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# Evidence-based, cost-effective management of abdominal wall hernias: An algorithm of the *Journal of Trauma and Acute Care Surgery* emergency general surgery algorithms work group

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This algorithm developed by the *Journal of Trauma and Acute Care Surgery* emergency general surgery (EGS) algorithms working group addresses the initial evaluation and management of ventral abdominal wall and groin hemias presenting in the emergency setting. The algorithm is intended to serve as a bedside reference for clinicians. It is annotated with letters linked to corresponding text that provides the rationale and references to support these recommendations. The algorithm is not a substitute for the clinical judgment and experience of bedside clinicians and should not be considered as the "standard of care." We encourage institutions to use these recommendations to formulate local protocols but recognize that there are patient-specific factors and institutional resource availability that may require deviation from this algorithm.

Abdominal wall hernia includes ventral hernias (umbilical, incisional, epigastric, spigelian) and groin hernias (inguinal, femoral). While the majority of abdominal wall hernias are treated in the elective setting, there is a subset of patients who present to the emergency department (ED) with acute issues, including severe

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pain, intestinal obstruction, incarceration, and strangulation. Emergency surgery may be required for patients with an abdominal wall hernia, with an incidence of 16 to 19 emergent hernia repairs per 100,000 person-years.<sup>1</sup> Presentation with acute hernia incarceration (inability to reduce hernia contents) warrants prompt repair, and concern for strangulation (compromise of blood supply to the contents), particularly bowel ischemia, is a surgical emergency that requires prompt intervention to avoid the increased morbidity associated with delay in definitive management.<sup>2</sup> Identifying strangulation can be a clinical challenge as physical examination, laboratory, and imaging findings can be nonspecific. Therefore, the evaluation of patients with abdominal wall hernia in the emergency setting and the decision to proceed with operative intervention should be made using a systematic approach.

### INITIAL EVALUATION AND MANAGEMENT

A. The workup for a patient with concerns of a ventral abdominal wall or groin hernia begins with a thorough history and physical examination (Figs. 1). It is essential that the physical examination include all potential sites of abdominal wall hernia, including the groin and perineal areas, especially in patients with more vague presenting symptoms. Incarcerated hernias, especially in the groin, can be easily missed by a more superficial examination. After the diagnosis of a hernia has been made, the specific location, surgical history, associated symptoms, and patient-specific factors will help determine the appropriate next steps in management. History should focus on the duration of symptoms, prior episodes of hernia incarceration, past surgical history, and evidence of systemic signs of illness, including fever, nausea, vomiting, anorexia, or skin changes overlying the hernia. Physical examination should evaluate the location of the hernia, the size of the fascial defect, the presence of hernia incarceration, and any redness or ecchymosis of the overlying skin. For a well-defined localized fascial defect, adding imaging to the initial diagnostic workup is of unclear benefit and is not mandatory. If there are concerns for a

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Figure 1. Algorithm for workup of abdominal wall hernia presenting in the acute setting.

complicated abdominal wall hernia, based on either patient factors or hernia variables,<sup>3</sup> additional workup should be considered, and laboratory evaluation should be obtained to include a basic metabolic panel, complete blood count, and lactate.

- B. The determination of the need and urgency for surgical repair will depend on multiple factors. Patients with a reducible hernia, improvement in symptoms, no evidence of complications, and an otherwise normal physical examination should be referred for outpatient surgical follow-up to discuss elective hernia repair. Patients with concern for abdominal wall hernia complications, including strangulation, intestinal obstruction, hernia incarceration, unrelieved severe pain, overlying skin changes, or evidence of systemic illness, should be seen by an acute care surgeon. Ideally, surgical evaluation should precede imaging in patients with nonreducible hernias and worrisome findings on physical examination.
- C. Patients with an incarcerated hernia and concern for strangulation or presence of peritonitis require prompt surgical intervention, as increased time from onset of symptoms to

