



# Emergency Management of Curling Ulcers: Exploring Strategies for Timely Diagnosis and Intervention in Critical Care Settings



Nadia Nishat<sup>1</sup>, Miguel Eduardo Rodriguez-Rodriguez<sup>2,3</sup>, Chinyere Pamugo<sup>4</sup>, Vianka Vanessa Yanez Montalvo<sup>5</sup>, Marcellina Nwosu<sup>6</sup>, Daniel Arias Vargas<sup>7</sup>, Marcela Garzon Olave<sup>8</sup>, Susy Elizabeth Alfaro Pereira<sup>9</sup>, Sandra Estefanía Mejía Ruiz<sup>10</sup> and Maria Isabel Gomez Coral<sup>11\*</sup>

<sup>1</sup>Mandya Institute of Medical Sciences, India

<sup>2</sup>Universidad de Oriente, Venezuela

<sup>3</sup>Larkin Community Hospital, Miami, Florida

<sup>4</sup>University of Texas Houston, Health Science Center, USA

<sup>5</sup>Universidad de Guayaquil, Ecuador

<sup>6</sup>American University of Integrative Sciences, Barbados and El Paso Interventional Pain Center

<sup>7</sup>Universidad de Ciencias Medicas, Costa Rica

<sup>8</sup>Universidad de los Andes, Colombia

<sup>9</sup>Universidad Nacional de El Salvador

<sup>10</sup>Instituto Politécnico Nacional, México

<sup>11</sup>Universidad del Valle de México, México

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\*Corresponding author: Maria Isabel Gomez Coral, Universidad del Valle de México, México. Email: mariaisagcoral@gmail.com

## Abstract

Curling ulcers, a type of stress-related mucosal damage, present a significant challenge in critical care settings due to their propensity for rapid onset and potentially severe complications. Prompt diagnosis and intervention are crucial to mitigate the risk of gastrointestinal bleeding, perforation, and other adverse outcomes associated with these ulcers. This review explores various strategies and protocols to facilitate the early diagnosis of curling ulcers in critical care settings. Bedside assessments, including thorough physical examinations and point-of-care testing, are initial screening tools to identify patients at risk for developing curling ulcers. Additionally, imaging modalities such as abdominal X-rays, computed tomography (CT) scans, and endoscopic evaluation are essential in expediting the diagnosis and guiding management decisions. The review discusses the role of these diagnostic tools in identifying characteristic findings associated with curling ulcers, such as gastric distention, mucosal erosions, and active bleeding. Furthermore, the review highlights the importance of a multidisciplinary approach in the emergency management of curling ulcers, involving collaboration among surgeons, intensivists, gastroenterologists, and nursing staff. Early recognition of risk factors, timely diagnostic evaluations, and prompt initiation of appropriate interventions are essential to effective management strategies. The review offers recommendations for optimizing the emergency management of curling ulcers in critical care settings and suggestions for future research to enhance our understanding and improve clinical outcomes in this challenging patient population.

**Keywords:** Curling Ulcers; Stress-related Mucosal Damage; Critical Care; Emergency Management

**Abbreviations:** GI: Gastrointestinal; NSAID: Nonsteroidal Anti-inflammatory Drug; COVID-19: Coronavirus Disease 2019; SUP: Stress Ulcer Prophylaxis; PPI: Proton Pump Inhibitor; H2RA: Histamine-2 Receptor Antagonist; MODS: Multiple Organ Dysfunction Syndrome; TNF- $\alpha$ : Tumor Necrosis Factor-alpha; MMPs: Matrix Metalloproteinases; CT: Computed Tomography; GERD: Gastroesophageal Reflux Disease; PUD: Peptic Ulcer Disease; CRP: C-reactive Protein

## Introduction

Stress ulcers, a consequence of stress-induced gastritis or gastropathy, occur when the mucosal barrier of the gastric, esophageal, or duodenal lining is disrupted due to severe acute illness. Among these, Curling ulcers, typically from systemic burns

affecting approximately 30% or more of the body, represent a critical subset. While stress ulcerations commonly affect the gastric body and fundus, they can also manifest in the antrum and duodenum, resulting from systemic stress-induced mucosal damage, leading to multiple superficial erosions [1]. The clinical

presentation of stress ulcers often manifests as acute upper gastrointestinal bleeding, characterized by symptoms such as hematemesis or melena, particularly in patients with acute critical illnesses. Additional symptoms may include coffee ground vomitus, abdominal pain, nausea, and orthostasis, particularly in severe cases. Complications of Curling ulcers can be severe, ranging from anemia to strictures, perforation, peritonitis, hemorrhagic shock, and even death [1].

