic sutures have more manufacturing options, are often cheaper to produce, and have much lower tissue reaction.

Absorbable sutures have the advantage that they are hydrolysed (or digested in the case of natural materials) and leave no remnants in the wound. These materials should be selected on the basis that there is still enough strength remaining during the tissue healing process. These are well suited to subcutaneous applications and for suturing of conduits such as intestine and ureters.

Non-absorbable sutures are preferred for skin closure, or where longer term suture strength is required. Modern suture materials are very close to inert and can remain in the body for prolonged periods of time without causing any or minimal tissue reaction.

Monofilament sutures have minimal tissue reaction but have memory and greater knot weakness. Braided sutures are easier to handle, have more secure knots, but can harbour bacteria.

Properties of some of the more commonly used materials are listed in Table 5.1.

Although there are different strengths for the varying materials, the main determinant of strength is suture diameter. Thicker and stronger sutures are required where strength is an issue such as closing abdominal fascia.

Table 5.1 Common suture materials

Material (BSR)[a]	Commercial name	Monofilament/ braided	Natural/ synthetic	Absorbable/ non-absorbable
Catgut (1–11)			Natural	Absorbable
Silk		Braided	Natural	Non-absorbable
Nylon	Ethilon, Dermalon	Monofilament	Synthetic	Non-absorbable
Nylon	Surgilon, Nurolon	Braided	Synthetic	Non-absorbable
Polypropolene	Prolene, Surgilene	Monofilament	Synthetic	Non-absorbable
Polydioxonone (35)	PDS	Braided	Synthetic	Absorbable
Polyglactin (5–15)	Vicryl	Braided	Synthetic	Absorbable
Polyglycolic Acid (12)	Dexon	Braided	Synthetic	Absorbable
Polyglycolide-caprolactone (7)	Monocril	Monofilament	Synthetic	Absorbable
Polyglycolide-trimethyl carbonate (35)	Maxon	Monofilament	Synthetic	Absorbable
Polyester	Mersilene	Braided	Synthetic	Non-absorbable
Polyester and polybuterate	Ethibond	Braided	Synthetic	Non-absorbable
Polyester and silicone	Tichron	Braided	Synthetic	Non-absorbable
Polyester and teflon	Tevdek	Braided	Synthetic	Non-absorbable

[a]BSR-Number of days with 50% breaking strength remaining (for absorbable sutures)

The two main types of suture needles are cutting and non-cutting. Cutting needles are used to pierce tougher tissue such as skin. Tapered non-cutting needles are used for most other tissues. They have the advantage of spreading the tissue as opposed to cutting through it. This is especially useful when doing vascular repair.

5.9 Control of Bleeding

Bleeding from wounds occurs as a result of trauma and can be external or internal (hidden). It can be significantly affected by underlying bleeding disorders. These need to be corrected at the same time as mechanical control of bleeding is underway. The timing depends on priorities of management—severe arterial bleeding requires prompt local control whereas slow diverticular bleeding in patients with a high INR is best treated by managing the extrinsic coagulation pathway.

External wounds can be due to;

- surgical incision
- laceration
- abrasion
- puncture/missile
- tissue avulsion
- contusion

5.10 Control of External Bleeding

Direct pressure method—direct pressure over wound pads, elevation if a limb is involved, proximal pressure over arteries, e.g. brachial, femoral

Tourniquet method—only use when other methods have failed, life-saving, traumatic amputations, needs to be checked every 10–15 min until bleeding becomes controllable.

5.11 Internal Bleeding

Often difficult to recognise. Common features include;

- Change of vital signs, tachycardia, hypotension, hypothermia
- Pale skin
- Falling haemoglobin (less useful with rapid bleeding)
- Pain over the affected area

Initial treatment should always focus on ABC of resuscitation. Once stable, appropriate imaging should be organised to assess internal bleeding. Always remember to reverse/correct any bleeding disorder.

Diagnostic Imaging in Surgery

6

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6.1 Background

Diagnostic radiology is recognized as a key component of the modern healthcare. Basic radiological services are now deemed mandatory for the effective provision of primary care; nevertheless, there is marked inequality in global access to imaging. An estimated one-half to two-thirds of the world's population lack access to basic medical imaging; this portion of population coincides in most with the rural populations in low- and middle-income countries.

In 2010, the World Health Organization (WHO) published national estimates of high-end medical imaging resources based on member countries' questionnaire surveys that highlighted disparities in the high-end resources among countries in the same world bank economic class. These data do not include basic equipment such as general radiography units and basic ultrasound machines.

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WHO recommended that the minimum standard radiological equipment is about 20 general radiography units per million people, suggested that approximately 1 Computed Tomography (CT) scanner is required for every 10 general radiography units and stated that an estimated 90% of all imaging needs in low- and middle-income countries can potentially be addressed by the provision of one simple x-ray unit and a basic ultrasound machine for every 50,000 people.

6.2 Diagnostic Work-up in the Emergency Department

The nontraumatic acute abdomen is a common emergency department presentation. It represents 5–10% of all Emergency Department (ED) visits.

The term "acute abdomen" (AA) defines a clinical syndrome characterized by the sudden onset of severe abdominal pain requiring emergency medical or surgical treatment. Various potentially life-threatening diseases can cause AA, and thus a rapid and accurate diagnosis is essential to decrease morbidity and mortality due to unnecessary interventions or delayed treatments.

Clinical features of patients presenting with AA can be unspecific and challenging; consequently, it can be very difficult to differentiate acute life-threatening disease from nonspecific abdominal pain (NSAP) with a high level of diagnostic accuracy only by clinical evaluation of the patient but the patient age, gender, history and physical examination should be always the first step in constructing a set of diagnostic hypotheses.

Epidemiology of the main complaint related to the geographical area would then better define the boundaries of the differential diagnosis process of which imaging should be part. However, the exact diagnosis of the disease, requiring the definition of the etiology is not mandatory in an emergency setting, especially when the patient presents with signs of shock and surgical exploration should not be delayed. Imaging has a role in assessing AA in hemodynamically stable patients and to plan the best surgical approach or in diagnosing intra-abdominal potentially surgical diseases that could benefit from a conservative treatment, according to international available guidelines. AA in women are a typical clinical situation requiring a differential diagnosis between disease for which conservative treatment could be indicated such as pelvic inflammatory disease (PID) or other gynecological and non-gynecological conditions requiring a surgical approach. Ectopic pregnancy, PID, and hemorrhagic ovarian cysts are the most commonly diagnosed gynecologic conditions presenting with acute pelvic pain. Other causes to consider include endometriosis, and postpartum causes such as endometritis, or ovarian vein thrombosis. Finally, non-gynecologic conditions may present with a similar clinical feature of acute pelvic pain and should also be considered, the most important of these is acute appendicitis. In case of high suspicion of a disease requiring surgery or when surgery is indicated without a clear pre-operative diagnosis, explorative laparoscopy play an important role in the diagnostic work-up of AA. In case laparoscopy in not available imaging may play an important role in such clinical cases. The ideal diagnostic imaging modality for evaluation of AA in adult patients should provide a balance between the highest diagnostic value and lowest radiation exposure; physician's strong diagnostic

Table 6.1 Imaging in assessing acute abdomen in low resource regions

• Working diagnosis	• Imaging options
• Appendicitis	• Ultrasonography, contrast-enhanced computed tomography
• Cholecystitis	• Ultrasonography
• Bowel obstruction	• Abdominal radiography, contrast-enhanced computed tomography
• Acute diverticulitis	• Ultrasonography, contrast-enhanced computed tomography
• Perforated viscus	• Abdominal radiography, computed tomography
• Gynecological diseases	• Ultrasonography—abdominal and transvaginal
• Renal colic	• Ultrasonography, low-dose computed tomography
• Acute intestinal schema	• Contrast-enhanced computed tomography

hypothesis and latest international evidence-based guidelines in the management of the suspected abdominal disease underlying AA; the cost to the health care system. An imaging technique is useful when the result modifies clinical management, and/or to confirm or rule out a diagnostic choice or else to stage the risk of potentially serious situation.

Traditionally, in ED diagnostic work-up of non-traumatic acute abdominal pain (Table 6.1) with imaging consists of Abdominal plain Radiography (AR), US abdominal examination, and CT.

6.3 Abdominal Plain X-ray

Abdominal radiography is widely available, readily accessible day or night, and it can be easily performed. The radiation dose delivered at AR is relatively limited (approximately 0.1–1.0 mSv) compared with that delivered at CT (approximately 10 mSv) but is equal to 50 chest radiographs.

In ED conventional radiography examination includes supine and upright AR and upright chest radiography (to rule out air under the diaphragm or thoracic etiologies presenting as abdominal complaints). An abdominal series can include the basic supine and upright anterior-posterior (AP) views that show the abdomen from the domes of the diaphragm to the obturator foramen. Other supplementary projections are the horizontal beam view with the patient in erect position or lateral decubitus, that is a useful alternative to the erect AP view if the patient is unable to sit or stand.

It is recommended to maintain an erect position or lateral decubitus for at least 10 min before obtaining the X-ray exposure to let the gas rise above the liver dome.

The KUB (kidneys, ureters, bladder) projection is a plain frontal supine radiograph of the abdomen that includes the entire urinary system, from the pubic symphysis to the superior aspects of the kidneys and not necessarily include the diaphragm.

Plain radiographs have relatively poor sensitivity but it is often the only imaging available in low resource region.

Indications for AR differ therefore depending on the availability of CT or US but some indications should however be considered specific in ED assessing AA such

as suspicion of perforated viscus, urinary tract stones, bowel obstruction and ingested or anorectal foreign body.

6.4 Abdominal Ultrasonography

US abdominal examination should be easily available and accessible as first-line imaging investigation to evaluate patients admitted in ED for AA. It has lower costs and provides no radiation exposure.

US has the potential for a tailored use in confirming diagnostic hypotheses at the patient's bedside, without waiting for radiologists' availability. However, training should be encouraged since its efficacy is linked to the experience of the operator.

US can detect intraperitoneal free fluid and/or collections and evaluate the solid organs as liver, spleen, pancreas, uterus, ovaries. US is a real-time dynamic examination that makes use of postural variation and can be guided by the sight of pain. Furthermore, it can be adapted to allow further investigations based on findings during its performance. Point-of-care ultrasound (POCUS) is defined as a goal-directed, bedside ultrasound examination performed by healthcare providers to answer a specific diagnostic question or to guide performance of an invasive procedure. It has the advantages to clarify uncertain findings of the physical examination, to identify acute abdominal diseases, or provide image guidance that improves the success and safety of percutaneous procedures in the acute care setting. The examiner's goal is to "rule in" or "rule out" a specific condition or answer a "yes/no" question. The most common US technique used to examine patients with AA is the graded-compression procedure. The technique allows fat and bowel to be displaced or compressed by means of gradual compression to show underlying structures and reveal the presence or absence of intestinal peristalsis and depict blood flow. Furthermore, if the bowel cannot be compressed, the non-compressibility itself indicates the presence of pathology such as inflammation, intussusception, malignancy or luminal distension resulting from obstruction. Health professionals and physicians training should be promoted; increased training and availability of US-experienced supervisors might further improve utility of this important adjunct to the practice of emergency medicine. The great disadvantage of US is the possibility of inter-examiner variability.

6.5 Computed Tomography Scan

Computed Tomography scan (CT) has gained widespread acceptance as the first-line imaging modality in patients presenting with acute abdominal pain when it is available. CT is the most time-effective and accurate imaging technique and provides sufficient information for an alternative diagnosis. The increasing use of CT in ED is related to the high accuracy of this technique in the diagnosis of specific emergent diseases.

Unfortunately, it is not possible to perform a CT scan in all patients with AA because of the non-uniform availability of the technique, the exposure to ionizing radiation, the increased health system costs, the increased personnel requirements, the administration of contrast medium that is contra-indicated in case of acute or chronic kidney failure and allergy.

The CT technique in evaluating patients with AA generally involves scanning of the entire abdomen and can be performed with or without intravenous (IV) iodinated contrast medium, and with or without oral/rectal contrast. In ED the use of oral contrast adds little, if anything, to the accuracy of diagnosis in patients with non-traumatic abdominal pain which can lead to an increase in the length of stay in the ED. Although abdominal CT can be performed without contrast medium, the benefits of diagnostic information gained from contrast-enhanced CT in assessing AA are fundamental in some clinical scenarios such as acute vascular conditions like hemorrhage, bowel ischemia, compared with the risk of contrast-induced nephropathy and ionizing radiation.

CT provides further clarification and finer distinction, identifying not only the cause but also the precise localization of bowel obstruction, and the specific anatomic location of the appendix. Such findings help to optimize management strategy including surgical treatment.

CT provides greater accuracy than US or AR for identifying pneumoperitoneum, as well as evaluation of bowel pathology. It has high sensitivity and specificity for evaluating acute appendicitis, diverticulitis, and bowel obstruction. The administration of IV contrast is generally recommended since it increases the diagnostic yield of the study, especially in thin patients with scant body fat.

6.6 Emergency Imaging in Low Resource Regions

After having made a systematic abdominal examination, splitting the abdomen into four major quadrants: the upper right and left quadrants and lower right and left quadrants, the focus is on a working diagnosis. Imaging is of crucial importance when the clinical picture related to acute abdominal pain does not allow to distinguish overlying clinical situations, the differential diagnosis of which involve a decision on urgent surgical approach or initial conservative treatment. The role of imaging for the most common cause of acute abdominal pain (Table 6.2) involved within the differential diagnosis of AA is described below.

Table 6.2 Assessing acute abdomen according to pain location and imaging techniques availability in low resource regions

• Pain location	• First-line and second-line imaging option
• Right upper quadrant	• Ultrasonography, chest and abdominal radiography
• Right lower quadrant	• Ultrasonography, computed tomography
• Left upper quadrant	• Ultrasonography, computed tomography
• Left lower quadrant	• Ultrasonography, computed tomography
• Generalized pain	• Abdominal radiography, computed tomography

6.6.1 Perforated Viscus

The specific finding of gastrointestinal tract perforation on plain films is the presence of air outside the gut lumen, the pneumoperitoneum that is usually shown as subdiaphragmatic air on erect AR. The extraluminal air may be in the free peritoneal cavity, retroperitoneal spaces, mesentery, or ligaments of organs. Erect radiograph is the recommended technique for the detection of free abdominal gas, a supine radiograph having low sensitivity for the diagnosis pneumoperitoneum. Gas outside the lumen will make the bowel wall much easier to detect because loops with gas on either side of the bowel wall are seen very clearly. Rigler's sign is a good indication of free intraperitoneal gas as it identifies the inner and outer surfaces of the intestine. However, pneumoperitoneum may not be identified if the perforation is very small, self-sealed, or well-contained by adjacent organs. The "falciform ligament sign" is free air or an air-fluid level crossing the midline and accentuating the falciform ligament. This sign can be seen with perforation of the stomach and small bowel.

CT is the most reliable modality for detecting small amounts of free air especially in "lung window"setting. CT also helps identify the cause of GI tract perforation. The direct CT findings of GI tract perforation include discontinuity of the bowel wall and the presence of extraluminal air and/or extraluminal enteric contrast are considered specific signs of gastrointestinal perforation. Indirect CT findings of bowel perforation include bowel wall thickening, abnormal bowel wall enhancement, abscess, and an inflammatory mass adjacent to the bowel.

Other indirect signs identifying the location of a GI perforation include:

1. Free air in either the supra or inframesocolic compartments,
2. Gas bubbles adjacent to the intestinal wall,
3. Localized extraluminal fluid,
4. Segmental wall thickening (>3 mm),
5. Perivisceral fat stranding,
6. Abscess formation.

In the hands of expert ultrasonographers, US could be superior to AR for the detection of pneumoperitoneum.

6.6.2 Bowel Obstruction

The combination of vomiting, increased bowel sounds and a distended abdomen has a positive predictive value for intestinal obstruction that is only slightly increased by AR which is diagnostic in 50–60% of cases, uncertain in 20–30% and confusing in 10–20%.

Useful radiographic signs of bowel obstruction (BO) include a distended stomach and bowel loops (>3 cm), multiple air–fluid levels (more than 5 air–fluid levels on erect AR, greater than 2.5 cm in length is abnormal), a "step ladder" pattern of dilated bowel loops, a "string-of-beads" sign corresponding to air bubbles trapped

in valvulae conniventes, the "stretch sign" or "slit sign" in which a slit of air is caught in valvulae.

In particular, two findings derived from the upright abdominal radiograph are significant and predictive of the higher grades of small bowel obstruction: the presence of air–fluid levels (>3 in number and air–fluid levels of >1 cm height) and a mean width of air–fluid levels measuring greater than or equal to 25 mm. Other findings suggesting strangulation or ischemia include pneumatosis and portal venous gas.

The clinician has to keep in mind the 3/6/9 rule: small bowel should measure less than 3 cm, large bowel less than 6 cm, and the cecum and sigmoid colon should measure less than 9 cm. If the bowel measures greater than this, there is bowel dilatation and mechanical obstruction or adynamic ileus should be considered.

US allows analysis of gastrointestinal tract including thickness and motility, such as increased peristalsis in early stage of mechanical obstruction, the absence of peristalsis in functional obstruction and demonstration of inflammatory or tumoral involvement. Bowel wall thickening with fluid-filled distention should raise suspicion for a bowel condition as the cause of abdominal pain. In this setting, perforation should be suspected if extra-luminal echogenic reflectors with reverberation artefacts, signifying gas, are found.

When it is available, CT is the modality of choice for evaluating suspected BO. It can reveal the degree, location, and cause of obstruction as well as display signs of threatened bowel viability. CT has high sensitivity and specificity for diagnosing high-grade obstructions. Intravenous contrast is ideally recommended while assessing BO on CT, whereas oral contrast can be considered based on patient tolerability. Oral contrast should not be used if there is intention to assess enhancement/viability of the bowel wall. CT is an excellent modality for detecting hernias and their associated complications such as strangulation, volvulus, and ischemia. At the site of obstruction, there may be a whirl sign, a beak sign, or triangular configuration of adjacent collapsed loops. The diagnosis of small BO is made on the basis of dilated bowel loops >3 cm in diameter with a discrete transition point. "Small bowel feces sign" is often seen closer to the anticipated transition point and suggestive of slow transit. In general, imaging signs of high-grade obstruction, an abnormal vascular course, abdominal free fluid, and the presence of a transition zone are useful predictors of surgical intervention. However, a "small bowel feces sign" inversely predicts the need for surgery. The absence of visible lesion at a transition point of a bowel obstruction in a patient with previous surgery indicate a probable adhesive etiology of the obstruction. A higher prevalence of the ''beak sign'' in patients with bands than in patients with matted adhesions, and the double beak sign has been reported in cases of closed loop (two points along the course of a bowel are obstructed at a single location) obstruction due to hernias including internal hernias and volvulus.

6.6.3 Renal Stones

Renal stones should be considered in the differential diagnosis of AA especially in case of flank pain and dysuria and/or hematuria. Sensitivity and specificity of AR may vary according to the composition of stones, calcified stones being the most easily detectable at AR.

US is used to detect hydronephrosis in patients presenting with renal colic; to check if the bladder is full in case of acute urinary retention. Renal or ureteral stones, are detected at US as a highly reflective surface and brightly reflective posterior.

Non-contrast CT has high sensitivity and specificity (>95% and >96%, respectively) for the detection of stones compared with plain radiography and US.

Limitations of CT in urolithiasis include cost, availability, and radiation exposure.

6.6.4 Ingested Foreign Body

Foreign body ingestion is a common problem in ED. AR has a sensitivity and specificity of 90% and 100%, respectively for the detection of intra-abdominal foreign bodies with even an accuracy of 100% according to their radio-opacity.

Nevertheless, nonradiopaque foreign bodies are common limiting the reliability of radiographs for initial evaluation. Fish and chicken bones, wood, plastic, and thin metal objects are some of the most common radiolucent objects. Thin fragments of aluminum, such as pull-tabs or pop-tabs of beverages, are not often radiopaque. Once a radiographically identified object is deemed likely to pass without intervention, serial imaging is conducted to ensure prompt progression and confirm elimination.

CT is indicated in case x-rays fail to localize a foreign body. CT scan can be indicated in nonmetallic foreign body (e.g., plastic or wooden object, or fishbone) and is also helpful in the detection of GI perforation secondary to foreign body ingestion.

6.6.5 Abdominal Aortic Aneurysm (AAA)

AAA is an abdominal aortic dilation of 3.0 cm or greater. The prevalence of AAA increases with age. It is uncommon in persons younger than 50 years. A ruptured AAA is a medical and surgical emergency associated with high mortality rates. The classic syndrome is characterized by hypotension, shooting abdominal or back pain, and a pulsatile abdominal mass. This triad may be incomplete or absent, and misdiagnosis can occur in up to 60% of cases.

An asymptomatic AAA is often discovered incidentally because of the performance of abdominal US and CT for other purposes. An AAA may also be found with plain x-rays showing some calcification in the wall of the aneurysm. However, they are not reliable because some aneurysms do not have sufficient calcification to be detected.

Abdominal US is considered the screening modality of choice for AAA because of its high sensitivity of 95–100% and a specificity of nearly 100%, as well as its safety and relatively low cost.

Ultrasound can measure aortic dimensions: the presence of a dilated aorta in patients with circulatory instability significantly speeds up diagnosis of leaking

abdominal aortic aneurysm. Thrombus or echo-dense calcifications in or adjacent to the aortic wall may also be seen and both are quite common. Disadvantages of abdominal US are that it is operator dependent.

If available, CT can provide more details assessing the shape of the aneurysm with more comprehensive anatomical details of the mesenteric and iliac arteries, and also provides better imaging of suprarenal aneurysms. Disadvantages of CT scanning compared with US include increased cost, requirement for contrast, and exposure to radiation with repeated scans.

6.6.6 Acute Cholecystitis and Cholangitis

US is the main diagnostic modality to confirm the presence of gallstone disease with high sensitivity and specificity. A combination of two or more of the following features is highly suggestive of acute cholecystitis: the sonographic Murphy's sign (tenderness elicited by pressing the gallbladder with the ultrasound probe), thickened gallbladder wall (>4 mm; if the patient does not have chronic liver disease and/or ascites or right heart failure), enlarged gallbladder (long axis diameter >8 cm, short-axis diameter >4 cm), incarcerated gallstone, debris echo, pericholecystic fluid collection, and sonolucent layer in the gallbladder wall. In presence of jaundice, fever and pain to the right hypochondrium the finding of biliary dilation at US is highly suggestive for a cholangitis.

Because ultrasound is sensitive, specific, and also low in cost and free of ionizing radiation, it is considered the primary imaging technique in case of suspected acute gallbladder and biliary diseases. CT should be considered only in case of uncertain diagnosis.

6.6.7 Acute Appendicitis

CT is considered the gold standard technique to evaluate patients with suspected appendicitis, because of its high sensitivity and specificity. US may be valuable as an initial imaging technique, especially in children and female patients.

Direct US signs of acute appendicitis are appendix larger than 6 mm in diameter and larger than 2 mm in wall thickness. Indirect US signs of appendicitis are nonexpansion of the appendiceal lumen, nonuniform internal echo, with or without hyperechoic appendicolith; peri-appendiceal hyperemia and free fluid; firm mass in the lower right abdomen; ileocecal wall thickening and edema; bowel dilatation, pneumatosis with weakened peristalsis in the lower right abdomen.

In differential diagnosis with appendicitis, adeno-mesenteritis, that is visualized as multiple enlarged lymph nodes some of them disposed as a chain in the mesentery, and gynecological diseases should be considered. Moreover, in female patients, endo-vaginal scanning allows visualization of intrauterine structures and is useful to identify a viable intrauterine pregnancy or ectopic

pregnancy. The disadvantages of the use of US in the diagnosis of acute appendicitis are the difficulty to display appendix in obese patients or in condition of flatulence, retrocecal, or extraperitoneal appendicitis.

CT signs of acute appendicitis are increased transverse diameter of the appendix >6 mm, increased thickness of the appendiceal wall >2 mm, appendiceal wall hyper-enhancement, the presence of a focal defect in the appendiceal wall, the presence of appendicolith/fecolith, peri-appendiceal changes, cecal wall thickening, and right lower quadrant free fluid. The CT findings of focal defects in the appendicular wall, periappendicular abscess, larger appendicular diameter (>15 mm), thickening of terminal ileum wall, extraluminal free air or extraluminal appendicolith should be considered as early signs of perforated appendicitis. The presence of extraluminal gas, abscess, and ileus are more specific for perforation.

Although US is recommended in young patients as the first imaging modality, low-dose CT should be considered if there are equivocal findings.

6.6.8 Acute Bowel Ischemia

Intestinal ischemia, which refers to insufficient blood flow to the bowel, is a potentially catastrophic entity that may require emergent intervention or surgery in the acute setting. Most cases of mesenteric ischemia are due to an acute event leading to decreased blood supply to the splanchnic organs. Chronic mesenteric ischemia is uncommon, accounting for less than 5% of cases of mesenteric ischemia, and is almost always associated with diffuse atherosclerotic disease.

Clinical signs and symptoms of intestinal ischemia are often nonspecific.

CT angiography (CTA) has high sensitivity and specificity in diagnosing acute mesenteric ischemia and should be considered the first-line imaging in most cases. CTA identifies atherosclerosis, thrombus, occlusion, compression or invasion by tumor, and trauma. Other CT findings include bowel wall thickening and edema, submucosal hemorrhage predominantly in cases of venous infarction, increased bowel enhancement in the early phase or decreased enhancement of the bowel wall in later phases, mesenteric stranding or fluid, and pneumatosis in cases of bowel necrosis and perforation.

US is less useful for this disease. If pneumatosis related to bowel ischemia is suspected at the time of US, an assessment for portal venous gas should be performed. It appears as echogenic mobile reflectors within the main portal vein and its major branches at gray scale US. Accumulation within the smaller peripheral intraparenchymal portal veins in a branch like pattern also appears with an increasing amount of gas in portal vein.

6.6.9 Acute Diverticulitis

Acute diverticulitis may be acute, chronic, uncomplicated, or complicated by an abscess, fistula, bleeding, bowel obstruction, or free perforation.

Abdominal CT is the test of choice in patients with suspected diverticulitis.

Contrast-enhanced CT depicts the early stages of diverticulitis and has become the optimal method for evaluation of diverticular disease in the emergency setting, with a reported accuracy of 80–100%. The main CT findings are bowel wall thickening and fat stranding; other findings include abscesses, arrowhead sign, fascial thickening, free air, inflamed diverticulum, intramural air, intramural sinus tract, and phlegmon. The presence of free air, abscess formation, and a "target pattern" of contrast enhancement on CT supports the diagnosis of diverticulitis but with low specificity. In the differential diagnosis locally advanced perforated colonic cancer should be considered as well as mesenteric infarction and epiploic appendangitis. Epiploic appendagitis usually appears as a well-circumscribed fatty lesion with a "central dot" which represents partially thrombosis vessel.

Ultrasonography has good diagnostic accuracy for diverticulitis and its related complications compared with CT. However, its accuracy is inferior to CT in estimating the extent of large abscesses and in evaluating the presence of free air. Using a graded compression technique, ultrasound images of diverticulitis include thickening of the wall of the colon, which is surrounded by hyperechoic inflammatory fat with the probe tenderness sign. Sometimes an inflamed diverticulum can be visible with intraluminal coprolites. Abscess and developing phlegmon can also be visible on US, which helps image-guided procedures. US should be considered for pregnant women suspected of having diverticulitis to avoid ionizing radiation.

The accuracy of ultrasonography is suboptimal in patients who are obese and in patients with overlying gas that may obscure structures.

A step-up approach with CT performed after an inconclusive or negative US may be a safe approach for patients suspected of acute diverticulitis.

6.7 Conclusion

- CT scan is the most useful imaging in the ED for patients presenting for AA.
- When CT is not available, hemodynamically stable patients presenting with AA should undergo a supine AR with an erect chest X-ray to confirm or exclude a perforated viscus or bowel obstruction.
- Even when CT is available, AR is indicated in case of ingested foreign body search and suspicion of fecal impaction in hemodynamically stable patients.
- US examination is the imaging of choice in case of right upper quadrant pain to confirm acute cholecystitis and explore the biliary tree and the liver; in case of right lower quadrant pain, in gynecologic and pelvic diseases, in suspicion of acute appendicitis or to search abscesses formation anywhere in the abdomen or pelvis as well as in renal colic to assess hydronephrosis; if the patient is young, female of child-bearing age, pregnant.
- No other imaging modalities could replace contrast enhanced CT in cases of suspected life-threatening gastrointestinal emergencies, in fact it is the only imaging able to assess acute mesenteric ischemia or intestinal viability in case of hernias or other mechanical obstruction. In hemodynamically unstable patients, surgical exploration is mandatory.

Post-operative Care and Complications

7

Andrea Nicole Rodrigues

Surgical complications are a considerable cause of death and disability around the world, and are devastating, not only to patients but also costly to health care systems, particularly in low-resource regions. The poorest third of the world's population is estimated to receive only 3.5% of the 234 million surgical procedures undertaken annually. Despite being such a small proportion of global surgical output, the undertaking of these procedures and management of post-operative complications represent a substantial challenge for healthcare providers in low-resource regions.

Surgical complications occur for a variety of reasons, and emergency surgery by its nature is associated with a higher rate of complications compared to elective procedures due to an interplay between patient, disease and surgical factors.

Ideally, prevention of complications starts from careful patient selection and meticulous preoperative preparation of the patient, a luxury which is often not afforded in the emergent setting. Many acutely ill patients with surgical disease in low-resource regions are unable to access the definitive life-saving surgery that they need, and of those who do access surgical care, most present late in the course of their disease process. They may also experience considerable delays waiting for time-sensitive surgical intervention due to lack of staff or facilities. All these sources of delay contribute to the development of post-operative complications, compounding the inherent risk of emergency surgery.

Preoperatively, the use of the 19-item World Health Organisation (WHO) Surgical Safety Checklist has been shown to reduce surgery-related deaths and complications by more than one-third. By advocating for and adhering to the safety checklist before the start of the operation, surgeons in low-resource regions can reduce the burden of human error and the rate of avoidable complications.

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During the operation, the surgeon can also do much to influence the post-operative outcome by adhering to the fundamental principles of proper surgical technique, which involve:

1. Careful handling of tissues
2. Meticulous dissection, haemostasis and debridement of devitalised tissue
3. Compulsive control of all intraluminal contents to minimise contamination
4. Preservation of blood supply to tissues
5. Elimination of any foreign body from the wound
6. Maintenance of strict asepsis
7. Thorough drainage and irrigation of any pockets of purulence in the wound
8. Ensuring the patient is kept euthermic and fluid resuscitated during the procedure
9. Careful selection of method for skin closure or packing depending on the level of contamination

After the operation is completed, there needs to be close surveillance for any deviation from normal post-operative course so that swift action can be taken. This chapter will detail the goals of post-operative care as well as the presentation and management of common surgical complications that follow emergency surgery.

7.1 Post-operative Care

7.1.1 General Approach

Vigilance is the key to excellent post-operative care for the acute surgical patient. This involves regular examination of the patient to identify post-operative complications at an early stage when they can be most effectively addressed. On the round, the surgeon needs to be compulsive in checking all wounds, input and output charts, vital signs, nutritional status, pain and activity levels, and act on any complication promptly and appropriately. In this way, a brief inconvenient complication can be dealt with before it becomes a devastating and disabling one.

The key ingredients to the management of every post-operative patient are ensuring adequate analgesia, fluids and electrolytes, nutrition, prevention of thromboembolism and control of potential sources of infection. The specifics of each of these aspects of management have already been covered in previous chapters. However, the importance of integrating these into the post-operative care of acute surgical patients cannot be overstated. Developing a systematic approach to ensuring that all of these aspects of care are addressed for each and every patient seen on the post-operative round will go a long way to preventing surgical complications.