operative intervention is associated with an increased need for bowel resection.<sup>4</sup> Signs of bowel incarceration causing obstruction (nausea, vomiting, abdominal distension, and obstipation), in addition to severe pain at the hernia site, are suggestive of strangulation. Systemic signs of strangulation may include hypotension and tachycardia, with elevations in serum lactate (>2.0 mmol/L) and white blood cell often (although not definitively) found on initial laboratory evaluation.<sup>5</sup> Physical examination may also show erythema or bruising/discoloration of the skin overlying the hernia. When these findings are present, or the patient is otherwise deemed at risk for strangulation within the hernia, an emergent exploration should be undertaken, with assessment of the viability of involved bowel, reduction of the hernia, and definitive hernia repair if practical. In many cases, imaging is not required and may lead to unnecessary delay. Similar to other EGS procedures, patients requiring acute urgent operation for hernia complications are at increased risk of complication compared with their elective counterparts.<sup>6</sup>



Figure 2. Algorithm for acute repair of complicated abdominal wall hernia.

D. In circumstances of diagnostic uncertainty or a difficultto-interpret examination (as can be found in obesity), imaging should be obtained to confirm the diagnosis and to evaluate for high-risk imaging features associated with strangulation. While ultrasound can be used to help with the initial diagnosis, cross-sectional imaging with computed tomography scan is preferred. Even when the diagnosis of hernia is confidently made on physical examination, computed tomography imaging can provide useful clinical information on the fascial defect size and hernia contents to evaluate for signs of intestinal obstruction or ischemia. In the absence of a high index of suspicion for strangulation, attempts should be made to reduce an incarcerated abdominal wall hernia unless it is known that the patient has had a chronically nonreducible incarcerated hernia. Acute hernia incarceration that is not reducible should prompt urgent operative intervention to reduce the hernia, evaluate for the viability of the incarcerated bowel, and repair the hernia defect.

**TABLE 1.** High Risk Clinical and Imaging Findings Suggestive of Strangulation

High-Risk Features for Strangulation Inability to reduce the hernia Persistent abdominal pain after reduction Fluid within the hernia sac Transition point at the neck of the hernia Bowel thickening within the hernia Inflammatory stranding along the hernia

- E. Acutely incarcerated hernias that are reducible but have high-risk features (Table 1) on imaging or physical examination should favor urgent repair (defined as nonemergent but performed during the index admission). These features are related to the patient's presentation and imaging findings. Clinical high-risk features include persistent abdominal pain after reduction or persistent nausea/vomiting. Radiographic findings associated with a higher risk for hernia complications should be considered when determining the need for urgent surgery in patients without clear signs of strangulation. Beyond the typical signs of bowel ischemia (e.g., pneumatosis, portal venous gas, or free air), the presence of fluid within the hernia sac, a transition point of the bowel at the neck of the hernia, bowel thickening within the hernia, and inflammatory stranding in the tissue along the hernia are considered high-risk features.8,9
- F. While repair of a hernia on initial presentation may be ideal, patient factors or local capacity may not permit this to be reasonably performed in all settings. Patient-specific factors should be considered, including age, frailty, American Society of Anesthesia score, and preadmission anticoagulant use, as each of these variables is associated with an increased risk of complications.<sup>10–12</sup> Some patients with hernias that exhibit a higher risk of recurrence may be discharged but with a defined plan to repair it in the short term to minimize patients' loss of follow-up. Variables associated with a higher risk of recurrence include clinical factors and radiographic features of the hernia (Table 2).<sup>13</sup> Acute onset and escalation of symptoms should be considered potential reasons to

TABLE 2.	Features <sup>-</sup>	That Increase	Risk of	Recurrent
Hernia Co	mplication	าร		

