24 Bedside Laparoscopy in the Elderly and Frail Patient

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24.1 Definition and Rationale for Use

Laparoscopy performed at bedside is a valuable diagnostic tool that can be used safely and efficiently in the evaluation of intra-abdominal pathologies, especially in the frail patients admitted to the Intensive Care Unit, when conventional methods are equivoques or difficult to be performed.

Progress in critical care management, especially timely, aggressive resuscitation, has resulted in a subset of intensive care patients, dependent on a multitude of technical devices ranging from monitors, to ventilators, to medication dosimeters. These patients' courses can be complicated by unexpected new disease processes at any given moment, resulting in acute deterioration unless recognized and managed promptly and accurately. The abdomen is a notorious "black hole" for such unforeseen adverse events, such as septic foci, secondary perforations, hemorrhages, or missed injuries [1, 2].

The conventional diagnostic evaluation usually includes history/physical examination/serum investigations, plain film X-rays, ultrasonography (US), and computed tomography (CT), the latter requiring transport to the radiology suite. However, their application is sometimes frustrating for the following reasons:

1. History may bring suboptimal information in ICU patients from their impaired mental status due to metabolic encephalopathy, brain injury or pharmacologic sedation. Moreover, abdominal examination is often impaired because of different reasons, such as a possible spinal cord injury, a postoperative abdomen, and immunocompromised state which underlies a condition of frailty and hyporeactivity. Therefore, the physical exam is often unhelpful, aiding in diagnosis of only 43–69% of the time with intra-abdominal abscesses [3]. On the other hand, serum investigations can often be nonspecific in the critically ill subjects, with leukocytosis, renal impairment, and a lactic acidosis, all being relatively frequent but nonspecific findings.
2. In the absence of pneumo-peritoneum, plain film X-rays have limited utility and rarely drive the decision to operate.
3. While US of the abdomen has the advantage of portability, it is mostly utilized for the evaluation of the biliary tree, pleural space, cardiac dysfunction, free fluid in the abdomen, and hypovolemia, but is less useful in the frequent case of the presence of bowel gaseous

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distension and therefore it is limited as a diagnostic tool. It is also not likely to be diagnostic in cases of mesenteric ischemia. Diagnostic yield from US examination of the abdomen is also operator-dependent. For instant, in the traumatically injured patient, the sensitivity of US for detection of acalculous cholecystitis is only 30% [4].

4. Additionally, unlike plain film X-rays and US, CT requires transport that presents a risk for the hemodynamically unstable patient. Actually, most of these patients are hemodynamically labile requiring multiple vasopressors and escalating ventilatory support thereby imposing significant risks during patient transport for imaging or even to the operating room. Life-threatening complications during patient transport, including hypotension, respiratory distress, central line disconnections, and dysrhythmias are not uncommon and have been reported to occur in up to 45% of ICU patient transports [5]. Furthermore, though CT is an excellent diagnostic modality for intra-abdominal pathology, studies have shown limited utility in the critically ill patient: the accuracy of CT in critically ill patients varies between 78 and 89% and can be nonspecific in subtle cases of mesenteric ischemia of recent onset [6]. Its sensitivities is as low as 33–48% for detection of acalculous cholecystitis in the ICU population [7]. Moreover, in some studies, the average time to perform a bedside laparoscopy was less than that needed to obtain a CT scan [8].
5. Diagnostic peritoneal lavage (DPL) is used often to investigate suspected intra-abdominal pathology in patients too unstable for transport; however, DPL has a similar risk profile to diagnostic laparoscopy and does not provide definitive information [9].
6. Finally, the association between occult intra-abdominal infection and organ dysfunction has been deemed sufficiently strong enough to justify empiric laparotomy for the patient with progressive organ dysfunction but no defined focus of infection. However, exploratory laparotomy has not demonstrated an overall decrease in mortality given the large percentage of negative or nontherapeutic results. Of note, laparotomies under these circumstances are associated with reported morbidity rates ranging from 5 to 22%. These data may further encourage diagnostic laparoscopy, which seems to avoid useless laparotomies in up to 25–50% of these patients, particularly in the setting of acalculous cholecystitis, with much less morbidity than a "blinded" laparotomy [10].

