Gastrointestinal dysfunction

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Abstract

Gastrointestinal dysfunction is common in critically ill patients and it is important to prevent or manage its manifestations. In this article we discuss the aetiology, management and prevention of: stress ulceration, ileus, bacterial translocation, intra-abdominal hypertension, abdominal compartment syndrome, diarrhoea and constipation in the context of critically ill patients. We also discuss feeding strategies for intensive care patients who cannot be fed normally.

Keywords Abdominal compartment syndrome; bacterial translocation; diarrhoea; feeding; ileus; stress ulceration

Introduction

In critically ill patients the gastrointestinal system, like any other organ system, is prone to failure, causing increased mortality and morbidity. There are many ways by which the abdominal organs can fail, mostly influenced by the patient's general health and admitting diagnosis. However, there are specific patterns of gastrointestinal organ dysfunction regularly seen within the critically ill population. This article describes these complications and explains the various management strategies that are currently used to treat and avoid these problems.

Stress ulceration

As early as 1969, a clinical syndrome was reported of lethal 'stress ulceration' where around 5% of intensive care patients died from this complication. At post mortem these patients had multiple superficial gastric ulcers confined to the gastric fundus. Mucosal stress ulceration causing upper gastrointestinal bleeding with an associated increase in mortality and morbidity is now a recognized complication in critically ill patients. Over 75% of critically ill patients have demonstrable gastric mucosal damage within 24 hours of admission to intensive care. It is worth noting that the rate of GI bleed is thought to be less than 4%, and is usually not significant. Significant bleeds usually are from non-stress related sites such as varices.[1]

In health, gastric mucosal cells are protected from gastric acid and enzyme attack in three ways. They secrete a mucus layer to prevent contact with the potentially corrosive gastric fluid, secrete bicarbonate ions to neutralize the gastric acid and have tight junctions between them to create a physical barrier. The cause of mucosal damage in the critically ill is incompletely understood, but it is thought to be related to an ischaemic insult to the gastric mucosal cells which compromises mucosal integrity. This insult may be further exacerbated by a reperfusion injury. The ischaemic insult is thought to be due to a combination of hypovolaemia, catecholamine induced vasoconstriction to abdominal organs, and dysregulation of vasopressin levels. The altered levels of catecholamines and vasopressin could be due to an endogenous stress response or adrenaline, noradrenaline or vasopressin infusions administered to prevent hypotension in a systemic inflammatory response syndrome (SIRS).

Histamine 2 receptor blockers (H2RB) work by blocking the histamine receptors on the acid-producing parietal cells in the stomach, thus preventing the stimulus for acid production. It has been shown that using H2RBs to prevent stress ulcers in critically ill patients significantly decreases the risk of bleeding from the stomach. But there has been some evidence to suggest that the efficacy of H2RBs decreases over time with the stomach pH dropping below 4 after 24 hours of continuous ranitidine infusion.[2] This finding led to the use of proton pump inhibitors (PPIs) that block acid production in the parietal cells. The use of either a PPI or an H2RB for stress ulcer prophylaxis in ventilated patients is now common practice in the majority of intensive care units within the UK. There has been no proven reduction in mortality even with a reduction on GI bleeding but the expert guidelines still recommend treatment ideally with PPI over H2RBs.[3]

Stress ulcer prophylaxis is not without risks. *Clostridium difficile* is killed by gastric acid and the risk of infection by this microorganism is increased in patients on acid suppression therapy. Increasing gastric pH allows bacterial colonization of the upper gastrointestinal tract which may be the cause of the increase in hospital-acquired pneumonia seen in patients on gastric acid suppression therapy. However recent meta-analysis has disputed this and suggests that PPIs do not increase the risk nosocomial pneumonia and acidified feeds do not decrease the risk.[4]

There is evidence to suggest that early (within 48 hours) initiation of enteral feeding in critically ill patients helps to prevent stress ulceration, presumably by increasing the gastric pH and preventing the accumulation of potentially damaging gastric enzymes by providing food-derived substrates. There is also a suggestion that small bowel feeding may decrease the incidence of ventilator acquired pneumonia.

Bacterial translocation

It is postulated that one of the factors that initiates and/or fuels SIRS is translocation of gut bacteria or exotoxins into the blood stream. This may follow failure of the intestinal barrier due to intestinal ischaemia, with a breakdown of tight junctions between cells and subsequent leakage of intraluminal bacteria and/or their exotoxins into the blood stream. Intestinal villous atrophy (which occurs when the gut is not used) is another possible reason for this leakage. Early introduction of enteral feeding may prevent this villous atrophy and consequent leakage.

Selective gut decontamination (SDD) with intraluminal antibiotics has been proposed to prevent bacterial translocation and SIRS. At present, there is contradictory evidence to support this approach and concern over increased *C. difficile* rates and antibiotic resistance.[5] Although SDD and regular oral decontamination have not been shown to decrease the mortality or morbidity

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from sepsis or SIRS it has been shown to reduce the number of respiratory infections in critically ill patients. This is perhaps due to a decrease in microaspiration of bacteria regurgitated into the pharynx past an endotracheal or tracheostomy tube cuff into the lungs. Cuffs on endotracheal and tracheostomy tubes are not always completely watertight and in critically ill patients, even adequately inflated cuffs have the potential to allow microaspiration.