High-Risk Features for Recurrent Hernia Complications

Femoral hernia Spigelian hernia Female with groin hernia Need for conscious sedation for reduction Acute initiation or escalation of symptoms from hernia Fascial defect 3–4 cm in size "Mushrooming" hernia — narrow neck compared with hernia size Hernia size-to-fascial defect (neck) ratio >2.5

hasten repair.<sup>14</sup> The need for conscious sedation to achieve a successful visceral reduction marks patients as higher risk, and they should undergo expedited repair (when performed within 4 weeks, reincarceration rates of ~2% have been reported).<sup>15</sup> High-risk anatomical features include certain types of hernias with femoral and Spigelian hernias exhibiting a higher incarceration rate and need for emergent repair; there-fore, these should be addressed promptly.<sup>16,17</sup> Women with groin hernia have a higher risk of requiring emergent surgery compared with men, especially if a femoral hernia is present.<sup>18</sup> The size of the fascial defect is an unreliable predictor of the need for urgent repair, but primary hernia defects between 3 and 4 cm are at higher overall risk of incarceration compared with smaller or larger defects (with a rate of 10%; odds ratio, 3.31; 95% confidence interval, 1.91-5.74; p < 0.0001).<sup>19</sup> Specific measurements comparing the width of a fascial defect and the height of the hernia sack can also be used to estimate an increased risk with a "mushrooming hernia," one with a narrow neck as compared with height creating an acute angle with the abdominal wall being associated with a higher risk of requiring emergent surgery (odds ratio, 6.12; 95% confidence interval, 2.24–20.00).<sup>20</sup> Similarly, a study by James et al.<sup>21</sup> identified the ratio of hernia size to fascial defect (neck) as a potential aid in surgical decision-making, finding that a hernia-to-neck ratio >2.5 predicted the need for emergent repair.

Patients presenting to the ED with acute abdominal wall hernia symptoms who do not have an indication for urgent surgery are at high risk of being lost to follow-up. A prior multicenter study of patients with an ED visit for hernia-related symptoms showed that over 50% did not follow up in the outpatient clinic, with 20% returning to the ED with additional hernia-related complaints.<sup>22</sup> Considering socioeconomic factors and health care disparities to determine the need for operative intervention at the index admission will address low clinic follow-up rates and prevent future ED resource utilization. When immediate repair is not required, an effort should be made to ensure follow-up and initiate planning for definitive repair before the patient is discharged from the ED or the inpatient setting. The ability to followup in the outpatient clinic and access to elective, outpatient surgery should also be considered.

G. Nonurgent repair or repair after patient optimization prior to surgery can be pursued for symptomatic hernias without

high-risk features. These patients can likely be safely discharged from the ED with elective outpatient follow-up. If modifiable patient risk factors are identified at the time of hernia diagnosis (such as smoking, need for weight loss, or control of diabetes), these should be addressed before surgery. If the hernia is deemed complex, its eventual repair should be scheduled when patient optimization has been achieved and performed by a surgeon experienced in complex abdominal wall reconstruction techniques. Prediction of the need for component separation can be a subjective determination or made in various ways using data from cross-sectional imaging comparing aspects of the hernia to the remaining abdominal wall.<sup>23</sup> Watchful waiting and outpatient follow-up may be considered for asymptomatic ventral, inguinal, and umbilical hernias found incidentally on imaging. While these have a reasonably high rate of requiring an eventual repair, it is likely safe to monitor these hernias after the patient has received counseling on monitoring the hernia for symptoms in the future.<sup>17,24</sup>

## SURGICAL MANAGEMENT OF ABDOMINAL WALL HERNIA IN THE ACUTE SETTING

Basic principles of acute hernia repair include evaluating the incarcerated contents for evidence of ischemia or necrosis, reducting the hernia contents, and reconstructing the abdominal wall defect. Acute hernia repair surgery can be performed using open, laparoscopic, or robotic techniques depending on patient factors and surgeon experience. Laparoscopy can be helpful in assessing bowel perfusion and viability if there are concerns for strangulation. The use of minimally invasive approaches to EGS hernia repair is increasing, is safe, and is associated with decreased wound complications and hospital length of stay.<sup>25–27</sup> Regardless of the approach, the goal of a hernia repair surgery should be to perform an operation that yields the greatest chance of a durable repair while minimizing the risk of harm to the patient. In the setting of acute hernia reconstruction, the risks of mesh infection must be weighed against the risk of hernia recurrence (Figure 2).<sup>28</sup>