24.2 History of Application

The oldest documentation of attempts at minimally invasive surgery comes from the beginning of this century. The technique of insufflation with carbon dioxide and the use of the Verres needle were described in the 1930. Though this concept of diagnostic, or even therapeutic, access to the abdomen without formal laparotomy appeared exciting, several decades passed before it received widespread acceptance. The introduction of the safer open technique for insufflation and trocar insertion and the advent of video laparoscopy with its superior view of the abdominal cavity resulted in an enthusiastic, explosive expansion of applications for diagnosis and surgical procedures by laparoscopic techniques in the 1990. The simplicity of laparoscopy itself, the limited requirement of instruments and personnel, have made this modality attractive for applications outside the operating room setting, such as the ICU or the emergency room. In 1989, Iberti et al. reported the use of bedside laparoscopy in the ICU to diagnose gangrenous bowel after aortic reconstruction surgery [11]. In 1991, Berci reported the use of emergency mini-laparoscopy with the use of a 4-mm laparoscope in the emergency department and in the ICU with local anesthesia and intravenous sedation in both trauma patients and critically ill patients [12]. Since 1992, there have been increasing number of reports of diagnostic laparoscopy in the ICU with a total of several hundred patients.

24.3 Advantages and Indications

Most reports consider the use of laparoscopy in the critically ill patient as a diagnostic tool of high accuracy, which is well tolerated by these high risk frail patients and it avoids nontherapeutic laparotomies and their associated morbidity, cost, or risky transport to the radiology department or operating room. On the contrary, bedside diagnostic laparoscopy (BDL) in the ICU may offer the potential for an accurate assessment in the suspected intra-abdominal pathologies, thanks to a direct intra-abdominal visualization.

Percentages of patients who may avoid an open laparotomy range from 30 to 65%, and 50% of the septic patients with a bedside laparoscopy diagnosis are followed by a causal therapeutic intervention [13].

Complications related to the transportation of critically ill patients include hemodynamic instability, respiratory distress, and airway occlusion due to intra-orotracheal tube dislocation [14].

However, BDL must be applied with sticks indications in order to avoid dangerous side effects. The Agency for Healthcare Research and Quality lists such pathophysiological indications for BDL in ICU patients [15, 16]:

1. *Unexplained sepsis, with or without abdominal pain, systemic inflammatory response syndrome (SIRS), or multiorgan failure with no obvious indication for laparotomy*. Common intra-abdominal conditions causing septic shock in the critically ill patients consist of acalculous cholecystitis, acute mesenteric ischemia, pancreatitis, visceral perforation, and intra-abdominal collections. Acalculous cholecystitis is common in these patients due to a combination of prolonged fasting, opioid analgesics, and low cardiac output states [17]. Any delay in the recognition or management of these conditions can lead to multiple organ dysfunction syndrome and mortality rates that approach 100%. In this subset of patients, it is therefore critical that a rapid diagnosis is achieved, and definitive intervention performed. Intra-abdominal pathology may be also the primary cause of sepsis and hence admission to a critical care unit. Speaking about acute mesenteric ischemia (AMI), nowadays the gold standard for diagnosis is CT, which offers a good accuracy in AMI detection with high values of sensitivity and specificity, but it is well-known that these values are not similar in each etiological type [18]. Nonocclusive mesenteric ischemia mechanism is an exclusion diagnosis. It presents the most important diagnostic problems due to lack of specific radiological features on CT, which usually shows a normal bowel wall and a high variability of its contrast enhancement ranging from absent or diminished to increased. In this setting, laparoscopy could be a feasible and safe surgical approach for diagnosis of ischemic tract of bowel and to removing it [19].
2. *Increase in abdominal distension in the absence of bowel obstruction*. Such condition may arise from ischemic colitis, colic paralysis due to functional (Ogilvie syndrome) or infective (pseudo-membranous colitis) etiology, which may degenerate to the life-threatening condition of toxic megacolon or abdominal compartment syndrome if not rapidly diagnosed and healed.
3. *Unexplained metabolic (lactic) acidosis*. Lactic acidosis (LA), defined as a serum lactate of ≥4 mmol/L, is a common finding in critically ill patients since some conditions, such as hypovolemia and septic shock (e.g., intra-abdominal pathology), cause impaired oxygen delivery to tissues [20]. Moreover, there is a reduced hepatic and renal clearance. It is an indicator of higher morbidity and mortality especially in patients who are relatively unstable. Diagnosing the intra-abdominal cause of LA in critically ill patients remains challenging. Patients are usually too unwell to undergo radiological investigations like CT scan. In such cases, suspicion of an intra-abdominal catastrophe often results in an emergency laparotomy which carries its own morbidity and mortality. In these patients, BDL is thought to be a useful diagnostic tool for the investigation of intra-abdominal cause

