

Greenish-Blue Gastric Content: Literature Review and Case Report on Acute Copper Sulfate Poisoning

E. Nastoulis¹, M.-V. Karakasi^{1,2}, C. M. Couvaris¹, S. Kapetanakis³, A. Fiska³, P. Pavlidis¹

¹Laboratory of Forensic Sciences
School of Medicine
Democritus University of Thrace
Alexandroupolis, Greece

²Adult Psychiatry
Psychiatric Department
G. Papanikolaou General Hospital of Thessaloniki
Thessaloniki, Greece

³Department of Anatomy
School of Medicine
Democritus University of Thrace
Alexandroupolis, Greece

TABLE OF CONTENTS

INTRODUCTION	78
<i>The Essential Function of Copper in the Human Body as a Trace Dietary Element</i>	78
<i>Copper Sulfate in Its Available Forms</i>	78
<i>The Everyday Practices of Copper Sulfate Pentahydrate in Agriculture, Industry, and Religion</i>	78
<i>The Use of Copper Sulfate in Medical Science</i>	78
<i>Copper Sulfate Poisoning — General Information</i>	78
I. METHODOLOGY	79
II. RESULTS	79
A. Incidence and Trends Over the Years	79
B. Sociodemographic Variables	79
C. Mortality Rates	81
D. Fatal Dose in Relation to the Method of Intake	81
III. DISCUSSION	81
A. Physiology of Copper	81
B. Pathology, Mechanism of Toxicity, and Clinical Expression	81
C. Complications	83
D. Clinical Course in Pediatric Cases	84
E. Diagnosis and Prognostic Indicators	84
F. Management and Treatment	84
IV. CASE PRESENTATION	85
<i>Background — Clinical Management</i>	86
A. Postmortem Examination — External Forensic Examination Findings	86
B. Autopsy Findings	86
C. Histopathological Findings	86
D. Toxicological Examination	87
F. Case Study	87
CONCLUSION	87
ACKNOWLEDGMENTS	89
REFERENCES	89
ABOUT THE AUTHORS	91

* Corresponding author: Dr. Pavlos Pavlidis, Laboratory of Forensic Sciences, School of Medicine, Democritus University of Thrace, Dragana GR 68100, Alexandroupolis, Evros Prefecture, Greece; + 30 25513 53822 (voice); pavliidi@med.duth.gr.

Greenish-Blue Gastric Content: Literature Review and Case Report on Acute Copper Sulfate Poisoning

REFERENCE: Nastoulis E, Karakasi MV, Couvaris CM, Kapetanakis S, Fiska A, Pavlidis P: Greenish-blue gastric content: Literature review and case report on acute copper sulfate poisoning; *Forensic Sci Rev* 29:77, 2017.

ABSTRACT: A literature review of cases of acute poisoning by copper sulfate was conducted, emphasizing therapeutic interventions, and a new fatality case is reported. Specifically, the relevant literature was reviewed for incidence rates, sociodemographic variables, pathophysiology, diagnosis, prognosis, and therapeutic outcome of copper sulfate poisoning. Results conclude that copper sulfate poisoning incidence varies in different regions. It is rare in western countries, while it is very common in South Asian countries. The majority of patients belong to rural populations and are males in the third decade of their lives. The lethal dose of ingested copper is considered to be 10–20 g; 14–36% of the patients pass away within a few hours of ingestion, while the average hospitalization time is more than 20 days. The clinical features of copper sulfate poisoning include erosive gastropathy, intravascular hemolysis, methemoglobinemia, hepatitis, and acute kidney injury. The therapeutic management focuses on absorption reduction, close observation for complications, supportive therapy, and chelation therapy.

KEYWORDS: Acute, blue vitriol, bluestone, copper sulfate, cupric sulfate, depression, forensic pathology, forensic science, legal medicine, pesticide, poisoning, suicide.

INTRODUCTION

The Essential Function of Copper in the Human Body as a Trace Dietary Element

Copper is essential in the human body as a trace dietary element. It is an ingredient of certain enzymes including cytochrome c oxidase, catalase, tyrosinase, peroxidase, and uricase, functioning as a cofactor that participates in several enzyme reactions [19]. Its presence is also necessary in mediating the absorption of iron from the gastrointestinal tract.

Copper Sulfate in Its Available Forms

Copper sulfate — also known as cupric sulfate — is considered to be the most important of copper salts. This salt exists in various forms that differ in their degree of hydration. The anhydrous form has the appearance of a pale greenish powder, while the pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) is a bright blue crystalline material that contains five molecules of water. Copper sulfate pentahydrate (CSP) is colloquially called “blue vitriol” or “bluestone,” while in Asia, it is also known as “Neela Thotha” [35].

The Everyday Practices of Copper Sulfate Pentahydrate in Agriculture, Industry, and Religion

Burning copper sulfate is a common domestic practice among Buddhists and Hindus for religious activities as a good luck charm. However, children find the marine blue color of copper sulfate crystals attractive, which sometimes results in unintentional poisoning [27,63].