- H. Not every operative intervention involving a hernia will provide the opportunity to perform the "definitive operation." After initial surgical exploration of the abdomen and evaluation of the hernia contents, a determination should be made as to whether the operation will be used as the first in a staged hernia repair approach or if the definitive hernia repair should be performed. The staged repair will adequately address the hernia in the short term but will result in either a high likelihood of recurrence or just provide temporary control of the hernia while the patient can be better optimized for definitive repair in the future.<sup>29</sup> Contraindications to definitive repair include patient instability, sepsis, comorbidities, or large abdominal wall defects that are inappropriate for definitive repair in the acute setting.
- I. Definitive hernia repair can be pursued in the absence of clear contraindications. Options for the type of repair depend on wound class (Table 3), as the presence of bowel ischemia or contamination at the time of surgery must be considered.<sup>30,31</sup> Patient factors should also be a consideration before pursuing

TABLE 3.	Surgical	Wound	Classification <sup>30</sup>
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Wound Class	Description
Class I Clean	Uninfected wounds without inflammation; alimentary, respiratory, genital, or urinary tracts not entered
Class II Clean-contaminated	Alimentary, respiratory, genital, or urinary tracts entered elective under controlled circumstances; no unusual spillage or contamination
Class III Contaminated	Open, fresh, accidental wounds; gross spillage from gastrointestinal tract; major breaks in sterile technique; incisions in which acute nonpurulent inflammation is encountered
Class IV Dirty/infected	Old traumatic wounds with retained or devitalized tissue; wounds with existing clinical infection; perforated viscera

definitive repair, including tobacco use, uncontrolled diabetes, cancer, cirrhosis, large volume ascites, severe obesity, and the presence of an unrelated infection that will increase the risks of repair failure in the postoperative period.<sup>32</sup> While the absolute risks of each factor may be hard to estimate for each patient, they should be considered in conjunction with the specific repair being considered.

When the case is clean (wound class I), the majority of groin hernias should be addressed with the use of a flat synthetic mesh and the avoidance of plug placement, similar to elective repair.<sup>33</sup> For ventral hernias in wound class 1, very small defects may likely be closed adequately with only a primary repair with a slowly absorbable suture.<sup>34</sup> Most ventral hernias in both the elective and acute setting, however, are best addressed with the achievement of fascial closure and the placement of a permanent mesh as reinforcement to this repair (with a fourfold reduction in recurrence rates described).<sup>35</sup>

J. When no definitive contraindications exist to definitive repair but the surgical site is not clean, as in the case of patients requiring bowel resection without gross spillage (clean-contaminated, wound class II), an attempt at definitive care of groin and ventral hernias should be considered. Acute groin hernias can be approached via a standard anterior approach taking care not to reduce the hernia contents prior to visualization to assess bowel viability. A preperitoneal approach can also be used, as it allows for good visualization of the bowel prior to reduction. If a bowel resection is required, the peritoneum can be opened to perform bowel resection and to run the bowel to ensure adequate perfusion. Regardless of operative approach, a groin hernia repair with synthetic mesh can be used in wound class II.<sup>36,37</sup> A nonmesh repair using the Shouldice technique, or other standard approaches to tissue-based repair, can be considered after shared decision-making with the patient, in circumstances where the patient does not want a mesh repair and is willing to accept a higher risk of recurrence.<sup>32</sup>