of LA in critically ill patients when medical causes of LA have been excluded, like cardiorespiratory, renal, alcohol, or drug-related. An intra-abdominal source of pathology is found in 43% of patients undergoing BDL for these indications.

Patients who have undergone open-heart surgery or major vascular surgery utilizing extracorporal circulation have rather frequently complications with the above-mentioned pathophysiological patterns, and especially with ischemic origin [21]. Morbidity ranges from 0.3 to 13%; ischemic mesenterial, complications, cholecystitis, and hyperamylasemia or acute pancreatitis are the most important morbidities. Several risk factors for the development of abdominal pathology have been defined, including patient age (>70 years), preoperative New York Heart Association (NYHA) classification (NYHA 4), duration of cardiopulmonary bypass, and need for blood transfusion [22]. The diagnosis of abdominal abnormalities is often extremely difficult in critically ill patients, because these patients often do not show typical symptoms due to sedation or activity. Moreover, they often have numerous other conditions that may be responsible for changes in physical status or laboratory parameters. Therefore, the early diagnosis of abdominal complications is a clinical challenge, but it is of utmost importance because early diagnosis and especially early treatment are the key determinants of clinical outcome.

The use of bedside diagnostic laparoscopy has also been proposed in post-traumatic intra-abdominal injuries for both blunt and penetrating mechanisms, to facilitate a faster diagnosis in the emergency room [23]. Its use in this setting has been extensively analyzed by Stefanidis and colleagues in a review [24]. Most of the anectodical reports on trauma patients concern trauma-diagnostic of penetrating mechanisms, in particular, peritoneal penetration that leads to thoraco-abdominal or tangential diaphragmatic injury, trans-diaphragmatic pericardial window, evaluation of presence and extent of hemoperitoneum, evaluation for seat-belt injuries, acute abdomen after blunt mechanism with a negative CT. However, a more extensive discussion of this indication is beyond the scope of this book as there is no direct correlation between trauma and the frailty or elderly condition of the patient.

24.4 Contraindications and Potential Adverse Effects

The physician should be aware of patient selection and understand the absolute and relative contraindications for DL, which can be summarized as follows:

Absolute contraindications for DL:

1. Prior abdominal surgeries, that can make laparoscopy difficult and increase potential risk due to intra-abdominal adhesions, that is enterotomy.
2. Uncorrected coagulopathy.
3. Known or obvious indication for therapeutic intervention such as perforation or peritonitis.
4. Suspected intra-abdominal compartment syndrome.
5. Intestinal obstruction with associated massive bowel dilation.
6. Wound dehiscence.
7. Clear indications of bowel injuries such as the presence of bile or evisceration.

