Considerations Regarding Appendicitis at Sea

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Introduction

When are military providers comfortable providing an 'austere' level of care versus pursuing a higher echelon of care for patients with acute appendicitis? This is a non-issue in active combat scenarios or when medical transport is unavailable. But often, as deployed providers, the decision to treat the patient in a forward, austere location with limited personnel and resources or to medically evacuate (MEDEVAC) them to a more capable care environment is nebulous. The balance when considering the quality of care, risk of transport, cost of transport (including monetary, supplies and personnel) and capability to manage complications makes these decisions complex.

Acute appendicitis is among the most common general surgical diagnoses in the United States (US). Both amphibious warships and aircraft carriers have the capability to perform a laparoscopic appendectomy while at sea, which is the standard of care. That being said, a combination of diagnostic uncertainty, given no afloat cross-sectional imaging and management of potential complications, have given pause to performing these surgeries. There is a need for ongoing discussion regarding the decision making surrounding acute appendicitis at sea.

Case comparison

Two patients presented on a deployed US Navy ship with surgical capabilities. Both patients had abdominal pain, which migrated to the right lower quadrant, normal vital signs and right lower quadrant tenderness to palpation. Symptoms in each case were present for approximately 12 hours prior to workup and diagnosis. No CT is available on the ship, but abdominal ultrasound was attempted in each case without identification of the appendix.

The first patient was a 49-year-old female with a leukocytosis of 19 000. She was evacuated to an American military hospital due to relatively close geographic proximity for further workup and management, where a CT was obtained, confirming the diagnosis of acute appendicitis. The patient underwent an uncomplicated laparoscopic appendectomy the following morning. Due to operational limitations, the patient did not return to the ship for 3 weeks.

The second patient was a 21-year-old male with a leukocytosis of 16 000. He underwent an uncomplicated laparoscopic appendectomy onboard. The patient was given 1 week without duty, followed by return to duty with standard lifting and activity restriction.

Discussion

These cases demonstrate the differential care at sea for similar presentations of the same disease. The following discussion aims to elucidate the major operational and ethical concepts to be considered.

From a military perspective, the goal of deployed medicine is to return the greatest number of service members to their duties by prioritising life, limb and eyesight.[1] This simplified concept becomes more complex when you consider medical personnel's obligation to mimic shore-based standards of care with the available resources. Providers must bias themselves to the best interest of the patient, which may conflict with the operational logistics of a command. With this context, we must weigh the treatment options for acute appendicitis at sea.

Need for cross-sectional imaging

As previously mentioned, the tension between treating a patient at sea versus MEDEVAC ashore is primarily based on the availability of cross-sectional imaging and concern for managing post-operative complications. Both factors directly relate to the lack of cross-sectional imaging on amphibious warships and aircraft carriers, namely computed tomography (CT).

There is evidence that CT appreciably affects surgical management. Rosen et al. noted a surprisingly low 37% concordance between pre- and post-CT diagnosis in patients with a suspected abdominal surgical disease.[2] They reported that CT changed surgical management in 40% of patients, having the greatest impact on patients with suspected appendicitis.[2]

Shaligram et al. studied differential outcomes in patients with suspected appendicitis and found that patients who underwent CT scans experienced significantly lower morbidity, lower ICU admissions and lower readmission rates.[3] The authors further demonstrated that the group most affected were those who did not undergo a CT scan and did not undergo surgical intervention.[8] Separately, Raman et al. showed that increased use of CT was associated with decreased incidence of appendiceal perforation[4].

These data suggest that a critical error occurs when appendicitis is suspected and non-operative management is pursued, leading to an associated delay in definitive management and increased morbidity. While it seems obvious that CT improves the care of patients with suspected appendicitis, it is not the current reality of care at sea.

Antibiotics versus surgery for acute uncomplicated appendicitis

The 'antibiotics versus surgery for acute appendicitis' is a conversation that frequently occurs in shipboard medical departments and deserves mention. There is often a perception that operative management carries an inherently higher risk than antibiotic treatment. The thought is that risk can be mitigated by electing for antibiotic treatment, which is supported as a primary treatment for appendicitis in the literature. What is important to note is that in studies directly comparing antibiotics to surgery for acute appendicitis, the antibiotic group experienced treatment failure requiring operative management in 29% of patients at 90 days, 40% at 1 year, and 49% at 3 years.[5,6] Alarmingly, when patients in the antibiotics group recurred, perforation was reported in 20% of patients.[6] Given the already noted lack of cross-sectional imaging or interventional radiology capabilities, the high rate of failure with antibiotics alone and associated morbid complications, specifically abscess formation and sepsis without access to reliable percutaneous drainage, carry a greater risk than surgery at sea.[7]

Logistical considerations

Based on the data presented, the most appropriate option is appendectomy versus MEDEVAC for a shore-based diagnostic workup and probable surgery. Assuming the risk of surgery is the same for the patient at sea and ashore, the risks associated with the MEDEVAC process must be addressed and considered. Notably, performing an uncomplicated surgery at sea returns the service member to their duties the quickest (3 weeks sooner in this case comparison). However, that should not necessarily be the provider's foremost concern ethically. The MEDEVAC process involves maritime air transport and the finite resources of fuel, aircraft repairs, aircraft maintenance and the low but present risk of an aviation mishap at sea.[8] Ship diversion for aircraft range also represents a difficult-to-quantify cost. In many cases, the patients are transported multiple times in the MEDEVAC process, adding both cost and risk.[8] In addition to the obvious material and personnel considerations in the MEDEVAC operation, a patient with acute appendicitis could quickly deteriorate during this process without access to a physician, much less surgical capabilities. All these described costs and risks are difficult to quantify in bulk for direct comparison to afloat medical care.

Command discussion

The recommendation for operative management must be approved by both medical and line commanding officers. It should be communicated that appendectomy carries a complication rate of about 5% for uncomplicated appendicitis and up to 25% for perforated appendicitis.[9] The treatment and logistical options should be communicated in terms of risk to the patient, specifically noting that increased time to treatment contributes to a greater risk of perforation and complications[9]. Additionally, risk profiles should include not only initial treatment risk (surgery vs MEDEVAC vs antibiotics), but also latent risk (surgical complications and risk of treatment failure). It cannot be overstated that the patient's best interest of the patient, agnostic to any perceived risk to the command, should always be at the forefront of the discussion.

Final thoughts

Military medical providers working in austere environments will always be required to make clinical decisions without the standard medications, technology- personnel compared to shore-based facilities. Service members understand and implicitly accept that equal care to US based hospitals is not always possible. This back and forth between the ideal care scenario, what is available on the ship, and what is available through the MEDEVAC process is not a clear-cut concept.

The expected yet disappointing answer is that there is not an obvious solution. The data suggests that a lower threshold for operative management in an austere environment, will lead to better patient outcomes versus treating with antibiotics alone. One could argue that MEDEVAC to a medical facility meeting home port standard of care with CT capability and the ability to manage potential

complications with interventional radiology is equally reasonable. The decision to operate at sea versus MEDEVAC is complex. However, if a MEDEVAC is easily attainable to a care facility equivalent to the shore-based standard of care for the service member, then MEDEVAC is a reasonable alternative to ship-based surgical care. Discussion between multiple providers is essential to formulating an appropriate plan that is in the patient's best interest regardless of the operational environment.

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