Diagnosis typically involves esophagogastroduodenoscopy, while nonpharmacological interventions encompass early enteral feeding, nasogastric tube placement, intravenous fluid resuscitation, blood transfusion, and coagulopathy reversal [1]. Pharmacological management strategies include proton pump inhibitors, antihistamines, and sucralfate, with endoscopic therapies such as epinephrine injection, electro-cauterization, or clipping of bleeding vessels being potential options. Surgical intervention becomes necessary for patients with refractory bleeding who are hemodynamically unstable [1]. However, timely diagnosis and intervention of Curling ulcers in emergencies pose significant challenges, given the complexity of patient presentations, diagnostic difficulties, limited treatment options, and the potential for complications. Effective management necessitates a multidisciplinary approach, requiring coordinated efforts, adequate resources, and ongoing education and training of healthcare providers in emergency medicine and critical care. This article offers a comprehensive overview of the management and early diagnosis of Curling ulcers in critical care patients, addressing these challenges and providing insights into optimal patient care.

## Pathophysiology and Etiology of Curling Ulcers

Stress ulceration results from damage to the mucosal barrier secondary to systemic stress, resulting in multiple superficial erosions of the gastric mucosa. The pathological changes lead to ulceration due to an impaired mucosal barrier. The mucosal glycoprotein is denuded by increased refluxed bile salts or uremic toxins due to a critical illness. Increased secretion of gastric acid in response to higher secretion of gastrin hormone in patients is also thought to be responsible for stress ulceration. However, this is more commonly seen in patients with acute neurological trauma than other stress-related diseases [2]. The cascade of events is initiated by physical aggression or severe trauma, which acts as a catalyst for a dysregulated stress response. Exponential release of catecholamines and glucocorticoids, central mediators of the stress response, leads to peripheral vasoconstriction and hemodynamic redistribution that compromises the blood perfusion to the gastrointestinal mucosa, generating an environment of hypoxia and ischemia, which results in a decrease of synthesis and release of gastroprotective prostaglandins, responsible for maintaining the integrity of the mucosal barrier,

thereby resulting in decreased production of bicarbonate and mucus [3]. Gastrointestinal microcirculation and the mucus layer normally maintain the integrity of the gastric mucosa by providing nourishment, eliminating hydrogen ions, oxygen radicals, and other toxic substances, and increasing bicarbonate secretion to neutralize hydrogen ions [4-6]. Ulceration occurs when the mucosal barrier is compromised and can no longer block the detrimental effects of hydrogen ions and oxygen radicals [4].

Simultaneously, tissue ischemia and hypoxia promote the excessive release of free radicals and reactive oxygen species, which perpetuates oxidative stress and causes direct cellular damage. Cell membrane injury and the activation of the complement system incites a progressive and exacerbated inflammatory response, characterized by the dysregulated release of proinflammatory cytokines, such as tumor necrosis factor-alpha (TNF- $\alpha$ ) and interleukins, which in turn contributes to tissue damage and a mucosal barrier breakdown [6]. The exacerbated inflammatory response also promotes the activation of immune system cells, such as neutrophils, which infiltrate the damaged mucosa and release proteolytic enzymes, such as matrix metalloproteinases (MMPs), that degrade the extracellular matrix and accentuate mucosal damage [1]. In addition, two important molecular regulators of vascular tension are dysregulated in critical illness. While the production of a vasodilator nitric oxide is reduced, the level of endothelin-1, a strong vasoconstrictor, is significantly increased [1,8,9]. *Helicobacter pylori* infection has also been associated with stress ulcers, though the evidence is limited. There could be a subgroup of critical care patients who may present with overt GI bleeding without stress ulceration or stress-related mucosal damage (SRMD), such as a patient with variceal bleeds, vascular anomalies, or diverticulosis. Hence, these GI bleeds may not respond adequately to stress ulcer prophylaxis (SUP) or antireflux therapy with proton pump inhibitors (PPI) or antihistaminic [2].

