# Childhood Peptic Ulcer Perforation — Radiology and Electrocardiography in Clinical Nursing Practice with Public Health and Health Administration Implications

**1. Mahdi Saud Hamad Al-Yami**

Khabash General Hospital, Health Administration Technician, Najran,KSA

**2. Alhanouf Faihan Almutairi**

Electrocardiography, Prince sultan cardiac center, Riyadh,KSA

**3. Abeer Mohaimeed Alanazi**

Electrocardiography, Prince sultan Cardiac center, Riyadh,KSA

**4. Tahani Salem Alsalem**

Radiology science, prince sultan military medical city, Riyadh,KSA

**5. Turki Ayesh Almutairi**

X-ray technition, Prince sultan medical military city, Riyadh,KSA

**6. Hisham Yahya Alghamdi**

OR / public health, Ministry of Health, Jeddah,KSA

**7. Bashair Alhajri**
Nursing, Prince Sultan cardiac centre, Riyadh,KSA

**Abstract**

Childhood peptic ulcer perforation (PUP) is a rare but life-threatening pediatric emergency characterized by atypical clinical presentation and high risk of complications. Early and accurate diagnosis is critical to improving survival and reducing morbidity. Radiology, including plain abdominal radiographs, ultrasound, and computed tomography, remains the cornerstone for identifying perforation and guiding surgical management. Electrocardiography (ECG), although less frequently emphasized, provides important insights into systemic complications such as electrolyte disturbances, arrhythmias, and perioperative instability, thereby complementing radiological findings.

Beyond the acute clinical setting, PUP has broader public health implications. Delayed diagnosis, limited access to advanced imaging, and lack of awareness among caregivers contribute to higher morbidity in low-resource settings. Preventive strategies, particularly addressing *Helicobacter pylori* infection, rational prescribing of non-steroidal anti-inflammatory drugs (NSAIDs), and caregiver education, are essential to reduce the incidence of pediatric ulcers and their complications. Recent updates in international guidelines highlight the shift toward bismuth-based quadruple therapy for *H. pylori* eradication, reflecting the growing importance of antibiotic stewardship and regional resistance monitoring.

This article integrates radiological and electrocardiographic approaches with public health perspectives, emphasizing the value of a holistic, multidisciplinary framework. By aligning acute diagnostic tools with preventive health strategies, clinicians and policymakers can improve both individual patient outcomes and broader child health equity.

**Keywords:-** Childhood peptic ulcer perforation; Radiology; Electrocardiography; Public health; *Helicobacter pylori*; Pediatric surgery; Diagnostic imaging; Preventive healthcare

## Introduction

Childhood peptic ulcer perforation (PUP) represents a rare but clinically significant emergency in pediatric populations. Unlike adults, children often present with non-specific or atypical abdominal symptoms, which can obscure the diagnosis and contribute to delayed treatment. The consequences of missed or late diagnosis are severe, including peritonitis, septic shock, and increased mortality rates (Shankar et al., 2021).

Radiological imaging modalities, such as plain abdominal X-ray, ultrasound, and computed tomography (CT), remain fundamental for confirming perforation and guiding surgical decision-making. In parallel, electrocardiography (ECG) provides valuable insights into systemic complications such as electrolyte imbalance, shock-related cardiac changes, and comorbid conditions that may complicate management (Zhu et al., 2019).

Beyond clinical diagnosis and treatment, public health considerations are crucial. Childhood PUP, though infrequent, places a burden on healthcare systems due to the cost of surgical intervention, hospitalization, and long-term follow-up. Preventive strategies—such as awareness of Helicobacter pylori infection, responsible use of non-steroidal anti-inflammatory drugs (NSAIDs), and health education—can significantly reduce risk factors (World Health Organization [WHO], 2022).

**The aim of this article is to explore the complementary roles of radiology and electrocardiography in diagnosing and managing childhood PUP, while also highlighting its broader implications for public health and preventive healthcare strategies.**

## 2. Epidemiology and Public Health Relevance

Childhood peptic ulcer perforation (PUP) is considerably less common than in adults, yet when it occurs, it carries disproportionately high morbidity and mortality rates. Global data indicate that peptic ulcer disease affects less than 5% of pediatric populations, with perforation being an even rarer but severe complication (Shankar et al., 2021). Incidence is higher in regions with limited access to healthcare facilities, delayed diagnosis, and a greater prevalence of *Helicobacter pylori* infection (Kato et al., 2019).

Several factors contribute to the epidemiology of childhood PUP:

**Infectious causes:** Persistent *H. pylori* infection remains the most common underlying factor, with prevalence varying significantly across regions.