7.1.2 Analgesia

All operations will result in some level of pain for the patient, and adequate analgesia is vital for their post-operative recovery. Not only does uncontrolled pain contribute to suffering, but it also increases sympathetic outflow resulting in increases in heart rate, vasoconstriction and increased oxygen demand, which can contribute to myocardial ischaemia. Inadequately controlled pain also impairs pulmonary function, especially following abdominal and thoracic procedures, where pain induced by movement inhibits effective coughing and diaphragmatic function leading to atelectasis and pneumonia. When pain is under control, patients are able to mobilise which reduces their incidence of venous thromboembolism, improves pulmonary function, and prevents deconditioning. It also contributes to their overall psychological well-being and avoids setting up the neural circuits for the development of chronic pain. As soon as practicable, parenteral routes of analgesia should be changed to oral routes to facilitate removal of intravenous access devices.

7.1.3 Fluids and Electrolytes

It is important to recognise that acute surgical patients are easily fluid depleted. They are kept nil by mouth prior to the procedure, subjected to long operations with insensible losses and typically have limited oral intake after the procedure. The disease process often contributes to this volume depletion, especially gastrointestinal pathology resulting in increased losses from fevers, vomiting, diarrhoea and third-space sequestration of fluid, such as seen in bowel obstruction. Hypovolaemia needs to be avoided due to its detrimental effects on cardiac output, organ perfusion and resultant oxygen delivery to tissues, with the potential development of multi organ dysfunction. Adequate fluid resuscitation on presentation and thoughtful management of maintenance fluid requirements are vital to ensuring patients remain euvolaemic. Clinical signs such as dry mucous membranes and reduced skin turgor can provide indications of a patient's fluid status; however, the most sensitive indicator of hypovolaemia is the urine output. Strict fluid balance monitoring particularly in the immediate post-operative period is essential to guide fluid management, with the aim to maintain urine output of greater than 0.5 mL/kg/h. Fluid requirements can be met by using 30–35 mL/kg per day as a guideline, with additional fluid to compensate for pyrexia, and increased drain, fistulae or stoma losses.

Depletion of electrolytes such as potassium, magnesium and phosphate are common in the perioperative period and attention to their appropriate replacement will facilitate wound healing and reduce the risk of complications associated with electrolyte deficiencies. The daily requirement of the major electrolytes is summarised

Table 7.1 Daily electrolyte requirement

Sodium	1–2 mmol/kg/day
Potassium	0.5–1 mmol/kg/day
Magnesium	0.1 mmol/kg/day
Phosphate	0.1 mmol/kg/day

in Table 7.1. These should be added to intravenous maintenance fluids, with additional supplementation provided for deficiencies. Once the oral intake is established, patients should receive adequate amounts in a well-balanced diet. Supplementation should be considered if the diet is of poor micronutrient quality, which is often the case in low-resource regions.

7.1.4 Nutrition

Surgery causes significant physiological stress on the human body, related to the severity of the underlying disease and complexity of the procedure, resulting in increased energy expenditure and protein mobilisation moderated through the release of pro-inflammatory cytokines. Wound healing requires an adequate supply of macro- and micronutrients, and this is particularly at risk when patients are in a hypercatabolic state in the perioperative period. Adequate nutrition support during this time is known to enhance wound healing, reduce post-operative complications, shorten the period of convalescence and help prevent further deterioration of the nutritional state. Due to food insecurity, undernutrition is a major problem in many low-resource regions. This chronic undernutrition of macro- and micronutrients puts the acute surgical patient at particular risk of post-operative complications. This is compounded by the practice of keeping patients 'nil by mouth' for the procedure, sometimes for a protracted period due to delays in surgery, followed by the slow progression of diet post-operatively whilst gut function is being re-established.

Early enteral feeding, within 6–12 h post-procedure, if clinically appropriate, is associated with a significant reduction in post-operative complications. Consideration should be given to the level of nutritional intake whenever a post-operative patient's progress is being reviewed, and consider the need for more intensive nutritional support if any deficiencies are identified. A good starting point to determining a patient's daily requirement is 30–35 kcal/kg/day total energy and 0.8–1.5 mg protein/kg/day. The critically ill patient will require more nitrogen in the form of protein and more energy.

Refeeding syndrome can occur when a patient is refed after a period of starvation. The details of which are discussed in a separate chapter. Patients at risk are those who have had little to no food intake for more than 5 days, especially if already undernourished and particularly those who have low levels of potassium, magnesium or phosphate prior to feeding. These patients should have feeding introduced at maximum of 50% of total energy requirements for the first 2 days with full requirement for fluid, electrolytes, vitamins and minerals met from day 1. They

should be supplemented with thiamine and multivitamins. Potassium, magnesium and phosphate need to be closely monitored and replaced accordingly.

7.1.5 Prevention of Thromboembolism

Every surgical patient requires prophylaxis against venous thromboembolism. The perioperative period is a high-risk period for thromboembolism due to all three factors involved in the Virchow's triad—venous stasis from immobility during the operation and relative immobility during recovery; endothelial dysfunction due to inflammatory cytokines released and hypercoagulability from hypovolaemia and fluid shifts. Use of thromboembolic deterrent stockings (TEDS) during the whole hospital admission, with sequential compression devices intraoperatively is important. Patients need to be encouraged to mobilise from post-operative day 1 and chemical prophylaxis using unfractionated heparin or low molecular weight heparins is essential throughout the hospital admission. The intricacies of thromboprophylaxis are discussed elsewhere. This is well covered in another dedicated chapter.

7.1.6 Control of Potential Sources of Infection

The patient often emerges from the operating theatre with a number of lines and drains, all of which are potential sources for external pathogens to enter the body. On the post-operative round, consideration should be given to early removal of intravenous access devices, indwelling catheters and surgical drains as soon as they are no longer required.

7.2 Complications

7.2.1 Wound Complications

7.2.1.1 Seroma

A seroma is a collection of liquefied fat, serum and lymphatic fluid that builds up in the subcutaneous layer under the incision. This most commonly occurs after large skin flaps are developed in the course of the operation such as in the repair of large hernias due to the dead space that remains. This will usually present as a localised, well-circumscribed swelling, and may be associated with clear discharge from the immature wound. Placement of a suction drain in the potential space may help reduce seroma formation. A large symptomatic seroma may be aspirated under aseptic conditions. If it continues to re-accumulate after at least two aspirations, the incision may be opened and packed with gauze to allow healing by secondary intention. An infected seroma should also be treated with open drainage.

7.2.1.2 Haematoma

A haematoma is an abnormal collection of blood that collects in the subcutaneous layer under an incision or in a potential space in the abdominal cavity. Haematomas are at higher risk of becoming secondarily infected compared to seromas, therefore are more worrisome. They are related to inadequate haemostasis, depletion of clotting factors and coagulopathy. Clinical signs depend on its size and location. Under the surgical wound, it may present as a painful, expanding swelling and dark red fluid may drain out of the fresh wound; in the neck, it can cause airway compromise; in the abdomen, it can present as anaemia, abdominal pain and paralytic ileus that fails to improve post abdominal surgery. Preoperatively any clotting factor abnormality should be corrected and anticoagulation medications discontinued. During surgery, adequate haemostasis with ligature and electrocautery must be achieved before closure. Management of haematomas again depend on their size and location in the body. Small wound haematomas may not require any intervention as they mostly will resorb over time. On the other hand, a haematoma in the neck may need to be evacuated in the operating theatre, as will an expanding haematoma under a skin flap detected soon after surgery or one that has become secondarily infected.

7.2.2 Wound Infection

Surgical site infections occur due to bacterial contamination of the surgical site and continues to be a significant problem. Several factors contribute to the risk of developing a wound infection, outlined in Table 7.2, one of which is emergency surgery. Emergency surgical wounds are more likely to be contaminated than those in elective procedures, and the rate of infection is up to 40% for dirty wounds (Table 7.3).

Table 7.2 Risk factors for post-operative wound infection

Patient factors	Environmental factors	Treatment factors
Ascites Chronic inflammation Undernutrition Obesity Diabetes Extremes of age Hypercholesterolaemia Hypoxaemia Peripheral vascular disease Post-operative anaemia Previous site of irradiation Recent operation Remote infection Skin carriage of staphylococci Skin disease in the area of infection Immunosuppression	Contaminated medications Inadequate disinfection/ sterilisation Inadequate skin antisepsis Inadequate ventilation Presence of foreign body	Drains Emergency procedure Inadequate antibiotic coverage Preoperative hospitalisation Prolonged operation

Table 7.3 Classification of surgical wounds

Category	Criteria	Infection rate
Clean	No hollow viscus entered Primary wound closure No inflammation No breaks in aseptic technique Elective procedure	1–3%
Clean-contaminated	Hollow viscus entered but controlled – Small bowel Low-velocity traumatic incisions, e.g. – Kitchen knife injury, clean glass cut Primary wound closure Minor breaks in aseptic technique Mechanical drain used	5–8%
Contaminated	Uncontrolled spillage from viscus – Large bowel Low-velocity lacerating, tearing or bursting wounds High-velocity injuries – Crush injuries, garden tools Inflammation apparent Open, traumatic wound Major break in aseptic technique	20–25%
Dirty	Untreated, uncontrolled spillage from viscus Pus in operative wound Open suppurative wound Severe inflammation More than 12 h after injury Severe tissue damage and excessive ischaemic tissue – Severe crush injuries – Penetrating abdominal trauma with hollow viscus perforation – Wounds sustained in warfare – Cloth, shrapnel, faeces in wound	30–40%

Infections occur most commonly 5–6 days post-operatively, but may be sooner or later than that. Up to 90% of all post-operative infections occur within 30 days post-operatively. Superficial and deep wound infections present with tenderness, erythema, oedema, and there may be drainage of purulent fluid from the wound. The patient may also have leukocytosis and fever. Preoperative antibiotics should be given for prophylaxis in clean-contaminated procedures, and for therapeutic intentions in contaminated and dirty procedures. Clean-contaminated wounds can be closed primarily after a wound wash. Contaminated and dirty wounds may be converted to a clean-contaminated one after wide debridement and copious wound irrigation and be considered for primary closure. However, because of the high risk of wound infection, often delayed primary closure or healing by secondary intention is recommended. A wound infection deeper than superficial cellulitis should be opened to allow drainage and managed as a dirty wound. Negative pressure dressings, if available, can expedite the process of healing by secondary intention.

Table 7.4 Factors associated with wound dehiscence

Technical error in fascial closure
Emergency surgery
Intra-abdominal infection
Malnutrition
Wound infection, haematoma and seroma
Previous wound dehiscence
Elevated intra-abdominal pressure
Advanced age
Chronic corticosteroid use
Obesity
Radiation therapy and chemotherapy
Systemic disease (uraemia, diabetes mellitus)

7.2.3 Wound Dehiscence

Wound dehiscence or acute wound failure is the post-operative separation of any or all abdominal musculoaponeurotic layers. It is of great concern to surgeons due to the risk of evisceration, need for immediate intervention, possibility of repeat wound failure, surgical site infection and formation of incisional hernia. Dehiscence develops most commonly 5–10 days post-operatively when the wound is at its weakest but can occur any time after surgery. The factors that contribute to wound dehiscence are summarised in Table 7.4. Deep wound infection is one of the most common reasons for local wound separation. Acute wound failure may present without warning, or patients may have felt a popping sensation during straining or coughing. Evisceration makes this an obvious diagnosis. A discharge of a large amount of clear, haemoserous fluid heralds wound dehiscence in around 25% of patients. It may also be detected by probing the wound with a gloved finger. Once diagnosed, the degree of fascial separation and presence of evisceration or intra-abdominal contamination will determine the subsequent treatment. A small dehiscence in the proximal aspect of the wound may be treated by packing with saline-soaked gauze and using an abdominal binder. In the event of evisceration, the intestines should be covered with moist towels and arrangements made for return to the operating theatre for exploration of the abdominal cavity. Any intra-abdominal sepsis should be addressed then attention turned to the closure of the wound. Necrotic or infected fascia should be debrided. If the fascia cannot be brought together without undue tension, a mesh, either non-absorbable or biologic should be used to bridge the fascia. In some patients, the wound may be left open with a negative pressure dressing to allow healing by secondary intention.

7.3 Gastrointestinal

7.3.1 Ileus

An ileus is a functional obstruction that occurs due to inhibition of bowel peristalsis. A primary or post-operative ileus occurs without any precipitating factors and tends

to resolve within 2–4 days. A paralytic ileus is one that is associated with a precipitating factor and may have a delayed return to bowel function. Altered bowel motility in the post-operative period is likely an interplay between surgical stress, manipulation of the bowel, restricted oral intake and use of narcotic analgesia. In paralytic ileus, the precipitating factor may be a manifestation of intra-abdominal infection, electrolyte abnormalities, prolonged exposure of abdominal contents during a lengthy surgical procedure or systemic illness. This should be differentiated from a mechanical obstruction to guide management. The patient usually has a distended abdomen, nausea with or without vomiting and a quiet abdomen with few bowel sounds. An abdominal X-ray may show diffusely dilated small and large bowel with air in the colon and rectum, with or without air-fluid levels. This is in contrast to mechanical small bowel obstruction, where there is small bowel dilatation, air-fluid levels and prominent valvulae conniventes proximal to the transition point, with the absence of gas in the distal bowel. A CT if available, is more accurate at differentiating functional from mechanical obstruction. Steps should be taken to correct the common causes of paralytic ileus, such as replacement of electrolytes. The patient should be placed on bowel rest and a nasogastric tube may be placed to decompress the stomach and small bowel if the patient is vomiting. Prompt management of the ileus is important following bowel surgery as increased intraluminal pressure can predispose to rupture of anastomoses. In certain cases where there is closed-loop bowel obstruction or intra-abdominal sepsis precipitating the functional obstruction, emergency re-laparotomy may be required.

7.4 Post-operative Collections and Anastomotic Leaks

Emergency bowel surgery is associated with high morbidity and mortality, in part due to sepsis and anastomotic leakage. This is related to the poor nutritional status, immunocompromised state and presence of intra-abdominal contamination or sepsis to begin with. Adequate microcirculation at the resection margins is crucial for the healing of an anastomosis and colorectal anastomoses are considered at higher risk for leaks compared to those involving the small bowel.

All surgeons dread the anastomotic leak due to its potentially catastrophic sequelae. It results in sepsis and can lead to enteric fistula formation, need for reoperation, possibility for permanent stoma and potentially death. In the early stages, an anastomotic leak may manifest as malaise, fever, abdominal pain, ileus, localised erythema around the wound and leukocytosis. As it progresses, it can form fistulae to the skin or any contiguous structure such as the bladder or vagina. In emergency surgery, particularly in haemodynamically unstable, immunocompromised and nutritionally depleted patients, and in the presence of faecal peritonitis, significant bowel dilatation and oedema, an anastomosis is best avoided as a leak may prove to be fatal. In these situations, defunctioning stomas are advisable until the primary pathology has resolved, at which time a stoma reversal may be considered. Once an anastomotic leak is suspected or diagnosed, the patient needs to be adequately resuscitated and given broad-spectrum antibiotics. Bowel rest needs to be instituted

and an NG placed to reduce intraluminal pressure. Any infected surgical wounds should be opened. Reoperation is required if there is diffuse peritonitis, intra-abdominal haemorrhage, suspected bowel ischaemia, major wound disruption or evisceration. In the critically ill and unstable patient, damage control surgery may be required in the first instance. The compromised segment of bowel is resected, both ends left stapled off, peritoneal lavage performed and abdomen left open. A re-look laparotomy with the formation of stoma in 24–48 h is then performed when the patient is more stable. In the otherwise stable patient, a new small bowel anastomosis or stoma with or without distal mucus fistula may be formed.

A single intra-abdominal abscess may be drained percutaneously under image guidance; however, presence of multiple abscesses probably requires open or laparoscopic drainage.

7.5 Intestinal Fistula

A fistula is an abnormal connection between two epithelialised structures, one of which is a hollow organ. Gastrointestinal fistulas are most commonly iatrogenic, occurring as a result of anastomotic breakdown or unrecognised bowel injury. They may also develop after instrumentation or drainage of intra-abdominal collections. The risk factors that increase the likelihood of developing a fistula are the same as those predisposing to anastomotic leakage. The diagnosis is obvious when there is enteric or colonic content discharging to the structure with which it has fistulated, such as discharge of enteric content through the abdominal wound in an enterocutaneous fistula or faecaluria in a colovesical fistula. Fistulas can be classified based on the volume of output, which is influenced by whether it originates proximal or distal in the intestine. A low output fistula drains less than 200 mL/day, moderate output 200–500 mL/day and high output more than 500 mL/day. Sepsis tends to be a prominent feature and presents in up to 75% of cases. Patients can develop hypovolaemia, dehydration, electrolyte and acid-base imbalance, loss of protein and trace elements with resultant malnutrition, especially in high output fistulas. The skin surrounding an enterocutaneous fistula is at risk of excoriation and breakdown due to the corrosive effects of GI effluent. The principles of management can be remembered using the mnemonic ‘SNAP’, which stands for control of Sepsis and Skincare, optimising Nutrition with fluid and electrolytes, defining the Anatomy with imaging and Planning for definitive repair.

7.6 Respiratory

7.6.1 Atelectasis and Pneumonia

The most common post-operative respiratory complication is atelectasis, which is the combined result of the anaesthetic, splinting from abdominal wound, immobility and post-operative narcotics. The patient may have a low-grade fever, malaise

and reduced breath sounds at the lung bases. Adequate analgesia and strict instructions to mobilise, deep-breathe and cough, together with chest physiotherapy, will help re-open collapsed alveoli and prevent the development of pneumonia. Pneumonia if it develops, should be treated with appropriate antibiotics and aggressive chest physiotherapy.

7.6.2 Thromboembolic

Venous thromboembolism encompasses deep vein thrombosis (DVT) and pulmonary embolism (PE), and as previously stated, patients hospitalised for surgery are at particularly high risk. Patients who develop a DVT may present with calf pain, swelling, warmth, redness and congested veins; however, most will show no physical signs and PE may be the first manifestation of the disease. Most signs and symptoms of PE are non-specific such as sudden dyspnea, chest pain, haemoptysis and tachycardia. Massive PE resulting in haemodynamic instability and death occurs in 5–10% of patients. The diagnosis of PE is best achieved using a CT pulmonary angiogram (CTPA) or V/Q scan; however, these may not be available in the low-resource setting. Bedside echocardiography can provide a rapid, non-invasive method for diagnosis in the hemodynamically unstable patient. The value of a 12-lead ECG should not be discounted. In some instances, a 'S1Q3T3' pattern of acute cor pulmonale is classic of a PE. A provisional diagnosis of PE in patients with the above symptoms may be made with the following criteria:

1. Chest X-ray showing no abnormality
2. ECG showing no features of acute myocardial infarction
3. Doppler ultrasound of lower limbs showing deep vein thrombosis
4. Echocardiogram showing right atrium/ventricular dilatation, right ventricular dysfunction or pulmonary hypertension in a patient with no previous findings
5. No previous cardiopulmonary disease.

In these patients, it may be appropriate to initiate treatment with a low molecular weight heparin, such as 1.5 mg/kg/day of enoxaparin. The patient can then be referred to a centre where CTPA is available for definitive diagnosis.

Part II

Gastrointestinal Surgery: The Acute Abdomen

Approach to the Acute Abdomen

8

Francesco Piscioneri

8.1 Overview

The term acute abdomen is not totally precise. Its specific definition varies from surgeon to surgeon. It is generally understood to mean a patient who presents with a rapid onset of severe symptoms consisting mainly of abdominal pain which is severe enough to make them present to a hospital and is likely to require surgical review and possibly intervention in that admission. The pain has usually arisen in the last 24 h.

The pain may be generalised, central or in a particular quadrant, or radiating from elsewhere to other parts of the abdomen or the back. Its characteristics can range from sharp or dull to intermittent and colicky. There may also be associated symptoms such as nausea and vomiting.

These patients need to be assessed urgently and a decision made as to whether this is a true acute abdomen that will require urgent surgery or whether there is another cause for the pain that can be managed non-operatively.

Patients typically have been relatively well and then go through a fairly rapid course of moderate to severe pain, and other associated symptoms. Where the pain has been more long-term an acute cause is less likely.

As these patients can deteriorate quite rapidly, it is important to get an accurate diagnosis and to institute appropriate treatment as soon as possible. The history and examination should focus on narrowing down the differential diagnoses. Laboratory tests are useful in helping to identify organ dysfunction or an inflammatory process. CT scans are becoming the first investigation of choice in order to try to find a definitive diagnosis in the patient with an acute abdomen. Ultrasound is also a useful investigation but is best used when a focused or specific organ is looked at.

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There exists some controversy regarding the radiation risks of CT scans. In the case of acute abdomen, the risk of increased morbidity from delayed diagnosis supersedes the risks of radiation. Indeed, the amount of radiation from modern CT scanners is much lower than the past and poses far less risk than previously thought.

Laparoscopy is also now being considered as an early intervention tool in the acute abdomen for both diagnostic and therapeutic treatments.

Acute pain is a driver for hospital presentation. In the past, there was reluctance to give any narcotic analgesia to these patients whilst they were still going through the diagnostic process. It is both safe and humane to treat the pain with narcotic analgesic. It is best to do this by using small amounts of intravenous analgesia and titrating it until the patient gets adequate pain control.

In certain demographics, such as the elderly, pregnant, children, those patients who are not able to communicate clearly and the immunosuppressed, arriving at a diagnosis is fraught with difficulty.

The elderly often have other confounding comorbidities, less obvious signs, and blunted responses such as milder tachycardia and febrile response.

In pregnancy, the altered physiological state and the enlarging uterus can typically mask acute pathologies in the lower abdomen. This is especially so in acute appendicitis. An awareness of this and a lower threshold for intervention is important in order to avoid an adverse outcome for both mother and foetus.

Children are not small adults. They have a range of other possible differential diagnoses. Their signs and symptoms are not always reliably reproduced.

Early management consists of addressing hypotension with intravenous fluids or blood products. If the patient is unstable then urgent intervention is indicated before a definitive diagnosis can be made. Unstable patients should not be sent for CT scans. Broad-spectrum antibiotics should be instituted if there is any suspicion of an infective process or ruptured viscous. Where there is a possibility of another surgical discipline being involved then those members should be consulted early and advised of the condition of the patient and the planned management. This is especially so when gynaecological input is likely to be required.

Where the pain is out of proportion with the physical signs then consideration should be made of the possibility of mesenteric ischemia and urgent surgery should be performed. Bear in mind that often there is inoperable disease. A laparoscopy or a mini laparotomy to determine the extent and the viability of resection is a satisfactory approach.

The acute abdomen is a surgical emergency that is best treated in an acute surgical unit and have a timely operative intervention. Treatment can be expedited by having senior surgical personnel assess the patient at the earliest opportunity.

8.2 Clinical Assessment

The initial clinical assessment should be focused on whether the patient needs immediate surgical intervention or urgent non-surgical therapy or can wait and be more thoroughly investigated. If the patient is critically unwell then immediate resuscitative steps should be taken before going into details of history and examination.

It is important to develop a differential diagnosis. As pain is a significant feature it is important to localise the pain in order to help with refining the diagnosis. Classically the abdomen is divided into quadrants. However, realistically, there is an overlap of pain across the quadrants and also the presentations that are less specific are often referred to the midline. Consideration should also be given to extra abdominal sources that may manifest as abdominal pain and these include respiratory, cardiac, gynaecological, endocrine, and scrotal conditions. Specific non-surgical conditions include ruptured ectopic pregnancy, torsion of ovarian cyst, myocardial infarction, lower lobe pneumonia, testicular torsion, and diabetic ketoacidosis.

Clinical assessment encompasses a standardised approach where the vitals signs are recorded. A stepwise assessment of regions and organs is undertaken in a logical and organised manner. Note should be made of the blood pressure, pulse, and temperature. Is the patient pale, jaundiced, or flushed? Examine the respiration, is it shallow and rapid? This may be a non-specific sign of peritonitis owing to the pain on inspiration. Is the patient lying still or are they writhing around? This may indicate a more colicky cause for the pain. Carefully palpate the abdomen and check for guarding, rebound tenderness, and also for masses. Listen for presence or absence of bowel sounds and remember to check all hernial orifices. It is essential to examine the testes and scrotum in males.

8.3 Investigations—Laboratory

There is a basic set of laboratory tests that all patients with acute abdominal conditions should have.

The most readily available tests are the bedside urine dipstick and finger prick for blood glucose monitoring. The former test can quickly give an indication of possible infection or ureteric colic. A sterile sample of urine is also sent for formal microscopy culture and sensitivity.

Routine blood tests include full blood count, urea and electrolytes, liver function tests, CRP, and either lipase or amylase levels. Additionally, blood should be taken for grouping and saving if early surgery is indicated. A specimen should also be sent for blood culture if there is suspicion of sepsis or peritonitis.

Blood gases should also be done either from an arterial or a venous sample. Patients with sepsis or acute bleeding often have markedly altered levels of pH and lactate.

8.4 Investigations—Imaging

Imaging should be ordered according to the main components in the differential diagnosis. Most patients will have a chest x-ray plus supine and erect abdominal films. This is arguably the most important radiological test as it provides rapid acknowledgement of gas under the diaphragm in the case of the perforated viscus and for looking for fluid levels in the case of bowel obstruction.

Ultrasound investigations are very good for the biliary tree and liver, rule out gynaecological, and to examine the kidneys.

The gold standard abdominal imaging technique for the acute abdomen is CT scan of the abdomen and pelvis with intravenous contrast. There is a good demonstration of perfusion of the abdominal organs as well as any obvious malignancies or obstructions. Where the pain is thought to be due to bowel ischaemia, an arterial phase CT should be performed.

8.5 Management

There are conditions that require urgent intervention before a definitive diagnosis can be made. This includes a ruptured abdominal aortic aneurysm and patients who are persistently hypotensive in spite of resuscitation. These patients should be personally taken to the operating theatre.

For patients who are hemodynamically stable and where there is no immediate threat to organ viability a more measured approach to be taken. These can be treated with analgesia in the first instance whilst being diagnostically worked up.

The definitive management will of course depend on the cause and this will be covered in the following chapters. Good initial management includes reliable intravenous access, keeping the patient fasted, timely and appropriate investigations, attention to VTE prophylaxis and, the commencement of antibiotics once a working diagnosis of sepsis has been made.

8.6 Implications for Low Resource Regions

Early diagnosis of acute abdominal conditions has become very reliant on the availability of effective imaging. The mainstay being CT scans and abdominal ultrasonography.

Where the diagnosis is highly likely on clinical grounds then it is quite reasonable to proceed towards appropriate directed management.

However, if uncertainty exists to the diagnosis, then further management can proceed along the following pathway.

1. The patient can be transferred to a centre where further facilities and expertise are available.
2. The patient is acutely unwell with severe abdominal guarding and the staff proceed directly to a laparotomy.
3. In the patient that requires further evaluation but there is no indication for urgent surgery, it is quite reasonable for a period of observation in the current hospital

and look for trends. In these situations, the patient should be examined regularly by the same person where possible and patterns may become obvious with time eventually making the underlying diagnosis more apparent. If there is marked deterioration then a decision can be made to proceed to laparotomy.

4. In the special case of suspected mesenteric ischaemia, it is quite feasible to do a mini laparotomy under local anaesthesia to assess the viability of the bowel.

Acute Appendicitis

9

Francesco Piscioneri

Acute inflammation of the appendix is the most common abdominal emergency worldwide. The overall lifetime risk varies from country to country but is in the range of 10–15%. It can occur in any age group although the 20–40-year-old group is the most common. Appendicitis is one of the most frequent indications for an emergency abdominal surgical procedure worldwide.

The appendix is classified as a vestigial vermiform structure. The presence of B and T lymphoid cells in the mucosa and submucosa of the lamina propria make the appendix histologically distinct from the cecum. The lymphoid tissue undergoes atrophy with age.

The natural history of appendicitis is similar to that of other inflammatory processes involving hollow visceral organs. Initial inflammation of the appendiceal wall is followed by localised ischemia, perforation, and the development of a contained abscess or generalised peritonitis. Appendiceal luminal obstruction is seen as the inciting event. Appendiceal obstruction may be caused by fecaliths, calculi, lymphoid hyperplasia, infectious processes, and benign or malignant tumours.

9.1 Diagnosis

The mainstay of diagnosis is a careful history and examination.

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9.2 History

The most reliable symptoms are pain in the right iliac fossa, migration of pain from the peri-umbilical region to the right iliac fossa and anorexia. Less reliable symptoms are vomiting and alteration of bowel habits.

Initially, pain is commonly felt centrally in the abdomen because of the visceral innervation of the midgut. At this stage, the pain is often colicky because of obstruction to the lumen of the appendix. As the inflammation continues through the full thickness of the appendiceal wall the pain becomes locally peritonitic and the patient complains of constant pain which is aggravated by movement and coughing.

9.3 Examination

The most reliable physical signs are tenderness in the right iliac fossa, localised rigidity, rebound tenderness, psoas sign, and guarding. Rectal tenderness is less reliable as it is influenced by the intra-abdominal position of the appendix.

Up to 45% of patients may present with signs and symptoms that are not initially typical.

Patients may often have a moderate tachycardia and a low-grade fever in the region of 38 °C. Although rebound tenderness is a very good sign demonstrating peritonism, it is very uncomfortable for the patient. A more useful alternative is to perform a test for percussion tenderness by tapping the non-tender parts of the abdomen and demonstrating pain at McBurney's point.

The location of the appendix can also influence the signs and symptoms.

A retro-caecal appendix lies in a position protected from the anterior abdominal wall. There is usually tenderness in the right iliac fossa however often there are no signs of local peritonism. The psoas stretch sign may be more useful in this situation as the appendix will be lying directly on the psoas sheath. Approximately 25% of appendices may be found in this location.

About 1–2% of appendices are found in the retro-ileal position. Symptoms may be vague and the pain may be poorly localised as the inflamed appendix is lying behind the terminal ileum. There may also be increased occurrences of diarrhoea as the inflamed appendix can irritate the terminal ileum.

A pelvic appendix lies in contact with the rectum and often the bladder. As a result, patients may complain of diarrhoea and/or urinary symptoms (usually increased frequency of urination). There may be psoas spasm and tenderness on digital rectal examination.

9.4 Appendicitis in Pregnancy

The appendix is displaced by the uterus during pregnancy and tenderness is not often localised to right iliac fossa but can be anywhere along the right side of the abdomen. Ultrasound is a useful test to help distinguish appendicitis from

extrauterine gynaecological pathology. The risk of miscarriage or premature labour is not significantly increased by simple appendicitis however it is dramatically increased if there is perforation and peritonitis. Therefore, it is important that an accurate early diagnosis of appendicitis be made and appendicectomy performed. Where available, an MRI is an appropriate diagnostic investigation to rule out appendicitis in pregnancy.

9.5 Appendicitis in Young Children

Appendicitis can be a difficult diagnosis in young children as the pain is often not easy to localise and can be non-specific. It can be difficult to differentiate it from gastroenteritis or mesenteric adenitis. This leads to potential delay in diagnosis and together with the thinner walled appendix found in children, there is a much higher risk of perforation and peritonitis. Abdominal ultrasound is more useful in diagnosing appendicitis in children compared with adults.

9.6 Appendicitis in the Elderly

As stated earlier appendicitis is more common in the younger age group but can occur at any age. It should always be considered as a possible diagnosis. Symptoms are less pronounced and patients may have less of an inflammatory response. There may be additional pathology in the region of the caecum which also requires further investigation.

9.7 Laboratory Investigations

Useful laboratory investigations are a full blood count and CRP. These are non-specific indicators of inflammation. There is a lag of 12–24 h before they become elevated. Their main utility is that a negative CRP and normal white cell count, in the presence of abdominal pain being present for more than 24 h, makes the diagnosis of acute appendicitis less likely.

All women of reproductive age should have a pregnancy test to exclude the possibility of ectopic pregnancy. A pelvic ultrasound is useful in ruling out other gynaecological causes of pain.