Should any of these circumstances be present, an exploratory laparotomy is mandated.

Are instead relative contraindications:

1. Morbid obesity.
2. Pregnancy.
3. Presence of anterior abdominal wall infection.
4. Recent laparotomy (4–6 weeks).
5. Extensive adhesions from previous surgery.
6. Aorto-iliac aneurysmal disease.
7. Decreased distensibility of the abdomen, such as that due to diffuse carcinomatosis or tuberculous peritonitis or in patients with augmented volume in the abdominal cavity such as bowel nonobstructive distention that interferes with visual access.

These conditions are to be evaluated very carefully when considering diagnostic laparoscopy.

The potential negative impact of the physiologic consequences of peritoneal insufflation is increased in an already critically ill patient, including the chemical effect of carbon dioxide and the inherent increased intra-peritoneal pressure associated with pneumo-peritoneum and adequate insufflation, and this is to be considered when planning the procedure [25].

Moreover, the increased intra-abdominal pressure elevates the diaphragm and subsequently results in the collapse of basal lung tissue. Potential deleterious respiratory effects include decreased functional residual capacity, ventilation perfusion mismatch, increased intra-pulmonary shunting of blood leading to hypoxemia and increased alveolar arterial oxygen gradient. Increasing the frequency of mechanical ventilation with positive end-expiatory pressure (PEEP) and increasing the fraction of inspired oxygen during the procedure will decrease the intra-operative atelectasis and improve the gas exchange and oxygenation.

Compression of the vena cava may occur during insufflation yielding decreased pre-load (thus cardiac output) and increased vascular resistance in the arterial circulation. This effect can be minimized with adequate fluid resuscitation. Furthermore, limiting insufflation pressures (<10 mm Hg) leads to less hemodynamic compromise. Cardiac arrhythmias including bradycardia from vagal stimulation, premature ventricular contractions, or ventricular tachycardia can also occur and should be closely monitored.

Hypercarbia can also result due to the reabsorption of the carbon dioxide into the circulation. If coupled with hypo-ventilation, it can yield acidosis and further depression of the cardio-pulmonary system. The use of continuous end-tidal carbon dioxide monitoring may help to prevent worsening acidosis in these circumstances.

If the procedure is kept short and is performed at low insufflation pressures, the physiologic alterations that do occur are of little or no consequence. Bedsides laparoscopy should therefore be used primarily as a diagnostic tool or only for basic straightforward, short interventions, such as coagulating a minor bleeder or placing a drain. These recommendations also keep the necessary equipment simple and the required sedation less complex and not necessarily dependent on an anesthesiologist.

24.5 Results and Complications

When proposing the use of a novel surgical approach, three aspects should be critically evaluated: feasibility, safety, and efficacy. After an advantage is shown over the current approach, recommendations can be made to adopt the newer modality.

The feasibility of diagnostic laparoscopy in the critically ill patient, both in the ICU at the patient's bedside and in the operating room, was shown by several small series and case reports. The equipment (camera, monitor, and insufflator) is readily available on a mobile cart, and the number of instruments required for diagnostic laparoscopy is small. The procedure is therefore simple to accomplish outside the operating room environment [26, 27].

Because only small incisions are involved, with no exposure of the abdominal contents, diagnostic laparoscopy can be performed in the ICU using standard sterile equipment, with a low infection rate. The procedure is feasible even in the "difficult" abdomen, as in patients after open laparotomy. Extra care is needed when gaining access to the reoperated abdomen, and the use of open approach is recommended.

The safety of laparoscopy in critically ill patients was questioned because of two common conditions observed in these patients: hemodynamic instability and abdominal sepsis. As above reported, the use of CO_2 pneumo-peritoneum was shown to be associated with adverse hemodynamic effects, of which the cardiovascular and respiratory are the most prominent. These effects may be even more pronounced in the high-risk patient, causing temporary myocardial failure. Experimental studies demonstrated hemodynamic compromise in septic animals undergoing laparoscopy, mostly related to hypercarbia and acidosis [28].

