Chapter

Postoperative Follow-Up and Recovery after Abdominal Surgery

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Abstract

Postoperative patient care has several components: - surveillance, – prevention of complications associated with surgical disease or other preexisting comorbidities, – specific postoperative treatment of the surgical disease and its complications. While these distinctions are purely didactic, the postoperative care merges into an active surveillance with a higher level of standardization than it would seem at first glance. Computing, interpreting and integrating signs and symptoms with active search of proofs by lab tests or other paraclinical explorations highly depends on skills and dedication of the entire healthcare team. Those attributes gained through continuous theoretical preparation but validated by current practice bring added value, always in favor of the patients' best interests. In this chapter, we propose to explore the main clinical and paraclinical means and tools that can improve the outcomes of surgical procedures for a faster and safer recovery. We will also discuss the need for different types of surgical bed drains placement and their management, the use of antibiotics and thrombotic event prophylaxis.

Keywords: postoperative, follow-up, surgery, complication, prophylaxis, treatment

1. Introduction

The surgical act, defined as the time that a surgeon effectively operates on the patient, remains the center of surgical therapy, however, it is increasingly clear that the preoperative and more importantly the postoperative care can enhance or unfortunately compromise the results of a technically successful surgery. For reducing the mortality and morbidity rates in the postoperative period, it is crucial to identify risk factors, prevent and treat as soon as possible any deviation of the patient state from the normal rehabilitation course. Timely interventions reduce the impact of the negative events in the patient's recovery. Early recognition of signs and symptoms by close surveillance is the key and starting point for active surveillance. This allows targeted lab testing or imaging (if needed) to rapidly identify any undesired event in patient recovery and allow for specific and proper action.

2. Fever

To monitor the operated patient, we have at our disposal the clinical and paraclinical parameters. The patient's **temperature,** despite being a general and non-specific parameter, is one of the most important and easy to monitor.

During the follow-up period of the surgical patient, the temperature is usually measured at least twice a day, in the morning and in the afternoon, and whenever there is a suspicion of fever. The determinations are included in the observation sheet completing the temperature graph whose oscillations become suggestive in a clinical context. A single febrile rise, below 38 degrees Celsius can often be caused by the resorption of blood degradation products from the operative wound or secondary to the excessive maintenance of a drainage tube, without major pathological significance [1]. However, the persistence of the fever with the configuration of "saw teeth" on the thermal chart suggests the development of a septic process. The first to be checked is the surgical site, then the lung and urinary system, as these are the most frequent sites of infection after surgery. Particular attention should be paid to the occult causes of fever such as endocarditis, phlebitis, lamellar atelectasis that should be systematically searched for in the context of an unjustified febrile syndrome with an apparently good evolution in the operative site. In a large cohort study [2], the most common causes of fever development were stratified a few days after surgery. On the day of surgery, cardiac pathology and specific myocardial infarction seem to be the most common, then pulmonary pathology – pneumonia and atelectasis seem to cause fever in days 1–3 postoperatively. Urinary infections usually occur in 2–3 days postoperatively but can also begin later. From day 4 to 30 postoperatively, superficial or profound surgical site infections become the main cause for fever development, while thrombosis can cause fever at any time between the day of surgery and postoperative day 30. When the febrile ascension appears suddenly on the fifth day after surgery, without signs of wound infection anastomosis dehiscence should be suspected, however, it can also be caused by thrombophlebitis. Therefore, we can conclude that fever is a general sign that should always be interpreted in accordance with other signs and symptoms but it is an alarming sign that should lead to careful and complete physical examination and laboratory tests or imaging studies evaluated on a case-by-case basis.

3. Supervision of the cardiovascular system

Cardiovascular system stability is crucial in the postoperative evolution of the patient. Complex surveillance is needed in many cases and the rehabilitation measures must be intensive and prompt, conducted in most cases by the intensive care specialist or cardiologist. However, the surgeon must be prepared to recognize cardiac risks and main syndromes and even manage the patient until one of the above mentioned specialists are available.

Heart rate is systematically monitored several times a day. Immediately postoperatively, the pulse rate is usually higher than normal with a decreased amplitude, may be justified by intra operative blood loss, which may remain insignificant in the overall economy of the patient's healing, or by anesthetic drugs, the extent of surgical "aggressiveness", pain, etc. As these factors are progressively corrected, the heart rate should return to normal. Additional oxygen administration can help achieve a faster normal rate as it improves tissue oxygenation [3]. It is very important to compare the pulse frequency with the values noted preoperatively taking into account the patient's underlying pathology (thyroid, heart, etc.). The pulse with increasing frequency from one determination to another, with a small amplitude that becomes progressively filiform, associated with hypotension in a sweaty and pale patient, may be caused by a bleeding at the operating site (which is not always in the drain tube or in the container); this may require analysis of reoperation for hemostatic purposes. Tachycardia with low pulse amplitude and a decrease in blood pressure that occurs on days 4–6 postoperatively, may indicate a septic complication or

anastomosis dehiscence. On the other hand, bradycardia is however associated with increased cardiac, pulmonary, renal and pain-related morbidity at 3 and 5 days after surgery [4]. The discovery of arrhythmias whether extrasystolic or atrial fibrillation as a new event, requires rapid correction of ionic and hydric imbalances and the search for a septic process, the most likely causes in this context. Both bradycardia and arrythmias always require a postoperative cardiac consult [4, 5].