All patients should have a urinalysis which should be normal in appendicitis except in those cases where there is a pelvic appendix which may lead to leucocytes or red cells in the urine. Urine microscopy, culture and sensitivity are useful in ruling out a urinary tract infection in those patients with less specific signs and symptoms.

9.8 Imaging

Plain abdominal X-rays have minimal use in the diagnosis of acute appendicitis. There may be increased density and suggestion of a mass in the case of an appendix abscess or phlegmon. Occasionally fecaliths may be seen on plain X-ray if they are calcified.

Ultrasound is commonly used in the diagnosis of appendicitis. It is very useful in paediatric cases because it is radiation-free and there tends to be less gas in the small bowel. Its role in male adults is less clear. Its main role in females is to rule out gynaecological pathology.

CT scan, in spite of the radiation dose, is the most useful investigation tool in the diagnosis of appendicitis. It will either show an inflamed swollen appendix with contrast uptake in the walls or more commonly show significant stranding in the region of the appendix both of which are highly suggestive of acute appendicitis. An additional benefit of CT scan is that is able to pick up other intra-abdominal pathologies which may be mimicking the symptoms of appendicitis. Although acute appendicitis should as often as possible be a clinical diagnosis, CT scan will reduce the number of negative appendicectomy quite significantly. It is recommended in patients over the age of 40 to rule out other additional pathology which may be associated with appendicitis (e.g. carcinoma of the caecum).

MRI is reserved for those with a diagnostic uncertainty of appendicitis in pregnancy.

If a patient continues to have lower abdominal pain but the diagnosis is not clear then a diagnostic laparoscopy becomes both a diagnostic and therapeutic tool.

9.9 Treatment

The mainstay of treatment is an appendicectomy. The traditional operation is based on an incision centred over McBurney's point, which is located two-thirds of the way along a line from the umbilicus to the anterior superior iliac spine on the right-hand side, followed by a muscle splitting approach of the underlying three body wall muscles. This usually directs the operator immediately to the underlying appendix. If the appendix is not all locatable then it can be found by a variety of techniques the most common being tracing the taeniae coli of the ascending colon down to the point where they converge on the caecum. This technique helps to identify the base of the appendix. The appendix and the mesentery are then tied off at the base and the specimen subsequently removed. The local operative field is then lavaged with warm saline and excess fluid is removed. Fluid may also accumulate in the pelvis and this should be suctioned as well.

Broad-spectrum antibiotics are shown to be most effective as a single perioperative dose. If there is considerable contamination then consideration should be given to a longer course of antibiotics ranging from 3 to 5 days. A common combination

is a cephalosporin and metronidazole. Gentamicin can be added in situations with generalised peritonitis.

There is now a trend for this procedure to be performed laparoscopically. The advantages of laparoscopic surgery are shorter hospital stay, less pain and reduced incidence of wound infection. Disadvantages include slight increase of intra-abdominal infection, difficulty of access if there has been previous abdominal or pelvic surgery and also a requirement of additional skill level in the operator.

Another advantage of laparoscopic surgery is that there is the opportunity to have a better view of the peritoneal cavity and its contents. This is especially useful in the situation of finding a non-inflamed appendix whereby another cause for the problem can be sought.

If a non-inflamed appendix is found, the question arises as to whether the appendix should be removed or not. It is important to have this discussion with the patient during the consent process. Practice varies but one approach is to remove the normal looking appendix in the situation where the clinical diagnosis was appendicitis. If the intent of the laparoscopy was diagnostic then a normal looking appendix may be left in situ.

9.10 Post-operative Complications

9.10.1 Wound Infection

This is the most common complication of appendicitis. Rates vary from about 5% in simple appendicitis up to 30% in complicated appendicitis which includes gangrenous changes and/or perforation. These patients are treated with opening or drainage of the wound and an additional course of antibiotics.

9.10.2 Intra-abdominal Abscess

These occur where there has been significant peritoneal contamination. Common sites include the pelvis and subphrenic areas but any area in the peritoneal cavity is susceptible. Patients present several days after surgery with fevers, rigors and often have diarrhoea in the case of pelvic abscess. Diagnosis is performed with either ultrasound or abdominal CT scan. These are best drained percutaneously under ultrasound guidance. Failing this, the cavity can be debrided by an open procedure and a drain inserted. It is important that the fluid be sampled to allow directed antibiotic therapy where necessary.

On occasions, patients re-present several days later with increased tenderness over the appendix area with fever and pain. Scanning does not show an abscess but does show inflammation at the caecal pole. The most likely cause is a persistent localised infection and these patients respond very well to a short course of antibiotics.

9.10.3 Neoplastic Pathology

In approximately 1% of cases, a neoplastic lesion is found in the pathological specimen. Often this will require further treatment.

If the lesion is benign and has been completely excised then usually no further treatment is required.

If the finding is of adenocarcinoma of the appendix then a completion oncological right hemicolectomy should be performed and specimen sent for further histology and staging. If there is further disease within the specimen then a full staging process should be carried out for the patient plus medical oncology referral.

If the neoplastic finding is of a carcinoid then further management should be performed in discussion with the medical oncologist. If the lesion is 1 cm or less in diameter and fully excised then no further surgery is usually indicated. If the lesion is greater than 2 cm in diameter or has not been fully excised, the patient should have a right hemicolectomy and medical oncology follow-up. For those lesions between 1 and 2 cm in diameter, there should be a discussion with medical oncology and the patient to determine any further appropriate treatment.

9.10.4 Fistula

This is an uncommon complication of appendicectomy. It can occur if there is an underlying inflammatory bowel disease or if there is a problem with the appendiceal stump. In the first instance, these patients should be treated with conservative management as per the fistula protocol.

9.10.5 Appendix Mass

Appendix mass describes a condition where there is a tender palpable mass in the right iliac fossa. It consists of the inflamed appendix which has become surrounded by adjacent loops of small intestine, caecum or greater omentum. These patients can be treated conservatively if they are clinically stable and the tenderness is only localised to the area of the mass. Management consists of intravenous antibiotics, nil by mouth or clear fluids, and close observation in hospital. If the clinical condition improves and the patients become well again then they can continue on a 5–7-day course of antibiotics and be discharged home. If the condition deteriorates then this is an indication of failed non-operative treatment and the patient should proceed to surgical removal of the appendix or in the case of an abscess developing, percutaneous or open drainage of the abscess.

If there was no fecalith present on the original scan and if the inflammation fully resolves then there is little need for an interval appendicectomy as the risk of recurrent appendicitis is similar to that of general population appendicitis. The patient needs to be fully informed of all of the surgical options. An outpatient colonoscopy should also be considered. This is particularly important in the elderly population as

appendicitis may be masquerading a much more concerning pathology (e.g. malignancy).

9.10.6 Appendix Abscess

Where there is a delay in diagnosis or in presentation, an abscess may develop. Abscesses are usually found in the region of the appendix either in the lateral paracolic gutter or in the adjacent pelvic area. Treatment is similar to any other intra-abdominal abscess. This consists of percutaneous drainage under ultrasound guidance and antibiotics. Smaller abscesses (under 2–5 cm diameter) can be treated with a trial of antibiotics alone. If either of these approaches fails, an open approach can be used to drain the abscess. At this time the appendix can also be removed. The role of interval appendicectomy has already been discussed.

9.11 Low Resource Alternatives

9.11.1 Diagnosis

If the diagnosis is in doubt and imaging is not readily available then a period of observation is appropriate. The patient is admitted to hospital and placed either nil by mouth or clear fluids only and regularly observed. This will consist of checking the vital signs and doing regular abdominal examinations at least every 4 h. It is best that the most experienced person on the surgical team performs this. Using this approach, a more accurate diagnosis is able to be made within 12–24 h.

9.11.2 Surgical Management

If the operative expertise is not available to perform an appendicectomy then it is best to transfer the patient as soon as possible to a unit that has this capability. If transfer is not possible and surgery cannot be safely performed then antibiotic management using broad-spectrum intravenous agents can be trialled. If dealing with early uncomplicated appendicitis this approach yields good results. There is a high risk of late recurrence in the order of 30–50%.

9.11.3 Late Presentation

In many areas with poor transport or limited health facilities, patients often present late with complicated appendicitis. In many of these situations, the appendix has formed an abscess in the right iliac fossa and can be felt as a firm mass in this area.

It is safe to do a limited drainage of this abscess. This can be done by direct aspiration if no surgical facilities are available or a direct incision over the mass and

drainage of the abscess using an extraperitoneal approach. The standard muscle splitting approach is used and once the peritoneum is reached the abscess becomes obvious and can be entered directly and drained. Sometimes it is possible to remove the appendix through this same extraperitoneal approach.

9.12 Summary

Acute appendicitis is a common surgical problem worldwide. With the range of options described in this chapter, it is possible to effectively and safely treat the condition in a wide variety of varying resourced locations.

Gallstone Disease

10

Edwin Beenen

The presence of gallstones is quite common in the Western World and increases with age and gender, being more present in women. The prevalence in the Western World ranges from 10– 60% in females aged 30–60 years old. The prevalence in men is approximately 40%. Incidence and prevalence in developing countries are less well known but considered relatively uncommon. It is estimated that each year, up to 5% of gallstones carriers become symptomatic and present with either a biliary colic, acute cholecystitis and less common with acute cholangitis or pancreatitis.

The gallbladder functions to store bile. It is filled passively in a retrograde manner. When a meal is consumed and the Sphincter of Oddi relaxes, it will empty by 50–70% in the next 1–2 h to be mixed with the enteric contents.

Gallstones are formed as the hyper-saturated bile fails to remain in a soluble state and crystals form. Admirand's triangle is the most often quoted model for this process where the components leading to crystal formation (cholesterol and bile pigments) are in imbalance with the dissolvent (lecithin). Contributing factors include the ability of the gallbladder to extract water from the stored bile and gallbladder dysmotility that leads to stasis and further concentration of bile salts and pigments.

Any condition influencing the above will lead to an increased risk of gallstone formation. For example, haemolytic disorders leading to increased bile pigment production, rapid weight loss leading to increased cholesterol excretion or prolonged gallbladder dysmotility and biliary stasis in critically ill or malnourished patients. Females are at an increased risk due to the fluxes of oestrogen and progesterone. This leads to altered cholesterol metabolism and increased dysmotility.

Although pure cholesterol or bile pigment stones exist, the majority are mixed. Only 15% contain enough calcium to be radiopaque.

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The complaints caused by gallstones are all mechanical in nature and caused by a blockage somewhere within the biliary system. If the stone is lodged at Hartmann's pouch or within the cystic duct the gallbladder can no longer empty itself and a biliary colic will occur. If the obstruction persists acute cholecystitis may occur; initially as a biochemical response, but culminating in an infection owing to the stasis of bile.

The distal common bile duct (CBD) is another point of obstruction. This results in post-hepatic (obstructive) jaundice. Cholangitis develops along the continuum described above.

The ampulla serves as the final point of obstruction in the biliary system. This is a point of confluence of the CBD and pancreatic duct before it empties into the duodenum. The obstruction of the pancreatic duct can lead to pancreatitis as well as obstruction of the CBD thus leading to obstructive jaundice and cholangitis. However, as the stones are smaller in calibre and often pushed through into the duodenum by the increased biliary pressure, the biliary obstruction is mostly transient in nature and only the (biliary) pancreatitis remains.

10.1 History and Examination

Right upper quadrant pain radiating to the tip of the right shoulder blade is a typical presenting problem. The pain is continuous in nature but it escalates in waves. To some it is comparable to labour of pregnancy. A biliary colic should settle within a few hours, but if it persists for longer it would be more in keeping with acute cholecystitis. Attention should also be paid to the presence of febrile episodes, pruritis, discoloured stools and darkened urine as a sign of CBD obstruction.

On examination, one should be conscious of identifying jaundice (e.g. scleral icterus and scratch marks) on general inspection. Further to this, pain on palpation of the right upper quadrant with guarding is considered typical for acute cholecystitis. The diagnosis is reaffirmed with Murphy's sign. However, it should be noted that clinical examination performs poorly in distinguishing biliary colic from acute cholecystitis.

In the elderly, it is prudent to exclude other differential diagnoses of right upper quadrant pain (e.g. myocardial ischemia, lower lobe pneumonia, Varicella Zoster rash).

10.2 Investigations

Elevated white cell count and C-reactive protein may support the diagnosis of an underlying inflammatory process (acute cholecystitis, cholangitis, or pancreatitis), but is not present in 20% of cases. A liver function panel including lipase should help in separating the differential diagnosis in which the pattern of biliary obstruction (bilirubin), liver cell damage (AST, ALT) and/or biliary endothelium injury

(GGT, ALP) can aid in confirming a diagnosis. Bedside and biochemical investigations discussed in the acute abdomen chapter should be considered here.

Ultrasound imaging is considered the gold standard for confirming the presence of gallbladder stones with an estimated sensitivity and specificity of over 95%. However, often due to gas in the overlying duodenum, the bile duct is less accessible for assessment. As most stones do not contain enough calcium, they may not be radiopaque to be seen on plain abdominal films or CT scan. An MRI/MRCP is highly sensitive in diagnosing cholelithiasis in both gallbladder and bile ducts, but due to its cost and reduced availability it is not the first choice in imaging. Ultrasound is less reliable in diagnosing acute cholecystitis. Historically, oral cholecystogram has been used to diagnose gallstones.

10.3 Differential Diagnosis

All diseases or conditions of the organs in the right upper quadrant may present in a nearly similar manner and only by combining history, examinations, and investigations can a proper diagnosis be made. As gallstones are endemic their presence should not blind the clinician in ignoring alternative diagnosis. A differential diagnosis should consist of but not limited to:

- Biliary colic
- Acute cholecystitis
- Acute cholangitis
- Hepatitis
- Pancreatitis
- Gastritis
- Gastric or duodenal ulcer disease
- Pyelonephritis
- Cardiac pathology
- Pulmonary pathology

10.4 Treatment Options

10.4.1 Medication

Except for antibiotics and analgesia, no recognised medical treatment to treat cholelithiasis or cholecystitis exist.

10.4.2 Intervention Radiology

Ultrasound or CT guided percutaneous transhepatic cholecystostomy drainage is an alternative to cholecystectomy. Its use is preferred in those unfit for surgery. The

drain should pass through the liver partially as the parenchyma will help collapse the drain tract after drain removal and prevent persistent leakage. A cholangiogram through the drain before removal is advisable as a persistent lodged gallstone in Hartmann's pouch or cystic duct may lead to reaccumulating fluid within the gallbladder with a risk of recurrent cholecystitis. Only when a patent cystic duct draining into the common bile duct and duodenum is seen, can the drain be removed with absolute safety and certainty.

10.4.3 Intervention Endoscopy

An Endoscopic Retrograde Cholangio-Pancreaticography (ERCP) is not only diagnostic but also therapeutic. It serves as a means of extracting CBD calculi.

Where possible and available, in the presence of choledocholithiasis, ERCP should be undertaken prior to cholecystectomy. This allows CBD exploration to be performed in conjunction with the cholecystectomy if ERCP were to be unsuccessful.

In low resourced regions, it is likely ERCP is not as accessible and therefore an open or laparoscopic CBD exploration should be within the scope of the treating surgeon.

10.4.4 Surgery

Surgery is the definitive treatment for symptomatic cholelithiasis. The preferred option will depend on the surgeon's capabilities, the available resources and additional support by an endoscopy service or intervention radiology as well as the patient's suitability as determined by co-morbidities and previous abdominal surgery.

The most common approach would be by laparoscopy, with an umbilical port placed for the camera. Further ports placed in the epigastrium and two in the right flank provide manoeuvrability and retraction capability for the surgeon and assistant, respectively.

Alternatively, an open approach by a subcostal or midline incision can be used. A wound retraction system or fixed body wall retractor has merits but a second assistant is equally valuable. In an open approach it is wise to pack the liver posterolaterally to present the gallbladder anteriorly.

In a laparoscopic cholecystectomy, an antegrade dissection is preferred. The principles include identification of Rouvier's sulcus and segment 4b, dividing the peritoneum from Hartmann's pouch up towards the fundus, exposing Calot's triangle, identifying Strasberg's critical view of safety (CVS), consider the value of a cholangiogram, ligation of cystic duct and artery, dissection and retrieval of the gallbladder whilst aiming to abstain from spilling stones.

If a CVS cannot be obtained owing to severe inflammation or fibrosis a retrograde approach might be considered along with a subtotal resection and possibly conversion to open.

In a retrograde dissection, care should be taken to stay on the posterior wall of the gallbladder. When the gallbladder starts to separate from the liver is often a sign the surgeon is approaching the hilum and proceed further with caution.

If the hilum is too adherent to the ligament and anatomy cannot be defined with absolute certainty a subtotal cholecystectomy should be considered. Despite oversewing the remaining gallbladder stump it often leads to a post-operative bile leak, which will settle in time with the aid of a drain. Probing the gallbladder digitally via Hartmanns's pouch provides tactile feedback regarding the extent of the organ when delineation visually is difficult.

In the presence of choledocholithiasis, a bile duct exploration might be required. Again, depending on the surgeon's capability and local resources this can be done laparoscopically or open. Further options are a transcystic or an open bile duct approach.

A transcystic approach, mostly used during laparoscopy, requires a dedicated operating set and intraoperative radiography.

An open bile duct exploration is achieved by exposing the anterior surface of the common bile duct by dividing the overlying peritoneum of the hepato-duodenal ligament. In planning the choledochotomy, a partially filled saline syringe can be used to confirm the CBD. The duodenum can be Kocherised to better appreciate and palpate the distal CBD.

When closing the choledochotomy, small bites in small increments is advised. A relatively small-sized dissolvable suture should be used. Non-absorbable suture is discouraged as it forms a nidus for stone formation within the CBD.

Although little evidence exists regarding the benefit of drains post cholecystectomy, they can be considered if the suspicion of a leak is high. The placements of T-tubes have gone out of fashion. It is worth noting however that newer generation T-tubes are silicone as opposed to latex. The implication is such that, current T-tubes do not elicit an inflammatory response intra-abdominally and thus precipitate a bile leak via the choledochotomy.

Cholecystectomy in severely inflamed or necrotic gallbladders can be extremely challenging. If an intraoperative bile duct injury is suspected, abandoning the procedure and referring the patient to a hepatobiliary surgeon should be seen as a testament of holistic patient care.

10.5 Complications

Serious complications that occur with cholecystectomy, including bile duct injury, bile leaks, bleeding, and bowel injury, result in part from patient selection, surgical inexperience, and the technical constraints that are inherent to the approach.

10.6 Bile Duct Injury and Leak

Biliary injury may be recognised at the time of laparoscopic surgery; if so, conversion to an open procedure and repair of the injury should be attempted only if the surgeon is comfortable with advanced biliary surgery. Otherwise, an intraoperative consult should be undertaken or consideration made for transferring the patient to a hepatobiliary (HPB) unit. External drainage of the gallbladder fossa should be

achieved prior to referral to a specialist HPB surgeon. Repair of biliary duct injuries should always be approached by an experienced multidisciplinary team.

Recognition of biliary injury may be more likely if routine intraoperative cholangiography is performed. Its value however is controversial.

Major biliary leakage is usually seen typically 7 days post cholecystectomy. Patients typically present with fever, abdominal pain, and/or bilious ascites. Jaundice is usually mild secondary to reabsorption of bile in third spaces. Leukocytosis and elevations in serum alkaline phosphatase and gamma-glutamyl transferase are common.

The bile ducts of Luschka conceptually include both small ducts that distinctly enter the gallbladder bed or small tributaries of minor intrahepatic radicals of the right hepatic ductal system. Regardless of origin, both can continue to leak after removal of the gallbladder. Clinically significant leakage from the ducts is rare.

In general, the source of the bile leak and amount of drainage determine the next course of therapy. Following radiological workup typically with a CT scan, though transabdominal US can be used, large loculated collections may need to be percutaneously or operatively drained. CT cholangiogram, Magnetic resonance cholangiopancreatography (MRCP), percutaneous transhepatic cholangiography (PTC) or hepatobiliary iminodiacetic acid (HIDA) scan can help to provide anatomical clarification of the leak. ERCP is useful as it allows CBD stent placement to control a leak.

Injuries to common bile or common hepatic ducts are the most serious and mandate an HPB unit referral and transfer.

10.7 Wound Infection

Wound infections are treated with antibiotics and open drainage where appropriate.

10.8 Bleeding

The incidence of uncontrollable bleeding from cholecystectomy can occur from three distinct sites—liver, arterial/venous sources, or port insertion sites. Bleeding from the liver bed is fairly common and is appreciated to be from the close proximity of the middle hepatic vein and its radicals to the gallbladder fossa. Bleeding usually occurs during the final aspects of the removal of the gallbladder and generally requires immediate conversion to open to control profuse haemorrhage through stitch ligation, if initial attempts at laparoscopic haemostatic control fail. Trocar site bleeds usually present subacutely and management is along a continuum that encompasses local pressure and suture to re-laparoscopy or laparotomy in those who are haemodynamically unstable.

10.9 Bowel Injury

If the injury is noted at the time of surgery, then conversion to an open procedure for repair is indicated if it cannot be repaired laparoscopically. In those that present in a delayed fashion but harbour signs of instability, peritonism, or sepsis, laparotomy and repair are indicated. In cases where the presentation is more indolent and controlled, standard enterocutaneous fistula management with nutritional support and adequate drainage and wound care is advised.

10.10 Spilled Stones

The surgeon endeavours to remove the gallbladder intact to limit spillage of stones. However, in some circumstances, gallbladder entry is inevitable. In such situations, it is prudent to identify and evacuate all spilt stones as they may form a nidus for infection and worst still contribute to post cholecystectomy syndrome.

Typically, those with spilled stones present with non-specific abdominal pain, fevers, or a discharging wound or sinus. The diagnosis is delayed owing to the lack of identification of stones radiographically in most instances. When identified, removal should be planned. It is wise to be mindful of surround friable tissue and lack of planes.

10.11 Post Cholecystectomy Syndrome (PCS)

PCS is a complex set of non-homogenous symptoms such as persistent abdominal pain and dyspepsia that recur and persist after the cholecystectomy. Diagnosis of the underlying problem causing PCS usually requires imaging. The intention is to identify retained or recurrent stones, a bile duct leak, stricture, or transection. This can be accomplished in most cases with ultrasound and/or CT scanning followed by ERCP or MRCP.

10.12 Summary

Gallstone disease in the developing nations is poorly defined. It is essential to consider the mechanics behind the stone formation with the same vigour as confronting the consequences of stone formation.

In developing countries, the delayed presentation rates are higher and thus heightened awareness of this possibility is required when multiple bouts of recurrent inflammation result in an unusually small shrunken gallbladder. In these situations, the surgeon should consider cholecystostomy or subtotal cholecystectomy.

Peptic Ulcer Disease

11

Krishanth Naidu

11.1 Introduction

Peptic ulcer disease (PUD) is a significant health care burden. Its presentations range from being asymptomatic, having mild gastrointestinal type symptoms—dyspepsia and bloating—and succumbing to features of haemorrhage or perforation. Ulcers arise as a result of a breach in the muscularis mucosa of the gastroduodenal wall. The gastric juices exert a deleterious effect to the susceptible mucosa. A strong correlation is seen between PUD and Helicobacter pylori (HP) infection. 95% of duodenal ulcers and 80% of gastric ulcers are seen to harbour the pathogen. There is a younger preponderance in developing countries. This is because most children have HP infection before age 10. The prevalence of HP infection is modified by factors such as the use of non-steroidal anti-inflammatory drugs (NSAID), smoking, socioeconomic conditions and age.

11.2 Presentation

Most patients with PUD may be asymptomatic. Epigastric pain and discomfort with complaints of dyspepsia are the most prevailing symptoms. A myriad of other symptoms includes postprandial belching, fullness, early satiety, fatty food intolerance and nausea. The latter symptoms result in an entity known as silent PUD. This is preferentially seen in the Asian continent and is relatively uncommon. The manifestation of symptoms is the result of pyloric channel ulcers with reduced visceral sensation and resultant gastroduodenal dysmotility. Radiation of pain to the back may occur but pain as the primary isolated symptom is atypical with PUD.

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The classic pain of PUD is described as epigastric and or left hypochondrium in location that occurs 2–5 h after a meal. This pain is related to gastric acid that is secreted into an empty viscus. Furthermore, the pain is pronounced between 11 p.m. and 2 a.m. when circadian stimulation of gastric juices is at its peak.

Given the myriad of symptoms, there is a range of PUD presentations. Bleeding related to PUD may present as haematemesis, haematochezia and hypotension if the volume loss is significant. Furthermore, gastric outlet obstruction may occur with pyloric placed lesions. Fistulisation to adjacent viscus structures such as colon and small bowel may occur.

The signs reported with PUD are limited unless complications arise, e.g. haemodynamic instability or succussion splash with delayed gastric emptying.

11.3 Management

PUD management begins with establishing the aetiology whilst simultaneously resuscitating the patient. All patients diagnosed with PUD should undergo HP infection testing—histopathology or breath-based—depending on the nature of presentation. No assessment is complete without an appreciation of drug, alcohol and smoking history primarily NSAID and steroid use, endoscopy and other evaluations to exclude differentials such as Zollinger-Ellison syndrome, malignancy, pancreatobiliary disease.

Following the confirmation, eradication of HP with commencement of antisecretory therapy and plans to withdraw offending factors should be instituted. Maintenance anti-secretory medications should be restricted to the high-risk population as approximately, 90% of ulcers heal with the abolition of HP infection. It is good practice to perform a surveillance gastroscopy in patients with giant, non-benign appearing ulcers without a clear aetiology. Furthermore, follow-up gastroscopy should be offered to all those who have had inadequate sampling at the index gastroscopy, persisting symptoms despite medical therapy, evidence of dysplasia or malignancy and those with risk factors for gastric cancer.

Similar to surveillance endoscopy, the indications for surgery in PUD is small and finite and include bleeding, perforation, obstruction, recurrent disease recalcitrant to medical treatment and suspected malignancy.

The goals of surgery in PUD is to treat and halt progress to complicated ulcer pathology, gastric acid suppression and in doing so promote tissue healing, and prevent and limit recurrences and post-operative complications, respectively.

When dealing with bleeding duodenal ulcers, therapeutic gastroscopy is the mainstay following fluid resuscitation and transfusion. However, with refractory bleeding, the approach is to inspect for the bleeding vessel and control directly by suture ligation or under running the gastroduodenal artery at the superior and inferior aspect of the ulcer via a longitudinal duodenotomy (distal to the pylorus in some instances—pyloroduodenotomy) with a large non-absorbable suture placed in a ‘U’ configuration. This will also aim to ligate the transverse pancreatic branch in its course posterior to the ulcer. Closure of the enterotomy is with the

Heineke-Mikulicz technique, this way not only is mucosal apposition ensured but there is less risk of stenosis. During this time, performing a highly selective vagotomy can be considered but needs to be undertaken with a pyloroduodenotomy. Be cautious in performing a vagotomy in a hemodynamically unstable patient.

With giant duodenal ulcers, partial gastrectomy or antrectomy with Roux-en-Y reconstruction (or gastrojejunostomy) can be considered. In the event of difficulty closing the enterotomy, the duodenal stump can be closed over a T-tube using the Nissen technique or draining it into the second part of the duodenum via a Foley catheter.

When dealing with gastric ulcers, options of management include either a partial gastrectomy with Billroth reconstruction or excisional biopsy of the ulcer with pyloroplasty combined with truncal vagotomy. It should be appreciated that to remove all offending exocrine cells, the gastrin producing cells extend to within 2 cm of the gastroesophageal junction along the lesser curve and at least 35% of the stomach distally needs to be resected. It is important to consult speciality surgical/medical services.

In those with a perforated duodenal ulcer, a modified Graham patch is undertaken following a generous peritoneal lavage. Close the defect primarily where able with absorbable sutures in an orientation that is parallel to the defect as much as possible. This is followed with the application of an omental patch that is secured with non-strangulating absorbable sutures. This is particularly important in the duodenum to prevent unwanted narrowing and possible stricturing. When repairing the duodenum, the risk of leak is perceived to be high and though primary repair may be performed, one should consider the option for gastrectomy and pyloric exclusion (pyloric closure and formation of a gastrojejunal bypass) with gastric drainage for duodenal diversion.

In gastric ulcer perforations, choice of approach extends from patch closure to partial gastrectomy. The fundamental difference between gastric and duodenal ulcers is the risk of malignancy in gastric ulcers. Thus, principles of surgery with gastric ulcers are such that the ulcer should be generously biopsied if not excised.

11.4 Summary

Management of PUD in low resourced or developing countries encompasses medical, endoscopic and surgical arms. Eradication therapy is highly recommended and significantly reduces the burden of PUD.

Acute Pancreatitis

12

Francesco Piscioneri

Gallstones and excessive alcohol intake account for approximately 80% of cases. Other causes have been attributed to viral infections, medications, hypertriglyceridemia and hypercalcaemia.

12.1 Terminology

Severe acute pancreatitis is characterised by the presence of organ failure or local complications. If an uncomplicated course ensues or there is transient dysfunction it is termed mild and moderate, respectively. There are several scoring systems for severity (e.g. Ranson, Imrie, APACHE and CRP). In practical terms, the CRP is very useful for monitoring progress.

Pancreatic necrosis is usually diagnosed by contrast CT. Large areas of swollen and inflamed tissue which are poorly perfused are an indication of likely necrosis. CT can also demonstrate gas formation which is indicative of infected necrosis. CT can also demonstrate peripancreatic fluid. In the first 4 weeks this usually does not have an organising wall. After 4 weeks the fluid is often within a contained capsule. This is the time when pancreatic pseudocyst formation occurs. Fluid collections in necrotising pancreatitis are classified as acute necrotic collection prior to 4 weeks and walled-off necrosis beyond 4 weeks.

Pancreatic pseudocysts appear as cystic structures within and around the pancreas that have formed from inflammatory exudate and fibrosis. It is caused by the disruption of the main duct of the pancreas. The contained fluid has inflammatory material and is enzyme-rich.

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Necrosoma (organised pancreatic necrosis) results from liquefaction of the pancreatic necrosis. It can take 4–12 weeks to form. It is semi-solid and well demarcated. This makes it more amenable to surgical excision.

12.2 Epidemiology

The incidence varies by region. About 80% have mild disease and make a full recovery. Around half of patients with severe disease will develop infected pancreatic necrosis. These patients have high mortality approaching 50%. Of these, approximately half the deaths occur during the first week as a result of organ failure. Infective complications are responsible for many of the later deaths.

12.3 Pathophysiology

There are two aspects to the disease. There is local inflammation and complications. The other is the Systemic Inflammatory Response Syndrome (SIRS) and Multiple Organ Dysfunction Syndrome (MODS).

The enzyme trypsin is central to the initial insult. It is able to not only activate itself but also activate other enzymes. This leads to autodigestion of the pancreas. The exact mechanism of how this occurs is not fully understood; however, the main risk factors are biliary disease and high alcohol intake. Inflammatory mediators spill out into the systemic circulation leading to SIRS and eventually MODS. The specific inflammatory mediators and their actions will not be discussed here.

12.4 Diagnosis

The majority of patients present with acute pain in the upper abdomen which often radiates to the back. Most patients have associated vomiting. Pain is relieved by sitting forward. Examination reveals marked epigastric tenderness and guarding. There may be a significant history of gallstone disease or recent high alcohol intake. There may also be evidence of retroperitoneal haemorrhage (Cullen's sign and Grey—Turner's sign). These are uncommon and occur usually after 48 h.

The main laboratory tests are serum amylase or serum lipase with levels greater than three times above the upper limit of normal. Patients with chronic pancreatitis who suffer an acute attack may not show significantly elevated levels. As alluded to before, CRP indices are a practical measure of severity and progress.

CT scanning of the abdomen will not only demonstrate acute pancreatitis but can also show areas of necrosis or gas formation. CT is also useful in ruling out other causes of abdominal pain. Ultrasound can demonstrate gallstones in the gallbladder and presence of a dilated common bile duct. It is less useful for diagnosing acute pancreatitis.

