

Gastric Content Analysis in Clinical and Toxicological Investigations: Is It a Valuable Tool?

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Introduction

Poisoning is a major global health concern and remains a leading cause of preventable injury-related mortality worldwide. According to the World Health Organization, poisoning accounted for approximately 84,000 deaths globally in 2019. In Pakistan and other LMICs, poisoning continues to be a significant public health burden, with unintentional exposure contributing substantially to mortality. Self-poisoning is more prevalent in LMICs due to pesticide availability, socioeconomic stressors, and limited access to emergency toxicology services. In contrast, high-income countries report drug overdoses as the leading cause of poisoning-related deaths.^{1,2}

Initial management of suspected poisoning in emergency settings includes gastrointestinal decontamination strategies such as gastric lavage, activated charcoal administration, and supportive care.³ Gastric lavage is most effective when performed within one hour of ingestion; beyond this period, systemic absorption reduces its efficacy.⁴ Although the clinical use of gastric lavage has declined, gastric content analysis continues to provide valuable diagnostic and forensic information in selected cases. However, its role in modern toxicology remains under discussion due to methodological and economic limitations.

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Authors Contribution

HSM conceptualized the project. ZF, SA, ZZ & MU did the literature search, drafting, revision & writing of manuscript.

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Methods and Results

Clinical Applications

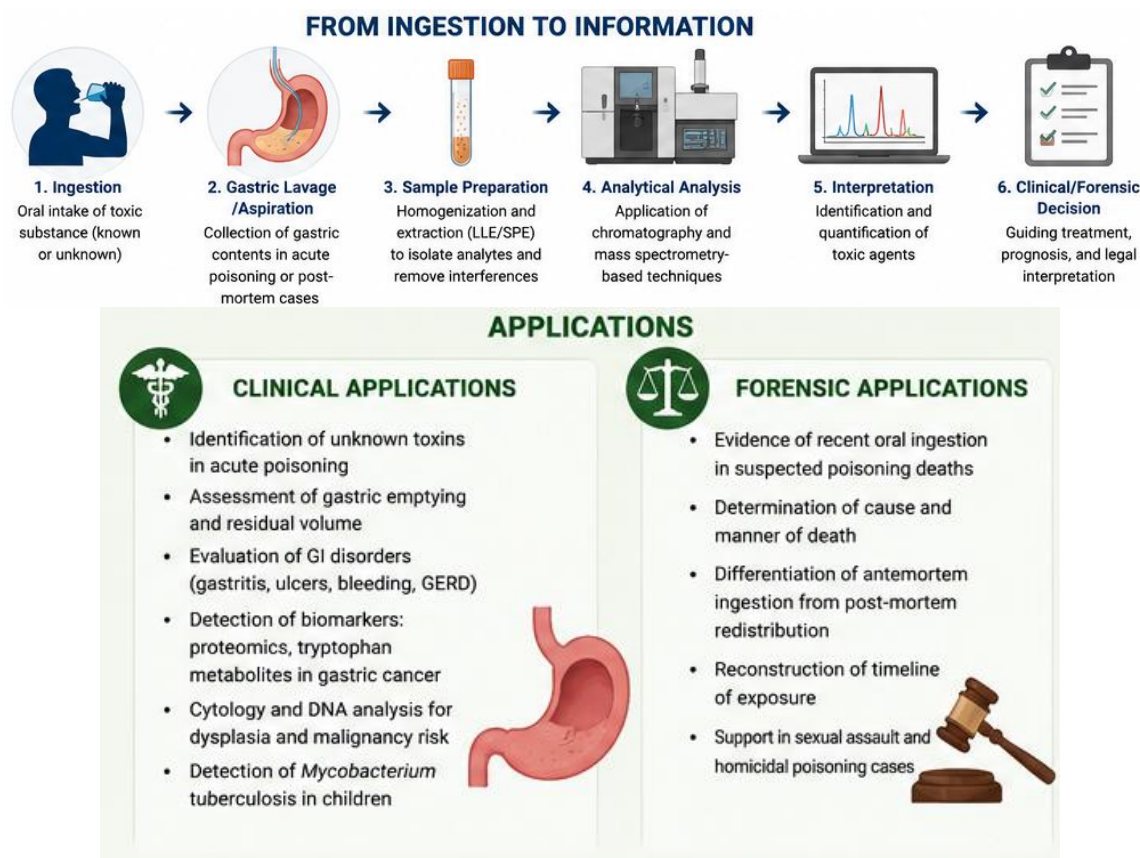
Gastric content analysis plays an important supportive role in clinical toxicology, particularly in acute poisoning cases where the ingested substance is unknown or patient history is unreliable. It enables early identification of toxic agents prior to full systemic absorption, thereby assisting clinicians in selecting appropriate antidotal therapy and supportive interventions. In intensive care settings, gastric analysis also contributes to the assessment of gastric physiology, including evaluation of gastric emptying,⁵ pH changes, and gastrointestinal bleeding.