Blood pressure is determined at least twice a day. The recorded values are interpreted in a dynamic clinical context, always compared with the normal values of the patient determined preoperatively. Low blood pressure levels can be found immediately postoperatively, in conditions of shock, dehydration, bleeding or heart failure, etc. All these causes of low blood pressure require immediate and accurate diagnosis and correction as they bring increased mortality [6]. Elevated blood pressure levels occur especially in patients with a history of hypertension in the context of an exaggerated postoperative catecholamine reaction, fluid overload or inadequate pain control. When they exceed certain values, beyond physiological variations, both increases and decreases in blood pressure values must be promptly corrected to prevent cerebral or cardiac events or ischemia of a recent anastomosis [7, 8]. Due to the high complexity of the measures required, it is recommended that an unstable cardiovascular patient be transferred to the intensive care unit and evaluated by a cardiologist [8].

4. Respiratory surveillance and care

The quality of respiratory function has a major impact on the patient's postoperative recovery, especially after major surgery. Immediately postoperatively, the anesthetist cleans the oropharyngeal and orotracheal cavities by suction to evacuate excessive secretions; this should be done easily so as not to increase or trigger local inflammation and spasm. Additional oxygen administration (via facemask or nasal tube) is recommended to reduce the effort of the respiratory muscles. In patients with ventilatory deficit, a high back position of 30–40 degrees can be adopted [9]; this improves respiratory dynamics and promotes the drainage of secretions [10]. For this purpose, back percussion is usually performed several times a day with the patient in sitting position, followed by respiratory toilet. The patient is encouraged to take deep breaths in order to relax and open the alveolar spaces thus reducing the ventilation "dead spaces" [9–11]. Under conditions of tracheobronchial fluid overload with excessive secretions, expectorants and mucolytics may be administered [12]; this improves drainage and reduces the effort of coughing. In such conditions, the patient is encouraged to cough in a controlled and effective manner, with the protection of the abdomen [13] (the most common site of surgery) either by gentle external pressure exerted by patient, doctor or nurse (as appropriate), or by using means of abdominal restraint like girdles. Prolonged, inefficient coughing may result in undue strain and tension on the surgical wounds, increasing the risk of evisceration or eventration. Aerosol solutions can be very useful [14] administered 2–3 times a day by nebulization for 5–10 minutes helps to "dry" or "thin" of the secretions as needed. It should be noted that postoperative pneumonia is one of the most common causes of significant morbidity and mortality after major surgery [9–11]. Prophylactic or therapeutic antibiotic therapy may not protect the patient from such a complication if excessive secretions remain undrained in the tracheobronchial tree [15]. The impact of a deficient oxygenation is systemic [16, 17], manifested at the level of the operative site (with the hypooxygenation of an anastomosis for example), at the cardiac level (decompensation of an ischemic heart disease), cerebral, etc. However supplemental oxygen should not be

administered on a regular basis, but only when the oximetry drops under 90–92%, due to secondary risks of hyperoxia [18, 19]. The presence of prolonged, productive cough, especially when associated with fever and altered general condition, becomes an indication for a chest X-ray in order to capture changes responsible for the occurrence of this symptomatology and take appropriate measures [20, 21]. In this context, the findings suggest that pneumonia is a strong indication for antibiotic therapy. Irritant cough associated with sore throat and hoarseness, reported by the patient, are elements that draw attention to a digestive reflux with secondary aspiration in the airways and glottis irritation. The situation is not unusual in conditions of prolonged postoperative intestinal paresis. In such cases, the first goal is to combat gastric stasis and hyper pressure and the most rapid way is by placing a nasogastric decompression tube. If we already have a nasogastric tube in position, we need to ensure its permanent patency because the tube can be obstructed with cloths, fibrin deposits partially digested food or gastric mucosa. Otherwise, the tube becomes a reflux promoting factor by keeping the cardia open and incompetent [22]. Concurrently adopting a semi-sitting position (maintained also during sleep) to prevent or reduce reflux is an extremely useful element in combating Mendelson's syndrome (aspiration of the digestive fluid with acid content in the patient airways).

5. Surveillance of the excretory system

It is usually done by tracking the quantity and quality of urine output over a given time and more importantly in 24 hours. All patients undergoing medium and major abdominal surgery usually have a urinary catheter placed under anesthesia [23]. Catheter placement should be performed under sterile conditions, usually in preanesthetic room or on-table [24] to avoid infection, bladder injury during surgery, and to accurately monitor renal function during surgery. There are numerous causes of acute kidney injury or otherwise low urine output in the perioperative period, the risk being reported up to 5–10% in surgical patients [25]. In the immediate postoperative setting, low flow and concentrated urine indicate a good renal function but poor hydration of the patient or a state of shock due to blood loss or impaired cardiovascular function. Decreased urinary flow that occurs under conditions of proper hydration and previously normal renal function may be an indicator of fluid retention in the setting of third spacing, abdominal compartment syndrome or blood transfusions adverse reactions [10, 25]. If this event occurs within 4 to 6 days postoperatively, it is usually secondary to the development of fistular or suppurative complications at the site of surgery, alerting the surgeon and allowing a prompt diagnosis of the complication. Failure to recognize the causes and the attempt to obtain adequate diuresis can lead to overloading the patient with fluids; this impairs the function of all the systems up to acute pulmonary edema or cardiac decompensation by increased preload.

Hyperchromic urine also occurs in conditions of mechanical jaundice when the urine turns intensely yellow to brown due to the renal elimination of soluble bile pigments [26]. The presence of large amounts of urobilinogen in urine usually indicates the hemolytic or hepatocellular nature of jaundice. Hematuria is the evacuation of blood into the urine. Bleeding can be located at any level of the urinary tract from the kidneys to the urethra and usually denotes an intraoperative lesion or clotting disorder. Hematuria can be microscopic and constantly appears after pelvic or retroperitoneal surgery [27] or macroscopic - when the red color of the urine is obvious, sometimes with deposits and blood clots to the point of obvious blood (Gross hematuria). Usually, hematuria caused by minor intraoperative

lesions or produced at the placement of the urethro-bladder catheter is self-limiting. Persistent hematuria requires a complete specialist diagnosis. Hemoglobinuria defines hyperchromic urine, purple to dark brown that occurs during major hemolysis after transfusion accidents [28]. Early recognition is extremely important because if undiagnosed and subsequently untreated, it can precipitate acute irreversible renal failure by blocking glomerular filtration.