12.5 Initial Management

This centres around adequate analgesia, oxygen, aggressive treatment with crystalloids and nasogastric suction for management of gastroparesis and ileus. All patients must have DVT prophylaxis unless otherwise indicated.

Monitoring is by way of laboratory studies for renal function and electrolytes, cardiovascular observations and respiratory tests (blood gas/chest x-ray). Most patients can be managed in a general ward unless there is organ compromise and those patients should then be cared for in an ICU or HDU setting.

There are no specific treatments for acute pancreatitis so close monitoring and effective fluid management are essential. The CRP is a good indicator of patient progress and is readily available in most hospitals. The onset of organ dysfunction indicates a poorer prognosis and the requirements for more aggressive supportive therapy.

Early sphincterotomy (of the sphincterof Oddi) by ERCP is not usually indicated. Where there is common bile duct obstruction leading to acute cholangitis the situation then becomes more urgent for bile duct clearance. Most common duct stones will pass without operative intervention. If the cause is due to excessive alcohol intake, then appropriate preventative measures should be advised.

There is a small group of patients where no obvious cause is found and MRCP or ERCP in these patients can be performed in order to determine if there is a structural cause leading to pancreatitis.

The more severe cases are complicated by SIRS followed by multiple organ dysfunction syndrome (MODS). The transition usually occurs towards the end of the second week. There is some overlap of the conditions.

12.6 Role of Antibiotics

There is no indication for the routine use of antibiotics in acute pancreatitis. If infection is suspected by increased inflammatory markers, worsening observations or by CT evidence of infection, then directed antibiotics should be used. It is preferable that a fine needle aspiration is performed to identify the organism. Up to 30% of infected pancreatitis can contain candida so an antifungal therapy should be considered. Appropriate antibiotics are guided by local antibiotic stewardship practices. The length of course of antibiotics is controversial but any decision to prolong antibiotics greater 14 days should be taken on a case-by-case basis and in consultation with local infectious diseases experts. If the unit is receiving a transferred patient who has already been commenced on antibiotics then the 14-day course should be completed.

12.7 Nutrition

In mild acute pancreatitis, there is no need to fast the patient unless they are vomiting. If the patients are unable to tolerate oral intake, other methods need to be contemplated as these patients are in a state of catabolism. Most patients tolerate a

nasogastric tube and can be fed peptide-based feeds. For those that do not tolerate this then nasojejunal tubes can be inserted endoscopically or under radiological guidance. If either of these approaches are not successful then total parenteral nutrition should be considered.

12.8 Clinical Management

The management is influenced by whether the disease is mild or severe.

Those with mild disease usually resolve in 4–5 days. When the cause is gallstones, cholecystectomy should be undertaken during the index admission following duct clearance or resolution of the acute episode. Otherwise, the recurrence rate is in the order of 30% over the next few months.

Severe pancreatitis can be divided into early and late phases. The acute phase is related to the SIRS factors with features of hypovolaemia, inflammation and fluid exudation. The later phase is more closely related to MODS and usually manifests itself during the second week of disease. Death due to the complications of organ dysfunction are unusual in the first week.

Mild cases can be treated in a general surgical ward with supportive therapy and progress to discharge as the patient improves over the first few days.

Severe pancreatitis is quite resource-intensive. These patients are best treated in a HDU setting. An early contrast-enhanced CT scan will help determine the initial extent of tissue damage.

Management is related very much to how the patient is progressing. If the signs are that the patient is improving then repeat CT after 7–10 days is appropriate. If the patient deteriorates then a CT can help guide management. The main worrying concern at this stage is the infection of necrotic pancreatic tissue. If the inflammatory markers are rising and there are signs of gas bubbles on the CT then it has to be assumed that there is infection. Tissue sampling is required and this can be done either with a fine needle aspiration or the insertion of the pigtail catheter into the retroperitoneal space if there is a collection of fluid. Antibiotics should be started immediately and should be broad-spectrum and based on local antibiotic guidelines including consideration of antifungal therapy.

Early debridement of tissue should be avoided as surgical intervention in the first few weeks has a high mortality. It is best to wait until the necrotic tissue has organised and is better demarcated. This usually occurs by the third–fourth week. The traditional approach has been through open repeated laparostomies. However, there is now a trend to percutaneous drainage and repeated use of a resectoscope under direct vision.

If the facilities or skills do not exist for safe surgical intervention then patients should be transferred to a centre that can provide this level of care. In low resource regions where transfer is not an option, operative intervention should be avoided and supportive therapy is maximised.

A special mention should be made about haemorrhage. It can either be as a result of necrotising pancreatitis or iatrogenic due to intervention. The latter can be

associated with early surgical intervention of the necrotic tissue. This reinforces the need to delay surgery until at least 3or 4 weeks as stated above.

The inflammatory effect of pancreatitis can lead to pseudoaneurysm formation typically in the splenic, left gastric or gastroduodenal arteries. The haemorrhage can be massive and often rapidly fatal. If the bleeding is slow, then there is time for the patient to be adequately resuscitated and angioembolization to be organised and performed. This approach gives the best overall chance of survival.

Venous bleeding is less common and more difficult to diagnose. It requires carefully controlled resuscitation. If bleeding continues the only surgical option would be surgical removal of the distal pancreatic tissue.

12.9 Summary

Acute pancreatitis can be managed non-operatively in most situations. Operative intervention should be left to those with appropriate experience. Where resources are very limited it is best to transfer those with severe pancreatitis to a major centre when it is safe to do so.

Acute Colonic Diverticulitis

13

Francesco Piscioneri

13.1 Introduction

Acute diverticulitis is an inflammation of the large bowel diverticulae.

Anatomically, the diverticulae are outpouching of the colonic mucosa through the natural defects created where the supplying blood vessels enter the colonic walls.

It is a relatively common presentation in the over 40 age group in the more developed countries. The prevalence can be more than 50% of the over 60's group in these countries. The aetiology is thought to be related to the lower residue diet in these population groups. The smaller diameter of the bowel leads to increased intraluminal pressures thus predisposing to the development of diverticulae.

In spite of this large prevalence, only about 25% of people will get symptoms related to diverticulae. These can include colonic spasms manifesting as migratory abdominal pain, as well as inflammation or bleeding from the diverticulae.

Inflammation is thought to be due to obstruction at the mouth of the diverticula either by a faecolith or an undigested food particle such as a seed. This can lead to proliferation of infection, perforation of the diverticula and spread of the infection outside of the bowel wall.

Hinchey classified acute diverticulitis into four categories;

1. Local bowel wall inflammation only
2. local inflammation plus abscess formation in the local area or in the pelvis
3. perforation with purulent peritonitis
4. perforation with faecal peritonitis

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These four levels of presentation have an escalating severity and require quite different treatment regimes.

13.2 Diagnosis

13.2.1 History

This is a disease of an older population with an average age of 60. The clinical presentation will depend on the severity of both the underlying level of inflammation and the presence of any associated complications.

The most common symptom is abdominal pain which is usually in the left lower quadrant due to the sigmoid colon being the predominant site of inflammation. The abdominal pain has often been present for several days and is usually constant in nature.

Pain however can be anywhere in the lower abdomen including the right side if there is redundant sigmoid colon. Asian populations can get right-sided diverticulitis.

Patients may give a history of preceding diarrhoea, but most patients will have constipation for at least 1–2 days prior to presentation. Nausea and vomiting are variable however most patients have anorexia as well as a low-grade fever.

13.2.2 Examination

Most patients with early disease will have localised tenderness in the lower abdomen mainly on the left side. They may also have localised peritoneal signs over the area of maximal tenderness. This includes localised guarding, rigidity and rebound tenderness. More severe features such as hypotension, and generalised peritonitis are less common and usually associated with perforation.

13.2.3 Complications

Approximately 25% of patients with diverticulosis will develop diverticulitis. Of those that develop diverticulitis approximately another 25% will get complications either acute or chronic.

13.3 Abscess Formation

Abscesses develop in approximately one in five patients who are hospitalised with acute diverticulitis. Clinically these patients are difficult to differentiate from those with uncomplicated diverticulitis. Diverticulosis is usually noted on the initial CT scan at the time of presentation. If there has not been any imaging then suspicion of

the diverticular abscess is raised when there has been minimal clinical response after several days of adequate intravenous antibiotic therapy. The abscesses may be located adjacent to the sigmoid colon and also may arise in the pelvis. The latter may cause diarrhoea as a symptom. Rarely, infection may spread through the mesenteric planes and vessels towards the liver leading to pyogenic liver abscesses.

13.4 Perforation and Generalised Peritonitis

Perforation leads to generalised peritonitis. This can occur in two ways. A pre-existing abscess may rupture leading to purulent peritonitis (Hinchey 3). Alternatively, an inflamed diverticulum may rupture and there is direct faecal contamination of the peritoneal cavity (Hinchey 4). This leads to a purulent peritonitis.

13.5 Intestinal Obstruction

The underlying cause can be acute or chronic. Acutely there may be inflamed tissue causing a relative narrowing of the large bowel lumen with symptoms similar to that of bowel obstruction. The chronic situation is due to long-term intermittent inflammation leading to stricture formation.

Patients typically complain of symptoms suggestive of large bowel obstruction such as lower abdominal pain, abdominal distension, nausea and constipation. Vomiting can occur but is less likely with large bowel obstruction.

Small bowel obstruction can occur usually in the form of an ileus. Adjacent small bowel may be affected by the inflamed large bowel leading to symptoms of small bowel obstruction.

13.6 Fistula Formation

This is a relatively common complication of diverticulitis with an incidence of up to 20%. Most occur between the sigmoid colon and adjacent structures. The most common is colo-vesical fistula but colo-vaginal, colo-uterine and colo-enteric can also occur.

Colo-vesical fistulas have symptoms which include dysuria, pneumaturia and faecaluria. This may be the first presentation of diverticula disease.

13.7 Investigations

13.7.1 Laboratory

Patients generally have raised inflammatory markers including elevated white cell count and elevated CRP. A urinalysis should be performed. This may show an

elevated white cell count in the urine due to the colonic inflammation being adjacent to the bladder. The presence of a colo-vesical fistula will show the presence of enteric organisms in the urine.

13.7.2 Imaging

A contrast-enhanced CT is the preferred investigation in acute diverticulitis. Features suggestive of acute diverticulitis include localised bowel wall thickening, fat stranding and evidence of complications such as free gas and abscess formation. Presence of diverticulae can also be demonstrated if contrast is used. Other features include the presence of fluid levels in the adjacent bowel indicating possible ileus, gas within lumen of adjacent structures indicating fistula formation.

Abdominal ultrasound is less specific regarding the diagnosis of diverticulitis however is reliable for demonstrating abscess formation.

Plain abdominal and chest x-ray are not diagnostic for diverticulitis however can demonstrate air-fluid levels in the presence of ileus and air under the diaphragm if there has been significant perforation.

13.7.3 Differential Diagnosis

Other causes of intra-abdominal inflammation need to be considered. These include acute appendicitis, inflammatory bowel diseases, infectious colitis and ischaemic colitis.

Colorectal cancer should also be considered in the differential diagnosis. This condition can present with localised inflammation, perforation and obstruction.

13.8 Management of Acute Diverticulitis

13.8.1 Early Diverticulitis

Early diverticulitis is characterised by pain in the left lower quadrant, mild fever and elevated white cell count. Examination will show an area of localised tenderness and voluntary guarding which are indicative of localised peritonitis. The corresponding CT findings are of bowel wall thickening and mesenteric fat stranding.

At this stage, the diverticulitis can be managed non-operatively. Over 70% of patients will respond to antibiotic treatment alone. Some patients can be treated with outpatient oral antibiotics. Those patients suitable for outpatient treatment generally have an absence of systemic signs, absence of localised peritonitis and are able to tolerate oral intake. Antibiotics should be broad-spectrum and have anaerobic cover. The length of treatment should be no more than 5–7 days. After resolution and return of normal bowel function, a diet high in fibre may decrease the risk of recurrence.

Those patients selected for inpatient non-operative treatment should have intravenous broad-spectrum antibiotics and bowel rest. This would consist of nil by mouth or in the less severe cases clear fluids orally. There should be a noticeable improvement in both clinical signs and improvement of white cell count within 48 hours. If the patient remains unchanged, this may indicate the need for a longer course of antibiotics for greater than 1 week. If the condition of the patient deteriorates then this is an indication for further scanning to determine the progression of the disease or development of further complications.

As the condition of the patient improves, oral diet can be restored and the patient can be changed to oral antibiotics.

13.8.2 Complicated Diverticulitis

This includes perforation, abscess formation, bowel obstruction or fistula formation.

Small contained abscesses can be treated expectantly with intravenous antibiotics. Those larger than 5 cm in diameter need to be treated surgically. The best option is percutaneous drainage either with an in situ drain or simple aspiration. An in situ drain is the preferred option.

For abscesses between 2 and 5 cm in diameter, a trial of antibiotics is acceptable management. Failure of resolution is an indication for drainage. The advantage of a drain is that it can be kept in place until there is minimal discharge. Simple aspiration may be required to be performed on repeated occasions until there is full resolution of the abscess. Both techniques should be image-guided with the gold standard being CT. Ultrasound guidance is acceptable if a clear passage can be seen to the abscess.

If the inflammatory mass is not controlled by drainage and antibiotics then surgical resection of the inflamed tissue is required. The standard approach has been a Hartmann's procedure where the sigmoid colon is resected with a variable amount of affected descending colon. An end colostomy is performed and the distal stump is closed either with staples or with sutures.

13.9 Peritonitis Secondary to Diverticulitis

If the presentation is with generalised peritonitis (Hinchey 3 or 4) surgical intervention is required. This has traditionally been by way of a Hartmann's procedure. More recently there have been reports of laparoscopic lavage. These patients had to be carefully monitored and taken back to theatre for resection surgery if management fails. Some specialist centres are performing primary anastomosis for selected cases. Post-operatively these patients are managed as per local laparotomy and peritonitis protocols. Patients can usually be changed to oral antibiotics as symptoms resolve and have remained afebrile for greater than 24 h.

13.10 Post Discharge Management

Patients should be advised to commence a high fibre diet once the acute episode has resolved. In the past, they have been advised to avoid seeds in their diet but there is no evidence that this poses an increased risk of recurrence.

All patients should be reviewed after 4– 6 weeks. Those with continued low-grade diverticulitis should be considered for further workup including consideration of surgical removal of the affected colon.

Asymptomatic patients should be referred for colonoscopy to rule out any underlying malignancy. The colon cancer rate in this cohort of patients averages 3% and it is closer to 5% in those who have had complicated diverticulitis.

13.11 Recurrent Diverticulitis

About one-third of patients will have a recurrent attack of diverticulitis after the first episode. Risk factors include complicated first attack, obesity, younger age, smoking and female gender. Recurrent attacks are not necessarily more severe than the initial episode.

13.12 Elective Surgery

In the past, elective surgery was offered based on severity and the number of attacks; usually after two attacks of diverticulitis.

Selection of patients should be based on the risk of developing serious complications and in immunosuppressed patients as subsequent attacks carry a significant risk of dying.

The other group of patients who should be offered surgery are those whose recurrent attacks are frequent and are imposing on their lifestyle.

13.13 Low Resource Implications

If CT scanning is not available then the diagnosis will be a clinical one and is generally fairly straight forward. The advantage of CT is to determine the presence of complications as well as to confirm the diagnosis.

Patients who do not resolve with non-operative management and still have a significant inflammatory load in spite of antibiotics will require operative intervention. Without a guiding CT, this usually involves an open procedure with abscess drainage and often a Hartman's procedure.

An ultrasound of the abdomen (if available) may demonstrate intra-abdominal abscess collections.

Broad-spectrum antibiotics should be continued throughout the episode of care.

Liver Abscess

14

Janaka Balasooriya

Liver abscess is a relatively uncommon but potentially life-threatening condition which has been described since the time of Hippocrates. The advances in bacteriology and diagnostic techniques, improvement in drainage techniques, as well as improved supportive care, have reduced morbidity and mortality significantly over the past few decades.

The two major forms of liver abscesses are,

- Pyogenic abscess, which is most often polymicrobial and
- Amoebic abscess which is common in tropical regions mainly where "*Entamoeba histolytica"* is endemic.

Rarely Fungal abscess can be recognized most often due to *Candida* species.

14.1 Pyogenic Liver Abscess (PLA)

Although a significant proportion of liver abscesses are cryptogenic, most often microorganisms enter the liver tissues via either hepatic artery, portal vein, or biliary system. Attempt should be made to find out correctable causes.

- Biliary disease—Biliary disease is the commonest cause for the PLA. It occurs following ascending cholangitis secondary to extrahepatic biliary obstruction associated with choledocholithiasis, benign and malignant tumors, or postoperative strictures. Biliary-enteric anastomoses, endoscopic biliary procedures, and

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intrahepatic rupture of gangrenous gall bladder also contribute to the formation of abscess.

- Infection via portal system (portal pyaemia)—With the use of antibiotics for intra-abdominal infections, portal pyaemia is now less common but it still can occur with appendicitis, acute diverticulitis, inflammatory bowel disease, and perforated hollow viscus.
- Hematogenous (via hepatic artery)—This usually occurs from systemic bacteremia due to a distant infection such as bacterial endocarditis, dental and ENT infections, or urinary sepsis.
- Traumatic—Blunt or penetrating trauma and interventions for liver masses such as embolization and ablations can be complicated with pyogenic abscesses.

14.1.1 Presentation

Early symptoms are nonspecific. A febrile illness and right upper quadrant pain are the most common complaints. These can be mistaken for acute cholecystitis or hepatitis. A chronic history is typical and may be associated with anorexia, malaise, and jaundice. In some cases, patients present with symptoms related to the primary cause. During clinical assessment, an attempt should be made to identify the cause and related complications.

14.1.2 Examination

Swinging pyrexia and a tender right upper quadrant are common signs. Jaundice is more of a feature if it is associated with the biliary system. Apart from these, lung signs due to effusion or atelectasis may be evident. Assessment of circulatory status is essential as the patient may be in septic shock.

14.1.3 Laboratory Studies

The routine blood tests are nonspecific. Neutrophilic leukocytosis in full blood count (FBC) and elevated CRP are common findings and serial testing is done to monitor response and progress. Hypoalbuminemia and elevation of alkaline phosphatase are the most common abnormalities in liver functions while elevations of transaminase and bilirubin levels are variable. Renal functions and electrolytes are important in resuscitation and recognizing organ failure.

Blood cultures are positive in roughly 50% of cases while culture of abscess fluid yields more than 75% positive rates. Most commonly isolated microorganisms include *Escherichia coli*, *Klebsiella pneumoniae*, *Bacteroides* species, and *Streptococcal* species and sensitivities determine final antibiotic choices.

14.1.4 Imaging

Plain abdominal and chest radiographs have less diagnostic value in liver abscess. Indirectly, there may be an elevation of the right hemidiaphragm and respiratory complications such as effusion and atelectasis. Rarely gas loculi in the abscess may be visible.

Ultrasound scan (USS) is the initial imaging modality of choice. It has a sensitivity of 75–95%. It also provides information about the biliary tract pathology, the presence of gallstones and their complications. It avoids radiation exposure and thus is widely used in pediatric age group.

Disadvantages of USS include difficulty in detecting an abscess high in the dome of the liver and especially multiple small PLAs. When the fluid is dense, it may be confused with a solid lesion.

A CT scan is more accurate than USS in the differentiation of PLA from other liver lesions and has a sensitivity of approximately 95%. Apart from detecting smaller liver lesions, it will provide more details of causative pathology as well as abdominal and respiratory complications.

Magnetic resonance imaging (MRI) does not seem to have any advantage over CT or USS.

14.1.5 Management

Management include the following steps;

- Resuscitation,
- Initiation of appropriate antibiotics,
- Drainage of purulent collections—aspiration, drainage, or surgery, and
- Establishing the source and its management.

14.1.5.1 Antibiotics

Broad-spectrum antibiotics should be started parenterally to cover Gram-negative and positive aerobes and anaerobes. Initial therapy with amoxicillin, an aminoglycoside, and metronidazole or a third-generation cephalosporin and metronidazole generally covers the causative organisms most commonly found. Once an offending agent is identified, antibiotic regimes can be streamlined. Regardless, the regimes are of longer durations. Traditionally antibiotics are continued for 2 weeks and converting to oral forms and continuation for a prolonged period will depend on the patient's clinical response, culture results, and institution policies. Expert microbiological opinion may help in the decision-making at this stage. During this period the patient should be monitored regularly with clinical and biochemical parameters and also with repeat imaging.

- In patients with multiple PLAs that are too small to drain, antibiotics may be the only treatment. This regime has been shown to be effective in patients with unilocular abscesses that are smaller than 3 cm.

14.1.5.2 Percutaneous Procedures

Percutaneous procedures are performed under USS or CT guidance. Aspiration of PLA is usually followed by the insertion of a drain.

Primary treatment by percutaneous catheter drainage (PCD) is performed when:

- The fluid is too dense to be aspirated
- The abscess is greater than 5 cm in diameter
- The wall is thick and non-collapsible after aspiration

Once positioned, the catheter should be irrigated with isotonic sodium chloride solution and placed to allow gravity drainage. The drain is removed when it dries off and the abscess cavity collapses, as confirmed by imaging. An abscess with biliary communication may also be treated by PCD but the continuous output of bile for a prolonged period should be expected even after endoscopic decompression. Close proximity to vital structures will be a contraindication for percutaneous drainage.

14.1.5.3 Surgical Treatment

Although the above measures are successful in 80–90% of cases, surgical drainage has to be considered in the following situations.

- Failure of nonoperative treatment.
- Intraperitoneal rupture or impending rupture.
- Abscess not amenable for drainage—complicated, multi-loculated, thick-walled abscess with viscous pus.
- Complications of percutaneous drainage, such as bleeding or intraperitoneal leakage of pus.
- Coexistence of intra-abdominal disease that requires operative management.

Open surgery can be performed using the following approaches.

- Transperitoneal approach via midline or right upper quadrant incision which allows abscess drainage and abdominal exploration to identify previously undetected abscesses and the location of an aetiologic source.
- Posterior transpleural approach for high posterior lesions which limits the access for intra-abdominal organs.
- Extraperitoneal approach which avoids peritoneal contamination.

Laparoscopic approach with the help of endoscopic ultrasound is also used in selected cases and affords the opportunity to explore the entire abdomen and it may reduce the morbidity.

14.1.5.4 Treatment of Underlying Pathology

When the biliary system is obstructed, decompression with ERCP and stenting will be the preferred method. Percutaneous transhepatic biliary drainage can be used if ERCP fails.

Most antibiotic regimes used in PLA will also cover the distant septic foci.

Strict glucose monitoring in diabetic patients, stabilization of renal function, and measures to improve immunodeficiency status should be implemented as required.

14.2 Amoebic Liver Abscess (ALA)

This is the most common extraintestinal site of *E. histolytica* infection. It is more common in men between 20 and 40 years of age who reside in or had a recent travel to an endemic region. ALA lesions are usually single and mostly found in the right lobe of the liver. Main risk factors include heavy alcohol intake, immunodeficiency, crowding with poor hygiene, and malnutrition.

Amoebic cysts are usually transmitted to the human gut via contaminated food and water. The cyst wall is broken down by trypsin in the small intestine to release the trophozoites which colonize the caecum. These trophozoites penetrate the mucosal layer to enter into mesenteric venules and then find the pathway to the liver via the portal circulation to form the abscess.

14.2.1 Clinical Features

Most of the clinical features are as above. Diarrhea may be present in less than one-third of patients at the time of diagnosis and some patients describe a history of having had dysentery within the previous few months. When the patient describes a recent visit to an endemic region, the onset of symptoms usually occurs within 8–12 weeks from the date of travel.

On examination, a febrile illness complemented with right upper quadrant tenderness and hepatomegaly are prominent features.

14.2.2 Investigations

Amoebic abscess may cause leukocytoctosis and liver function derangement. Understandably, these are again nonspecific. Blood cultures are negative unless the abscess becames secondarily infected with bacteria.

When amoebic origin is suspected, serologic testing is the most widely used method of diagnosis. EIA (enzyme immune assays) detects antibodies specific for *E histolytica* in approximately 95% of patients with extraintestinal amoebiasis. EIA serology reverts to being negative in 6–12 months following eradication of infection. Serum antigen testing is another option with an advantage of diagnosing acute infection.

Although positive results in stool examination for cysts and microbial antigen suggest the diagnosis, negative results are not reliable as less than a third of patients with ALA have concomitant intestinal amoebiasis.

Aspiration of the abscess may not be helpful in diagnosis either as the centre of the abscess is filled with necrotic material and amoebae are usually found in the marginal wall.

14.2.3 Imaging

As with pyogenic abscess, both USS and CT scans are used in diagnosis with almost similar sensitivities. Rarely, nuclear imaging is used to differentiate the two abscesses. Amoebic abscesses appear as a cold lesion with hot halo while pyogenic abscesses appear as a hot lesion.

14.2.4 Management

Management principles are similar to that of pyogenic abscesses. Fortunately, most uncomplicated amoebic liver abscesses can be treated successfully with conservative management with amoebicidal drug therapy alone which eradicate the invasive trophozoites in the liver. Metronidazole remains the drug of choice for amoebic liver abscess and is usually given for 5–10 days. Chloroquine and Tinidazole are used as alternatives.

This has to be followed by a course of luminal amoebicides such as Paromomycin or Diloxanide Furoate for the eradication of the asymptomatic colonization state otherwise this can lead to relapse of infection.

When there is no improvement in 3–4 days of adequate medical therapy aspiration is considered. There should be a low threshold to aspirate left lobe abscesses which can cause cardiac complications and ones with a risk of impending rupture. Like PLA, percutaneous drainage is indicated when a thick collection is not readily aspirated by needle or when repeated aspiration is required.

Surgical intervention is only rarely required when the patient is not improving with the above measures and to deal with complications such as rupture.

14.2.5 Monitoring

The response to treatment is assessed clinically and biochemically due to lag in radiological changes of response. The complete sonographic disappearance of the lesion may take several months and relapses are very uncommon.

14.3 Complications

The complications of hepatic abscess result from rupture of the abscess into adjacent organs or body cavities. If rupture occurs into pleural cavity it can result in pleurisy and pleural effusion, empyema, and bronchohepatic fistula while intra-abdominal rupture may cause subphrenic abscess and generalized peritonitis. Most often these patients need a multidisciplinary approach in management.

14.4 Low Resource Alternatives

Due to the vague clinical features and laboratory findings, imaging is necessary for the diagnosis. USS is sufficient is in most cases. Resuscitation with fluids and optimization of clinical and biochemical parameters are of prime importance in initial management irrespective of the definitive diagnosis. With the diagnosis, trial of broad-spectrum antibiotics and anti-amoebic therapy is commenced and the patient is monitored with clinical and biochemical parameters. Culture results will then guide antibiotic therapy.

If amoebic abscess is suspected and serology tests are not available, stool examination can help in diagnosis in some patients.

If the USS is negative in a patient with symptoms suggestive of a liver abscess, CT scan needs to be considered as it will demonstrate smaller lesions.

When the medical therapy is unsuccessful and a guided aspiration is indicated in the absence of an interventional radiologist, an experienced surgeon may be able to aspirate a large superficial abscess under USS guidance safely. The procedure can be repeated several times if there is no response. Risks and benefits should be balanced in deciding on operative intervention as surgery carries significant morbidity.

When the operative expertise is not available and if the patient is not improving with adequate medical and interventional radiological measures then it is best to transfer the patient as soon as possible to a unit that has this capability. The same will apply for the patients with ruptured abscess with peritonitis, patients with complications due to guided procedures, and when the causative pathology needs to be addressed with operative measures.

Although open surgery carries relatively high morbidity compared with laparoscopy, it is safe in experienced hands, and with transperitoneal approach it gives access to other related pathologies. When the pyogenic abscess is not resolving due to ongoing biliary obstruction and if ERCP facility is not available, open bile duct exploration with T-tube placement is an alternative.

Some of these patients especially with PLA are acutely unwell and septic requiring ongoing supportive care in an intensive care unit. Decision on optimum management of these patients has to be done by a multidisciplinary team including gastroenterologist, radiologist, surgeon, and intensivist.

14.5 Conclusion

Liver abscess share many clinical features and biochemical derangements with other hepatobiliary pathologies requiring imaging for diagnosis. Because of the difficulty in differentiating between PLA and ALA, anti-amoebic therapy is usually recommended in addition to broad-spectrum antibiotics initially. Medical therapy alone is effective in most cases of ALA. Some form of intervention is usually needed for PLA.

Intra-Abdominal Abscess

15

Francesco Piscioneri

Intra-abdominal sepsis can arise from a variety of sources. It is usually related to perforation of an internal viscus. It is important also to have an appreciation of intra-abdominal spaces and gutters.

Intra-abdominal fluid will gravitate to the lowest parts of the peritoneal cavity. With the patient lying supine the lowest part is pelvis followed by the subhepatic space.

Excessive fluid can find its way into the subhepatic spaces, subphrenic spaces, the left and right para-colic gutters, the pelvis, the central peritoneal area, and between loops of the small bowel.

The greater omentum is an important component of sepsis containment. It migrates to areas of inflammation and helps seal off the inflamed tissue in order to control the spread of sepsis.

Sources of sepsis include;

Lower oesophagus—the lowest part of the oesophagus has an intra-abdominal course. Perforation can occur due to instrumentation (endoscopy) or malignant perforation.

Stomach and duodenum—mostly due to perforated peptic ulcer although perforated malignancy can occur with gastric cancers. The spillage contents are mainly low pH gastric juices which cause severe peritoneal irritation. Infection risk is high as contents often contain food materials and environmental contaminants.

Small bowel—perforations are less common. Spillage less irritant than gastric juices but still contains bacterial material. Causes include perforated Meckel's Diverticulum, small bowel lymphoma regressing from chemotherapy, necrosis and perforation resulting from ischaemic segments in adhesive bowel obstruction. Mesenteric ischaemia leading to necrotic bowel segment is less common.

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Large bowel—contents are high in bacteria. Perforations due primarily to diverticulitis, but malignant perforations of colorectal cancers are also significant. Inflammatory conditions include toxic megacolon. Caecal perforation can also occur from distal large bowel obstruction.

Appendix—one of the most commonly inflamed organs in the body. Delayed treatment can lead to perforation resulting in either peritonitis or localised abscess. Retro-caecal appendicitis is more likely to proceed to abscess because of its more enclosed location.

Gallbladder—acute cholecystitis can lead to empyema of the gallbladder. Intra peritoneal abscess is less likely although can occur if the gallbladder wall perforates.

Liver—abscesses may occur within the body of the liver. Often there is an underlying biliary disorder. Infection can also arise either from diverticulitis with mesenteric involvement, or from colitis (e.g., amoebic dysentery) and spread via the portal venous system.

Anastomotic leaks—in patients with recent abdominal surgery requiring bowel resection, anastomotic leaks usually present 2–5 days after the surgery.

15.1 Diagnosis

History is mainly focused around a differential diagnosis of abdominal pain. Suspicion of an abscess is from a prolonged history, inflammatory bowel disease, failed use of antibiotics, description of fever and chills, and localised abdominal pain. The description may be that of a deep-seated pain. Vomiting may be present although can be suppressed due to peritoneal irritation. Diarrhoea may occur in the presence of a pelvic abscess.

Additional risk factors include diabetes, recent abdominal surgery, and recent appendicitis, diverticulitis, or perforated peptic ulcer.

The examination can be non-specific. There may be localised or generalised tenderness. There may be a palpable mass. This is more likely with the appendiceal mass. The patient may have fever or hypothermia, the latter being more common in the elderly or immunocompromised. Tachycardia is usually present but is non-specific. Patients with a pelvic abscess will usually have tenderness on digital rectal examination.

Other things to look for include signs of malnourishment, and of generalised sepsis including septic shock.