## Clinical Presentation and Diagnostic Challenges

Curling ulcers, encountered often in critically ill patients secondary to systemic burns, can present as upper abdominal discomfort, nausea, coffee ground vomitus, and potential complications such as gastrointestinal bleeding, Orthostasis, or death [1]. Also, the etiology of stress ulcers is closely tied to severe physiological stressors, often stemming from conditions like burns, trauma, extensive surgeries, infections, and alterations in various immunomodulatory and anti-inflammatory effects [1,12]. It may present "like erosive gastritis, which may be asymptomatic lesions and occult gastrointestinal (GI) bleed to aggressively clinically significant GI bleeding, anemia, and death" [13]. Research has shown the critical need to recognize and address underlying stressors and risk factors associated with curling ulcers and their prevention [1].

Utilizing prophylactic measures to prevent curling ulcers in critically ill patients has been very effective [9].

Stress ulcer prophylaxis medications and enteral nutrition have been discussed as practical strategies to mitigate the risk of ulcer development [1]. In a recent study conducted by Song, M.J., et al., the authors opined that “prophylactic treatment of stress ulcer with a histamine-2 receptor blocker reduces the risk of gastrointestinal bleeding” [9]. Also, according to Ohbe, H., et al., it’s imperative to note that calorie count, route, nutrition method, and nutritional components are crucial factors in treating critically ill patients to prevent malnourishment or overfeeding [11]. Hence, the management of curling ulcers in critically ill patients using explorative measures such as endoscopy and medical interventions enhances the multidisciplinary care approach, which is very significant in early diagnosis and intervention to prevent complications such as bleeding or death [10].

## Challenges in Diagnosing Curling Ulcers

Challenges in diagnosing curling ulcers in emergency situations stem from the complexity of symptoms that often overlap with various gastrointestinal conditions, necessitating careful consideration and differentiation. Limited accessibility to diagnostic tools in emergency settings further compounds the difficulty in accurately diagnosing curling ulcers. Differential diagnoses such as acute gastritis, gastroesophageal reflux disease (GERD), and peptic ulcer disease (PUD) must be meticulously evaluated to avoid misdiagnosis and ensure timely intervention for positive patient outcomes [12-14].

## Differential Diagnoses

Among the myriad of potential differentials, distinguishing curling ulcers from conditions like NSAID-induced gastritis, alcoholic gastropathy, and various malignancies requires a comprehensive understanding of clinical presentations and diagnostic criteria [1]. Endoscopy stands as a vital tool in the diagnostic arsenal, facilitating direct visualization and grading of ulcer severity, while computed tomography (CT) scans offer detailed imaging for detecting complications associated with abdominal problems, especially in emergency situations such as the COVID-19 pandemic [15,16].

## Diagnostic Modalities

Navigating the challenges of diagnosing curling ulcers in emergency scenarios, a nuanced approach involving the use of appropriate diagnostic modalities is essential. Endoscopy stands out as a cornerstone, enabling direct visualization and grading of ulcer severity, while computed tomography (CT) scans offer valuable detailed imaging for detecting complications, particularly crucial in emergency situations like the COVID-19 pandemic, providing quick assessment and analysis. A multidisciplinary perspective, along with awareness of potential differential diagnoses, is imperative for ensuring efficient and accurate diagnoses in emergency settings [15,16].

## Strategies for Timely Diagnosis

In critical care settings, timely diagnosis of curling ulcers is imperative to prevent complications and optimize patient outcomes. Various strategies and protocols have been developed to facilitate early detection of these ulcers. Bedside assessments play a crucial role in the initial evaluation of critically ill patients, allowing clinicians to identify early signs and symptoms suggestive of curling ulcers. These assessments may include thorough physical examinations focusing on abdominal tenderness, gastrointestinal bleeding, and hemodynamic instability, as well as assessment of risk factors such as mechanical ventilation, severe burns, or prolonged periods of critical illness [17]. Additionally, point-of-care testing, such as gastric pH monitoring or occult blood testing, can provide rapid diagnostic information at the patient’s bedside, aiding in promptly identifying curling ulcers [18].