The proper timing of catheter removal is debatable, numerous studies and metanalyses have addressed this question as the risk of urinary infections increases with the duration of catheterization. For abdominal surgery that does not involve the genitourinary systems or pelvic surgery it seems that the optimal timing of catheter removal is the first postoperative day [29] which in most cases coincides with the time when the patient becomes ambulatory. However, for major surgery (extensive dissection, usually for cancer) involving the pelvic organs or requiring a longer period of immobilization, the catheterization period can be extended to 3–6 days or even longer, adapted to the clinical needs [29]. For instance, whenever the bladder is sutured (after iatrogenic lesions or deliberated partial resection) the urinary catheter should be left in place for at least 10–14 days.

6. Digestive system surveillance

The digestive system is the most common surgical site in general surgery, hence the special attention paid to its care. Systematic clinical examination can provide valuable information about the patient's progress, adapting postoperative measures for an eventless and rapid recovery.

Usually forgotten or neglected, oral cavity inspection provides information about the patient's hydration level; dry oral mucosa, for instance, requires an increase in fluid intake. The presence of whitish deposits on the lingual mucosa may suggest candidiasis infection caused by prolonged antibiotic use, while red depapillated glossy mucosa suggests iron deficiency. Toileting of the oral cavity by brushing and washing with antiseptic solutions is almost as important as postoperative wound care, as germs ingested at this level colonize and contaminate the lower levels of the digestive tract accentuating dysmicrobism and promoting complications. Moreover, pathogens in the oral cavity can colonize the lung and lead to postoperative pneumonia with increased morbidity and mortality [30]. Until the patient is able to exercise basic hygiene, the task must be performed systematically by the medical personnel.

Pain therapy. Pain is one of the main factors that can delay the recovery of the operated patient. Pain delays the patient's mobilization, limits the range of motion of the diaphragm, delays the resumption of intestinal transit, and psychologically stresses the patient. Postoperative pain therapy begins during surgery, avoiding excessive traction, tension in the sutures or unjustified extensive dissections outside anatomic planes. From this point of view, laparoscopic surgery and generally mini-invasive surgery, whenever possible, brings major advantages. Also, a very important role in combating pain is the positioning of the patient in bed after surgery. The patient should be positioned as comfortably as possible, avoiding tension on the muscles around the incision areas. The movement of the patient in bed after surgery should not be forbidden; on the contrary the patient should be encouraged to adopt the position in which the pain is minimal and to change his/her position periodically. Beds with semi-rigid elastic mattresses are preferable, which can provide the patient with effective support to achieve active movements and which evenly distribute the patient's weight.

The abdomen should be examined at least twice a day. In the first 24 hours after surgery, the patient may complain of low to moderate pain in the abdomen, accentuated by active movements or coughing. The pain must be combated accordingly, in order to avoid the development of the "fear" of mobilization. Pain therapy must be adjusted to the extent of surgery and known mechanisms of pain. Multimodal postoperative analgesia appears to provide better outcomes [31]. Usually, the combination of acetaminophen with a non-steroidal anti-inflammatory drug is sufficient for most patients, but in some cases, local analgesia [32], or even patient-controlled epidural analgesia may be needed. In case of prolonged use of non-steroidal anti-inflammatory drugs (NSAID), prophylaxis of gastroduodenal disorders like erosions, hemorrhage or ulcers should be considered, especially if the patient's oral feeding has been temporarily suspended. In those cases, proton pump inhibitors and E-prostaglandin analogs seem to be the most effective, then the histamine receptors antagonists, while barrier agents are mostly useless since they do not interfere with the pathogeny of NSAID-induced ulcer. However, proton pump inhibitors are to be diverted in patients with a current or recent history of antibiotherapy, since the two conditions act synergically favouring severe *Clostridium difficile* colitis [33]. The use of major opioid analgesics is not indicated because it contributes to the accentuation of intestinal paresis and favors the accumulation of tracheobronchial secretions [34]. There are combinations of painkillers (analgesics) that combine a non-steroidal anti-inflammatory and an opioid in low concentrations where the side effects are absent or negligible. In the context of intense pain that does not yield to milder painkillers, it is recommended to place an epidural catheter to ensure the effective analgesia administration with minimal effects on the intestinal smooth muscles [35, 36].

The inspection of the abdomen helps in monitoring the degree of distension of the abdomen due to the accumulation of gases and fluids in the digestive tract lumen. This condition is mainly caused by the absence of peristalsis but also by the change of microbiome. Postoperative paresis, present after interventions involving or exposing the intestinal loops, must be actively prevented. Prevention can and should begin in the preoperative period and continue in the operating room and beyond. The very important measures are related to the optimum hydration and correction of the electrolyte imbalances. Because - Enhanced Recovery After Surgery - (ERAS) protocols have been progressively adopted, the patient is usually advised to avoid starving in the preoperative period and to have a light liquid diet in the evening, before scheduled operation. Clear fluid diet is allowed up to 2 hours preoperatively [37]. Specific medications – prokinetics - like anticholinesterases and parasympathomimetics may be prescribed in order to stimulate peristalsis [38]. Neostigmine, a synthetic anticholinesterase alkaloid, stimulates intestinal peristalsis with less extensive side effects on the cardiovascular and respiratory systems [39]. Local-acting intestinal peristaltic stimulants, such as castor oil may be administered orally or introduced through the nasogastric tube (NGT). Prolonged paresis requires the placement of an NG-tube for decompression of the digestive tract, prevention of vomiting and airway aspiration or Mendelson's syndrome. We do not usually use nasogastric decompression tube, but only in emergency surgery and just in cases associated with high fluid and gas distension or in cases with expected prolonged ileus [40].