Laboratory investigations should include full blood count, CRP, liver function tests, and electrolyte tests. These tests should include evaluation of albumin and glucose levels.

Contrast CT scan gives an excellent evaluation of the abdominal cavity. Abscesses are usually well-defined, have an enhancing border, and can be evaluated for suitability of drainage. Other features include the presence of gas in the abscess fluid. In pregnant women, an alternative to CT would be MRI scanning.

Abdominal ultrasound is less sensitive than CT scanning. Useful with hepatic and appendiceal abscesses. Has a role to play when access to CT scanning is not available. Also has a role in guiding percutaneous drainage once the abscess has been defined by previous imaging.

If there is limited access to CT or ultrasound, a plain abdominal x-ray can be used. Features to look for include, air-fluid levels, extraluminal gas, elevation of diaphragm, collapse/consolidation of lung base, and soft tissue mass displacing bowel.

15.2 Management

Many of these patients can be quite unwell with either generalised sepsis or septic shock. They should all be rapidly assessed with the ABC of resuscitation and treated appropriately. Most will have at least some degree of dehydration.

Antimicrobial therapy should be commenced once a diagnosis of sepsis has been made. Treatment should be broad-spectrum until specific organisms and sensitivity have been defined. Local antibiotic protocols plus the condition of the patient will define treatment. If patients are immunosuppressed additional isolation precautions should be instituted. Early identification of organism is very important. Blood culture and if possible, infected exudate, should be taken prior to the institution of antibiotic therapy. If multiresistant organisms are suspected, antimicrobial therapy should be modified appropriately.

These patients are highly catabolic and nutritional/caloric needs should be addressed. All should have intravenous fluid therapy with volumes based on replacement and maintenance. This should be balanced against any underlying comorbidity such as congestive cardiac failure. If possible the oral or enteric routes should be used if the patient's condition allows. Otherwise, the patient should be assessed for early institution of total parenteral nutrition (TPN).

15.3 Percutaneous Drainage

Most intra-abdominal abscesses can be well-managed with percutaneous drainage and antibiotics.

- If percutaneous drainage is considered, the following conditions should be satisfied;
- there is an anatomically safe access route;
- the abscess is well-defined and unilocular (multilocular abscesses can be attempted with the repeated drainages if there is a good response);
- image guidance is available (non-image guide can be used in liver abscesses if facilities unavailable and abscess readily palpable);
- availability of a "pigtail-type" catheter;
- there is a surgical backup for treatment failure or development of complications.

Post drainage management includes;

- laboratory evaluation of the causative organism including sensitivities,
- maintenance of a closed drainage system with daily irrigation to avoid catheter blockage,
- Ultrasound or CT scan follow-up to check the progress.

Complications include;

- bacteraemia and sepsis,
- enteric puncture,
- enterocutaneous fistula,
- vascular injury,
- inadvertent trans-pleural catheter placement.

Catheters can be removed once there is;

- minimal drainage (typically <5 mL per day),
- clinical resolution of sepsis,
- imaging evidence of resolution.

Should consider surgical drainage if;

- percutaneous drainage cannot be technically done due to poor access,
- there is widespread infection including peritonitis,
- the contents of the abscess are too thick to be adequately trained through the catheter,
- facilities for percutaneous drainage do not exist.

15.4 Surgical Access

This should be performed if antibiotic and minimally invasive treatments have failed, there is a large abscess with difficult access percutaneously, or if there is associated peritonitis.

Approach can be transperitoneal or extraperitoneal depending on the location of the abscess. Abscesses adjacent to the abdominal wall are suitable for extraperitoneal approach. A drain is left in situ and managed post-surgically as per a percutaneous drain.

Transperitoneal surgery has significant complications. If bowel resection is required in the presence of significant sepsis, a primary anastomosis should be avoided and a temporary stoma created. Many of these patients will need to be managed in an intensive care environment after the initial surgery.

15.5 Summary

Intra-abdominal abscesses should be considered if patients with suspected sepsis are not resolving with antibiotics alone. Abscesses are readily demonstrated by CT scanning and usually with abdominal ultrasound.

Treatment is stepwise with antibiotics, percutaneous drainage, and the surgical approach. Antibiotic treatment is guided by suspected organisms and results of culture and sensitivities. The size of the abscess will influence the complexity of the approach.

These can be successfully treated in areas of low resource with repeated percutaneous aspirations subject to the abscess being readily identified either clinically or with image guidance.

Mesenteric Ischaemia and Ischaemic Colitis

16

Francesco Piscioneri

16.1 Mesenteric Ischaemia

Acute mesenteric ischaemia is a catastrophic abdominal emergency. The critical feature is a sudden interruption to mesenteric blood flow which often leads to bowel infarction and death. Most mesenteric ischaemia is acute but there can be chronic presentations.

Mesenteric vascular compromise can be arterial (embolic, thrombotic), venous (thrombotic), or non-occlusive (vascular narrowing).

Embolism is the commonest cause of mesenteric ischaemia. The majority of emboli arise from the left atrium in patients with atrial fibrillation. The superior mesenteric artery is most commonly affected.

Thrombosis has a worse prognosis and usually occurs in the presence of atherosclerosis. There is often a history of fear of eating, intestinal angina, and weight loss.

Non-occlusive disease results from hypoperfusion including congestive cardiac failure and shock. Surgical patients may have intense vasoconstriction due to treatment of shock with vasoconstrictors. Arterial vasospasm may persist even after correction of the underlying event. Overall prognosis is poor.

Acute mesenteric ischaemia due to venous thrombosis most commonly affects the superior mesenteric vein. It is very uncommon. Causative factors are hypercoagulable states (e.g., Factor V Leiden mutation and Protein C, S, antithrombin III deficiency) or acquired hypercoagulable states (e.g., malignancy, portal hypertension, oral contraceptives, intra-abdominal sepsis, and post abdominal surgery).

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16.1.1 Presentation

Severe abdominal pain that is out of proportion with the clinical signs is present in over 95% patients. Other early symptoms include nausea, vomiting, and diarrhoea. Late symptoms are indicative of progression of the ischaemia and include bloody diarrhoea, abdominal distension, and eventually signs of peritonitis (fever, tachycardia, and shock).

16.1.2 Pathophysiology

The ischaemic insult leads to mucosal barrier disruption which has two main effects.

Bacteria, toxins, and vasoactive compounds are released and lead to systemic inflammatory response syndrome (SIRS) which can lead to multi organ dysfunction syndrome (MODS) and eventually death.

Large amounts of protein-rich fluid is released into the gut leading to hypovolaemia which if untreated leads to shock.

If there is complete vessel obstruction with no collateral flow, then absolute ischaemia will occur. There is then a rapid progression with mucosal sloughing in the first 3 h. At this stage, the damage is still reversible. Within 6 h there is transmural necrosis, gangrene, perforation, and peritonitis.

16.1.3 Investigations

Blood findings are non-specific and include haemoconcentration, leucocytosis, metabolic acidosis, and lactic acidosis.

Plain abdominal x-rays may show dilated bowel loops, 'thumb-printing' sign indicating bowel wall oedema and thickening, gas in the bowel wall (pneumatosis intestinalis), and gas in the portal vein.

CT angiogram is the main imaging modality. It can demonstrate occlusions and narrowing in the mesenteric arteries, bowel wall oedema, gas in the bowel wall and in the portal vessels, and pneumo-peritoneum.

16.1.4 Management

Look for history and examination consistent with ischaemic bowel. Pain will be out of proportion with the clinical signs. Look for risk factors.

If peritoneal signs are present, it is likely that there is a breach of the intestinal wall and the patient should have an immediate laparotomy.

If there are no peritoneal signs, the patient proceeds along a diagnostic pathway. Once acute mesenteric ischaemia has been established the following treatment should be commenced;

- oxygen therapy
- fluid resuscitation
- nasogastric tube to decompress the stomach and bowel rest
- broad-spectrum antibiotics
- heparin 5000U IV followed by a therapeutic infusion
- invasive monitoring in HDU setting for the more severely ill patients
- treat arrhythmia/heart failure

16.1.5 Surgical Exploration

Approach is via a midline laparotomy. Necrotic bowel should be excised. Only consider re-anastomoses if there is good blood supply to the bowel ends and the patient is not requiring circulatory support with vasopressors or inotropes. If there is any doubt about the security of a primary anastomosis the bowel ends should be closed and a second look laparotomy performed the next day to assess the viability and to perform a bowel anastomosis. During this time the patient's physiology is able to be restored in the intensive care unit. If there is extensive bowel necrosis with little or no residual healthy bowel the situation becomes unsalvageable and is best to close the patient and proceed to palliation.

If there is no obvious infarction but there are signs of ischaemia then there are two options. If vascular expertise is available angiography and clot retrieval should be performed. If this service is not available then the patient should be closed, continued with heparin infusion, and closely monitored. Further deterioration warrants a second look laparotomy.

Intravenous papaverine should be considered for 24 h in those patients who have had a revascularisation procedure as arterial spasm can continue after revascularisation has been successful.

If a second look laparotomy is mandatory, such as in the case of having to perform a bowel anastomosis, the abdomen can be left open with a suitable covering such as a vacuum dressing. There is no place for routine open abdomen. Close observation and selective second look laparotomy is the preferred course of action. This should be performed within 24–48 h.

16.1.6 Non-Occlusive Mesenteric Ischaemia

Treatment is non-operative unless peritoneal signs develop. In such situations, the patient requires a laparotomy and surgical management of the findings.

Non-operative management consists of;

- correction of underlying disorder (e.g., treatment of shock)
- elimination of vasopressors
- optimising fluid status and cardiac output
- arterial catheter infusion of vasodilator (e.g., papaverine)

16.2 Mesenteric Venous Thrombosis

Treatment is mainly non-operative with heparin infusion. A search should be made for a hypercoagulable state and this should be managed long-term. Any development of peritoneal signs should be treated with laparotomy and bowel resection as required.

16.3 Low Resource Regions

Mesenteric ischaemia can be managed in limited-resource regions. The diagnosis can be made clinically and the patient managed either operatively or non-operatively according to the abdominal signs.

Mortality, even in the best of centres, approaches 80%.

16.4 Ischaemic Colitis

Ischaemic colitis is defined as a sudden and often temporary reduction in colonic blood flow that is insufficient to meet the metabolic needs of parts of the colon.

The colon derives its blood supply from the superior mesenteric and inferior mesenteric arteries. The Marginal Artery provides collateral circulation in the mesentery between the two arterial systems. There are watershed areas of potential diminished blood flow at the splenic flexure and the recto-sigmoid junction. The blood supply to the colon is less than that of the rest of the gastrointestinal tract and thus is more vulnerable during periods of hypotension.

It affects males and females equally, is more common in the left colon, and in the over 60 age group. It has similar risk factors as small bowel ischaemia but in addition can be affected by bowel obstruction and colonic infections.

Hypoxia leads to tissue necrosis with an inside to out progression. Transmural infarction can occur in 8–12 h.

16.4.1 Presentation

The presentation is in three phases.

The initial hyperactive phase is with severe abdominal pain and usually blood stained loose stools. This is then followed by paralytic phase characterised by the pain diminishing but becoming more continuous and generalised, the abdomen distending, and bowel sounds becoming absent.

In 10–20% of patients, there is progression to a shock phase which features a very large fluid, protein, and electrolyte transfer through damaged gangrenous mucosa, metabolic acidosis, and shock. These patients require urgent surgical intervention to manage the necrotic bowel and associated peritonitis.

16.4.2 Diagnosis

History and examination are usually suggestive of the diagnosis. In the early stages, pain is out of keeping with the physical signs but with progression patient develops features of peritonism.

Laboratory investigations include;

- white cell count above 20,000
- elevated lactate, LDH, and ALP
- metabolic acidosis
- stool culture to rule out an infective cause

16.4.3 Imaging

Plain abdominal x-ray may show dilatation of a segment of the colon in the early stages. This later progresses to loss of haustrations and pneumatosis of the colonic wall.

CT scanning is a valuable investigation tool. Things look for include;

- disruption of the mesenteric vessels indicative of thromboembolism
- irregular narrowing of the bowel lumen with associated bowel wall oedema
- pneumatosis in both the bowel wall and the portal venous system
- dilatation of the bowel proximal to the ischaemic segment

Colonoscopy can be used if the diagnosis is uncertain. It should only be used in the early stages and can show mucosal ischaemia or necrosis. It should not be used once the patient develops signs of bowel atonia as the risk of perforation of potentially necrotic bowel wall is extremely high.

Barium enema is less diagnostic than CT scanning. Features include thickened bowel wall, segmental luminal narrowing, with stricture formation in the latter stages of the disease.

16.4.4 Surgical Management

There is a role for laparoscopy in the diagnostic workup. It is useful for ruling out gut ischaemia where other investigations have been inconclusive. The other role for laparoscopy is to determine the extent of established ischaemia in order to evaluate whether the patient is a suitable candidate for laparotomy and bowel resection, or whether the disease is so extensive that the best course of action is palliation thus avoiding an unnecessary laparotomy.

About 20% of patients will require surgical intervention whilst the remainder can be managed non-operatively with bowel rest until there is return of intestinal function and diminution of pain.

Acute surgical intervention is indicated for patients with peritoneal signs and those with persistent fevers and sepsis. All affected bowel should be resected and the mucosa of the resected margins inspected for viability. Questionable ischaemia should also be resected unless there is an extensive disease where a second look procedure can be done at 24–48 h to recheck viability of the colon. Primary anastomosis is usually avoided as it results in a high risk of anastomotic leakage in the acute setting. The usual procedure being an end colostomy with the distal segment either closed off or formed into a mucous fistula. If there is an extensive disease of the colon then total colectomy and terminal ileostomy are performed.

At the second look procedure anastomosis can be considered if there is clinically viable tissue and the patient is not requiring inotropic or vasopressor support.

In those patients that require surgical intervention, the mortality rate approaches 50–75%.

There is a small role for elective surgery in patients who have developed strictures or in those where bleeding and diarrhoea persists.

16.4.5 Low Resource Regions

Patients with ischaemic colitis can be well-managed in low resource regions. The diagnosis can usually be made clinically and most cases can be treated non-surgically. In moribund patients, a mini laparotomy can be performed to inspect the bowel to help determine the extent of disease and necrosis. This can often be done with simple local anaesthetic and sedation.

Part III

Non-inflammatory Conditions of the Abdomen

Upper Gastrointestinal Bleeding

17

Giuseppe Borzellino, Kouamé Bernadin Kouakou, Belinda De Simone, Maria Bencivenga, Wilson Petrushnko, and Michael Kelly

17.1 Background

Upper Gastrointestinal bleeding (UGIB), defined as bleeding within the lumen of the gastrointestinal tract (GIT) proximal to the Ligament of Treitz, is a common cause of emergency hospital admission worldwide. The incidence is higher in men than in women and increases sharply in older patients. There is also an increased risk of UGIB in those who drink alcohol versus non-drinkers. Endemic disease in low-resource regions may furthermore change the epidemiology of UIGB in such regions. Some endemic diseases such as Schistosomiasis Mansoni infection may influence aetiology of the UGI bleeding lesions, but the final pathological process, portal hypertension and the treatment of variceal bleeding in an emergency setting are not affected by different aetiologies. On the contrary, other endemic diseases

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such as HIV or HCV may affect the treatment of UGBI. Blood transfusion is one of the most important steps in the management of the UGIB but also a potential vehicle of viral infection. Risk of disease transmission is one of the determinants of the problematic availability of blood in sub-Saharan Africa.

The role of prevention should not be overlooked and includes eradication of *H. pylori*, prevention of peptic ulcer and liver disease. Emergency surgery is reserved for failure of the non-operative approaches. The optimal management of UGIB requires high-level resources, which are not available everywhere.

Endoscopy is critical in the modern management of UGBI but requires equipment and skilled medical staff and the ability to safely sterilise the endoscope and equipment, especially in the prevention of communicable diseases, which are endemic in some countries. Another limitation in the low-resources areas is given by the vast distances and the location of endoscopy service and the transport issues, especially if unstable.

17.2 Pathology

UGIB may be classified according to the anatomical site, the underlying pathophysiological mechanism and/or type of bleeding. Based on these criteria UGIB can originate from erosive and ulcerative lesions, complications of portal hypertension, traumatic lesions, vascular lesions, tumours or miscellaneous. A distinction between variceal and non-variceal bleeding is of importance when considering epidemiology, therapeutic approach and prognosis.

Table 17.1 shows a list of possible sources of UGIB.

Table 17.1 Aetiology of upper GI bleeding in adults

Portal hypertension complications	Erosive/ ulcerative lesions	Vascular lesions	Traumatic lesions	Neoplasm	Polyp
Oesophageal varices	Esophagitis	Angiodysplasia	Mallory-Weiss syndrome	Malignant upper GI	Upper GI
Gastric varices	Gastritis/ duodenitis	Dieulafoy's lesion	Iatrogenic	Benign upper GI	
Oesophago-gastric varices	Gastric ulcer	Gastric antral vascular ectasia (GAVE)	Aorto-enteric fistula		
Portal hypertension gastropathy	Duodenal ulcer	Bean Syndrome			

17.3 Epidemiology

The median age of the population suffering UGBI has been reported to lie between 38 and 52 years in the Sub-Saharan Africa, South Asia and Middle East and North Africa areas and whereas in more developed countries the mean age is 45–60 years. This also should be compared with respective life expectancy in low-resource and high-income regions. Although life expectancy forecasts indicate a world-wide increase in life expectancy including low-resource regions, differences still exist. Patients from low-resource areas who experience UGBI are younger and belong to a population with a shorter life expectancy.

Males are affected more often than females. A higher rate of tobacco use in men and the protective effects of oestrogens against peptic duodenal ulcer in young females may explain this. Moreover, the two well-recognised risk factors for UGBI, alcohol abuse and viral hepatitis, may also explain the role of sex in the epidemiology of UGBI in low-resource regions.

There is a lower prevalence of variceal bleeding in the sub-Saharan area compared to South Asia and Middle East and North Africa. It is not however possible to assess whether the difference may be a result of different selection of patients or it reflects a true epidemiological difference.

UGBI epidemiology in low-resource regions is different when compared to high-income countries except for the male/female ratio for which the prevalence of male has been confirmed. Patients may be younger and aetiologies may also differ especially due to some endemic diseases such as Schistosomiasis.

17.4 Diagnosis

Clinical history and physical examination are of fundamental importance in the initial assessment of patients with UGBI. Patients come to obervation for haematemesis and/or melaena. Medication history (use of NSAIDs, etc.) and the presence of co-morbidities such as liver cirrhosis and infectious disease are of critical importance. Assessment of haemodynamic stability is the clinical key point whilst the main instrumental tool for bleeding patients is endoscopy. In cases with negative endoscopy, CT angiogram and angiography may be required.

In low-income countries, the rate of diagnostic endoscopies in patients admitted for UGBI and the rate of early endoscopies, those performed within 24 h, can be considered as a good marker of quality of care. Early endoscopy has a better overall outcome with improved mortality rates.

Variceal bleeding occurs in patients with portal hypertension sustained by a chronic liver disease, these patients are usually frailer and suffer a higher morbidity and mortality rate compared to those with a different aetiology of their

bleeding such as erosive diseases or peptic ulcer disease. These considerations strengthened therefore the association between mortality and delayed timing of endoscopy.

17.5 Treatment

In high-income countries, endoscopy plays a central role in UGIB care and interventional radiology may be needed as a backup. The following describes the management of UGIB, according to the resources available in the health facility.

17.6 Initial Management

The immediate management of a patient with suspected or overt UGIB is based on whether the patient is classified as stable or unstable based on their haemodynamic status. Unstable patients require an immediate resuscitation. The patient is then prepared for endoscopic diagnosis and haemostasis where available, whilst receiving other therapeutic measures including treatment with proton pump inhibitors (PPIs) or H2 antagonists.

17.7 Resuscitation

The principles of resuscitation must first be applied prior to commencing endoscopic evaluation. High flow oxygen and ventilation support when necessary should be guaranteed. Crystalloid fluids should be used in the initial phases of resuscitation but the volume should be tailored according to the haemodynamic status, permissive hypotension should be advocated being aware of the risk of haemodilution and coagulopathy secondary to a fluid overload. Other emergency measures include blood transfusion as soon as possible with 'O'-negative blood while waiting the compatible group. The correction of a coagulopathy should also be taken into account with fresh frozen plasma, platelets and clotting factors when available. Patients with underlying cardiopulmonary disease may need to be considered for blood transfusion early before the Haemoglobin drops below 7 g/dL. In case of haemorrhagic cardiac arrest, external cardiac massage has little chance of restoring haemodynamic status without the control of the source of bleeding, cross clamping the descending aorta and internal cardiac massage through a left lateral emergency thoracotomy should be preferred.

17.8 In a Rural Health Centre

The staff consists of a general practitioner and nursing staff. The equipment is reduced to the bare minimum. No endoscopy or imaging is available. Diagnosis is only clinical in the presence of haematemesis and/or melena with or without

anaemia. Haemodynamic constants are taken for signs of systemic compromising. The haemoglobin level and blood grouping of the patient can be established. In the event of signs of active and persistent bleeding, treatment consists of vascular filling through a peripheral venous access. There is no possibility of blood transfusion. An H2 blocker (Cimetidine 40 mg) or a proton pump inhibitor (Omeprazole 80 mg) is given as an IV bolus. The patient is then referred to the nearest secondary or tertiary level health centre.

17.9 In a Secondary Level Hospital

The general practitioner, on the front line here, has recourse to an anaesthetist and a general surgeon. The resuscitation room and the operating theatre are equipped with basic equipment. There is no equipment for endoscopy, angiography or CT scan. The initial care of the patient is identical to that of the rural health centre. In case of active bleeding and or haemoglobin reaching level of 7 g/dL, vascular filling with crystalloids precedes ABO-identical and Rh-matched blood transfusion. 'O'-negative blood could be transfused in the absence of ABO-identical and Rh-matched blood, the transfusion objective being 10 g/dL of haemoglobin level.

The indication for a laparotomy is considered in case of the failure of medical treatment or a massive UGIB with shock. A midline laparotomy will usually be used. The surgical procedure depends on the lesion involved and the preoperative findings. When the site of bleeding is not obvious from the start, the UGI tract is investigated empirically, by trans-illumination of the supra-mesocolic upper gastrointestinal tract. Then the opening of the digestive tract will be required starting with a gastrotomy which may be extended through the pylorus to view the duodenum if necessary. An actively bleeding lesion can usually be quickly detected by opening the UGI tract but the search may not be obvious in cases where the active bleeding has ceased by the time of laparotomy.

Adequate exposure for proximal lesions may require fixed retraction using a Goligher frame and sternal hook or use of an omnitract retractor. The proximal stomach may need to be mobilised by dividing the short gastric vessels and the oesophagus may need to be encircled and controlled with a tape. This is especially important in a proximal lesion like a Dieulafoy, which may be difficult to access.

If the closure of the enterotomy or gastrotomy is problematic consideration should be given to a feeding jejunostomy. Nasogastric tube drainage as well as abdominal drains should be used.

17.10 In a Tertiary Level Hospital

As soon as the diagnosis is suspected and the volume or emergency resuscitation measures are implemented, the endoscopy team is notified. A treatment with PPI is initiated according to a codified protocol. Omeprazole injected at 80 mg by IV bolus and then 8 mg/h intravenously is routine. A 40 mg protocol every 12 h is as effective. Vasoactive

intravenous therapy (Terlipressine or Sandostatin and derivatives) is recommended in pre-endoscopy if there is a strong suspicion of portal hypertension bleeding.

17.11 Medical Treatment

This depends on the type and frequency of lesions, which may be ulcers, oesophageal varices or gastritis. In low-resource areas blood transfusions are the main treatment modality in bleeding patients. No publication where blood transfusion was not available has been found. Proton pump inhibitors in UGIB secondary to peptic ulcer or erosive are efficacious as an initial treatment. The use of vasoactive drugs for variceal bleeding is however limited in usual practice because of their high cost.

17.12 Endoscopic Treatment

Diagnostic endoscopies allow to identify the site of bleeding in a very high rate of cases.

General anaesthesia is advised for a difficult examination with lower quality equipment. Washing at each level of the digestive tract facilitates exploration. Washing is necessary in case of active or recent bleeding or heavy gastric stasis. Haemostasis may be achieved by injection, coagulation or a mechanical method, used alone or in combination. The injection of adrenaline and the application of clips for ulcers or band ligature for variceal haemorrhage are the most widely used methods in a low-resource environment. Use of argon plasma coagulation, synthetic glue and a Blakemore tube is very uncommon practice because of availability.

For variceal haemorrhage, band ligation at endoscopy should be the preferred method with sclerotherapy as a backup approach. Sengstaken-Blackmore tube is reserved for uncontrolled variceal bleeding.

17.13 Radiological Haemostasis

Arterial catheter embolization and the placing of TIPS (Transjugular Intrahepatic Porto-systemic Shunt) are the first alternatives in the event of a failure of endoscopic haemostasis. The radiological approach may be recommended after the first endoscopy for patients at high risk of bleeding, or even immediately in case of massive haemorrhaging which is difficult to control.

17.14 Surgical Treatment

Surgical treatment of UGIB is less and less indicated due to the advances in medical treatment such as proton pump inhibitor therapy, endoscopy and embolization. The few indications for emergency surgery are massive haemorrhage with a shock,

resistant to blood transfusion and resuscitation as well as for bleeding patients admitted in hospitals where there is no availability of the technical devices for a non-surgical treatment. Surgery may also be indicated in cases of failure of conservative or endoscopic treatment and the treatment of so-called surgical causes such as a tumour, aorto-duodenal fistula or haemorrhage of pancreatic origin.

17.15 Conclusion

The care of UGIB is primarily medical. It begins by stabilising or reaching a permissive haemodynamic status of the patient through emergency resuscitation measures. Treatment with proton pump inhibitors in the initial phase is supported by the type and frequency of the causal lesions. Endoscopy makes it possible to identify haemorrhagic lesions or those at high risk of re-bleeding and to perform haemostasis. For poorly equipped centres with a surgical facility, the choice of emergency surgical treatment remains acceptable.

Lower Gastrointestinal Bleeding

18

Cristina Frattini and Riccardo Zannoni

Lower gastrointestinal bleeding (LGIB) is defined as a bleeding distal to the ligament of Treitz, occuring from a source localized in small bowel, colon, rectum or anus. Most cases are due to colonic bleeding and carry a mortality of up to 20%. The incidence of LGIB in developed countries varies between 8 and 27 cases per 100,000 population, depending on the series. Factors influencing the incidence include age (more frequent in elderly), ethnicity and anticoagulant use.

Lower GI bleeding can be classified as occult lower GI bleeding, moderate lower GI bleeding and severe GI bleeding. Occult LGIB can occur in patients of every age, and because the bleeding is slow and chronic, patients develop microcytic hypochromic anaemia (Fe deficiency), with symptoms such as fatigue and shortness of breath. Faecal occult blood testing would result positive in these patients. Moderate LGIB presents with haematochezia in hemodinamically stable patients; per rectal passage of blood is usually maroon-coloured with clots, due to the partial digestion of the blood. Severe acute LGIB manifests itself as hemodynamic instability and profuse haematochezia with fresh blood.

In up to 10% of patients with haematochezia, the origin of the bleeding is located in the upper gastrointestinal tract. For this reason, an upper GI endoscopy is frequently performed in patients who present with haematochezia and a history suspicious for upper GI bleeding sources.

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18.1 Aetiology

Up to 40% of LGIB are caused by diverticulosis. Prevalence increases with age, and diverticular disease affects about two-thirds of the population over 80 years old. The bleeding occurs acutely from an arterial source and is painless. An estimated 50% of adults over the age of 60 have radiologic evidence of diverticular disease, most commonly in the descending and sigmoid colon, and 20% of these patients will go on to develop bleeding. 80% of diverticular bleeding stops spontaneously, with a risk of recurrence of 25% over 4 years; however, in about 5% of patients, the bleeding can be massive and life-threatening.

Angiodysplasia is associated with 9–21% of acute LGIB, and up to 8.5% of chronic colonic bleeding. Most of the lesions are in the right colon, they are numerous and tend to increase in number with age. Bleeding from angiodysplasia usually occurs in anticoagulated patients, or after therapy with non-steroidal anti-inflammatory drugs (NSAIDs).

Anorectal disease is responsible for 4–20% of LGIB. Haemorrhoids and anal fissures are the most frequent cause of recurrent acute bleeding in patients under 40.

Colorectal neoplasia is responsible for 2–9% of acute LGIB, and it is the most frequent cause of sideropenic anaemia due to colonic bleeding, especially from lesions located in the right colon. Polyps can cause 3–11% of LGIB, and between 0.2 and 1.8% polypectomies are complicated by bleeding.

Inflammatory bowel disease may account for 0.1–1.2% of severe bleedings which require hospitalisation; in about half of the cases, the bleeding stops spontaneously, with a recurrence incidence of 35%.

Other rare causes of LGIB are radiation colitis, infectious colitis, ischemic colitis, Osler-Weber-Rendu syndrome, and Dieulafoy lesions.

18.2 Diagnosis and Treatment

Evaluation should start by collecting history of bleeding onset and duration and number of episodes, presence of melaena/haematochezia, recent use of NSAIDs, anticoagulant or antiplatelet, procedures such as endoscopies or aortic stenting, and comorbidities. Physical examination might point out specific aetiologies or exacerbating factors and should be completed with digital rectal exam and rigid sigmoidoscopy. Findings such as tachycardia, tachypnoea, hypotension, pallor, stupor or agitation and profuse haematochezia suggest that the patient is unstable and in need of urgent resuscitation. Complete blood count, metabolic panel, ionised calcium, prothrombin time, international normalised ratio, partial thromboplastin time, fibrinogen, lactate, and arterial blood gas are useful tests to assess the severity of the patient's condition. Risk assessment and stratification are necessary to distinguish between patients at high and low risk, and those who are hemodynamically unstable should receive adequate fluid resuscitation prior to CT-Angiography (CTA), endoscopic evaluation and treatment.

The Oakland score is a risk assessment tool specifically designed to assess risk in LGIB and considers age, gender, previous hospital admission with LGIB, digital rectal examination findings, heart rate, systolic blood pressure, and haemoglobin. The score is calculated by summing the individual components. A patient scoring ≤8 points at presentation is classified as a minor bleeding, and has a 95% chance of safe discharge from the emergency department with a plan for outpatient follow-up. A patient scoring >8 points is classified as a major bleeding and is likely to benefit from hospital admission. Guidelines from the British Society of Gastroenterology suggest the use of shock index (heart rate/systolic BP) to differentiate between stable (SI <1) and unstable (SI >1) GI bleeding. Both scores, as much as clinical evaluation have the purpose to identify the correct algorithm for diagnosis and treatment.

Management will depend on the resources and skill sets available. Most patients with significant LGIB are admitted to the hospital and observed. Most cases stop spontaneously, and diagnostic tests can be done semi-electively. Colonoscopy is the initial diagnostic procedure for nearly all patients presenting with LGIB. In stable patients, an adequate colonic preparation is mandatory to identify the source of bleeding and, consequently, to intervene. Colonoscopy during active bleeding requires copious lavage to find the bleeding source. Control of the haemorrhage can be obtained through the use of clips, epinephrine injection, argon plasma or bipolar coagulation, endo-ligation, and application of topical haemostatic agents.

CTA is required as primary investigation when patients are hemodynamically unstable, or if colonoscopy fails to identify the source of bleeding or to treat it. CTA has the advantage to identify bleeding sources from the small bowel, does not require intestinal preparation, and can be performed in a shorter time compared to colonoscopy. When the source of bleeding is identified, catheter angiography and selective embolisation should be performed as soon as possible after the CTA. Embolisation can be performed using coils, liquid agents, or particles. Technical success rate is high, up to 93–100%. Bowel ischemia is the most commonly reported major complication. The risk of re-bleeding in the short term after embolisation varies from 10 to 50%.