Despite these concerns, conflicting data may be found in the literature regarding the occurrence and significance of these adverse effects. Specifically, there is a discrepancy between the experimental studies and the actual results in high-risk patients subjected to laparoscopy, and even when hemodynamic parameters are affected, the overall clinical significance of these measured changes is not clear. In many series, no significant hemodynamic changes were observed, even in patients who were dependent on high-dose amine support [8].

It should be remembered that ICU laparoscopy is performed under optimal monitoring conditions, and that the cardiovascular effects of laparoscopy are readily reversible by disinflation. The combination of slow insufflation and low abdominal pressure minimizes the adverse hemodynamic effects of laparoscopy. By its nature, diagnostic laparoscopy is a short procedure, so the effects of CO_2 pneumo-peritoneum are minimized. The use of alternative gases, such as N_2O, to reduce the chemical effects of CO_2, is also possible. Nitrous oxide may also be associated with less discomfort in patients who are not under general anesthesia.

The use of laparoscopy in a critically ill patient with abdominal sepsis is also a source of concern. Some experimental studies showed increased bacterial growth in the CO_2 peritoneal environment, but other models showed conflicting results, with similar or better outcome compared with laparotomy. An augmenting effect of pneumo-peritoneum on bacterial translocation was suspected but disproved. Despite theoretical concerns that pneumo-peritoneum may increase bacterial spread, results of many studies showed a decrease in infectious complications, so laparoscopy was considered a safe option for the diagnosis and treatment of peritonitis [29].

As laparoscopy is associated with less stress and a reduced acute-phase response, it appears that there is better preservation of immune function. As there are also fewer parietal complications such as wound infection and dehiscence, laparoscopy may be a safer option in the diagnosis of abdominal sepsis.

The efficacy of ICU laparoscopy was repeatedly demonstrated. The diagnostic accuracy is greater than 90% and was always better than ultrasound, CT scan, or diagnostic peritoneal lavage. Retroperitoneal pathology, which is less evident by laparoscopy, might be misdiagnosed. However, with careful exploration, the retroperitoneum organs, like the pancreas, are still accessible. A routine inspection of the lesser sac could help to obviate this problem [19].

The efficacy of ICU laparoscopy is also measured by the effect on further management. Avoiding an unnecessary laparotomy is important in these patients, and a change in management occurred in 33% of the patients [19].

In some cases, the diagnosed pathology can be treated laparoscopically, either in the ICU or after transfer to the operating room.

The overall prognosis in this group of patients is poor. However, when considering patient outcome, ICU diagnostic laparoscopy may affect treatment decisions even in the unsalvageable patient. Arriving at a correct diagnosis is important to the patient's family, as well as to the physician, before deciding to withdraw or implement further costly efforts [29].

In patients with findings that require laparotomy, such as mesenteric ischemia or necrotizing pancreatitis, initial laparoscopy does not significantly increase the operative risk. The slightly increased operating times are marginal, since experienced surgeons can perform the procedure in 10–15 min.

Complication rates of diagnostic laparoscopy range from 1 to 9%. Thus, even in critically ill patients, the procedure can be performed without increasing the standard risk [30].

The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) recommends that BDL is technically feasible and can be applied safely in appropriately selected ICU patients (grade B). According to this Society, it is generally well-tolerated in the ICU population with overall morbidity rates reported from 0 to 8% with no mortality directly associated with the procedure being described [31–33].

The positive outcome of bedside diagnostic laparoscopy can be guaranteed with three major factors: cooperation among anesthesiologists and the surgeon in the decision-making of whether to perform a bedside laparoscopy; single-bed isolated room setting, that guarantee an optimal operating room-like environment; and daily emergency surgery technical skills of surgeon. As the level of intraperitoneum pressure is the most critical intra-procedure parameter, the range of 8–15 mm Hg is suggested, because this is usually well-tolerated and does not compromise mechanical ventilation or the hemodynamic parameters in critically ill patients.