Ileus

Ileus is an inhibition of propulsive intestinal motility and often occurs in critically ill patients. Often, the cause of ileus is not completely understood but animal models suggest that it is caused by a compound mix, or 'soup' of inflammatory mediators. These mediators may affect the smooth muscle cells directly or cause ileus through a complex interaction between the lymphocytes and nerve cells of the gastrointestinal tract. The gastrointestinal tract is richly innervated by both the sympathetic and parasympathetic nervous system and further research is being undertaken to identify the inflammatory mediators involved in the process, with nitric oxide and prostaglandins both being likely candidates.[6]

There are four main mechanisms of postoperative ileus: firstly the operation itself can cause inflammation and bowel handling causes release of inflammatory mediators and sensitization of the immune system. Secondly, autonomic neurogenic reflexes occur in response to the surgical stimulus. The third cause is a hormonal stress response to surgery itself, resulting in elevation of corticotrophin releasing factor which further stimulates release of inflammatory mediators. The fourth mechanism is iatrogenic and is due to the administration of opioid drugs which cause ileus by binding to opioid receptors in the gastrointestinal tract and disrupting motility.[7] Some of these mechanisms may play a part in the development of ileus after trauma outside the abdomen and, in combination with other factors, lead to SIRS.

Ileus can cause many problems within a critical care setting. Gastric stasis and bacterial colonization of a static gastrointestinal tract can lead to an increased risk of aspiration and subsequent respiratory tract infections. Apart from the increased risk of bacterial translocation adding to SIRS, ileus may increase the intra-abdominal pressure and increase the risk of intra-abdominal hypertension and intra-abdominal compartment syndrome. Furthermore, ileus will prevent the absorption of much needed nutrients at a time when a patient is often metabolically hyperactive.

To prevent or reverse ileus the underlying cause should be treated and, if possible, large doses of opiates should be avoided. Prokinetic agents are used in many critical care units but without good evidence of benefit. The two most commonly used agents are erythromycin and metoclopramide. Erythromycin is a macrolide antibiotic with a prokinetic effect on the gut. It is not clear whether it works as a prokinetic agent when given orally and there are concerns about the development of bacterial antibiotic resistance when used routinely. Metoclopramide has prokinetic actions by antagonizing peripheral dopamine (D2) receptors in the gut; it also stimulates gastric emptying via muscarinic receptors.

To overcome gastric ileus and provide nutrition, a post-pyloric feeding tube can be inserted endoscopically, under radiological guidance or using a blind technique. This may reduce the risk of aspiration in patients with gastric stasis. A meta-analysis has shown there is no clinical benefit in the early 'prophylactic' placement of post-pyloric feeding tubes in critically ill patients, although it is a useful method of providing nutrition when gastric stasis occurs.[8]

Intra-abdominal hypertension/compartment syndrome

The abdomen is a closed compartment and the usual pressure in an abdomen is around 5 mmHg, although can be chronically raised in certain conditions such as obesity. Intra-abdominal pressure is measured at end expiration with a patient in the supine position and the abdominal muscles relaxed. The pressure can be measured with a needle in the peritoneal cavity and zero pressure taken from the mid axillary line, although in critically ill patients intra-vesical pressure is commonly measured by attaching a pressure transducer to the urinary catheter (Figure 1).

When intra-abdominal organs swell or blood/fluid/faeces/air accumulates within the compartment, the intra-abdominal pressure will rise. A continuous rise in abdominal pressure greater than 12 mmHg is defined as intra-abdominal hypertension. Once this pressure is greater than 20 mmHg or the abdominal perfusion pressure is less than 50 mmHg then by definition abdominal compartment syndrome is present. Abdominal perfusion pressure (APP) is defined as:

$$\text{APP} = \text{Mean Arterial Pressure (MAP)} - \text{Intra-abdominal Pressure (IAP)}$$

The causes of intra-abdominal hypertension (IAH) or abdominal compartment syndrome (ACS) can be separated into primary and secondary causes (Figures 2 and 3). Primary IAH or ACS is due to injury or disease within the abdomen or pelvis, secondary IAH/ACS is due to conditions that do not originate within the abdominal or pelvic cavity causing widespread capillary leakage. Large amounts of crystalloid resuscitation my exacerbate IAH/ACS by increasing the amount of oedema in the abdominal compartment. Risk factors for IAH and ACS are documented in Box 1 as published by the World Society of the Abdominal Compartment Syndrome (WSACS).[9]

Many critical care units do not measure intra-abdominal pressure routinely, so the true incidence may be higher than commonly perceived. A multi-centre study published in 2005 looking at a mixed population of medical and surgical admissions to intensive care units in Europe showed that 32.1% had IAH and 4.2% had ACS on admission.[10]

IAH and ACS will affect many organ systems. A rise in intra-abdominal pressure decreases intra-abdominal organ perfusion, which may reach a critical stage as ACS occurs. Renal function in particular may be impaired by increasing renal vascular resistance and reducing cardiac output. The reduction in cardiac output is due to decreased blood return to the right atrium caused by increased pressure on the inferior vena cava (decreased preload); there is also an increase in the vascular resistance within the abdomen that further decreases cardiac output (increased afterload). Moreover, the increased abdominal pressure can mechanically compromise the diaphragm and cause significant problems with respiratory function and mechanical ventilation.