Various methods of reducing postoperative ileus have been studied. It seems that something as simple as abdominal massage after colonic surgery can reduce the postoperative pain and help resume intestinal transit [41]. Similarly, numerous studies including a metanalysis advocate for the use of chewing gum in order to reduce the ileus period [42] but the results have been contradicted by other studies [43]. Chewing gum is adopted by the Enhanced Recovery After Surgery (ERAS) protocols as a measure that could reduce ileus [37]; we recommend its selective use whenever applicable.

Commonly used opioids such as morphine and fentanyl can prolong the postoperative ileus, by acting like agonists on mu receptors; it is recommended to reduce their use at least in the postoperative settings. In contrast, some kappa agonists like fedotozine U-50, 488H, bremazocine or asimadoline appear to reduce ileus in animal models studies but have never entered clinical practice [44, 45].

For the lower digestive tract surgery, the placement of a transanal gas tube may be used, in order to evacuate the increased pressures that may develop at this level [46]. The procedure is safe and very effective especially in low rectal anastomosis [47]. The transanal tube (TAT), usually 28–30 CH (Charrierre), is placed at the end of the procedure foiled in greased gauze and is primarily used for intraoperative leakage test. The tube is usually left in place for 48 hours or more, accordingly to the patient evolution. The TAT seems to reduce anastomotic leakage (AL), the need for re-interventions for AL, and it is proposed by some authors for the reduction of defunctioning stoma [48]. After interventions that do not involve the colon, an evacuation enema may be performed at 2–3 days postoperatively; this reduces stasis and microbial load at this level, and stimulate the resumption of normal peristalsis.

Close patient surveillance with abdominal palpation is required in order to take and adapt the appropriate postoperative measures. Palpation aims to detect possible areas of deep tenderness and infiltration in the abdomen, painful areas in which any discrete signs of peritoneal irritation draw attention to the occurrence of a complication. The jerky palpation may show flapping, a sign with great specificity for postoperative occlusive syndrome, especially when the patient has initially resumed intestinal transit. Percussion highlights diffuse tympanism during intestinal paresis, while persistent localized hypersonority in an area after hesitant resumption of intestinal transit may draw attention to a complication that may have developed at this level. Auscultating the abdomen can reveal a silent abdomen during the paretic period or vice versa- vivid noises, accompanied by whistling and crackling, an expression of the "struggle" of a loop to overcome a distal obstacle/obstruction. Anastomotic leakage is the most feared complication because it comes with significant morbidity and mortality in short but also in long term [49]. The earlier the recognition of an anastomotic leakage the better and prompter measures can be taken in order to limit or avoid major morbidity [50]. Postoperative peritonitis following an anastomotic leakage usually develops quietly and may remain undetected since the patient is on pain-killers and the peritoneal surface is less reactive after surgical aggression. CT scan can be falsely negative for anastomotic leakage in fairly large number of cases, therefore, in such cases, it is advisable to take action on first clinical signs of peritonism [51]. Measures may include various combinations of relaparotomy, percutaneous drainage, postoperative wound opening, antibiotics and complete parenteral nutrition. Earlier detection of the underlying pathology result in prompt intervention and therefore better outcomes [52]. In cases of diffuse peritonitis, relaparotomy is mandatory to remove the peritoneal contamination and try to gain control of its source. There is no ideal solution for controlling anastomotic leakage. In some cases, re-resection and anastomotic reconstruction can be an option depending on the local and general conditions. In some cases, the anastomosis may be suppressed, followed by closure of the distal end, while the proximal partner is exteriorized in a stoma. This seems to be the safest approach but it is not always feasible. In other cases, perianastomotic drainage might be enough [53], but usually a proximal diverting stoma is advisable in addition to local drainage. The decision is highly dependent on the surgeon's experience who should always thoroughly evaluate the local and general condition of the patient; it also depends on ICU level, and the local feasibility of endoscopic stenting, interventional radiology, and other interventions.

Some cases may be managed conservatively with the main purpose being to transform the leak into an isolated enterocutaneous fistula [53]. Adequate drainage of the leak results in reduction of the general and local signs of sepsis and inflammation with resuming of intestinal transit, tolerance to dietary intake and improvement of the general condition of the patient. The use of a low-pressure drainage system [54] can help organize the fistular tract, avoiding extensive contamination or digestion (by the activated intestinal enzymes) of neighboring tissues. For the success of this method, we need to ensure that the lumen of the tube remains patent and the surrounding tissues are not being sucked into the holes of the draining tube. The normal evolution of the fistula is with progressive reduction of the flow (which must be noted every 24 hours). In 5–7 days after fistular organization (clinically documented and by contrast enhanced imaging) and the reduction of the flow, we can progressively mobilize the drain by 2 cm every 2–3 days. This allows the tissues to collapse and close the fistula. Sudden reduction of a fistula flow or the early and fast suppression (in a single gesture, not progressively mobilized) of a tube that drains the leak, can result in local abscess formation or even peritonitis. Usually, the fistula closes in 2–3 weeks for the colon and 1–3 month for the small bowel but the time is variable depending on the various factors like type of surgery, age, general performance status, nutrition, level of anastomosis and partners of anastomosis quality [55], but most importantly dependent on the functional status of the bowel. If there are no anatomic (adherences or strictures for instance) or functional obstacles (residual abscess, Crohn disease, etc.) distally, the fistula closure will be faster. Insufficient drainage of the fistula or abdominal sepsis will result in persistence of local inflammation with secondary impairment of the peristaltic movements, creating a vicious circle that will delay fistula closure.