The most severe procedures-related complications is visceral perforation, pneum-operitoneum-induced bradycardia, intra-peritoneal hemorrhage and post-procedure ascitic leak from trocar site. Level II and III data demonstrate diagnostic accuracy ranging between 90 and 100% with the main limitation being the evaluation of retroperitoneal structures. Therefore, despite the technical challenges associated with bedside laparoscopy, it offers a viable alternative to exploratory laparotomy which has traditionally yielded higher mortality rates, particularly in ICU patients with multisystem organ failure [16].

24.6 Technique: Rules and Pitfalls

BDL procedures are performed in an isolated single bedroom of the ICU ward. Standard laparoscopy equipment required to perform a BDL in the ICU includes an insufflator, image processor, light source, cautery, camera head, lens, light cord, trocars, instruments, suture, and monitor (Fig. 24.1 and Table 24.1).

We recommend an experienced surgical team, nurse, and technician; an individual to serve as assistant for unexpected needs; an anesthesiologist (Fig. 24.1).

Excellent communication between the surgeon and anesthesiologist is required as the patient is mechanically ventilated and invasive arterial blood pressure, electrocardiogram, pulse oximetry, and end-tidal carbon dioxide are constantly monitored. When required, hemodynamic support is established by noradrenaline infusion. This monitoring is typical for a critically ill patient. While inhaled anesthetic may be used in the ICU, we recommend total intravenous anesthesia (TIVA) to minimize the equipment that must be transferred from the operative room.

All the staff present in the room wear protective clothing, a surgical cap, gloves, and a surgical mask. Sterility is warranted by adherence to routine operating-room protocols and sterilization of the operating site with povidone-iodine. The anesthesiologist on duty directs the administration of total intravenous anesthesia, ventilation, and hemodynamic support.

The patient is in a supine position and Trendelenburg or anti-Trendelenburg movements are assured to obtain the most appropriate laparoscopic view (e.g., diaphragmatic exploration).

Fig. 24.1 Scenario of BDL in ICU

Table 24.1 List of equipment needed to perform a BDL

Laparoscopic mobile tower	Operative materials	Backup equipment
Insufflator	Laparoscopic instruments	Open set
Image processor	Needle drivers	Lap sponges
Light source	Clip appliers	Suture
Cautery	Various sutures	Open suction
Monitor	Ports	Retraction instruments
Second monitor	Coagulating substrates	Lighting (overhead and headlamp)
–	Bipolar vessel sealing system or harmonic scalpel of choice	–