In conjunction with bedside assessments and point-of-care testing, imaging modalities serve as valuable tools in expediting the diagnosis of curling ulcers. Abdominal imaging, such as abdominal X-rays or computed tomography (CT) scans, can help identify characteristic findings associated with curling ulcers, such as pneumoperitoneum, free intraperitoneal air, or gastric distention [19]. While not typically performed at the bedside, endoscopic evaluation allows for direct visualization of the gastrointestinal mucosa. It facilitates the diagnosis of curling ulcers by identifying mucosal erosion, ulcerations, or active bleeding [20]. Furthermore, other diagnostic tools, such as fecal occult blood testing or serum biomarkers like C-reactive protein (CRP) or procalcitonin levels, may also contribute to the early detection of curling ulcers in critically ill patients [21].

## Emergency Intervention and Management Approaches

In critically ill patients, prompt intervention is essential to manage curling ulcers effectively and prevent complications. Current approaches to emergency intervention and management of curling ulcers encompass a range of pharmacological, endoscopic, and surgical modalities tailored to the severity of the ulcer and the patient’s clinical condition. Pharmacological interventions often serve as first-line therapy, with proton pump inhibitors (PPIs) being widely used to reduce gastric acid secretion and promote ulcer healing [22]. Additionally, histamine-2 receptor antagonists (H2RAs) may be adjunctive therapy to suppress gastric acid production further and alleviate symptoms [23]. These medications play a crucial role in mitigating mucosal damage and preventing ulcer progression, particularly in patients at high risk for stress-related gastrointestinal complications. Endoscopic therapies may be indicated in cases of refractory or severe curling ulcers to achieve hemostasis, promote ulcer healing, and prevent rebleeding. Endoscopic interventions such as injection sclerotherapy, thermal coagulation, or application of hemostatic agents can effectively control active bleeding and provide immediate relief of symptoms [24]. Endoscopic techniques also allow for the direct visualization of the ulcer site, enabling targeted

interventions and assessment of treatment response. In instances where conservative measures and endoscopic interventions are inadequate, surgical intervention may be necessary to address complications such as perforation, massive bleeding, or gastric outlet obstruction. Surgical procedures such as gastrectomy, vagotomy, or pyloroplasty may be performed to manage refractory ulcers or complications requiring definitive surgical management [25]. Close collaboration between surgical and critical care teams is essential to ensure timely and appropriate interventions for patients with curling ulcers in emergency settings.

## Complications

Prompt identification and timely intervention for patients diagnosed with curling ulcers are crucial for averting potential complications [1,26]. These complications can be prevented through a thorough history and adequate symptom assessment and follow-up through an interdisciplinary team approach involving physicians (including Gastrointestinal (GI) specialists, Surgeons, and internists), nurses, and pharmacists for diagnosis and management [1,26]. Three primary implications of curling ulcers include hemorrhage, perforation, and gastric outflow blockage due to strictures [1,26]. Other complications of curling ulcers include anemia, strictures, peritonitis, gastrocolic fistula, hemorrhagic shock, extended length of intensive care stay, and death [1]. Other complications associated with surgery in patients with bleeding or perforated ulcers cannot be undermined, such as pneumonia, wound infections, reoperation, wound dehiscence, postoperative leak, intestinal obstruction, and drainage of subphrenic and pelvic abscesses [27].

Among these complications, bleeding is the most prevalent and leads to 50,000-70,000 emergency room admissions annually [28]. As a result of the bleeding, around 5-10% of patients who have bleeding curling ulcers will experience fatal outcomes. Factors that increase the likelihood of death include advanced age, presence of other medical conditions, usage of nonsteroidal anti-inflammatory drugs (NSAIDs), and hemodynamic instability [28]. Typically, gastric wall perforation resulting in peritonitis or necrosis occurs in approximately 2% to 10% of patients with deep curling ulcers. Patients suffering from gastric perforations exhibit intense and widespread abdominal pain. Most of these instances necessitate surgical intervention; however, only a tiny percentage of gastric perforations will spontaneously seal off [1]. Hemigastrectomy and vagotomy are necessary for the treatment of perforation and severe bleeding, as other less invasive techniques have not proven to be beneficial. The mortality rate for patients who experience free wall gastrointestinal perforation and do not undergo surgical intervention is around 100% [1,30]. Gastric outlet obstruction is the least common complication of curling ulcers [1,26].