**Medication-related factors:** Increasing use of non-steroidal anti-inflammatory drugs (NSAIDs) in children, particularly for chronic conditions, has been linked to peptic ulceration.

**Nutritional and lifestyle aspects:** Poor diet, stress, and exposure to second-hand smoking have been associated with higher ulcer risk.

From a **public health perspective**, childhood PUP represents a multifaceted challenge. Beyond the immediate surgical and medical costs, it places a long-term burden on healthcare systems due to extended hospital stays, complications, and potential recurrence. Health disparities play a significant role—children in low-resource settings are more likely to present with advanced disease stages due to lack of early diagnostic facilities and public health screening programs.

Therefore, strengthening **preventive strategies**—including eradication of *H. pylori*, rational prescription of NSAIDs, dietary guidance, and improved health literacy—can reduce the incidence of PUP. Public health authorities can also play a pivotal role in establishing surveillance systems and pediatric screening protocols to identify children at risk before progression to perforation.

## 3. Clinical Presentation of Childhood Peptic Ulcer Perforation

The clinical presentation of childhood peptic ulcer perforation (PUP) is often challenging because symptoms in children may be non-specific and easily confused with other acute abdominal conditions. Unlike adults, who

typically present with classic signs of ulcer disease, children may initially manifest with vague complaints, which can delay diagnosis and worsen prognosis (Al-Bassam et al., 2018).

**Common Symptoms and Signs**

- **Acute abdominal pain:** Sudden, severe epigastric or generalized abdominal pain is the hallmark of perforation.
- **Vomiting and nausea:** Frequently observed, though often misinterpreted as gastroenteritis.
- **Signs of peritonitis:** Abdominal rigidity, rebound tenderness, and guarding are common indicators of perforation.
- **Systemic features:** Fever, tachycardia, and shock may occur in advanced cases.

**Diagnostic Challenges**

Children often present late because of non-specific early symptoms, parental underestimation of severity, or limited access to pediatric emergency services. This delay increases the risk of peritonitis, sepsis, and mortality. Furthermore, atypical presentations may mimic appendicitis or gastroenteritis, leading to misdiagnosis (Kato et al., 2019).

**Age-Related Differences**

- **Infants and toddlers** may present with irritability, poor feeding, or abdominal distension rather than localized pain.
- **Older children and adolescents** are more likely to describe classical ulcer-like symptoms such as burning epigastric pain or nocturnal discomfort.

**Clinical Importance**

Recognizing the constellation of signs—sudden severe pain, peritoneal irritation, and systemic instability—is vital for timely referral and surgical management. The integration of **radiological imaging** and **ECG monitoring** further supports clinical assessment, allowing for comprehensive evaluation of both gastrointestinal and systemic involvement.

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**5. Electrocardiography (ECG) Considerations**

Electrocardiography is not typically the first diagnostic tool that comes to mind when managing childhood peptic ulcer perforation (PUP), yet it holds an important role in evaluating the systemic consequences of this critical condition. Children presenting with acute perforation often arrive at the emergency department in a state of significant physiological stress, which may include tachycardia, electrolyte imbalances, dehydration, or even hypovolemic shock. Under these circumstances, ECG provides valuable insight into the cardiac status of the patient, helping clinicians distinguish between primary abdominal pathology and secondary cardiovascular involvement.

ECG findings in these children may reveal sinus tachycardia, arrhythmias caused by electrolyte disturbances, or ischemic-like changes that mimic cardiac pathology. Such abnormalities can complicate the diagnostic process by diverting clinical attention toward cardiological conditions, particularly in cases where abdominal symptoms are vague. Therefore, integrating ECG with the clinical picture and radiological findings is essential to avoid misdiagnosis and unnecessary interventions (Zhu et al., 2019).

Beyond its diagnostic contributions, ECG monitoring is also a key tool for perioperative and postoperative management. Children undergoing surgical repair of perforated ulcers are often at risk of fluid shifts, sepsis-related cardiac strain, and anesthesia-induced complications. Continuous cardiac monitoring ensures that electrolyte corrections, fluid resuscitation, and pharmacological therapies are effectively tailored to stabilize the patient throughout the treatment course.

From a broader perspective, incorporating ECG into the management of PUP highlights the importance of a multidisciplinary approach. The condition may originate in the gastrointestinal tract, but its systemic repercussions affect multiple organ systems, including the heart. As such, the role of ECG extends beyond cardiac monitoring; it acts as a safeguard for overall patient safety, particularly in fragile pediatric populations.