7. Postoperative wound surveillance

The postoperative wound should be closely monitored on daily basis. In the immediate postoperative period, a sterile dressing covers the wound so we may not be able to directly inspect the sutures. In the first postoperative hours soaking of the dressing [56] with blood is the main sign to look for. The presence of the blood prompts the physician to look for a source of bleeding at the superficial or deeper level and perform adequate hemostasis. In most cases, it is a low-flow bleeding from a dermal vessel that can be controlled by as simple as a local pressure dressing, placing a mesh with hydrogen peroxide, fibrin glue, or a supplementary stitch under local analgesia. This may also have psychological consequences on the patient since the psychological impact of the presence of blood in sight of the patient may induce a state of anxiety and agitation. For deeper bleedings that tend to form hematomas between the wound layers or margins, the evacuation of cloths is mandatory otherwise impairing wound healing. We should not forget that digestive surgery is a contaminated one, because of the breach of gut mucosa, and that blood is the ideal culture medium for bacteria. Therefore, leaving a dead space filled with a hematoma between the margins of the postoperative wound is equivalent with initiating a germ culture. Left in place, in the following days, the cloth will become a more or less profound abscess. At this moment, even if we drain it, the damage has happened already, and short-term morbidity as well as long-term (such as incisional hernia) increase. In order to avoid those unfavorable outcomes, the most appropriate action seems to be the immediate opening of the postoperative wound, (more or less extensive, but usually 2–4 stitches in the area of the bleeding), evacuating the hematoma under sterile conditions, lavage of the wound with antiseptic solutions, targeted hemostasis and primary closure. If there is doubt on definitive hemostasis

or sterility conditions the wound can be left open, covered with sterile dressing until granulation is obtained and secondary superficial suture can be accomplished.

Sometimes under the blood-soaked dressing, we may find a diffuse bleeding, accompanied by an ecchymotic aspect of the wound edges aspects that usually indicates poor coagulation. In this context, we must not forget that the superficial operative wound is a mirror of what is happening in depth, in the operative site, and the general measures for restoring the coagulation balance must be prompt and vigorous. Of course, an ecchymosis of the postoperative wound may seem a benign and maybe minor to negligible complication requiring no action or simply a bag of ice, but if the same happens at the level of the anastomosis deep in the abdomen, anastomotic leakage becomes plausible. In this context, we immediately adjust the anticoagulation treatment, postponing or even skipping a dose until we further investigate coagulation status of the patient. As long as the anticoagulation therapy is suspended, it is advisable to use alternative methods to prevent DVT in lower limbs such as intermittent compressive therapy [57, 58] or at least compressive stockings.

In the following days, the normal surgical wound is usually uncovered, "in plain sight" or "exposed to the air". There is no reason for covering with sterile dressing since the wound is already sealed by the fibrin that is organized between the two edges. Usually, this normal wound sealing process takes 24–48 hr. in clean or clean-contaminated wounds. Even if there is no strong evidence or consensus [54, 56] on how long we should keep a sterile dressing, our current practice is to avoid dressing after 48 hr. The zonal erythema of the wound accompanied by a localized swelling, possibly centered on a slightly ecchymotic area, suggests the development of the suppurative complication. In this context, the wound must be explored with a stylus or a fine forceps inserted relatively easily in the respective area. The evacuation of a seroma or hematoma that has already turned purulent will prompt the removal of several stitches, with wide opening of the wound, followed by mechanical and antiseptic debridement [56]. Insufficient opening of the wound without adequate drainage will perpetuate the infection and allow the infection to spread to new spaces in the vicinity of the wound. In such instances a superficial infection can become profound and healing may be delayed and deficient, with wound granulomas, postoperative incisional hernias or even eviscerations. Of course, in extensive surgical site infections, local measures must be accompanied by systemic antibiotic therapy, initially with large spectrum according to the most plausible germs and then targeted when culture results become available [10, 56].

8. Postoperative drainage monitoring

Drainage is one of the fundamental means of treatment and prophylaxis in general surgery. Intraoperatively, drainage can be established in various areas of the peritoneal or pleural cavity (in the case of interventions involving the opening of the pleura), at the level of segments of the digestive tract (stomach, intestine, bile ducts) or in remaining cavities following the evacuation of pathological processes (abscesses, hydatid cysts, on the soft parts after evacuation of abscesses, hematomas, tumors, etc.).

8.1 Drainages of the peritoneal cavity

They are usually placed after medium or major and contaminated abdominal surgical interventions that open the peritoneum. That said, there is no consensus in the literature around the need for drain(s) placement after abdominal surgeries [59–61]. It is advisable to use drains only when and where they are justified. Drains are then removed in due time after they have served their purposes [62].

In the first hours after surgery, peritoneal drains usually produce small amounts of serosanguinous fluid. Pure blood drainage usually indicates a hemostasis defect that can be minor in small vessels, often secondary to clotting disorders, or major by slipping of ligatures placed on relatively large vessels. Under these conditions, it is extremely important that the drainage be interpreted in the clinical context of the patient, the association with a hemodynamic instability raising the problem of an immediate reintervention to complete the hemostasis. It is advisable to check the condition of the drain tube and especially its permeability frequently, as it can be clogged with clotted blood [63]. In this case, the tube remains unproductive, "hidden" under a clean dressing on the surface, thus providing a false sense of surgical reassurance. Unclogging of the drain tube leads to the resumption of blood flow. If the hemorrhage is still active, the drainage will be with reddish coagulable blood, drop by drop, and will be a strong indication for relaparotomy or laparoscopy [64]. In some cases, not uncommonly, the source of bleeding can be identified in the parietal trajectory of the drainage tube that intercepted a more or less important blood vessel. Local anesthesia and targeted hemostasis can save the patient from an unnecessary laparotomy. Sometimes the drainage resumes with blackish, incoagulable blood, mixed with small partially lysed cloths. This aspect of drainage, which usually persists for several days, sometimes up to weeks, indicates the progressive evacuation of a clot or a large hematoma. Particular attention must be paid in these situations to dressing maneuvers as they can lead to germ contamination and the transformation of the hematoma into an abscess.