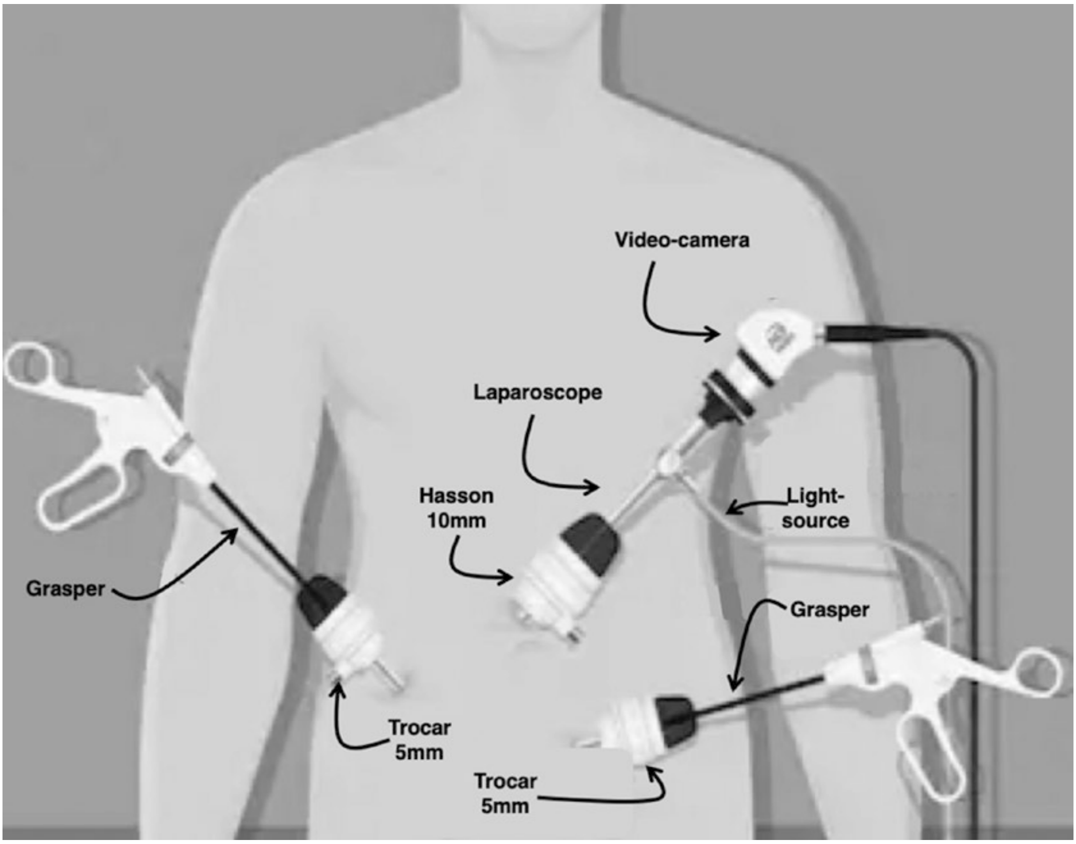

Fig. 24.2 Trocars placement for a BDL procedure

Trocars are placed into the paraumbilical region, as shown in Fig. 24.2.

The surgeon should utilize 5-mm ports and instruments to minimize equipment needs. We prefer the open Hasson technique to access the peritoneal space; however, the method most comfortable for the operating surgeon should be used. Pneumo-peritoneum should be limited to 8–10 mm Hg pressure, rather than the standard 15 mm Hg pressure, to decrease CO_2 absorption, minimize effect on preload, and reduce blood pressure. It is technically feasible to avoid chemical paralytics and perform BDL under local anesthetic and low insufflation pressure.

The use of alternative gases such as N_2O, helium and air has been described with the potential benefit of decreased hypercarbia/acidosis; however, both air and N_2O pose a significant risk of nitrogen or air embolus. However, usually low pressure (8–10 mm Hg) CO_2 is familiar to the OR team, readily available, safe, and does not compromise the ability to successfully visualize the peritoneal cavity.

The surgeon is careful to avoid injury to the bowel or cause bleeding. When the procedure is complete, the patient is monitored for any signs of bleeding at additional port sites following removal, and the umbilical port site is carefully sutured starting from the fascia.

Five Things You Should Know About Bedside Laparoscopy (BDL) in the Elderly

- The BDL finds its ideal application in ICU patients, and, to a lesser extent, in the emergency room.
- The indications to BDL in ICU are actually very strict: sepsis, abdominal distension and lactic acidosis of unknown origin, after a full diagnosis attempt has been made, including CT scan.

- Among the various diseases for which BDL represents an efficient and useful tool for a better management, the acute mesenteric ischemia is surely the most relevant since its time-dependent prognosis may be significantly affected by an early laparoscopic approach sometimes also avoiding moving the patients to the Radiology Unit.
- In critically ill patients, the procedure can be performed without increasing the standard risk.
- Given the advantages offered by this method, especially in patients hospitalized in ICU, it would be advisable for a laparoscopic equipment to always be kept in close proximity to the ICU, in case an urgent BDL is needed.

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