Beyond toxicology, gastric content analysis has been explored in broader clinical contexts.⁶ Proteomic analysis of gastric juice has shown potential in identifying biomarkers for gastric cancer, while metabolomic profiling, including tryptophan pathway derivatives, has been associated with malignant transformation. Cytological evaluation of gastric lavage fluid can detect malignant cells, and DNA content analysis may assist in identifying dysplastic changes. Additionally, analyzing gastric aspirates facilitates microbiological confirmation in pediatric patients suspected of having tuberculosis.⁷

Forensic Applications

In forensic toxicology, gastric content analysis is a valuable tool for investigating suspected poisoning-related deaths. It provides direct evidence of recent oral ingestion and helps reconstruct the timeline of toxic exposure. The presence of unmetabolized drugs or toxins in gastric contents may indicate ingestion shortly before death, which is particularly useful in cases involving unknown substances.

However, interpretation of gastric findings requires caution due to post-mortem redistribution, decomposition, and variability in gastric emptying.^{8,9}



These factors may alter drug concentration and complicate interpretation. Therefore, gastric content results must always be correlated with blood, urine, and tissue toxicology findings to ensure accurate medico-legal conclusions. A summary of the process from ingestion to the final report, along with its clinical and forensic applications, is presented in Figure.

Analytical Techniques

Gastric content analysis relies on both conventional and advanced analytical techniques. Gas chromatography–mass spectrometry (GC-MS) and liquid chromatography–tandem mass spectrometry (LC-MS/MS) are considered gold standards due to their high sensitivity and specificity. High-performance liquid chromatography (HPLC) is widely used in routine toxicology

laboratories, while immunoassays provide rapid screening but suffer from limited specificity.⁸⁻¹¹

Sample preparation typically involves homogenization followed by liquid–liquid extraction or solid-phase extraction to reduce matrix effects.^{12,13} Emerging techniques such as electrospray laser desorption ionization–mass spectrometry (ELDI-MS) allow near real-time detection of toxins with minimal sample preparation.¹⁴ However, these techniques are still under validation and are not widely implemented in clinical practice.

Economic Implications

From an economic perspective, gastric content analysis provides significant diagnostic value but is associated with high operational costs.

Comparison of analytical methods

Method	Sensitivity	Speed	Cost	Limitation
GC-MS	High	Slow	High	Time-consuming analysis
LC-MS/MS	Very High	Moderate	Very High	Expensive instrumentation
HPLC	Moderate	Moderate	Moderate	Lower specificity
Immunoassay	Low-Moderate	Fast	Low	Cross-reactivity issues
ELDI-MS	High	Very Fast	High	Limited validation

The requirement for advanced instrumentation, trained personnel, and laboratory infrastructure limits its widespread adoption, particularly in LMICs such as Pakistan. Most emergency departments lack on-site toxicology laboratories, resulting in delays in diagnosis and treatment.

Despite these limitations, selective application in medico-legal cases and severe poisoning scenarios may be cost-effective due to improved diagnostic accuracy and reduced uncertainty. The development of point-of-care analytical devices and rapid mass spectrometry techniques may improve future cost-effectiveness and accessibility.

Limitations and Challenges

Gastric content analysis is limited by lack of standardized protocols, variability in gastric composition, and post-mortem degradation. These factors can significantly affect analytical reliability. Additionally, accessibility issues, particularly in resource-limited settings, restrict its clinical utility. As a result, gastric content analysis cannot be used as a standalone diagnostic tool and must be interpreted alongside other toxicological data.

Comments

Gastric content analysis remains a valuable adjunct in clinical and forensic toxicology. It provides direct evidence of recent ingestion and contributes to toxicological interpretation in poisoning cases. However, its utility is limited by methodological, economic, and infrastructural constraints. Future advancements in rapid analytical technologies and point-of-care systems may enhance their clinical relevance, particularly in resource-limited healthcare settings.

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