The normal evolution of the drainage in the following days is towards the diminution and progressive clearing up. This is the optimal moment to remove the drain. When the drainage is supposed to "protect" an anastomosis we remove the tube after 5–7 days, once the anastomosis has passed the critical period and the intestinal transit is resumed [60]. The tube does not prevent anastomotic dehiscence but may avoid relaparotomy to control an anastomotic dehiscence. If the drainage is to be maintained for a longer period, it is recommended to mobilize the tubes after several days, with their dislocation from the fibrin deposits that form around, a condition for the drainage to remain effective and to prevent pressure lesions that the tube can determine on certain structures such veins, nerves, ureters, etc.

Persistence of significant drainage, over 500 mL/24 hr. (sometimes 3 L/24 hr), with serous fluid, denotes ascites production, secondary to an advanced malignancy (ovarian, peritoneal or massive hepatic metastases), liver cirrhosis or associated hypoproteinemia. Most often these conditions are suspected based on preoperative work-up and then well-documented by the intraoperative exploration. Few recent studies advise to avoid drainage in cirrhotic patients after abdominal surgery [65, 66]. If drainage is necessary, the same studies recommend discontinuing them as soon as possible. When suppressing the drain tube in these cases, a parietal restraint suture is often required to control the discharge of ascites that will otherwise persist through the parietal path of the tube. However, surgical suture dehiscence is frequent in such patients accounting between 20 and 45% [66], forced by the pressure exerted by the fluid and favored by hypoproteinemia and dysmetabolism. In those patients, we use a controlled-flow drainage tube or an abdominal decompression catheter left intraperitoneally until the wound is well healed and/or ascites production is therapeutically reduced. This management allow a controlled drainage of the ascites, in a closed system avoiding the infectious risk. Otherwise, if the tube is removed too early, intraabdominal pressure of the ascitic fluid will force the wound dehiscence and will leak uncontrollably.

After interventions involving an extended lymph node dissection, the initial drainage with serosanguinous appearance becomes sero-citrine after 2–3 days, but persistent, sometimes at flows between 50 and 300 ml / 24 h, consisting of lymph

fluid rich in protein. Since there is not a consensus [67] our practice is to keep the tube in position until a significant decrease in the amount drained, otherwise there is a risk of developing lymphatic collections [68] (lymphocele), which can become secondarily infected.

Under the conditions of perianastomotic drainage, the resumption of a bloody drainage, cherry colored with low flow, sometimes gray to frank purulent with specific odor, associated or following a febrile episode is most often the sign of the onset of an anastomotic fistula. This moment usually coincides with the recurrence of the intestinal paresis, the alteration of the general condition of the patient, the increase of the digestive aspirate or vomiting. Muscle guarding may be present but the specific contracture of peritonitis is most often missing. Postoperatively, most signs of peritonism are less pronounced [69], especially in the elderly patients. Abdominal examination usually reveals localized but difficult to delineate tenderness, accompanied by a local dull pain which is accentuated on palpation. Frequently associated is the suppuration of the surgical wound that must be monitored and opened as early and as wide as needed, a unique gesture that has the ability to limit the extensive evolution in depth. Over the next few days, digestive content according to the level at which the anastomosis was performed, will be evacuated on the drain tube or directly through the surgical wound. Under the conditions of a favorable evolution, the drainage tube will be the "splint" on which an entero-cutaneous fistula forms, the inflammation then gradually decreases, the patient becomes afebrile, resumes his intestinal transit, tolerates diet, and the abdominal signs gradually subside. The development of signs of generalized peritonitis with the persistence of fever and the progressive alteration of the general condition means an insufficient drainage of the anastomotic dehiscence defining a grade C leakage [70] and forces to reintervention. Prompt diagnosis is the key for better outcomes and in this respect the CT exam seems to offer the best diagnostic chances [69]. Either conservative or interventional management is applied, in such conditions addition of antibiotherapy in curative course and a non-steroidal anti-inflammatory drug is always necessary.

8.2 The drainages of some segments of the digestive tract

The drainages of some segments of the digestive tract are generally established intraoperatively and aim at achieving temporary decompression of the organs they drain (stomach, common bile duct, etc.) As mentioned, their main role is to evacuate the secretions accumulated in the conditions of postoperative paresis and fight against intraluminal hyper pressures. The most common form is represented by the upper digestive aspiration through a nasogastric tube (NGT), in which the probe inserted trans-nasally and is conducted intraoperatively at the level of the drained segment - esophagus, stomach, duodenum, small intestine. In general, the probe is placed in the conditions of performing anastomoses or sutures at the level of these segments having as main role the protection of the suture. (*anastomotic dehiscence prophylaxis role*). The quality and quantity of the digestive aspirate must be systematically monitored and interpreted in the context of the general and local examination of the abdomen (*diagnostic tool role*). Occasionally the tube can be used to administer medications, to perform lavage or even enteral nutrition (*therapeutic role*) [71]. Congruently with literature reviews we do not systematically use the nasogastric tube [72] but only in cases with stasis, intense paresis or expected impaired temporary deglutition.

The normal evolution of the aspirate is towards "clarification" and progressive decrease in the context of the resumption of the intestinal transit and the reduction of the abdominal distension, aspects that mark the optimal moment of NGT

suppression. The sudden decrease of the aspirate with the persistence or the accentuation of the distension denotes the clogging of the tube and the need to re-permeabilize it. It should not be forgotten that a significant amount of electrolytes is lost in the aspirated fluid, a loss that must be compensated by intravenous perfusion, correlated with the serum ionogram and the quality and quantity of the aspirate. Fluid loss through nasogastric tube must also be compensated by parenteral intake.