Specific caveats should be considered for ventral hernia repair in clean-contaminated cases. Based on current data for ventral hernia repair in wound class II, mesh repair is recommended with uncoated, midweight, macroporous polypropylene mesh, and its placement must be within an extraperitoneal layer of the abdominal wall (typically the retro-rectus plane).<sup>38</sup> While definitive repair with synthetic mesh can be justified with the currently available evidence, it should be understood that there will be a higher risk of infection and wound complication given the wound class. These wounds and mesh-related complications can result in chronic mesh infection, the need for reoperation, mesh removal, and fistula formation, which must be weighed against improved recurrence rates when synthetic mesh is used.<sup>39,40</sup> In 2022, Rosen et al.<sup>41</sup> demonstrated a fourfold decrease in hernia recurrence at a 2-year follow-up (20.5% vs. 5.6%, p = 0.001) when macroporous polypropylene mesh was used compared with a resorbable biologic mesh. These repairs were done in an elective setting with large hernias, almost all of which were managed with an open transversus abdominis release technique, with operations classified as either wound class II or III included in the study. Rates of infection were similar between the two groups.<sup>41</sup> However, these results have not been consistently reproduced in other prospective studies (although with less uniform surgical technique and mesh utilization), showing similar recurrence rates between mesh types but with worse in-fectious outcomes with synthetic mesh.<sup>42,43</sup> When extraperitoneal mesh placement cannot be safely achieved during the index operation, the decision to perform a staged ventral hernia repair should be made.

K. Staged repair should be pursued in the emergent setting when the risks of a permanent mesh are deemed too great to justify its use. This will be in heavily contaminated and dirty fields (wound classes III and IV), and after damage control surgery when the patient is felt to have a high likelihood of needing additional surgical procedures (either planned or unplanned) that would disrupt the hernia repair or if there is an inability to close the fascia without advanced abdominal wall reconstruction techniques that the surgeon is uncomfortable performing.44,45 There are data supporting synthetic, permanent mesh placement in contaminated fields (wound class III), but this comes from an elective setting with reasonably optimized patients.<sup>41</sup> Given the increased risk of complications in the emergency surgery setting, a more conservative approach for permanent mesh placement in this context is prudent. A staged repair encompasses several possible approaches, all contemplating a higher failure rate or a planned definitive repair under more optimal conditions in the future. A primary suture repair using slowly absorbable sutures without mesh reinforcement is adequate if the fascia can be closed. Temporary reinforcement of the fascial closure with the variety of absorbable meshes available can also be considered to reduce early recurrence/dehiscence, particularly if the hernia defect is large (>3 cm).<sup>46</sup> If the fascia cannot be closed, a bridging absorbable mesh should be used to provide temporary support in the acute setting and prevent immediate evisceration postoperatively. The ideal type of absorbable mesh to be used either as temporary reinforcement or as a bridge has not been established. Biologic, biosynthetic, or rapidly absorbable mesh such as polyglactin (Vicryl) has shown utility in these settings and is an ongo-ing area of active research.<sup>47–49</sup> Groin hernias within a heavily contaminated field will also be at higher risk for infectious complications. The role of absorbable meshes in this situation for groin hernias is unproven. Tissue repair should be

considered in inguinal hernia repairs with a high degree of contamination. The Shouldice technique is recommended by the 2023 HerniaSurge Guidelines for nonmesh inguinal hernia repair due to lower recurrence rates compared with other suture repairs and should be considered if the surgeon has experience with this technique.<sup>33,50</sup>

Patients presenting with acute, complicated abdominal wall hernias are at risk of potentially devastating complications if the diagnosis of strangulation is missed or delayed. Similar to other EGS disease processes, patients requiring surgical intervention for acute complications of abdominal wall hernias are at significant risk of serious postoperative complications.<sup>51</sup> A thoughtful systematic approach to patients presenting with acute issues related to abdominal wall hernia is required. Improved standardization of care may allow for prospective data analysis to identify best practices and guide future research designed to answer specific questions regarding decision-making and operative repair for acute abdominal wall hernias.

#### AUTHORSHIP

D.M., T.W.C., and R.C. contributed in the conception and study design. D.M., T.W.C., and L.N. contributed in the literature review. D.M., T.W.C., and R.C. contributed in the drafting of the manuscript. T.W.C., D.M., R.W., L.N., W.L.B., J.J.D., K.I., A.S., D.H.L., and R.C. contributed in the critical revision.

#### DISCLOSURE

Conflicts of Interest: Author Disclosure forms for all authors have been supplied and are provided as Supplemental Digital Content (http://links.lww. com/TA/E335).

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