Additional investigations need to be undertaken if endoscopy, CTA and angiography are not conclusive. Red cell scintigraphy has variable reported sensitivity (60–93%) and has less precision in identifying the anatomical localisation compared to CTA. Videocapsule endoscopy permits investigation of the whole small bowel in 79–90% patients, and is mostly used in patients with obscure GI bleeding and negative upper and lower GI endoscopy. Limitations of videocapsule include inability to drive its movements, lack of therapeutic actions, and the risk of retention.

Surgical intervention is required when both endoscopy and interventional radiology have failed, or in rare cases, such as an aorto-enteric fistula, for which it is justifiable to proceed directly with surgery. When the source of bleeding is localised, a specific operation could be performed to stop the bleeding: anatomic resection with or without primary anastomosis or a stoma. In unstable patients, anatomic resection with temporary abdominal closure may be considered. Proceeding to laparotomy

without a definite localisation is challenging. An upper GI endoscopy should be performed in the patient with an unknown source of bleeding before proceeding with surgery. Subtotal colectomy is empirically performed in unstable patients with unlocalised LGIB; however, this is associated with high morbidity and mortality.

18.3 Low Resource Alternatives

LGIB has a geographic variability with regards to its etiologies. Antibiotic-associated colitis and ischemic colitis are the most frequent causes in Japan, while cancer, colitis, and vascular malformations constitute the most common causes in Taiwan. In India, causes include idiopathic ulcerative colitis, acute colitis caused by parasites, polyps, radiation colitis, solitary rectal ulcer, malignancies, colonic tuberculosis, and enteric fever. In African Countries and in the area of Middle of Nile Delta, other causes include portal hypertensive colopathy and HIV-related ulcers.

Delay in diagnosis often occurs in low-resource regions, due to the difficulty to reach the hospital, which can be within days of distance for patients. Furthermore, in many locations, radiology imaging is a paid service and not all patients can afford the costs. The main diagnostic and therapeutic method used is colonoscopy, which is usually available in the third level hospitals of developing countries. CTA and interventional radiology still are not widespread available assets. The cost of machines' installation and maintenance, the amount of CT scans requested in third level hospitals, and the cost of the angiographic materials are all factors which concur in limiting the possibility of a regular employment. Surgery remains the last resource for treatment of LGIB which cannot be treated with colonoscopy.

Small Bowel Obstruction

19

Krishanth Naidu

19.1 Introduction

SBO presentations date back to the time of Praxagoras of Kos. Extreme by current standards, an enterocutaneous fistula was fashioned to remedy a bowel obstruction back in fourth century BC. Up until the late 1800s, non-operative strategies were employed principally due to the absence of safe surgical practice doctrines.

Bowel obstruction results from the impedance of intraluminal flow. Functional and mechanical causes have been described with the latter further classified into acute and chronic.

With excessive bowel distension, strangulation may ensue as a result of compromised perfusion. This may evolve to necrosis and perforation.

These complications have been greatly reduced with a better appreciation of pathophysiological processes combined with the advent and use of gastric/intestinal decompressive adjuncts, use of antibiotics and fluid resuscitation strategies. Despite this, in current surgical practice, SBO remains a vexing problem given the challenges with diagnosis, sequelae of complications, treatment, and the timing that bridges the latter three. Thus, apart from the fundamental dogmas that dictate the assessment of a patient, SBO requires a heightened sense of awareness.

19.2 Epidemiology

Mechanical SBO does not have a gender-specific preponderance with the average age of patients to be 64 years old. Despite the exhausting list of causes, the commonest aetiology in a developing world is hernias.

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19.2.1 Risk Factors

The causes of small bowel obstruction can be divided into three basic categories:

1. Extraluminal—adhesions, hernia, inflammatory, neoplastic, chemical, post-operative, pharmacological
2. Intraluminal—gallstones, bezoars, food bolus, parasites (e.g., ascaris), enterolith, foreign body
3. Intramural—primary and secondary tumour, inflammations, Crohn's disease, radiation enteritis, post-operative stricture, vasculitides

19.3 Pathophysiology

In the absence of obstruction, the jejunum and proximal ileum are considered sterile. Obstruction leads to progressive dilation of the intestine proximal to the blockage with vigorous peristalsis and pain to the central abdomen given its midgut embryological derivation. Luminal decompression occurs distal to point of obstruction. Swallowed air and gas from bacterial fermentation and overgrowth pronounces proximal luminal distension. As the process continues, the mural oedema ensues, normal absorptive function is lost, and intraluminal fluid accumulation occurs.

Third space fluid shift/losses will occur. There may also be transudative loss of fluid from the intestinal lumen into the peritoneal cavity. With proximal bowel obstruction, ongoing emesis leads to additional loss of fluid and electrolytes particularly Na^+, K^+, H^+, and Cl^- with resultant acid–base derangement. Typically, metabolic alkalosis is seen. These fluid losses can result in profound hypovolemia.

Mucosal and mural blood flow is subsequently compromised with elevated intraluminal pressures. If perfusion to a segment of small bowel is inadequate to meet the metabolic needs of the tissue, ischaemia will occur, with progress to mural infarction and possible perforation. Halting the process may limit progress to cellular death and necrosis but altered perfusion may result in the formation of strictures and ulcers.

Closed-loop obstruction is a type of complete obstruction which occurs when the intestine is obstructed at two locations, creating a segment with no proximal or distal outlet. Closed-loop obstruction can rapidly progress to bowel strangulation and perforation.

Alternatively, axial rotation of the SB along its mesentery or other lax peritoneal attachments may result in a volvulus with resultant compromise to mucosal perfusion.

19.4 Presentation

It is important to assess the patient's general state, particularly the degree of dehydration.

Typical symptomology includes colicky abdominal pain of central origin, bile stained vomitus, abdominal distension, failure or reduction in the passage of bowels and/or flatus. Signs of SBO include tenderness on palpation. Heightened awareness to peritonism should be held based on palpation and percussion. Hernial orifices throughout the abdomen should be explored and this includes a comprehensive examination of the male genitalia. Tympany and absent or 'tinkling' bowel sounds may be present. Auscultating hernial orifices may suggest enteric entrapment.

Vomiting in distal SB obstructions is less of a feature. Feculent effluent is a feature with prolonged distal ileal obstructions. Distal SBO has distension as opposed to vomiting as the predefining feature.

When dealing with complicated SBO presentations, peritonism, pyrexia, and/or haemodynamic instability warrants prompt and particular attention given the concerns of strangulation.

In the post-operative state, the clinician should be cognizant of the difficulty delineating and differentiating an ileus from a dynamic obstruction. Determination of a cause may not be necessarily possible without radiologic investigations.

19.5 Investigations

The investigations in SBO are targeted at global assessment of the patient, confirmation of the diagnosis that ultimately dictates treatment stratification.

Rapid access to diagnostic blood tests and appropriate imaging is very important. Thus, despite the advances in technology and radiological techniques, in areas with limited resources, contrast-enhanced imaging may not be readily available thus the value of simple and economical adjuncts to aid in the diagnosis is necessary for equitable healthcare provision—plain radiography, ultrasonography. The latter aides are not without limitations—ability to identify strangulation, user variation, and interpretation.

Inability to access advanced investigative technologies is not a setback principally because global consensus is such that the identification of strangulated patients remains difficult and complex. Thus, a thorough examination with an appreciation of the well-established strangulation criteria and a sound clinical reasoning with regular reassessments will dictate the surgeon's management strategy.

19.6 Management

Initial

1. Crystalloids with electrolyte supplementation is mandatory with judicious monitoring of urine output may be undertaken depending on the co-morbidities of the patient.

2. Nasogastric decompression of the stomach limits vomiting and reduces the risk of aspiration of gastric contents.
3. Analgesia should be provided early and may include opioids though sparingly given its motility effects. There is no evidence to withholding analgesia to preclude further assessment. Having said that, requirements should be recorded and reviewed in a timely manner as it could dictate the process of strangulation.
4. DVT prophylaxis

Non-operative

1. 'Drip and Suck' ± Water-soluble contrast
   (a) In the absence of clinical or radiological findings of strangulation, an initial non-operative approach ought to be considered. The latter should also be employed in patients with a partial obstruction.
   (b) A trial of water-soluble contrast for its therapeutic and diagnostic attributes is worthwhile considering. The appearance of contrast in the colon on abdominal radiographs within 24 h of administration predicts resolution, with contrast failing to reach the caecum within 4 h, highly predictive of the need for surgical intervention. Non-operative management can be prolonged up to 72 h in the absence of strangulation or peritonitis provided regular reviews are undertaken to assess deterioration.
   (c) It is worthy of mentioning that, the contrast studies are not only limited to pre-op imagining but have merits in post-operative setting principally when aiming to identify an obstructed patient in comparison to one who has an ileus.

Operative

1. Indications
   (a) Absolute
   - Peritonitic
   - Visceral perforation
   - Incarcerated hernia

   (b) Relative
   - 'Virgin' abdomen
   - Questionable improvement
   - Palpable mass
   - Diagnostic uncertainty (Ileus)
   - Incomplete obstruction

2. Principles
   (a) Causative factor is diagnosed at surgery.
   (b) Simultaneous resuscitation and optimisation of co-morbidities should be undertaken as surgical planning is underway. Prophylactic antibiotics and thromboembolic—chemical and mechanical—prophylaxis should be instituted.
   (c) 'Incision of indecision'—midline incision encompassing three finger breadths superior-inferior to the umbilicus provides flexibility in the unknown situation. The peritoneal cavity should be entered through the

midline where possible, including the need to excise previous scars or extending the incision to ensure 'virgin' territory is entered, to begin with, in individuals with previous midline incisions. A fixed wound retractor is recommended if available, though a versatile pair of hands from the assistant is as valuable.

(d) Diagnostic laparoscopy with adhesiolysis can be undertaken in some situations but it would seem apparent that most with adhesive SBOs who require surgery will have a laparotomy due to the loss of peritoneal domain secondary to the distension and/or due to the lack of surgical expertise managing SBOs laparoscopically. If laparoscopy is employed, a low threshold for conversion ought to be maintained.

(e) Transition point is identified by 'running bowel' from the duodenojejunal (DJ) flexure to the caecum. The intention is to appreciate the interface between proximally distended and distally collapsed bowel loops.

(f) In the event of failure to milk contents into the stomach or friable proximal bowel exist suction enterotomy can be employed. The enterotomy is closed with appropriately sized absorbable sutures. The enterotomy should ideally be placed in a non-diseased segment of bowel. Decompression though it has merits—closure of abdomen, reduced aspiration risk, etc.—it is not without risks as fluid-filled bowel loops direct undue strain and tension to the mesentery.

(g) With adhesiolysis, 'less is more'. Adhesions are divided within reason to allow a non-obstructed passage of contents from DJ flexure to caecum. Overzealous division has limited gain given the inevitable reformation of adhesions and increased incidence of serosal injuries and worse still, enterotomies.

(h) Bowel ought to be resected in instances of irreversible ischemia or is diseased from the non-exhaustive list of causes above. In the event of unknown viability, the bowel can be warmed with Normal Saline soaked packs and re-examined. However, when viability is questioned, resection should be undertaken with or without an anastomosis.

(i) An anastomosis is undertaken in well-defined circumstances—haemodynamically stable patient who is nutritionally intact with absent obstruction distally or marked contamination.

(j) Relook laparotomies within 24–36 h ought to be considered in individuals who are unstable and/or wide areas of ischemia is noted. At the return, plans for defunctioning stoma or anastomosis can be considered based on the patient's physiology.

(k) Fascial retraction ensues within hours and when combined with multiple relook procedures or returns to theatre, bowel oedema evolves to a point of limiting abdominal wall closure. In such circumstances, vacuum-assisted closure devices or prosthetic mesh application can be used to temporise an open abdomen. The latter aims to bridge formal closure in due course. Therefore, one should be cognizant when undertaking a laparostomy.

19.7 Hernia

Though any type of abdominal wall hernia can be implicated in SBO aetiology, efforts should be concentrated in identifying Richter type hernias given the high risk of bowel infarction without frank obstruction.

In the situation of a symptomatic irreducible hernia, one must endeavour to operate without undue delay. If bowel resection is undertaken or a contaminated field is confronted, the use of mesh is not encouraged. In such situations, primary repair is undertaken without mesh with acceptance of the recurrence risk.

Further to the routine presentations of SBO, asymptomatic hernias may pose as a red herring owing to raised intra-abdominal pressures as a consequence of another pathology. In doing so, asymptomatic hernias are pronounced to a point of possible incarceration. The distinction can be made on imaging subtleties such as the absence of a transition point at the hernia neck when dilated loops of small bowel are identified distal to the herniated segment. Such hernias can be repaired in an elective setting following appropriate planning.

In some situations, on induction of anaesthesia or administration of muscle relaxant, the hernia may reduce either spontaneously or with minimal manipulation. Though somewhat reassuring, proceed with caution.

19.8 Malignant Obstruction

Small bowel neoplastic processes are rare. Routinely what is encountered with regard to a malignant obstruction is due to a diffuse intra-abdominal malignant process and not of a primary small bowel origin. This thus raises the issue of management as unless a single point of obstruction is appreciated, surgery is beneficial, otherwise it is futile given the widespread intra-abdominal disease process. A bypass procedure ought to be considered in the latter circumstances.

Large Bowel Obstruction

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Krishanth Naidu

20.1 Introduction

LBO accounts for 25% of all intestinal obstructions. Similar to small bowel obstructions (SBO), LBO can be considered either functional or mechanical with acute or chronic presentations. The commonest cause of LBO is colo-anorectal malignancy. Interestingly, this statistic remains valid in developed countries despite the dissemination of screening programs.

Benign LBO aetiologies account for the remainder, with the majority (up to 15%) represented by colonic volvulus. Particularly in developing nations, sigmoid volvulus is the most commonly encountered pathology. It is unclear whether this considers countries that are collectively known as the 'volvulus belt'.

20.2 Pathophysiology

Though LBO pathophysiology parallels that of SBO in most accords, important governing laws of physics provides an added understanding of LBO. For instance, LaPlace's law dictates the most common site of colonic perforation with a distal LBO—caecum. The latter does not consider tumour infiltration and its resultant local perforation at the site of obstruction. Further to the above, risk factors for LBO include malignancy, recurrent/smouldering inflammation, previous abdominal surgery with or without colorectal resection, hernia, and anatomic anomalies disposing to volvulus.

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20.3 Presentation

Depending upon the time course of development of the obstruction, symptoms related to LBO can present acutely with abrupt onset of generalised abdominal pain to the infraumbilical location in keeping with the colonic hindgut derivation. The pain is described to be cyclical with paroxysms every 20–30 min. Patients are seen to present on average 5 days following the onset of symptoms. Localised and focal pain indicates peritonism and consideration of ischemia and or necrosis is warranted. Though some may have considerable pain tolerance, when complemented with the array of analgesic options available, it is not uncommon to be misguided by the patient's sudden relief of pain. This is a cause of concern as the decrescendo may be followed by the manifestation of significant pain reflecting possible peritoneal contamination from luminal perforation. Further to this, the plethora of LBO symptoms include bloating and obstipation, or more chronically, change in bowel habits, anaemia, weight loss, and per rectal bleeding with some of the latter eluding to potentially a more sinister aetiology. Nausea and vomiting are more commonly seen in right-sided pathology thus mimicking a distal small bowel obstruction. As the colon becomes capacious the more distally it progresses, symptoms manifest in a delayed fashioned. Tenesmus is seen as a symptom of rectal obstruction.

Systemic signs that manifest with LBO include that of dehydration and or shock with laboratory studies undertaken to ascertain the severity of hypovolemia and metabolic abnormalities that exist. Left-shift leukocytosis may be seen when complications begin to manifest. Carcinogenic Embryonic Antigen (CEA) levels are undertaken as part of workup in the subset of patients suspected to have a malignant aetiology. It should be stressed that tumour markers are complementary but not diagnostic of colorectal cancer.

Though a comprehensive history and examination—taking into account comorbidities and risk factors—provides clues towards the aetiology, the objective assertion to the diagnosis of LBO and severity of the underlying pathology (i.e., dissemination of malignancy) requires imaging. In some instances, the operating theatre is required immediately to diagnose the pathology and underlying aetiology.

CT scans of the abdomen and pelvis are favoured over plain films. However, the reality of restraints—universal availability and costs—and practicality dictates plain films as the first step logical step in radiological investigations. CT has high sensitivity and specificity for the diagnosis of LBO and delineation from pseudo-obstruction.

Plain films of the abdomen enable spot diagnosis of volvulus, caecal bascule, and pneumoperitoneum. Characteristic findings of the latter two pathologies are seen in Figs. 20.1 and 20.2.

Lower endoscopy has its role in some circumstances. In the case of sigmoid volvulus particularly, it is both diagnostic and therapeutic. Endoscopy is particularly useful in diagnostic dilemmas in patients with chronic symptoms and radiology presenting equivocal findings.

Fig. 20.1 Coffee bean sign (https://radiopaedia.org/cases/10633/studies/coffee-bean-sign-sigmoid-colon)

The use of lower gastrointestinal contrast/fluoroscopic studies is limited. It serves to tackle very defined issues such as rectal fistulas, strictures, and distal anastomotic integrity.

20.4 Management

Initial management involves supportive care—rehydration, electrolyte replacement, and gastrointestinal decompression for those with persistent vomiting and nausea.

Subsequent treatment is guided by the underlying aetiology, location of obstruction and acuity of the presentation. The treatment instituted however is dictated by two governing issues—comorbidities of the patient and the availability of expertise and resources.

The subset of patients identified to have benign colo-recto-anal or anastomotic stricturing disease who remain largely asymptomatic should be managed

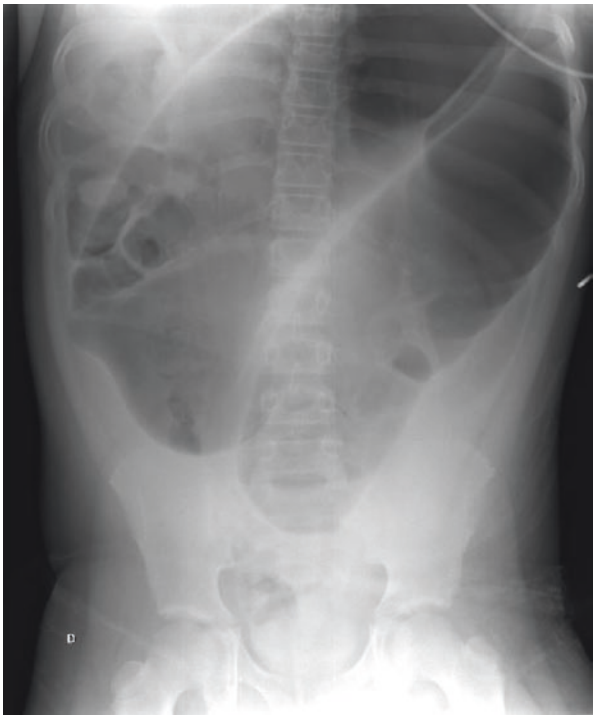

Fig. 20.2 Caecal volvulus (https://www.differencebetween.com/difference-between-sigmoid-and-vs-cecal-volvulus/)

expectantly in the outpatient setting. A variety of options exist and include transanal stricturoplasty with electrocautery or laser, dilation, stenting, and surgical resection.

For patients with evidence of sigmoid volvulus, an attempt should be made to decompress with flexible sigmoidoscopy. If unavailable, a flatus tube inserted via a rigid sigmoidoscope can be very effective however physically reaching the point of torsion is deemed an issue. This may well be the only tolerable management option in high-risk individuals. In those with a low-risk profile, elective plans for colonic resection ought to be considered given the high recurrence rate with endoscopic decompression is high.

Apart from decompressing a volvulus, endoscopy has its purpose in managing malignant obstruction. Endoscopic stenting is predominantly employed in those with left-sided malignant obstructions. The indications are stenting in individuals with colonic malignant obstructions either as a bridge to surgery or as a means of palliation in those with significant disease dissemination. With the former indication, it potentially allows for semi elective one-stage operation as opposed to one requiring an ostomy.

It is prudent that LBO be distinguished from its mimics—paralytic ileus, pseudo-obstruction, toxic megacolon, and small bowel obstruction.

Surgical management of acute LBO with total or near total luminal impedance of either benign or malignant aetiology involves one of three procedures—single-stage, two-stage, or three-stage procedure. It is poignant to also have a repertoire of specific procedures such as maturing an ostomy for faecal diversion (e.g., palliation), colonic resection with an index anastomosis with or without a covering ostomy, and Hartmann's procedure. The decision to adopt one procedure over the others is dictated by patient factors—comorbidities, goals of care, location of the lesion, integrity of the proximal colon, and its risk of perforation—imminent or delayed; ischaemic changes to colon proximal to point of obstruction, serosal tears, and presence of synchronous polyps. With the latter four factors, consider having a low threshold in undertaking a subtotal colonic resection with primary anastomosis.

Where possible, for uncomplicated right- and left-sided LBO of either benign or malignant aetiology, aim to undertake a colonic resection with primary anastomosis at the index operation without bowel preparation or on table lavage in the emergency setting. This is favoured over other staged procedures. When undertaking any of the described procedures above, a judgement is made between the risk of anastomotic leakage against the morbidity of maturing a stoma.

Intestinal Fistulae

21

Francesco Piscioneri

An intestinal fistula is an abnormal communication between two epithelized surfaces. Enterocutaneous fistulas occur between the gastrointestinal tract and the skin. Enteroenteral fistulas are between adjacent viscera.

Fistulas may develop from the underlying disease that affects the gastrointestinal wall such as Crohn's disease. There are also congenital fistulas (e.g., patent urachus).

High output fistulas are those that produce >500 mL in a 24-h period. These usually arise from the proximal small bowel and are more difficult to control and less likely to close spontaneously than lower output fistulas. Large bowel fistulas have a lower complication rate because of the lower output and lesser effect on nutrition.

Complex fistulas drain to the skin through longer tracks. These are often multiple and can involve an abscess cavity. Simple fistulas are shorter and usually have more direct communication between the gut and the skin. A commonly used acronym for remembering the factors that make fistula formation favorable and unlikely to spontaneously regress is "FRIEND." Below is a list encompassing the former and other factors:

- Foreign bodies
- Radiation exposure
- Infection/Inflammation
- Epithelization of the fistula tract
- Neoplasm
- Distal obstruction
- Malnutrition
- Bowel discontinuity

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21.1 Management

The first step is resuscitation and stabilization. Patients are at a high risk for electrolyte derangements, sepsis, and malnutrition. Electrolyte losses vary depending on the location of the fistula in the gastrointestinal tract and the amount of output. In septic patients, a source needs to be identified and appropriately treated. Intra-abdominal abscesses are common and the treating team should have a high index of suspicion. Most patients will need parenteral nutrition, but a subset of patients may be able to tolerate an enteral elemental diet if the fistula is distal and its output is unchanged with the commencement of oral intake. Furthermore, the role of a multidisciplinary service cannot be discounted in the optimization of the patient's recovery. The output can also be stabilized with pharmacotherapy. The fistula fluid needs to be properly contained as not to damage the surrounding skin and thus decrease the chance of healing. Various methods of wound care can aid in preventing skin loss, minimizing pain, and allowing the patient to function on a daily basis. Such strategies are similar to ostomy bag appliances, but some will require a more customized plan for containing the fistula output. A common approach is to use the "SNAP" process.

This involves;

- Sepsis elimination,
- Skincare optimization,
- Nutrition that is effective and complication-free,
- Assessment of the anatomy of the fistula, and
- Planning the final outcome approach either spontaneous closure or surgical management

21.2 Sepsis

Uncontrolled sepsis prevents healing and leads to multiple organ failure. It will drive catabolism and interfere with nutrition. A contrast CT scan is an excellent tool for baseline evaluation. Not only will pockets of sepsis be localized, but the condition and anatomy of the bowel will be demonstrated. Isolated abscesses can be percutaneously drained but if they are connected to the bowel then resection and formation of a stoma is the best option.

Control of sepsis also includes management of the skin adjacent to the fistula.

21.3 Nutrition

Enteral nutrition is the preferred route if the patient has a sufficient accessible functioning gut. This is more likely in distal small bowel fistulas. With very proximal fistulas it may be possible to institute tube feeding into the distal gut. Where

possible a feeding tube is inserted through the fistulous track into the distal bowel (fistuloclysis).

Where enteral nutrition is not feasible, total parenteral nutrition (TPN) is used. This gives a good steady flow of nutrition and rests the gut. The downside is that lack of exposure to nutritional elements can lead to atrophy of the mucosal glands.

21.4 Assessment of Anatomy

This is done by assessing the condition of the bowel both proximal and distal to the fistula using a contrast CT as well as direct injection of contrast into the fistula to provide a fistulogram.

The aim is to;

- Exclude distal obstruction,
- Determine if an abscess cavity is still present,
- Establish anatomy and relationship of the fistula,
- Determine if there is any residual underlying disease which may prevent spontaneous closure of the fistula,
- Assess the visibility of establishing distal tube feeding.

21.5 Planning

Planning is the final step after successful elimination of sepsis and nutrition and establishment of the correct anatomy. The preferred option is spontaneous closure however this is less likely if there is an underlying disease such as Crohn's disease, radiation enteritis, or colorectal cancer. Spontaneous closure occurs in 70% of patients after the establishment of parenteral nutrition. After this time, surgical correction should be considered if there is no evidence of closure.

21.6 Surgical Principles

It is best that definitive surgical treatment be delayed as long as possible, preferably up to 6 months. This allows time for the peritoneal cavity to reestablish itself after the hostility that occurs during the septic state. Early surgery should be limited to drainage of abscesses, resection of ischaemic bowel, or stoma formation.

At the time of definitive surgery, the entire bowel should be dissected free and inspected for distal obstruction, any underlying disease, and for delineation of the fistula. After excision of the fistula, a primary anastomosis is performed and the abdomen should be closed.

Once normal bowel function has returned, the patient can commence on a normal diet.

21.7 Radiation Enteritis

Fistulas usually occur quite sometime after the initial radiation exposure. Prognosis is poor and they rarely close with nonoperative management. Excision and primary anastomosis is associated with high morbidity due to a high incidence of anastomotic failure. A safe salvage procedure is to perform a stoma in healthy bowel proximal to the radiated tissue.

21.8 Primary Fistulas

21.8.1 Crohn's Disease

Presentation is often with a mass in the right of the iliac fossa with fistulation in combination with an abscess cavity. These fistulas are often enteroenteric. Enterocutaneous fistulas can occur as can perianal fistulas.

The principles of treatment are good medical control usually with monoclonal antibody targeted therapy producing a fistula closure rate of over 50% within 3 months. Definitive resection of the affected bowel settlement is usually required in most patients.

21.8.2 Diverticular Disease

Colo-vesical fistulas are relatively common and usually occur between the sigmoid colon and the dome of the bladder. Patients usually complain of passing gas bubbles or faecal material in the urine. These patients should have their bowel fully investigated with a colonoscopy and also have a cystoscopy to rule out bladder cancer. Treatment is resection of the affected part of the bowel. By the time the inflammation has settled and the bowel resection has been performed, the defect in the bladder has often disappeared.

Colo-vaginal fistulas may occur in women who have had a hysterectomy. Resection of the affected bowel is the treatment of choice.

21.8.3 Implications for Low Resource Regions

Fistulas can be successfully managed in low resource regions the main limitations being access to CT scanning and total parenteral nutrition.

Following the SNAP principle is an effective approach for the resolution of fistulas.

Part IV

Other Conditions

Anorectal Emergencies

22

Francesco Piscioneri

22.1 Introduction

This chapter will deal with the more common anorectal conditions. Although many of these conditions are not life-threatening, it is important to get an accurate early diagnosis so that effective management can be commenced at the earliest opportunity. Delays can lead to a less than optimal outcome. This is highlighted by anorectal sepsis which if left untreated can lead to severe morbidity and even mortality.

22.2 Anal Fissure

This is a short linear laceration usually at the 6 o'clock position. It is associated with pain and bleeding at the time of defecation and is usually asymptomatic in between times. It is important to closely examine the anus and look for the specific features of the anal fissure as anal cancer can cause similar symptoms. The presence of a sentinel tag is an indication of chronicity.

Most of the acute fissures heal within a few weeks with the use of conservative therapies such as stool bulking agents and laxatives. Once controlled, it is important that the patient continues with a high residue diet in order to minimise the risk of recurrence.

Additional relief and treatment can be achieved with topical medications such as nitrates and calcium channel blockers. These work by reducing the pain and sphincter tone. Chronic fissures are typically treated with lateral sphincterotomy however there is a risk of some level of incontinence if the sphincterotomy is excessive. Botulinum toxin can achieve similar results without the need for surgery.

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Conservative therapies are the mainstay, and the patients should be encouraged to persist with bulking agents for a least 3 months before considering surgery.

22.3 Thrombosed Internal Haemorrhoid

Occurs when the prolapsed internal haemorrhoid remains protruded and vascular compromise eventuates. The haemorrhoids are invariably swollen, irreducible, and very painful.

Reduction is very difficult and urgent haemorrhoidectomy is often required.

22.4 Thrombosed External Haemorrhoid

An external haemorrhoid is related to the veins just under the skin at the edge of the anus. There is an acute rupture of a blood vessel, often during straining during a bowel action, usually associated with severe pain. The pain is usually severe enough for the patient present to a hospital or to their family doctor and lasts for several days. Differential diagnosis is a thrombosed complicated internal haemorrhoid or anal melanoma.

Treatment depends on pain and time of presentation. If the pain is not too severe then the patient can be managed with simple analgesia and told to expect that it will settle down within several days. Patients with severe pain presenting in the first 48 h can be offered clot evacuation which gives instant relief. Although this can be done under local anaesthesia, patients are more comfortable if some level of sedation or anaesthesia is used.

22.5 Haemorrhoidal Bleeding

Bright red haemorrhoidal bleeding tends to be painless but can be quite alarming to the patient. It tends to occur immediately after a bowel action. In patients with platelet and coagulation problems, the bleeding can be quite significant. Differential diagnosis includes anal fissure and bleeding from a rectal neoplasm. Diagnosis is made from history, digital rectal examination, and proctoscopy.

Management depends on the severity of the haemorrhoids. Simple, non-prolapsing haemorrhoids are best managed with avoidance of constipation and high fibre diet. The next step would be rubber band ligation or sclerotherapy. For larger prolapsing haemorrhoids with significant bleeding, haemorrhoidectomy may be required.

Pregnant patients can be managed conservatively as the condition improves after birthing. If there are any platelet or coagulation abnormalities these should be corrected before any local treatment is embarked upon.

22.6 Anorectal Varices

These may be present in patients with long-standing portal hypertension. They are not common but need to be distinguished from bleeding haemorrhoids. Proctoscopy will demonstrate tortuous veins from the anal margin up to the mid-rectum.

Management consists of optimising the underlying portal hypertension and its complications. It if there is active bleeding then the varices should be under run with sutures under general anaesthetic. In severe cases, shunting procedures for the portal hypertension may need to be considered.

22.7 Rectal Prolapse

Rectal prolapse mainly occurs in the elderly but can occur at any age especially after prolonged straining during defecation. It becomes an emergency when it is irreducible or there is strangulation. It is important to be able to differentiate it from a prolapsed circumferential internal haemorrhoid. Usually, the full-thickness rectal wall is apparent whereas the haemorrhoid contains only the overlying anal mucosa.

For the non-strangulated prolapse, gentle reduction under sedation and analgesia is the first-line treatment. If this fails the patient should have definitive surgery such as perineal rectosigmoidectomy (Altemeier's procedure). If reduction is possible definitive surgery can be scheduled for a later date as recurrence is quite common.

Patients with strangulated rectal prolapse should proceed to a definitive excision and repair.

22.8 Anorectal Abscesses

An abscess usually forms in an infected anal gland and can spread into the intersphincteric area, perianal area, ischiorectal fossa, and occasionally into the supralevator space. There is an association with anal fistula.