CSP is widely applied in agriculture and industry, which makes it an easily available chemical compound

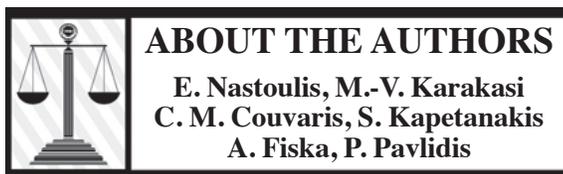
for some professionals in everyday life. It is frequently used as a fungicide, herbicide, and pesticide in common agricultural practice as well as an algacide in swimming pools, also inhibiting bacterial growth (e.g., *Escherichia coli*) [26,27,55,63]. Copper sulfate has multiple applications in industry, including photography and printing (as a component of binding pastes, glues, and dyes in order to prevent insect bites of paper) and in construction (as an additive to concrete for water resistance and sterilization) [27,63].

The Use of Copper Sulfate in Medical Science

In medicine, copper sulfate was once used as an emetic, antifungal, and anthelmintic agent. It was withdrawn, however, when fatal incidents were reported implicating emetic drugs containing copper sulfate. Several chemical tests also utilize copper sulfate, including anemia blood tests, Fehling and Benedict’s solutions to test for reducing sugars, and the Biuret reagent used in the Biuret protein assay, which is a colorimetric test determining protein concentration by UV/VIS spectroscopy at a wavelength of 565 nm [38,59].

Copper Sulfate Poisoning — General Information

Copper sulfate poisoning may occur by accident, due to suicide attempts, or after chronic exposure. It is reported that chronic occupational exposure to copper sulfate may cause liver disease after 3 to 15 years [60,63]. Animal research has revealed adverse effects on sperm quality, teratogenicity, and carcinogenicity [2,10,50]. Poisoning due to chronic exposure to copper sulfate is outside of the scope of the present paper and will not be discussed further. Acute copper sulfate poisoning due to



Evangelos Nastoulis obtained a medical degree (M.D.) and license to practice from the National Kapodistrian University of Athens (Athens, Greece). Dr. Nastoulis is currently a specialized forensic pathologist and doctoral student in the Department of Anatomy at Democritus University of Thrace (Alexandroupolis, Greece). His research interests focus on clinical-surgical anatomy and forensic medicine.

Maria-Valeria Karakasi obtained a medical degree (M.D.) and license to practice from the Democritus University of Thrace. Dr. Karakasi is currently a doctoral student in the Laboratory of Forensic Sciences at Democritus University of Thrace and a resident psychiatrist in Papanikolaou General Hospital of Thessaloniki (Thessaloniki, Greece). Her research interests focus on forensic psychiatry, issues of autonomy, suicidal behavior, sexual homicide, homicide, antisocial behavior, puerperal mental disorders, and drug abuse disorder from a psychodynamic perspective.

Constantinos (Michael) Couvaris obtained a medical degree (M.D.) and license to practice from the University of Crete (Heraklion, Greece). Dr. Couvaris is currently a doctoral student at the First Pathology Laboratory in the Medical School of the National and Kapodistrian University of Athens.

Dr. Couvaris is a specialized forensic pathologist. He holds the post of Pro Bono Forensic Anthropologist for the Forensic Service of Athens and he is a forensic consultant to the International Committee of the Red Cross (ICRC) for Greece. His research interests focus on forensic anthropology and examination of skeletal remains.

Stylios (Nicolaos) Kapetanakis obtained a medical degree (M.D.) and Ph.D. from the School of Medicine, Democritus University of Thrace. Dr. Kapetanakis is currently an assistant professor of anatomy in the School of Medicine, Democritus University of Thrace.

Dr. Kapetanakis is a specialized orthopedic and spine surgeon. He also holds the post of director of the South East Endoscopic Spinal Center in European Interbalkan Medical Hospital (Thessaloniki, Greece).

Aliki Fiska obtained a medical degree (M.D.) and Ph.D. from the School of Medicine, Democritus University of Thrace (Alexandroupolis, Greece). Dr. Fiska is currently an assistant professor of anatomy in the School of Medicine, Democritus University of Thrace. She also holds the post of director of the Laboratories of Anatomy and Clinical Anatomy in the School of Medical, Democritus University of Thrace.

Dr. Fiska is a specialized pathologist. Her research interests focus on anatomy, clinical-surgical anatomy, anatomical pathology, electron microscopy, and history of medicine.

Pavlos Pavlidis obtained a medical degree (M.D.) from the Faculty of Medicine, Trakia University (Stara Zagora, Bulgaria) and a Ph.D. from the Faculty of Medicine, Aristotle University of Thessaloniki (Thessaloniki, Greece). Dr. Pavlidis is currently an assistant professor of forensic medicine at the Democritus University of Thrace, School of Medicine.

Dr. Pavlidis is a licensed forensic pathologist and a court-appointed expert in matters relating to homicide, suicide, occupational accidents, rape, child abuse, domestic violence, (migration) border-related deaths, and toxicology. He is a frequent consultant to the national media and international press involving numerous newspaper articles and international documentaries. His published work includes a monograph: Pavlidis P: Elements of Medical Law, Ethics and Problematic; Publications Utopia: Athens, Greece; 2008.