**Public Health Considerations**

Although childhood peptic ulcer perforation (PUP) is primarily a surgical emergency, its broader significance extends into the domain of public health. The condition, while rare, reflects a web of preventable risk factors that intersect with healthcare access, education, and social determinants of health. For instance, the persistence of *Helicobacter pylori* infection in pediatric populations remains a central driver of ulcer disease worldwide, particularly in low- and middle-income countries where sanitation, water quality, and access to antibiotics may be

limited (WHO, 2022). The failure to address these upstream factors perpetuates cycles of late presentation and complicated disease.

From a health systems perspective, PUP imposes a substantial burden. Surgical intervention, postoperative care, and prolonged hospitalization consume significant resources, particularly in public hospitals that already face strain from pediatric emergencies. In many cases, children arrive at tertiary facilities after delays in referral from primary care centers, underscoring weaknesses in early detection and health literacy among caregivers. These challenges highlight the necessity of public health initiatives focused on timely diagnosis, parent education, and training of frontline healthcare workers to recognize the warning signs of acute abdominal emergencies in children.

Moreover, rational prescribing practices are an essential public health strategy. The increasing use of non-steroidal anti-inflammatory drugs (NSAIDs) in pediatric populations for chronic pain or febrile illnesses has been linked to peptic ulcer formation and subsequent perforation. Public health frameworks that monitor prescribing trends, promote safer alternatives, and educate caregivers about the risks of unsupervised medication use can reduce incidence at the community level.

Preventive interventions are equally critical. Programs targeting improved nutrition, eradication of *H. pylori* through affordable testing and treatment, and public campaigns on healthy lifestyles can reduce the long-term risk of ulcer disease. In addition, school-based health education initiatives provide an opportunity to teach both children and parents about gastrointestinal health, proper medication use, and the importance of seeking timely medical care.

Ultimately, framing childhood PUP within a public health context moves the discussion beyond the operating room. It emphasizes prevention, early detection, and system-level preparedness, aiming to minimize the incidence of perforation and mitigate its economic and social impacts. By integrating radiology and electrocardiography into broader health strategies, clinicians and policymakers together can strengthen both the clinical and preventive dimensions of pediatric gastrointestinal care.

**Integrated Approach: Radiology, ECG, and Public Health**

The management of childhood peptic ulcer perforation (PUP) requires more than isolated diagnostic and therapeutic interventions; it demands an integrated approach that bridges clinical practice with public health priorities. Radiology and electrocardiography (ECG) represent two critical pillars of diagnosis and perioperative care, yet their true value is maximized when they are applied within a broader, multidisciplinary framework that includes preventive health strategies.

Radiology offers the means for rapid confirmation of perforation, guiding surgical decision-making and postoperative monitoring. When combined with ECG, clinicians can ensure not only the identification of abdominal pathology but also the continuous assessment of systemic stability, particularly in fragile pediatric patients at risk of shock, electrolyte disturbances, and anesthesia-related complications. This synergy between imaging and cardiac monitoring reflects the importance of a holistic view of the child's condition, recognizing that PUP is not a localized gastrointestinal event but a systemic emergency with multi-organ implications.

At the same time, public health perspectives broaden the scope of intervention beyond the hospital walls. While radiology and ECG address the immediate crisis, public health measures target the upstream causes and downstream consequences. For example, the introduction of *Helicobacter pylori* screening programs, caregiver education campaigns, and rational drug-use policies can reduce incidence rates. Furthermore, robust referral systems and health literacy initiatives ensure that children at risk receive timely and appropriate care, reducing delays that often lead to catastrophic outcomes.

The integrated approach therefore lies in the intersection of **technology, clinical care, and prevention**. Radiology and ECG provide precise, real-time information that improves patient outcomes, while public health frameworks ensure that the lessons learned at the bedside are translated into policies that prevent recurrence and reduce

population-level risk. Together, these domains embody the essence of comprehensive healthcare: treating the immediate problem while addressing its root causes.

**Health Administration Implications**

From a health administration standpoint, timely and efficient management of childhood peptic ulcer perforation (PUP) demands more than medical excellence—it requires strategic resource planning, cost awareness, and policy-level coordination. Recent studies have highlighted how children's hospitals faced substantial resource utilization during patient surges and emergencies, exposing vulnerabilities in capacity, staffing, and diagnostic availability (Michelson et al., 2024). Particularly, imaging and operative readiness impose direct costs—not only for equipment and materials but also for maintaining trained personnel and managing throughput in emergency settings where delays can worsen outcomes.