Patients present with acute severe perianal pain often with an associated fever. There is associated tenderness, redness, and swelling which may or may not be fluctuant. Deeper abscesses may only be palpable on digital rectal examination. CT and MRI scanning can give additional valuable information especially in repeat and more complex cases. These modalities are also especially useful if a high abscess is suspected.

Management consists of draining the abscess and selective use of broad-spectrum antibiotics. Over 30% of these cases are likely to develop an anal fistula. Surgery should be performed under general anaesthesia and with an incision adequate enough to enable good drainage and to prevent premature closure of the incision.

The wound can be packed daily until a cavity can be managed with topical dressings alone. Antibiotics should be reserved when there is suspicion of systemic infection and in immunocompromised patients. Complex abscesses are best referred to an experienced colorectal surgeon.

Perineal Fournier's gangrene is dealt with in the chapter on urological emergencies.

22.9 Obstructing Rectal Cancer

A small proportion of patients (10–15%) with rectal cancer will present for the first time with an obstruction. Vomiting is uncommon but if it occurs is usually faeculent due to the long-standing nature of the obstruction. The abdomen is usually distended and there is generalised abdominal pain. Peritonism is uncommon unless there has been an associated bowel perforation, either from cancer or in the caecum due to distension (in the presence of a competent ileocaecal valve). Digital rectal examination will reveal a neoplasm if it is within reach. Plain abdominal x-ray will demonstrate a large bowel obstruction. CT scan of chest and abdomen will show not only the rectal cancer but may show signs of complications such as metastatic spread to lungs and liver.

This is a surgical emergency and initial management consists of resuscitation of the patient and correction of any electrolyte abnormalities. A nasogastric tube should be inserted to help decompress the bowel.

If there is any suspicion of bowel perforation the patient will require immediate surgery and a loop colostomy of either the sigmoid or transverse colon plus excision of any unviable tissue. If the patient is stable, decompression may be attempted endoscopically and an expanding temporary stent left in place.

If resources are limited, a defunctioning sigmoid colostomy is the best approach. This allows time to further assess the patient and to arrange definitive therapy either in the local hospital or in a special centre.

22.10 Summary

Anorectal disorders are common and can present as emergencies. Accurate diagnosis is required in order to plan treatment. Careful history and physical examination together with proctoscopy are diagnostic in most cases. Complex cases should be referred to a specialist centre after initial stabilisation.

Urological Emergencies

23

Francesco Piscioneri

23.1 Acute Urinary Retention

Patients usually present with severe suprapubic pain. These patients tend to demonstrate a large bladder clinically. Urgent decompression of the bladder is required either through a transurethral catheter or if this is not possible, a transabdominal approach is considered for placement of a suprapubic catheter. If left untreated renal function will deteriorate with resultant renal failure and infection leading to a severely adverse outcome.

Common causes include;

- Benign prostatic hypertrophy (most common cause)
- Pelvic masses
- Urethral strictures
- Iatrogenic damage during catheter insertion
- Neurological conditions

Once the underlying cause has been determined, a definitive management plan can be instituted. This may involve referral to a specialist urologist locally or if unavailable in another centre.

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23.2 Renal/Ureteric Colic

Ureteric stone arises in the kidney and migrate to the pelvic-ureteric system. Passage of the stone along the ureter is the cause of the pain. It is prudent to note that this causes ureteric colic as opposed to the commonly misrepresented renal colic. Pain is typically loin to groin, episodic, and variable in intensity. It can be misdiagnosed as urinary tract infection (UTI). Other differentials can include acute appendicitis, and rupturing aortic artery aneurysm.

Urinalysis will often show microscopic haematuria and no other features of UTI. If fever is present, the more probable diagnosis is pyelonephritis. If accompanied by an obstructing ureteric stone, the risk is obstructed infected kidney and is potentially life-threatening.

Non-contrast CT scan is the first-line investigation. If pyelonephritis is the working diagnosis, a renal ultrasound should be performed to rule out a ureteric stone.

Management is with pain relief and time to allow passage of the stone. Most stones under 5 mm size will usually pass spontaneously. Non-steroidal analgesic drugs are medications of choice. Allow up to 12 weeks for stones to pass. Surgical intervention is required for stones that do not pass. This involves ureteric stenting and stone destruction usually with transcystoscopic laser therapy. If this level of service is not available locally, patients with retained symptomatic stones should be referred to a specialist centre. In low-resource regions, these centres may not have advanced endoscopic therapies and open stone removal may be required.

Recurrences are common and can be reduced by maintaining a urine volume of at least 2 L per 24 h.

23.3 Priapism

Priapism is defined as a persistent penile erection of greater 4 h that is either unrelated to sexual activity or persists long after sexual activity. There are many predisposing conditions some of which are;

- Idiopathic
- Intra-cavernosal injection for erectile dysfunction
- Cocaine use
- Medication–Trazodone
- Sickle cell disease
- Haematologic malignancies

There are two main forms of priapism.

Ischaemic, or low flow, priapism is the most common. It is due to little or non-existent cavernous blood outflow. Some cases of ischaemic priapism have repetitive self-limited episodes and are known as stuttering priapism. These are often associated with sickle cell disease.

Non-ischaemic, or high flow, priapism is due to unregulated cavernous arterial inflow. It does not require urgent management and may resolve spontaneously.

Best results are obtained if treated within 24 h with a greater than 50% return of erectile function. Priapism lasting for more than 24 h has high rates of erectile dysfunction in the order of 90%.

Treatment is based around aspirating the retained blood and associated clots. A local anaesthetic is used in the form of a penile block. Do not use adrenaline in the block. Large bore needles are then inserted on either side of the penis and the stagnant blood and clots are removed by a combination of aspiration and saline irrigation. If this fails, very dilute phenylephrine (100–500 mcg/mL) can be injected into the corpora cavernosa. Care must be taken in patients with cardiovascular disease as phenylephrine can cause hypertension and reflex bradycardia.

23.4 Paraphimosis

Paraphimosis occurs in uncircumcised males when the foreskin remains retracted behind the glans and cannot be reduced into its non-retracted position. The foreskin becomes oedematous and swollen and if left in this position for a prolonged period of time the glans will become ischaemic and necrotic. The condition is painful.

Initial management is to reduce oedema and to attempt reduction. This is done by putting digital pressure on the glans and at the same time attempting reduction of the foreskin. Ensure the patient has adequate analgesia while attempting reduction.

If this fails, a dorsal slit of the foreskin must be performed. This can be done either under general or local anaesthesia. Two artery forceps are placed on either side of the 12 o'clock position of the foreskin with one arm under the foreskin and the other above. These are then clamped and a dorsal slit created between them. This will immediately release the trapped glans. The cut edges are then sutured in order to control bleeding. A formal circumcision can then be scheduled at a later date when the swelling has diminished. Careful observation must be taken in immunocompromised patients, such as diabetics, to watch out for infection and sepsis.

23.5 Testicular Torsion

This is a surgical emergency requiring correction of the torsion within 6 h in order to avoid the risk of loss of testicular viability. Although scrotal Doppler ultrasound is diagnostic, the diagnosis should be made on clinical grounds and surgical correction performed immediately. The findings are of a high riding testis that is extremely tender. The unaffected testis usually demonstrates a horizontal lie indicative of the bell-clapper deformity. All patients should be consented for orchidectomy in case a necrotic testis is found. If the testis is viable, the testis should be detorted and an orchidopexy should be performed bilaterally as the underlying bell-clapper deformity is present in over 80% of cases. If an orchidectomy is performed the other side should have an orchidopexy.

Differential diagnosis includes epididymo-orchitis and torsion of the appendix testis. With epididymo-orchitis there is usually a preceding history of lower urinary tract infection. With torsion of the appendix testis, the testis usually has a normal lie and there is often a very tender spot in the upper pole. In both of these situations an ultrasound is usually diagnostic; however, owing to the window for testicular salvage (4–6 h), most surgeons would consider a scrotal exploration as a diagnostic strategy that can easily be followed through with intervention where there is a high index of suspicion for testicular torsion.

23.6 Fournier's Gangrene

This refers to a form of necrotising fasciitis that is localised to the perineum and genital region. A high index of suspicion is required as perineal cellulitis can progress rapidly into the fascial planes and result in the necrotising fasciitis.

Once a diagnosis is suspected, high doses of intravenous antibiotics are commenced. If it can be arranged urgently, a CT scan will demonstrate the oedema of the deeper tissues and usually gas locules. Patient should then be taken for extensive debridement. Tissue planes must be explored and the excision proceeds until healthy bleeding tissue is obtained. Patients will need serial debridements over the ensuing days. Once the infection is under control and the wound is granulating, secondary closure can be performed with either skin grafting or flap repair.

Always ensure that the underlying immunosuppressive disorder is optimised.

23.7 Urethral Trauma

Urethral injuries are classified as either partial or complete, and either anterior or posterior (often associated with pelvic trauma). A urethral injury should be suspected if there is blood at the meatus, inability to void, pelvic fracture, penile trauma, or a distended bladder.

Ideally, a retrograde urethrogram should be performed before any attempt at catheterisation. Blind insertion of a catheter can lead to further urethral damage. A suprapubic catheter should be inserted to divert urine away from the damaged urethra.

In anterior injuries such as a fall astride a fence, surgical exploration and primary repair should be attempted and an indwelling catheter placed for 3 weeks. For other injuries, endo-urological treatment with a combined urethral and cystoscopic approach is used attempting to realign the urethra. A catheter is then left in place for a further 3 weeks.

Posterior injuries are more severe and have other associated injury. Definitive repair may depend on the management requirements of other pelvic injuries. Endo-urological approach is done when safe. These patients should have a complete perineal assessment as other luminal injuries may be identified.

All patients are at risk of long-term stricture. This is usually managed with dilatation. Refractory cases may need urethroplasty.

Where facilities are limited, the use of suprapubic catheterisation is the basic first line of treatment. Over 50% of partial tears will resolve with this treatment alone. All other patients should be referred to a specialist centre.

ENT Emergencies

24

Francesco Piscioneri

Ear, nose, and throat (ENT) conditions form a significant part of emergency surgical presentations. This overview will focus on:

24.1 Outer Ear

Trauma to the pinna is a common presentation. Haematomas should all be drained under local anaesthesia. The risk is of underlying cartilaginous necrosis. Antibiotics are recommended.

Lacerations should all be sutured in a single layer with the suture material traversing the skin and the perichondrium.

Foreign bodies in the ear canal are usually placed there by the patient. Occasionally insects may crawl into the canal. They should first be killed with a mineral oil. The foreign bodies should be removed under vision using micro-forceps or a right angle probe.

24.2 Middle Ear

Acute otitis media is a relatively common affliction in young children. The main clinical feature is pain and fever. It can be caused by both bacteria and viruses.

Treatment is primarily with antibiotics and decongestants. In some cases, it may progress to chronic otitis media. A rare complication is mastoiditis.

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Mastoiditis is a potentially serious condition. Initial treatment is with intravenous antibiotics and incision and drainage. This needs to be treated in a special centre where there is expertise with both mastoid surgery and intracranial surgery.

Intracranial complications include meningitis, cerebral abscess, and sigmoid sinus thrombosis.

Chronic otitis media is characterised by a chronic tympanic membrane perforation. Complications include pain, vertigo, sensorineural hearing loss, and facial palsy.

Treatment is both medical and surgical. Medical treatment consists of water precautions, topical antiseptic drops, hearing aids if required, and school assistance. Surgical treatment depends on the extent of disease but can include tympanoplasty to rectify the defect and mastoidectomy.

24.3 Nasal Fracture

Patients usually present with a history of trauma to the nose, profuse bleeding, and nasal deformity.

Initial treatment consists of;

- Ice and analgesia
- Exclude other facial, head, and neck fractures
- Look for septal haematoma

Immediate reduction can be attempted with the use of local anaesthesia which can either be injected or by use of nasal packs soaked with lignocaine and adrenaline. The patient is reviewed after 7–10 days and if still deviated a further reduction is performed. The normal practice is a delay reduction after swelling has settled.

24.4 Epistaxis

Nosebleeds are more common in the young and in the elderly. Most are either in an anterior or a posterior location.

24.5 Anterior Epistaxis

- Occur in Little's area
- 90% of all epistaxis
- Mainly in children and young adults
- Can be due to local trauma
- Desiccation of mucosa in drier months
- Irritants—sprays, illicit drugs

24.6 Posterior Epistaxis

- More common in the elderly
- 10% of all epistaxis
- Associated with coagulopathy, hypertension, atherosclerosis, and neoplastic processes
- More common in colder months with low humidity

24.7 Assessment

This should consider;

- The amount, frequency, and precipitants
- Whether anterior or posterior bleed
- Any significant bleeding history including family history
- Past medical history of hypertension, nasal surgery, and head injury
- Use of anticoagulants

24.8 Medical Management

Anterior bleeds in Little's area are usually due to capillary damage. These are usually well-controlled with local pressure. For recurrent bleeds cauterisation can be used. If there is a suspicion of a bleeding diathesis, this should be investigated.

Posterior bleeds are more problematic. Check the patient's blood pressure and if significantly elevated, consider pharmacotherapy. Often a single intramuscular injection of morphine is sufficient. If possible, urgently refer to an ENT surgeon. They have expertise in visualising the posterior nose and managing the bleeding points.

If no ENT services available, the best approach is to pack the nose. This can be done with anterior packing which involves a long ribbon gauze soaked in lignocaine and adrenaline and then inserted in the nasal cavity in layers. Commercial nasal tampons are available which are much easier to insert. Gently remove after 48 h.

Very posterior bleeding may not respond to this packing. An alternative technique is to insert a 12F Foley urinary catheter into the postnasal space and inflate the balloon with 7 mL of water. The area anterior to the balloons is then packed with ribbon gauze as described above. Gently remove after 48 h.

Prior to any attempt at packing the nose, the patient should have adequate analgesia and sedation.

If there is major bleeding which is not controlled with packing, then patients should be referred for selective embolisation if facilities are available. In severe life-threatening situations, the external carotid artery should be tied off just above the level of the facial artery.

24.9 Facial Cellulitis

This is commonly due to Streptococcus or Staphylococcus. It can rapidly progress and should be treated as a surgical emergency.

The mainstay of treatment is with intravenous a penicillin/flucloxacillin combination. The main complication is the risk of spread to the cavernous sinus.

24.10 Peritonsillar Abscess(Quinsy)

Presentation

- 3–4 days after a sore throat
  - Unilateral throat pain
  - Fever
  - Palatal swelling
  - Trismus
  - Deviation and oedema of the uvula

Treatment

- Intravenous penicillin, metronidazole, and steroids
- Incision and drainage of the abscess using local anaesthesia and a cruciate stab incision

24.11 Ludwig's Angina

This is a rapidly progressive cellulitis of the floor of the mouth. It is usually caused by a haemolytic Streptococcus and Bacteroides. It is more common in elderly debilitated patients and is usually precipitated by dental procedures. It can spread to all the neck spaces and is characterised by massive swelling of the neck and intraoral structures. These then expand backwards causing airway obstruction.

Patients should be commenced on intravenous antibiotics and admitted to the intensive care unit.

Treatment is urgent airway management. If possible, the airway should be protected with a nasotracheal tube, otherwise a tracheostomy should be performed. CT scan of the face and neck investigates for abscesses. Bilateral submandibular incisions to the skin and platysma muscle can be performed to help decompress the floor of the mouth.

24.12 Conclusion

Most ENT emergencies can be accurately diagnosed with a careful history and examination. It is important that the airway is protected and that infection is not allowed to spread to major structures.

All surgeons should be familiar with the techniques of both open and percutaneous tracheostomy.

Ophthalmologic Emergencies

25

Chamil Dayajeewa

Ophthalmic surgery can be challenging at times due to non-availability of proper ophthalmic equipment and instruments. However, it is still possible to carry out emergency surgeries with a very good outcome with low resources. Proper surgical techniques matter more than high-end equipment or instruments when it comes to emergency ocular surgery.

Whether operating in a highly equipped unit or low-resource centre proper consent after explaining the degree of injury, treatment options, and expected postoperative outcomes are very important.

25.1 Lid Lacerations

Lid laceration (partial or full-thickness with or without lid margin involvement) could be repaired perfectly well with the naked eye or with the help of magnifiers or loops. Having a microscope would be an added advantage whenever there is lacrimal canalicular involvement.

When a patient presents with a lid laceration it is very important to have a proper history and careful examination prior to surgical repair. This is to ensure that there is no other associated structural damage to the globe (globe rupture/penetration) or surrounding bony socket (blowout fractures).

In an ideal set up, depending on the nature of the trauma and associated injuries, it is recommended to have a CT scan of brain/orbits done to exclude any intracranial/orbital/ocular foreign bodies, fractures, and other pathology. When the resources are limited and there is no easy access to CT scans, at least a simple x-ray (occipitomental/Waters view and facial bones) should be taken.

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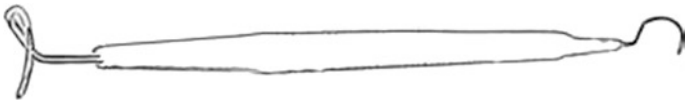


Fig. 25.1 Pigtail probe

If it is a simple uncomplicated lid laceration where the globe and socket are intact and there are no signs of embedded foreign bodies, repair under local/general anaesthetic should be carried out depending on patients cooperation. When suturing a lid laceration proper approximation of grey line to grey line matters most for good post-operative outcome. The tarsal plate and orbicularis muscle layers should be sutured with absorbable sutures such as Vicryl. Skin is sutured with black silk.

Whenever the lacerations involve lacrimal puncta or canaliculi, it is recommended that the repair should be coupled with a meticulous approximation of canaliculi and use of artificial material such as lacrimal tubes or *Mini-Monoka* stents to maintain patency of lacrimal canaliculi. A proper primary repair will prevent constant trouble due to epiphora for the patient. These stents should be left alone for 6–12 weeks depending on the severity of injury and type of the stents.

In a lower resourced setting, if these tubes are unavailable, thick nylon (2-0, 3-0) or other non-absorbable suture materials could be used to maintain patency of the lacrimal canaliculi. These sutures could be passed from upper to lower canaliculi, or vice versa, and tied together to make a loop with the help of simple pigtail probes (Fig. 25.1).

25.2 Corneal Lacerations

Corneal lacerations should be repaired under strict aseptic condition under general anaesthesia without delay. Similarly, depending on the severity and nature of the trauma, CT scan could be utilised to exclude any intraocular foreign bodies.

Examination under force or instilling fluorescein should be avoided at all cost if full-thickness corneal laceration is suspected. It is important to perform this surgery under microscopic guidance to detect and remove intracameral foreign bodies and debris entrapped in the corneal wound before closure.

When performing surgery, meticulous repair with 10-0 nylon to ensure a water-tight cornea is important. If there is no CT scan then it is recommended to repair and have an orbital x-ray done post-operatively to exclude radio-opaque foreign bodies

and send the patient for vitreoretinal opinion accordingly. If intravitreal foreign body is suspected intravitreal antibiotics should be injected during surgery as long as the posterior view is reasonably clear to exclude any associated retinal detachments, choroidal haemorrhage or when dense vitreous haemorrhage precludes view to the posterior segment. Otherwise, it is recommended to administer intraorbital/subconjunctival antibiotics prepared as guidelines to avoid and treat infections/endophthalmitis.

25.3 Globe Rupture

It is highly recommended to always suspect underlying globe rupture for patients presenting with significant ocular trauma where the intraocular pressure is significantly low or zero and there is a significant amount of subconjunctival haemorrhage and hyphaema precluding view to the posterior segment.

Again imaging could be helpful; however, primary repair matters most. Anaesthetist should be well informed prior to the procedure to minimise tension on the globe during anaesthesia. A surgeon's duty is to explore under the microscope with 360° peritomy with or without muscle detachment to exclude a sclera rupture if the wound is not obvious.

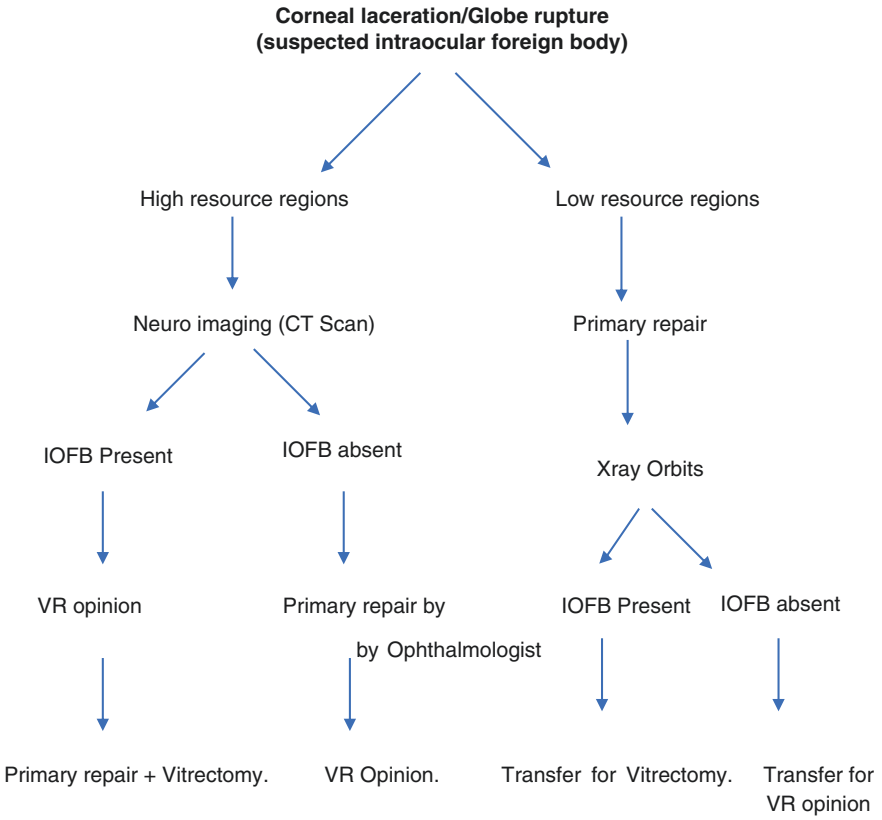
If present scleral rupture should be sutured with vicryl and special care is taken to avoid damage to the retina and underlying choroid. Vitreoretinal opinion should be sought as soon as possible following primary repair. In an ideal set up a vitreoretinal surgeon would take the responsibility for the surgery especially if there is an intraocular foreign body associated with the rupture.

25.4 Hyphaema

The general principle is to admit patients (especially children) with hyphaema to avoid a secondary bleed. There is a place for discharging patients home provided hyphema is small and intraocular pressure is not elevated. This could be done if strict bed rest is reassured and the patient understands consequences.

In low-resource settings, it is often best to manage these patients in hospital considering their socio-economic status. Often they have to travel far using public transport and may not be able to adhere to strict bed rest advice.

25.5 Corneal Laceration/Globe Rupture (Suspected Intraocular Foreign Body)



IOFB - Intraocular foreign body

VR - Vitreo retinal

25.6 Chemical Injuries

Chemical injuries are far more common and severe in low resourced areas. Unfortunately, they often present late and mismanaged causing significant complications and even blindness.

In developed countries, due to the accessibility of healthcare as well as the availability of facilities most patients have immediate access to proper first aid/proper ocular irrigation prior to consultation with ophthalmologists. Often ocular irrigation is initiated under local anaesthetics with Morgan irrigation lenses.

As Morgan lenses will not be available in most low-resource settings, proper effective continuous irrigation could be still carried out using local anaesthetics, lid speculums, and a saline drip system attached to the patient's forehead in the supine posture.

If there are embedded chemical deposits, such as lime deposits, it is recommended to remove subconjunctival as well as subtarsal foreign bodies under general anaesthesia to salvage these eyes.

25.7 Acute Angle Closure Glaucoma

In an ideal setup with proper medications and laser equipment managing patients with acute angle closure glaucoma should not be a difficult task. Availability of intravenous agents to lower intraocular pressures (IOP) such as IV Diamox, IV Mannitol often helps to control these angle closure episodes. Once the pressure is brought under control, the patient should have laser in both eyes whenever the corneal clarity is restored.

Unfortunately, in many low-economic centres, laser or specific intravenous agents may not be available. In these instances, particularly where laser is not an option, it is recommended to perform a surgical penetrating iridotomy (PI), once the IOP is brought under control, to prevent a recurrence of angle closure.

At times a decision will be made whether this surgical PI should be combined with a trabeculectomy with or without lens extraction and intraocular lens placement.

25.8 Retinal Tears

An experienced ophthalmologist working in a low-resourced centre could easily recognise a peripheral retinal tear with a basic slit lamp and indirect lenses. However, highly equipped centres with facilities such as wide-field colour fundus photography, super field contact lenses, and ultrasonography will assist even an ophthalmic technician to spot a retinal tear. Once the diagnosis is confirmed, the patient should be treated then and there with retinal laser to avoid the development of a retinal detachment.

However, in a low resourced centre, it is very unlikely there will be access to a retinal laser due to the cost. The patient may have to be transferred to a tertiary centre with laser facilities which might potentially delay treatment risking the development of a detachment. As opposed to having a laser machine, gentle treatment with far less expensive cryo machine could help to treat retinal tears. It will be very useful in a setting where there are retinal tears associated with significant vitreous haemorrhage which will anyway make laser treatment difficult or ineffective.

25.9 Retinal Detachment

Even though the current trend is to do a primary vitrectomy for most retinal detachments, an experienced surgeon in a low resourced centre could treat simple retinal detachment with the help of a cryo machine and external retinal buckles. What is required is a basic binocular indirect ophthalmoscope, cryo machine, and a retinal buckle/sclera bands. In contrast, vitrectomy procedures need high-end vitrectomy machines, expanding gases, specialised instruments, and a skilled retinal surgeon.

25.10 Diabetic Maculoedema (DME) and Proliferative Diabetic Retinopathy (PDR)

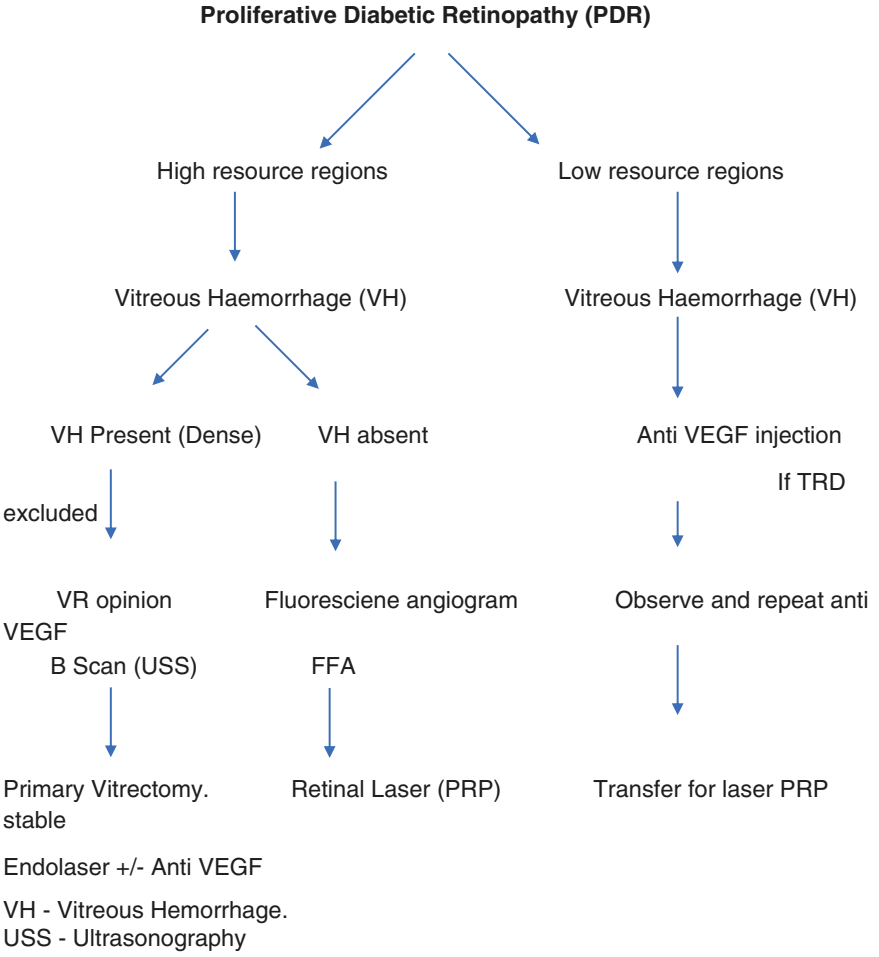
In centres with better resources, diabetic patients often receive the best treatments. Ophthalmologist working in these centres have the advantage of having advance OCT imaging capabilities, wide-field fluorescein angiography, retinal laser, and availability of anti-VEGF (Vascular Endothelial Growth Factor) treatments to treat these patients promptly and effectively. These facilities provide ophthalmologists with more information to predict treatment outcomes.

Low-resource centre ophthalmologists have to rely primarily on clinical examination findings with the help of basic slit lamp and indirect lenses managing patients with diabetic retinopathy. An experienced ophthalmologist could detect subtle clinically significant macular oedema and non-proliferative or proliferative diabetic retinopathy just with clinical examination. As in the past, most of these cases could be effectively managed based on clinical findings. However, the availability of laser treatment plays an important role in the management.

Fortunately, nowadays anti-VEGF treatments are available to even low-resource centres. Especially, intravitreal Bevacizumab (Avastin) is a cheap and safe alternative treatment option to other expensive anti-VEGF treatments. Diabetic macular oedema could be treated in tertiary centres as well as low-resource centres effectively as long as treatments are administered under aseptic conditions to avoid endophthalmitis. Currently, Avastin treatment is considered the first-line treatment especially for diabetic macular oedema where leaking microaneurysms are located close to the fovea contraindicating laser treatments.

Furthermore, studies have proven anti-VEGF treatments can achieve comparable results to primary laser when managing proliferative diabetic retinopathy. As there is a slightly higher risk of complications with anti-VEGF treatments compared to Laser (PRP—Panretinal photocoagulation), anti-VEGF treatment for proliferative retinopathy could be administered until patients could gain access to laser treatments (PRP). Maintaining a course of anti-VEGF treatment will regress proliferative diabetic retinopathy and chances of developing tractional retinal detachments delaying the need for vitrectomy/retinal surgery.

25.11 Proliferative Diabetic Retinopathy (PDR)



Furthermore, most other acute ocular issues such as retinal vascular occlusions, inflammatory eye conditions (uveitis), and optic neuropathies (anterior ischaemic optic neuropathy) can be managed equally effectively in both settings with clinical assessment alone. However, Low-resource centres may lack the privilege of having access to expensive and more specific investigations investigating these conditions further.

Principles of Burns Management

26

Francesco Piscioneri

26.1 Introduction

Burns are a specific type of trauma and should follow the ATLS pathway. One of the first priorities is to stop the burning and to prevent extension of burning to deep areas by aggressively cooling off the burnt surface.

Patients should be adequately resuscitated and the extent of the burnt area calculated.

Morbidity and mortality rise as the percentage of burnt area increases. Elderly people are at increased risk.

26.2 Calculation of Burn Size

The commonly used method is the 'Rule of 9's' which pertains to adult body size. The body is divided into regions which comprise multiples of 9% (Table 26.1).

For assessing smaller areas, the size of the patient's hand without the fingers spread out is classed as 1%.

Table 26.1 Rule of '9's'

Head	9%
Trunk—front	18%
Trunk—back	18%
Arm	9%
Leg	18%
Perineum	1%

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This assessment is unsuitable in children because of different body proportions. The head takes up a proportionately larger component of body surface area whereas the lower limbs are proportionately smaller. This varies with age and or some guidelines for this.

This pertains to age 0–10 (Table 26.2).