In some cases, the drainage of specific segments can be realized by tubes that are trans-parietally externalized, such as duodenostomies or jejunostomies. In the first 2–3 days postoperatively the main role of the tube is to decompress the bowel segments that they drain. The "prototype" for this use is lateral duodenostomy after total gastrectomy with "Roux en-Y" esojejunal anastomosis, in which the duodenum is partially excluded from digestive transit. After normal peristalsis resumption announced by the decreasing of the fluid output per tube over 24 hr., the drainage tube placed laterally in the duodenum can be used as a temporary feeding path [73] until the esojejunal anastomosis can support oral feeding. Although considered a "forgotten" method [73–75], the use of lateral duodenostomy gave us satisfaction (yet unpublished data), being the path that we use in order to achieve early enteral feeding, one of the main goals of ERAS protocol, especially in doubtful anastomosis or documented leakage.

External biliary drainage aims at decompressing the intra- and extrahepatic bile ducts after CBD exploration in the presence of a distal obstruction, or to obtain a controlled biliary fistula after major hydatid cyst resections or major hepatectomies [76]. The most common use is the "Kehr" drain with a "T" tube placed in the common bile duct (CBD) which will be suppressed in a controlled manner after resolving the distal obstruction or the proximal leakage. The indications for T tube decreased in the era of endoscopic retrograde colangio-pancreatography (ERCP), endoscopic drainage and stenting, etc. However, there are specific situations when the T tube remains a very good option. Usually the T tube is "guarded" by a subhepatic intraperitoneal drainage that in the first days after surgery will take over small amounts of bile that may leak around the T tube. In the following days the quantity and quality of bile drained by the T tube will be attentively monitored. Normal drainage should be clear bile with a flow of 3-400 ml/24 h and progressively decreasing. The persistence of a high flow clear yellow bile that sometimes can reach 1.5 l/day is a clear indication that the liver functions normally but the common bile duct is still obstructed. In those situations, the T tube becomes also a diagnostic tool, since it allows a rapid cholangiography that in most cases will clarify the diagnostic. Bile drainage containing floaters and deposits that persists for a few days raises the suspicions for intrahepatic acute cholangitis. In those cases, the T tube offers the possibility to collect seriated bile samples for bacteriology exam, culture and antibiogram, allowing thus a specific targeted antibiotherapy. In case that the drainage flow is low with a translucid uncolored fluid hepatic insufficiency should be suspected. Without becoming exhaustive in approaching an extremely complex subject, it should be mentioned that in conditions of abundant biliary drainage that persists for long periods, the imbalances induced in the body become major both by the complex loss of electrolytes, salts and bile acids but also by insufficient nutrient absorption from the digestive tract, generated by insufficient digestion. In such conditions, the reintroduction of the drained bile into the digestive tract by oral administration, via the naso-gastric tube or jejunostomy, should be considered especially in critical ill patients that do not support an internal diversion of the bile flow.

8.3 The drainage of residual cavities

The drainage of residual cavities after the evacuation of some pathological processes is generally a drainage with a long maintenance period (sometimes

1–2 month or more), time necessary for the repair processes to progressively reduce and eliminate the cavities (ex: infected hydatid cyst of the liver, pancreatic or peripancreatic abscess, etc.). The quality and quantity of drainage will be constantly monitored. Periodically the drain tube will be mobilized with dislocation of 1–2 cm in order to prevent its "anchoring" in the repair tissue, decubitus injuries on adjacent organs or structures, as well as to allow the progressive reduction of the depth of the cavity. If the drained process was a septic one, it is advisable to change periodically the drain tube since the germs tend to form biofilms on them. The profound tip of the drain will be sent for bacteriologic exam and cultures.

8.4 Drainage of the pleural cavity

Drainage of the pleural cavity is used after openings of the pleura, usually during esophageal interventions, a situation in which the drain is placed intraoperatively after re-expansion of the lung. The simplest drainage is with a transthoracic tube conducted in a half-loaded vessel with sterile saline solution, below the liquid level, to prevent pneumothorax. Mobile kits with unidirectional valves are available and considered better because they facilitate an easier and early mobilization of the patient. Normal drainage in the first days is serous, perhaps with a light serosanguinous color but with a low output, usually under 200 ml/24 h. Higher flows are reported after extended lymph node dissection (performed for esophageal carcinomas) or important bleeding [77]. The production of the bubbling phenomenon in the bottle usually denotes the existence of a "valve" through which air enters the pleural cavity - damage to the lung parenchyma or tracheobronchial-pleural fistula, another unrecognized pleural lesion (rupture), or lack of tightness of the drain tube in the parietal tract. If the intraoperative pleural lesions remain unrecognized, a situation sometimes encountered during at the esogastric junction interventions, especially in interventions for large hiatal hernias, postoperative dyspnea will require immediate clinical examination and chest X-ray which will evidence pneumothorax. In those cases, a pleural drain will be instituted under local analgesia. Pleural drainage will be removed when it becomes unproductive for gases and fluids and control X-ray will show normal pulmonary expansion, usually 5–10 days after surgery. During the removing maneuver the tube will be closed with a forceps and the parietal route will be closed with a suture and tight dressing for 24 h in order to avoid air aspiration in pleural cavity.

9. Postoperative nutrition

The postoperative diet should be strictly individualized. Current protocols recommend resuming oral feeding as early as possible [10, 37]. In conjunction with minimally invasive surgery, less aggressive anesthesia with reduced side effects, patient mobilization as early as possible, multimodal analgesia, all of which are part of the ERAS (enhanced recovery after surgery) protocol or fast track surgery.