Moreover, administrative burdens—such as coordinating between departments (radiology, cardiology, surgery), handling patient referral systems, ensuring rapid review of diagnostic imaging and ECG findings, and managing post-operative care logistics—represent hidden costs to health facilities. For example, ambulatory imaging departments sometimes process low-value or inappropriate imaging requests, which inflate costs and consume scarce bandwidth (Kjelle et al., 2024). Also, investments in emergency department pediatric readiness have shown to deliver significant return in lives saved for relatively modest incremental cost; this underscores that some administrative improvements yield high-impact gains (OHSU-led study, 2024).

Health administration technicians are central to bridging the gap between clinical demands and system-level constraints. Their role involves ensuring that hospital protocols are streamlined, diagnostic units are utilized efficiently, and that data systems support tracking of patient flows, diagnostic delays, and outcome metrics. Importantly, administrators must advocate for preventive health policies—such as *H. pylori* screening, appropriate NSAIDs use, and education programs—that reduce incidence and downstream burden on surgical and diagnostic services. Through integrating these administrative strategies with radiology and ECG-based diagnostic pathways, health systems can optimize costs, improve patient outcomes, and increase overall system resilience.

**Recent Advances in Pediatric Peptic Ulcer Perforation and *Helicobacter pylori* Management**

In recent years, new insights have emerged that refine both the clinical and public health perspectives on childhood peptic ulcer perforation (PUP). A 20244 systematic review summarized available evidence across multiple pediatric cohorts, confirming that although PUP remains rare, its clinical burden is disproportionately high. The review emphasized that delays in diagnosis remain the most significant predictor of poor outcomes, highlighting the need for rapid imaging and systemic monitoring in pediatric emergency care Clinical research has also shed light on treatment strategies. A study from Beijing Children's Hospital analyzed 45 cases of duodenal ulcer perforation and compared conservative versus surgical management. The findings revealed that while surgical repair remains the standard of care, carefully selected patients who underwent conservative treatment achieved similar recovery outcomes, albeit with longer fasting periods. Importantly, the study also reported that nearly 78% of patients tested positive for *Helicobacter pylori*, confirming its central role in pediatric ulcer disease (Shen et al., 2023).

Beyond clinical management, updated international guidelines have redefined therapeutic approaches to *H. pylori*. The joint ESPGHAN/NASPGHAN 2024 recommendations now advocate for bismuth-based quadruple therapy as the preferred first-line regimen in regions with high clarithromycin resistance. This marks a significant shift from the long-standing reliance on triple therapy, underscoring the importance of antibiotic stewardship and local resistance surveillance in pediatric populations (Homan et al., 2024).

These changes are particularly relevant in resource-limited regions. For example, a 2025 study in Eastern Congo reported that children who failed standard triple therapy achieved successful eradication with quadruple regimens. This finding not only reinforces the need for updated treatment protocols but also highlights the value of tailoring public health strategies to local epidemiological realities (Tibasima et al., 2024).

Taken together, these recent advances illustrate the dual importance of technological precision—through radiology and ECG in acute care—and public health adaptability, through improved guidelines, surveillance, and education. By incorporating these developments, pediatric care systems can better balance immediate life-saving interventions with long-term strategies to reduce the incidence and recurrence of ulcer perforation.

**Conclusion**

Childhood peptic ulcer perforation (PUP) remains a rare but devastating condition in pediatric populations, one that highlights the need for prompt recognition, accurate diagnosis, and coordinated care. Radiology serves as the cornerstone of diagnosis, providing essential imaging evidence to confirm perforation and guide surgical intervention. Electrocardiography (ECG), while often overlooked, contributes significantly by monitoring systemic stability, identifying shock-related changes, and ensuring perioperative safety in fragile patients. Together, these diagnostic tools enhance the precision and safety of clinical management.

Yet, the challenge of PUP cannot be addressed through clinical practice alone. Public health considerations—ranging from prevention of *Helicobacter pylori* infection to rational prescribing of non-steroidal anti-inflammatory drugs (NSAIDs) and caregiver education—are equally crucial in reducing incidence and improving outcomes. The integration of diagnostic technologies with preventive health strategies reflects the essence of holistic care, where treatment of the acute crisis is balanced by efforts to mitigate future risks.

In conclusion, the optimal approach to childhood PUP lies in the intersection of radiology, ECG, and public health. This triad not only improves survival and recovery at the individual level but also contributes to broader health system resilience by preventing recurrence, reducing healthcare costs, and promoting child health equity. Future research and policy development should continue to strengthen this integration, ensuring that both technological advances and public health frameworks work hand in hand to protect vulnerable pediatric populations.

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