26.3 Burn Depth

It is important to estimate the depth of the wound as this will direct treatment. The most straightforward classification is that of partial thickness and full thickness. Partial thickness burns retain most of the underlying elements of the skin and total regeneration is the usual outcome within 9–15 days. Full thickness burns will heal from the edges only and usually need some sort of grafting in order to get early wound closure but also to get a better-quality repair when compared to having a fibrous scar if using a delayed a non-operative approach.

Table 26.3 shows some different features regarding depth of burn.

Indications for hospitalisation include;

- Greater than 10% burn in a child
- Greater than 15% burn in an adult
- Burns in the very young or the elderly
- Full thickness burns likely to require grafting
- Burns of face, perineum, hands, and feet
- Inhalational injury
- Other associated trauma
- Presence of significant comorbidities such as diabetes

Table 26.2 Body surface area for children

	Birth	1 year	5 years	10 years
Arm	10%	10%	10%	10%
Trunk—front	13%	13%	13%	13%
Trunk—back	13%	13%	13%	13%
Head	20%	18%	14%	12%
Leg	10%	12%	14%	16%

Table 26.3 Features of burn depth

Depth of burn	Characteristics	Causes
Partial thickness	Pain Blisters Red/mottled skin	Contact with hot liquid Severe sunburn
Full thickness	Dry Dark and leathery	Fire Electrical burn Lightning Prolonged exposure to hot items Hot liquid in young children

26.4 Initial Resuscitation

As mentioned earlier, the ATLS trauma principles should be followed. Special consideration needs to be taken with fluid replacement as fluid losses are very high through the burnt tissue and fluid replacement needs to be aggressively managed. Acute kidney injury is a serious complication in patients who have been inadequately fluid resuscitated.

There are several different formulas used to determine fluid resuscitation, but the most common is the Modified Parkland Formula (Fig. 26.1). Maintenance fluids must also be calculated and added to the fluid management.

The adequacy of fluid resuscitation should be titrated against urine output as there may be inaccuracies in the calculation of patient weight and total percentage of the burn area.

Special considerations include;

- Major burns are prone to hyperkalaemia. Depolarising muscle relaxants (e.g., succinylcholine) must not be used.
- Patients are prone to hypothermia, so will need to be nursed in a warmer environment.
- Loss of skin barrier increases infection risk, so good quality aseptic techniques must be used as well as isolation if indicated. A single dose of prophylactic antibiotic is usually sufficient unless there is evidence on the established infection. Anaerobic cover should be considered. In addition, there is a case for a course of antibiotics in burns of feet and perineum.
- Major burns will need tetanus prophylaxis.

26.5 Treatment

Aim to prevent wound progression by the use of antimicrobial creams and occlusive dressings, as epithelialisation progresses faster in a moist environment. Non-stick dressings can be applied with or without silver sulfadiazine cream and changed on alternate days. Partial thickness burns will respond well to this regime.

By about day 10 it will become apparent if burns are full thickness as there will be the absence of skin regeneration. Wounds may be granulating or still have thick slough or eschar.

Small full thickness burns can be allowed to heal by secondary intention but skin cover is preferred to reduce healing time, scar formation, and wound contracture. Grafting should be completed within 3 weeks of the initial burn. Most skin cover

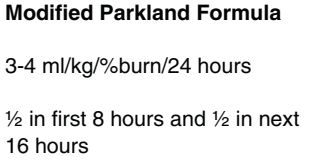

Fig. 26.1 Modified Parkland formula for fluid resuscitation

will be with meshed split skin from non-burnt areas. There is a role for full thickness grafts for smaller areas and where better-quality skin is required especially on the face and over joints.

All burns requiring hospitalisation are best managed in specialist burns centres (where available) after initial stabilisation and wound coverage.

Special mention needs to be made of circumferential burns as full thickness burns will form an eschar and contract causing neurovascular compromise which is a high risk of limb loss. All full thickness circumferential burns must be considered for longitudinal escharotomy to be performed as soon as the risk is identified. The eschar is divided until healthy vascularised tissue is on view from the upper to the lower borders of the burn and when the circulation has been restored. At the same time, an assessment should be made of the underlying muscular compartments. If at risk, then fasciotomy should be performed at the same time.

Physiotherapy is a key factor in return of function for these patients. It needs to be started early and followed through as part of their major rehabilitation.

26.6 Conclusion

Treatment of major burns needs to be aggressive and timely. Complications can develop rapidly and can be fatal. Treatment is best done in dedicated trauma centres but good care can be done in peripheral hospitals. This is especially so with the initial resuscitation phase.

Overview of Trauma

27

Francesco Piscioneri

This chapter aims to present an overview of minimum requirements for a trauma system in a regional hospital.

Trauma is the major cause of death in the under 35-year age group. In addition, there is a large burden of disability associated with trauma. This burden is carried not just by the individual, but also by family, friends, and society as a whole.

There are three phases of trauma care;

- Prehospital
- Hospital
- Rehabilitation

27.1 Prehospital Care

This needs to focus on;

- Initiation of protocols based on injury type and severity
- Stabilisation of patient with management of hypotension, pain, and control of bleeding
- Planning best mode/route and destination for transfer
- Rapid transfer of the patient to a trauma facility

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27.2 Emergency Department

Not all emergency departments are equipped to handle and receive severe trauma cases. In highly organised and well-resourced regions smaller emergency departments are often on trauma bypass and ambulance services will take patients directly to the designated trauma centre. There are often interhospital agreements on how to best manage and distribute trauma cases.

However, all emergency departments should be able to receive and manage the initial resuscitation of trauma patients. The Advanced Trauma Life Support course (ATLS) is designed primarily to have a protocol and regimented based approach to trauma care. This training enables staff in smaller centres to stabilise and treat acute life-threatening conditions prior to more definitive management that may possibly require transfer to another centre.

27.3 Classification of Trauma Centres

Trauma centres are classified according to their level of expertise and available services;

Level I—tertiary hospital, 24 h consultant cover
Level II—community or General Hospital with less comprehensive cover
Level III—smaller hospital with less resources
Level IV—small rural centre with the ability to stabilise and transfer

In addition, some of the centres also cater for very specialised care, e.g., paediatric trauma, burns management, and spinal cord care.

27.4 Advanced Trauma Life Support (ATLS)

This course is available to all staff who come in contact with trauma patients. It provides a systematic approach to trauma care. This is especially useful for medical staff in non-trauma centres so that they can effectively manage trauma patients until they can be transferred to a centre for definitive care.

27.5 The Primary Survey

This is summarised as the ABC (DE) of trauma care;

- Airway assessment with cervical spine protection
- Breathing
- Circulation
- Disability
- Exposure and Environment

27.6 Airway

- Check for airway patency, presence of foreign bodies, and any injuries that may interfere with the airway
- Always assume that there is a cervical spine injury when assessing an airway and ensure immobilisation with a cervical collar
- If airway is at risk then consider and have the ability to do a rapid sequence intubation
- Cervical spine immobilisation

27.7 Breathing

- Assess by inspection, palpation, auscultation, and pulse oximetry
- Ensure there is adequate ventilation and oxygenation
- Attend to tension pneumothorax urgently
- Urgently manage haemothorax and flail chest

27.8 Circulation

- Ensure good quality intravenous access, preferably two lines
- Check pulses, blood pressure, capillary refill, cyanosis, and conscious level
- Identify any source of ongoing bleeding and apply control measures
- Arrange for urgent infusion of saline and blood products as required
- Major transfusion protocol should be instituted at this stage if deemed necessary

27.9 Disability

- Check Glasgow Coma Scale (GCS)
- Level of consciousness
- Pupillary responses
- Response to external stimuli
- Movement and sensation

27.10 Exposure and Environment

- Fully expose patient to allow for examination of the whole body including spine
- Avoid hypothermia by controlling room temperature, use of overhead heaters, warmed infusion fluids, and use of thermal blankets
- Physically check all areas to minimise missed injuries

27.11 Secondary Survey

- Areas of concern with the primary survey have been completed and attended to
- A head to toe physical examination is performed including all orifices
- A more detailed history is obtained
- A decision is made on whether the patient needs further investigation, immediate transfer for surgery, or any requirements for further resuscitation. Ensure that blood products are available and administered early in the resuscitation period.

27.12 Urgent Surgery

There is an absolute need for urgent surgery if haemodynamic instability is thought to be due to an intrathoracic or intra-abdominal cause. Any further imaging or investigation in a potentially unstable patient may lead to a fatality due to delay in treatment. If the injuries are unlikely to be intra-abdominal or intrathoracic, and the patient has been stabilised, then it is appropriate to do further imaging to better delineate the extent of injury.

The operating room staff need to be prepared for a minimum of a trauma laparotomy. Depending on the facilities, this may include cell saver equipment, major transfusion protocol, and senior staff experienced in trauma management.

27.13 Imaging

Focused Assessment by Sonography for Trauma (FAST) is now readily available in most centres. Its role is to assess the presence of fluid (assumed to be blood) in the abdomen in an emergency situation. A positive FAST in the patient who remains unstable in spite of resuscitation is an indication for an emergency trauma laparotomy. A negative FAST does not rule out injury.

A trauma series CT scan, or Pan-Scan, is now a standard feature in most Level I trauma centres. This entails a CT of head, neck, chest, abdomen, and pelvis. Patients must be stable before going to CT. If there is the luxury of a CT enabled hybrid operating room then patients can go directly for surgery and have the CT at that location.

27.14 Skill Set

ATLS training or equivalent
- Rapid sequence intubation
- Access to peripheral and central vessels
- Thoracostomy and chest drain insertion
- Trauma Surgeon Skill
- Pericardiocentesis

27.15 Summary

Good trauma care is possible at all levels of service availability. The guiding principles include adherence to ATLS guidelines and a heightened awareness of the possibility of multiple injuries where large energy forces are involved.

Paediatric Surgical Emergencies

28

Rajay Rampersad

There is a significant overlap between paediatric surgery and adult general surgery in terms of pathologies and operations. Whilst unable to address in detail all aspects of paediatric surgical emergencies, this chapter aims to look at those specific to the paediatric population.

28.1 Testicular Torsion

Testicular torsion occurs in two main age groups—peripubertal and perinatal.

28.2 Peripubertal Torsion

These patients classically present with sudden onset of unilateral testicular pain, and may be associated with nausea or vomiting, and difficulty mobilising. The differential diagnosis includes torsion of the testicular appendage, or epididymo-orchitis (more likely in sexually active teenagers).

Torsion of the appendage (of hydatid of Morgagni) typically occurs at a slightly younger age (10–12 years) and presents with tolerable, focal pain at the upper pole, and possibly a 'blue dot' sign. These can be conservatively managed if the diagnosis is clear.

Epididymo-orchitis may present with more gradual onset pain and usually is associated with significant swelling and erythema of the scrotum (usually not present in acute torsion in the early stages). They may have fever as well. Ultrasound may show increased vascularity.

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Acute scrotal pain requires exclusion of testicular torsion, and if this is not possible, then surgical exploration is mandatory.

Surgical approach is via either a midline raphe scrotal incision or a transverse incision overlying the testicle. Most surgeons prefer a midline incision because it allows access to the contralateral testis if required. Following dissection through the tunica vaginalis, the testis is assessed for pathology, and detorsion performed if required. The ischaemic testis is wrapped in warm saline gauze and left for a few minutes. Use this time to explore the other side which often shows the same predisposing pathology (bell-clapper testis) and perform an orchidopexy. Repeat on the index side once viability is confirmed. Two main methods exist—a 'window orchidopexy' whereby the tunica albuginea is fixed to the tunica vaginalis opening in 3 or 4 positions with an absorbable or non-absorbable suture; others advocate for eversion of the tunica vaginalis and placement in a Dartos pouch. The latter is thought to have less risk of damage to the testis. Closure is performed using absorbable sutures in layers.

Torsion of the appendage, if found at operation, just requires resection of the appendage and closure.

If there is doubt about the diagnosis at surgical exploration, then swabs should be taken of the testis and epididymis for microscopy, culture, and sensitivities.

28.3 Perinatal Torsion

This may occur just before birth, or in the first few months of age. In contrast to the pubertal torsion, perinatal torsion is generally considered to be an extra-vaginal torsion, probably due to lack of fixation of the tunica vaginalis to the surrounding scrotal tissue. Only rarely can the testis be salvaged, as often the presentation is quite delayed. This might be when the parents notice a discoloured scrotum on routine nappy change (and of course may be even later in darker skin babies), which usually reflects a long duration since the acute event. In other cases, the patient is born with a discoloured and hard scrotum/testicle that will then atrophy with time.

The differential diagnosis of a tender erythematous scrotum in this age group is epididymitis/epididymo-orchitis. When infection is suspected, oral broad-spectrum antibiotics are started and follow-up organised to check the size of the testicle. Idiopathic scrotal oedema needs to be considered when the scrotal wall is non-tender and thickened.

General emergency treatment varies between emergency exploration and treating conservatively. Reserve exploration for cases where the timeline is suspected to be short and the chance of salvage is theoretically higher. This is the minority of cases. It is suggested that a non-dissolvable monofilament not be used as this can be quite irritable to the patient. It is reasonable to explore and fix the other side as synchronous torsion has been reported.

In delayed presentation or antenatal torsion, emergency surgery is not necessary. Many surgeons perform an elective exploration, excision of remnant, and contralateral orchidopexy.

28.4 Hernia's

Abdominal hernia's in children can cause a surgical emergency as in adults. However, there are differences in the types of pathology.

28.5 Inguinal Hernia

Emergency management of an inguinal hernia is a relatively common event and is nearly always an indirect hernia. Premature babies have a higher incidence of inguinal hernia's and neonates may have a higher rate of strangulation if not repaired early.

Infants and older children with a reducible inguinal hernia can be placed on an elective list for repair with a low risk of problems prior to their repair. For those under 6 months of age, it is advisable to repair them early, i.e., within a week or two to reduce the risk of strangulation.

Often, surgeons are called by the emergency room with an irreducible hernia. By far the most common error trying to reduce an inguinal hernia is the technique. As the hernia comes out from the superficial ring it often bulges anteriorly and superiorly, meaning if the doctor attempts to reduce it directly posteriorly they will not succeed. Instead, the bulge has to be milked inferiorly first around the superficial ring edge and then posterolaterally and superiorly into the inguinal canal and back into the abdominal cavity.

A truly irreducible inguinal hernia is an emergency and requires immediate intervention. Whether these are classified as irreducible, incarcerated, or strangulated is irrelevant, they all require intervention. (Always consider the differential diagnosis of lymphadenopathy, and undescended testis, and note that a tender groin lump with an empty scrotum may be a torted undescended testis.)

Surgical intervention involves assessment and reduction of hernia contents and repair of the hernia. If irreducible, the tissues will often be quite oedematous and will make identification of normal anatomy, dissection, and repair more difficult than normal. There is also a higher rate of testicular injury probably from the direct compression of the spermatic cord.

Approach the hernia via a groin incision and open the hernial sac to assess the bowel viability. If there are viable contents, following reduction a normal herniotomy is performed using absorbable suture. If the contents are ischaemic and require resection, there are two options—to resect and anastomose then reduce and repair the hernia, or reduce and repair the hernia then perform a laparotomy to assess/resect/anastomose the bowel. The laparotomy can be done via a separate abdominal incision, or via the same groin incision. In the latter, once the hernia is repaired and the inguinal canal closed, then the superior aspect of the wound can be retracted and the abdomen entered by dividing the lower abdominal muscles. In this way, a separate skin incision can be avoided. This approach is also advised if the bowel spontaneously reduces on the table but there is turbid/discoloured fluid in the sac and there are concerns about bowel viability (This is rare as ischaemic tissue

usually swells too much to allow spontaneous reduction). Mesh is never required in children in either the elective or emergency repair of a hernia.

In the event that there is no-one familiar or comfortable with a herniotomy in a paediatric patient, is not near a paediatric centre, and emergency treatment is required, the alternative would be a low transverse laparotomy and reduction of the hernia internally and closure of the deep inguinal ring, with care taken to keep the vas and vessels protected.

The patient's family should be advised that there are real risks of testicular atrophy in the setting of emergency repair of an inguinal hernia. Follow-up should be ensured to check for this and the higher rate of recurrence.

Umbilical hernia incarceration is extremely rare. Femoral hernias are also very uncommon, but included in the differential for a painful groin lump and is dealt with in a similar manner to adult femoral hernias (but with the closure of the femoral ring with sutures rather than mesh).

28.6 Intussusception

A common condition in the <4-year age group, ileocolic intussusception usually follows a viral illness and is thought to be secondary to enlargement of the Peyers Patches. Occasionally it is secondary to a pathological lead point such as a Meckel's Diverticulum or polyp, which become much more common causes in older patients (i.e., >4 years age). If left untreated bowel infarction can occur.

Symptoms may consist of colicky abdominal pain with drawing up of legs, vomiting, red currant jelly diarrhoea, lethargy, whilst clinically a right lower quadrant mass may be palpable.

X-ray may show the lead point of the intussusception, an empty colon, and potentially small bowel obstruction if long-standing.

Ultrasound scans are reliable in detecting a target sign, whilst air enema to reduce the intussusception is the gold standard in management, with a reduction of at least 90% of cases. The enema should be organised promptly as the success rate decreases with duration of intussusception. This is performed with a large catheter via the rectum and an airtight seal with tape across the buttocks. Air is insufflated up to a maximum of 120 mmHg under fluoroscopy and monitored for gradual reduction (Fig. 28.1). Three attempts of 3 min each can be attempted. If partially reduced, then it can be repeated 6 h later. Failed air reductions require surgical intervention. If there are no facilities or expertise for air reduction enema to confirm and treat the disease, then surgical intervention should be promptly initiated.

Surgical intervention involves laparoscopy/laparotomy and evaluation of the small and large bowel. Incision depends on the confidence of the diagnosis. Generally, a right lower quadrant incision is used, otherwise a midline laparotomy is appropriate. The intussusception can often be reduced manually and then

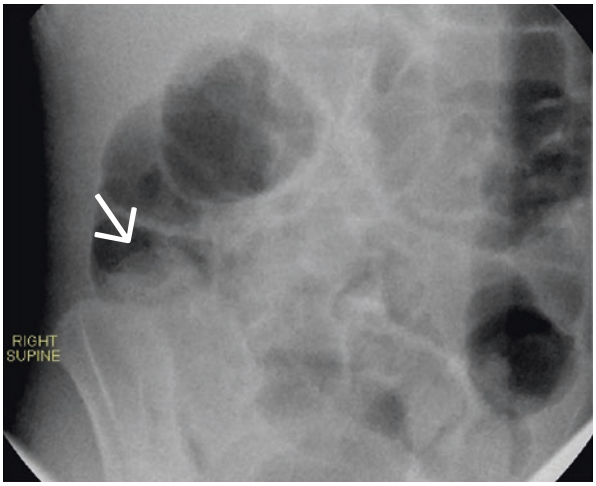

Fig. 28.1 Air reduction enema of ileocolic intussusception. This is taken during the procedure. The reducing intussusceptum can be seen as a meniscus sign in the ascending colon (arrow)

examined for lead-points or ischaemia. If these are present, or it is unable to be reduced, then resection and primary anastomosis is performed.

28.7 Appendicitis

Appendicitis management is the same as in adult patients. Symptoms are similar, except in the young ages (<5 years age) who often present late with complicated diseases such as perforation or abscess formation. Young patients may not have the same clinical signs, as peritonism may not be as evident even with widespread purulent contamination. These patients often present with fever, lethargy and a distended abdomen, and usually a corroborative history from parents suggest a short period of being unwell.

The diagnosis is based on clinical suspicion. If a more chronic disease with potential abscess or phlegmonous changes is suspected, an ultrasound may be performed, which upon confirmation, IV antibiotic treatment may be preferred to a very difficult operation. One must be cognizant of potential failure of medical therapy such that it forces the surgeon to operate.

Laparoscopic appendicectomy is becoming the standard in all age groups; however, if equipment or skills do not allow this, then traditional right lower quadrant incision and appendicectomy can be undertaken. If the diagnosis is in doubt then a more traditional laparotomy incision is recommended as this will enable access to all quadrants. A good suction/lavage is crucial in those with significant intra-abdominal pus to minimise delayed abscess formation. As in the adult population, the placement of intra-abdominal drains is not recommended.

28.8 Ingestion of Foreign Bodies

Button battery ingestion is potentially a fatal event if not acted upon swiftly. If lodged in the oesophagus, it can rapidly cause erosion which can lead to oesophageal leak, mediastinitis, or fistula with the trachea or aorta. The latter can be rapidly fatal. Injury begins immediately on contact with mucosa. Strictures can develop in the chronic stages leading to malnutrition.

Caustic ingestion is another cause of serious oesophageal injury and can involve the whole oesophagus in the worst case in contrast to button batteries which are usually focal injury. These can lead to severe strictures requiring lifelong treatment.

Other commonly ingested foreign bodies (Fig. 28.2) are coins (often stick in proximal oesophagus), sharp objects (e.g., pins), and food bolus obstruction.

The initial management for a suspected button battery ingestion is x-ray evaluation to prove and locate it. Lodgement in the oesophagus necessitates emergency intervention to evaluate the extent of the injury and retrieve it. Retrieval can be via either a rigid or flexible oesophagoscopy. Rigid has the advantage of easier retrieval using rigid graspers via the channel, at the cost of poor visualisation of surrounding tissues. The flexible option has better visualisation and easier control but the graspers are usually too fine for retrieving large objects, though some bag retrieval systems can be of help. Sometimes the object can be pushed into the stomach for easier manipulation and retrieval though this can injure mucosa on the way down.

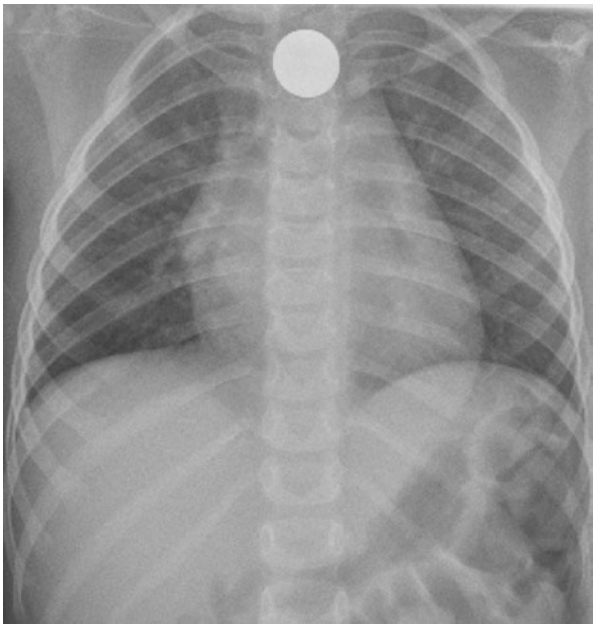

Fig. 28.2 Foreign body lodged at cricopharyngeal level, the narrowest point of the oesophagus. This was a coin and removed via rigid oesophagoscopy

Caustic ingestion management depends largely on the substance and timing from event. In the first 72 h, evaluation using a flexible gastroscopy is recommended to evaluate the injury. Minor injury can be managed conservatively, whilst more significant mucosal injury may require a nasogastric tube to enable enteral feeding until inflammation resolves. Re-evaluation can be undertaken a few weeks later. It is not advisable to scope >72 h after ingestion as the risk of further injury or perforation is higher.

Foreign bodies that have passed to the stomach generally do not need removal as they will usually pass through the pylorus and be evacuated. Exceptions are objects that do not pass the pylorus on delayed evaluation or those with symptoms of gastric outlet obstruction. Very large pins such as hijab pins also are unlikely to pass so should be removed early.

Small magnets are an increasing issue recently with the production of various magnet toys. The consumption of multiple small magnets can result in fistula between bowel loops and require laparotomy to repair in extreme cases. In these events, it is advisable to firstly perform serial x-rays to see if there is the movement of the magnets. If they are in a fixed location, suspect that they are in separate bowel loops and consider exploration early.

28.9 Urinary Retention

The most common cause of acute urinary retention in children is due to constipation. Treating this generally resolves the issue. The other major cause in boys is long-standing balanitis xerotica obliterans (BXO), a progressive inflammatory disease of the foreskin. Urgent circumcision may be required.

Rare causes include pelvic tumours such as rhabdomyosarcoma of the urogenital tract, or in male neonates posterior urethral valves. In the latter condition generally there will be significant hydroureteronephrosis and a thickened bladder on ultrasound. Diagnosis is confirmed with a micturating/voiding cystourethrogram ideally, and/or cystoscopy. Definitive treatment is with an 8F resectoscope, but it should be done by someone experienced in this condition. This can wait as long as the bladder is decompressed with a catheter. Usually, a urethral catheter is able to be passed, but if difficult, then a suprapubic catheter, or as a last resort, a vesicostomy (performed midway between the umbilicus and pubic symphysis) can be performed. The latter is rarely performed in large centres but could be an option for a very premature neonate who needs to grow to enable the resectoscope to pass per urethra.

28.10 Neonatal Conditions

The main emergency surgical conditions in neonates that a surgeon deals with are related to the abdomen. Pathologies include bowel obstruction, necrotising enterocolitis, and diaphragmatic hernia.

Bowel obstruction can take various forms. Congenital causes include atresias, which can occur anywhere in the alimentary tract and will require surgical intervention in the first few days of life. Malrotation and subsequent volvulus is a surgical emergency and often presents with a sudden onset bilious vomit, and may lead to rapid deterioration, bowel infarction, and demise if not acted on in a timely fashion. Emergency surgery involves detorsion of the volvulus, division of any congenital bands, widening of the mesentery, and placing the bowel in a non-rotated position (small bowel in right abdomen, large bowel in left). Resection is considered if non-viable bowel is present. In such a situation a temporary stoma may be justified.

Necrotising enterocolitis is a disease primarily of premature babies, especially the very low birth weight ones. This can often be treated conservatively, but in some cases can require surgical intervention. Perforation (Fig. 28.3) or failure of medical management are some indications to intervene. Often the management is damage control surgery with resection of necrotic segments and formation of stomas.

When reviewing a child with potential bowel obstruction, ensure that the anus is present and patent as an anorectal malformation may have been missed at birth. Ensure that a there is no irreducible inguinal hernia present. Always pass a nasogastric tube to check oesophageal continuity and to decompress the stomach.

Fig. 28.3 Neonate with perforation showing free intra-abdominal gas

It is beyond the scope of this chapter to discuss these conditions in detail. If a situation arises where there is limited expertise on the subject, a safe quick laparotomy and defunctioning stoma of dilated bowel are indicated. A right upper quadrant incision will generally give adequate access to all quadrants to locate the disease. Bringing up a loop or divided stoma in the most distal dilated bowel usually enables decompression, early feeding, growth, and subsequent planned repair in the future. The stoma can be formed in the usual fashion as in adult surgery with absorbable fascial sutures to secure the stoma and to create the spout to the skin. If skilled in the evaluation and management of neonatal bowel conditions then primary anastomosis can be performed. In those with Hirschsprung's disease, a defunctioning stoma should be formed unless the surgeon is skilled in definitive management.

In oesophageal atresia with a distal fistula the most important management step is to divide the tracheoesophageal fistula, as without doing this, gastric distension and subsequent perforation may occur, as well as ongoing soiling of the lung with gastric secretions. Division of the fistula tract is achieved via a right posterolateral thoracotomy approach. Ligation of the fistula involves absorbable sutures ensuring an airtight closure.

In congenital diaphragmatic hernia, the most important management step is the stabilisation of the cardiorespiratory function related to the hypoplastic lung, rather than emergency surgery. This may take many days to achieve in a neonatal unit, and early surgical intervention will not make a difference.

Gastroschisis requires emergency reduction of the bowel with either primary closure or delayed closure after placement in a silo. Prior to this, the bowel can be cocooned and an option is to place it in plastic kitchen film. This aims to reduce fluid and temperature loss, both of which may kill the baby. Ensure hydration is ongoing. Sutureless closure can be achieved with minimal analgesia and without intubation by using the umbilical cord as a biological dressing over the reduced defect. Secure the cord with steristrips and secure dressing. The defect is usually healed within 2 weeks. Alternatively, primary surgical closure under anaesthetic can be performed. Silos are used when the bowel is unable to be reduced either due to bowel quality, or inadequate intra-abdominal space. Silos can be formed from IV bags and sutured to the defect. The bag is then held vertically by ties. Gradual reduction over the course of the next few days using sequential ties on the bag in addition to gravity reduction is followed by surgical closure of the defect.

28.11 Pyloric Stenosis

This does not require an emergency operation. The hypochloraemic hypokalaemic metabolic alkalosis should be corrected first to reduce the chance of anaesthetic (respiratory and cardiac) compromise. Once normalised, the baby can be scheduled for a pyloromyotomy.

28.12 Abdominal Access

The rationale for a transverse laparotomy incision in children is related to the difference in abdominal proportions. A neonate has a relatively longer transverse diameter compared to adults, and hence the evaluation of all quadrants of the abdomen is easier via the transverse upper abdominal incision. This changes with age, and in reality, there is no significant difference above approximately 1 year of age. In neonates, this can be a transverse upper right to midline incision, whilst in older children use the more traditional midline incision because some of these children will require adhesiolysis as an adult, for which they will get a longitudinal incision by an adult surgeon.

Part V

Global Surgery

Model for a Training Partnership in General Surgery

29

Francesco Piscioneri

Specialist training in general surgery requires a reliable training infrastructure and dedicated training personnel. It takes many years to develop this level of expertise.

Where a training programme is required and the infrastructure is not yet developed, a partnership can facilitate a fast track approach to training.

The partnership relies on co-ownership of the process between all parties. Below is a proposed model.

29.1 Establishing the Need

The recipient country is able to identify an area of training that it wants to develop and create a sustainable infrastructure for the future. A local group helps define the need and establish partnerships to help fulfil the requirements. This group becomes the champions of the programme and usually includes local professionals and government representatives. There is often involvement of a local community organisation who are useful at providing community support for the programme. This may include such things as accommodation and transport for visiting training personnel.

29.2 International Partner

There are many surgeons around the world who are keen to share their expertise but not able to make a long-term commitment. They are however able to provide short-term (3–4 weeks) in-country assistance on a regular basis. The basis of a training programme can be started where a group of these trainers can be coordinated to

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make the most of their varied expertise. Most of these people do not require a salary for their time; however, most of the in-country expenses would have to be met by the recipient organisation.

29.3 Project Ownership

In order to reduce risks of failure, the project is best owned and managed by a committee or group that covers both the recipients and the trainers. This committee then becomes independent of individuals and can focus on the agreed outcome.

29.4 Model of Training

There are now well-established university-based training models for surgical training. Most of these come under the banner of Master of Medicine (General Surgery). This is usually a 4-year course of on-site training with an academic component and an exit exam. The degree is awarded by the local university in accordance with their rules and regulations.

29.5 Memorandum of Understanding

It is important that a memorandum of understanding (MOU) be created between the parties as to help define the roles and responsibilities of each party.

These include such things as:

- Medical registration and indemnification
- Responsibilities of the trainers which include service work, training, and reporting
- The responsibilities of the degree of awarding institution and how it will supervise and monitor the training
- In-country facilities for visiting trainers
- Scope and opportunities for short training courses both in the recipient country and in the trainer country
- Recognition that the purpose of the programme is a transfer of skills and building relationships

29.6 Funding

As the trainers will be coming for short periods of time the expectation is that there will be no request for salaries. It is important that additional costs are met by the supervising training committee and its sponsors. These include accommodation, daily living allowance, and where applicable airfares.

29.7 Sustainability

The training committee represents all parties involved in the programme. This is essential for sustainability. There should be less reliance on individuals.

This programme allows relationships to develop and long-term support consolidated.

29.8 Long-term Outcomes

A surgical training programme is developed and established in-country with good support and is designed for local needs.

Other programmes can then be developed using the same basic approach. These can be in surgery and in other disciplines.

Support staff such as theatre nurses, physiotherapists, laboratory staff, and technicians can also be included in short-term training workshops to gain specific skills.

29.9 Summary

An international partnership has great benefits for all parties involved. By giving ownership to the participants in this partnership the long-term sustainability is ensured.