Postoperatively, oral feeding is usually resumed progressively, starting with fluids, sometimes even from the day of surgery. Fluids can initially be administered in small amounts of "testing" of tolerance. The quantities of ingested fluids can then be increased even in the presence of the digestive tract high anastomosis [78]. In addition to the cleansing effect of the digestive tract, the dilution of toxic products and digestive enzymes, there is a proven trophic effect on the digestive mucosa, especially for glucose rich fluids, which strongly support this type of approach. The resumption of normal peristaltic and intestinal transit for gas usually marks the moment when we switch to a semi-solid diet based on vegetable purees,

cheese, eggs, etc., which gradually begin to bring protein capital to the organism. Meat based products are introduced in the diet usually 2–3 days postoperatively using easy to digest white meat like fish and poultry. In the immediate postoperative period we avoid uncooked food, especially raw fruits and vegetables since their fermentative potential and fiber content that make hem harder to digest and can cause distension. After transit resuming, a banana can be daily eaten for its potassium content and then small amounts of other fruits, but always taken during the meal.

Given that in some cases the enteral diet is impractical (ex: esophageal anastomosis dehiscence) the complex products of amino acids, lipids and vitamins will be added in parenteral nutrition. Because large amounts are required it is preferably to administer them on a central venous catheter. However, it should be noted that this type of nutrition can replace the normal oral diet only for a limited time. For patients who expect a long period of oral nutrition suspension, it is preferable to perform a feeding jejunostomy [79].

10. Postoperative antibiotic therapy

Postoperative antibiotic therapy is reserved for pathologies involving extensive infections, stray patients with major interventions involving prolonged septic time, soft tissue infections, associated urinary tract infections, infectious pneumonia or another well-documented infectious syndrome.

Prolonged postoperative "so-called prophylaxis" antibiotic therapy has no justification in another context [80]. It brings major disadvantages by selecting resistant bacteria, altering the normal intestinal flora, the strain of liver and/or kidney function. In localized infections as well as in wound suppurations, the healing process starts with the appropriate drainage and not the antibiotic therapy that will be useful but to limit extensive infections and prevent dissemination. In these situations, the antibiotic therapy will be initiated according to the clinical suspected pathogen and the bacteriological profile of the nosocomial infections in the respective service, and modified according to the antibiogram after culture results are available [56].

11. Prevention of deep vein thrombosis and pulmonary thromboembolism

To this end, anticoagulant therapy is usually started preoperatively with very broad indications for interventions exceeding 30 minutes, knowing that a large number of thrombotic events in the venous system of the lower limbs begin during surgery [81]. Fractionated (or low molecular weight - LMWH) heparins as well as low dose unfractioned heparin are currently used [82]. Anticoagulant therapy is continued postoperatively for several days after the patient's usual mobilization, sometimes up to 3 weeks depending on the risks. After this period, as appropriate, anticoagulant therapy with HGMM will be replaced with oral anticoagulants - acenocoumarin derivatives, novel oral anticoagulants (NOACs) or antiaggregants. For each aspects of the anticoagulation therapy (when to start, which type, what dose, for how long, etc.) there are numerous predictive scores and tables, mostly used being the PADUA Score [83] and the Caprini Score.

In at risk patients, the calves should be inspected and palpated at least once a day. Immobilized patients are encouraged to perform active exercises in bed until complete mobilization. The appearance of a seemingly unjustified swelling or leg pain, a discrete unilateral edema of the leg, sometimes with a positive Homans sign

(pain at the dorsiflexion of the foot) requires a Doppler ultrasound of the venous system of the lower limbs and the transition from prophylactic doses of anticoagulant to curative doses.

In patients with coagulation defects, with severe anemia (such as a gastrointestinal bleeding) often associated with coagulation disorders, in patients with unresectable gastrointestinal neoplasms, in polytraumatized patients with extensive hematomas at various levels or whenever heparin administration is considered risky, compressive therapy is recommended [84]. Compressive therapy can be passive, using pressure stockings, but desirable active using an intermittent compression system of the lower limbs, equipped with pneumatic cuffs that are progressively inflated and decompressed automatically, with computerized control of pressure and application times.

12. Prevention of bedsores and patient mobilization

The development of bedsores is an undesirable event that significantly influences the patient's recovery with increasing morbidity, hospitalization, medication consumption, time and resources. Elderly, deproteinized patients, diabetics, stroke patients, patients with urinary or fecal incontinence, patients with fractures or immobilized for a long time are susceptible to the development of bedsores [85]. Whenever we treat such patients, we must take into account those risk factors for an early application of bedsores prophylaxis. The most common areas affected by the development of bedsores are the sacral region, buttocks, trochanters and shoulder blades. Prophylaxis includes intermittent inflated mattresses that periodically change the pressure on the support areas, powdering of wet areas, passive mobilization for immobilized patients. They are passively transferred to alternative positions (left lateral decubitus, right lateral, dorsal, ventral) at the shortest possible time intervals (2–3 hours) after a schedule established and strictly observed. The pressure areas must be massaged to promote the opening of blood circulation in the area.

Postoperative mobilization as early as possible is an extremely important factor in the patient's recovery since it promotes the resumption of intestinal motility, reduces the risk of decubitus pneumonia and postoperative pneumonia by promoting normal respiratory dynamics, requires and stimulates the adaptation of the cardiovascular system, reduces the risk of deep vein thrombosis and thromboembolic events, prevents the appearance and development of bedsores. Thus, the patient must be passively mobilized on the edge of the bed from the first postoperative day and encouraged to repeat the maneuver several times during the day. The next day the patient will be accompanied for a few steps in the room and will later become independent at distances of 20–50 m. Of course, this mobilization program will have to be adapted to each case depending on the particularities (age, type of surgery, comorbidities, etc).

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