## Prognosis

The prognosis and outcomes for patients with curling ulcers undergoing emergency intervention and treatment are influenced by various factors, including the severity of the ulcer, the timeliness of intervention, and the presence of underlying comorbidities. Early recognition and prompt initiation of appropriate management strategies can significantly improve patient outcomes and reduce the risk of complications such as gastrointestinal bleeding, perforation, or sepsis [29]. However, despite advances in diagnostic and therapeutic modalities, curling ulcers remain associated with considerable morbidity and mortality, particularly in critically ill patients with multiple organ dysfunction syndrome (MODS) or those requiring mechanical ventilation [31]. In cases where emergency intervention successfully controls acute bleeding or resolves ulcer-related complications, the prognosis for patients with curling ulcers may be favorable, with many individuals experiencing complete resolution of symptoms and ulcer healing over time [32]. However, the long-term prognosis can be influenced by the presence of underlying medical conditions, the extent of mucosal damage, and the development of recurrent ulcers or complications. Close monitoring and follow-up care are essential to assess treatment response, prevent ulcer recurrence, and address any ongoing gastrointestinal issues or nutritional deficiencies that may impact patient outcomes [33].

## Future Directions and Recommendations

Future directions in the emergency management of curling ulcers in critical care settings should focus on optimizing diagnostic and therapeutic approaches to improve patient outcomes. It is essential to implement standardized protocols and guidelines for the early identification and management of curling ulcers, emphasizing the importance of multidisciplinary collaboration among healthcare providers. This includes the development of risk stratification tools to identify patients at high risk for developing curling ulcers and implementing targeted preventive strategies, such as stress ulcer prophylaxis, in high-risk populations [23]. Furthermore, efforts should be made to enhance clinician education and awareness regarding the clinical presentation, diagnostic evaluation, and management of curling ulcers to ensure timely intervention and reduce the incidence of complications [19].

In addition to clinical interventions, future research endeavors should focus on advancing diagnostic techniques and therapeutic modalities for curling ulcers in critical care settings. This includes exploring novel biomarkers, imaging modalities, and point-of-care testing platforms to facilitate early diagnosis and risk stratification of curling ulcers [25]. Moreover, there is a need for further research to evaluate the efficacy and safety of emerging



pharmacological and endoscopic therapies for the management of curling ulcers, particularly in high-risk patient populations [20]. Quality improvement initiatives should also be implemented to enhance healthcare delivery processes and optimize resource utilization in the emergency management of curling ulcers, ultimately improving patient outcomes, and reducing healthcare costs [26].

## Conclusion

The management of curling ulcers in critical care settings presents a multifaceted challenge requiring a comprehensive approach to optimize patient outcomes. With a thorough understanding of the pathophysiology, clinical presentation, and diagnostic challenges associated with curling ulcers, healthcare providers can implement timely interventions to mitigate complications and improve prognosis. Strategies for timely diagnosis, including bedside assessments, point-of-care testing, and imaging modalities, play a pivotal role in expediting treatment and preventing adverse outcomes. Moreover, a multidisciplinary approach involving collaboration among various healthcare specialties is essential for delivering effective emergency management of curling ulcers. Moving forward, future research and quality improvement initiatives should focus on enhancing diagnostic techniques, refining therapeutic modalities, and implementing standardized protocols to optimize the emergency management of curling ulcers. By addressing gaps in knowledge and implementing evidence-based interventions, healthcare providers can further improve outcomes for critically ill patients with curling ulcers, ultimately reducing morbidity and mortality associated with this condition. A proactive and integrated approach to emergency management, coupled with ongoing research and quality improvement efforts, holds promise for advancing the care of patients with curling ulcers in critical care settings and improving overall clinical outcomes.

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