

Forensic Pathology

Second
Edition



CRC SERIES IN
**PRACTICAL ASPECTS OF CRIMINAL
AND FORENSIC INVESTIGATIONS**

VERNON J. GEBERTH, BBA, MPS, FBINA *Series Editor*

Practical Homicide Investigation: Tactics, Procedures, and Forensic Techniques, Third Edition
Vernon J. Geberth

The Counter-Terrorism Handbook: Tactics, Procedures, and Techniques, Second Edition
Frank Bolz, Jr., Kenneth J. Dudonis, and David P. Schulz

Forensic Pathology, Second Edition
Dominick J. Di Maio and Vincent J. M. Di Maio

Interpretation of Bloodstain Evidence at Crime Scenes, Second Edition
William G. Eckert and Stuart H. James

Tire Imprint Evidence
Peter McDonald

Practical Drug Enforcement: Procedures and Administration
Michael D. Lyman

Practical Aspects of Rape Investigation: A Multidisciplinary Approach, Third Edition
Robert R. Hazelwood and Ann Wolbert Burgess

**The Sexual Exploitation of Children: A Practical Guide to Assessment, Investigation,
and Intervention, Second Edition**
Seth L. Goldstein

**Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques,
Second Edition**
Vincent J. M. Di Maio

Friction Ridge Skin: Comparison and Identification of Fingerprints
James F. Cowger

Footwear Impression Evidence, Second Edition
William J. Bodziak

Principles of Kinesic Interview and Interrogation
Stan Walters

Practical Fire and Arson Investigation, Second Edition
David R. Redsicker and John J. O'Connor

The Practical Methodology of Forensic Photography, Second Edition
David R. Redsicker

Practical Gambling Investigation Techniques
Kevin B. Kinnee

Practical Aspects of Interview and Interrogation
David E. Zulawski and Douglas E. Wicklander

Investigating Computer Crime
Franklin Clark and Ken Diliberto

Practical Homicide Investigation Checklist and Field Guide
Vernon J. Geberth

Bloodstain Pattern Analysis: With an Introduction to Crime Scene Reconstruction
Tom Bevel and Ross M. Gardner

Practical Aspects of Munchausen by Proxy and Munchausen Syndrome Investigation
Kathryn Artingstall

**Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced
Ridgeology**
David R. Ashbaugh

Forensic Pathology

Second
Edition

Vincent J. DiMaio
Dominick DiMaio



CRC Press

Boca Raton London New York Washington, D.C.

Library of Congress Cataloging-in-Publication Data

Di Maio, Dominick J.

Forensic pathology / Dominick J. Di Maio, Vincent J.M. Di Maio --2nd ed.

p. cm. (Practical aspects of criminal and forensic investigation)

Includes bibliographical references and index.

ISBN 0-8493-0072-X

1. Forensic pathology. I. Di Maio, Vincent J.M., 1941- II. Title .III. CRC series in practical aspects of criminal and forensic investigations.

[DNLM: 1. Forensic Medicine. 2. Pathology. W 700 D582f2001]

RA1063.4 .D5 2001

614'.1—dc21

2001025798

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the author and the publisher cannot assume responsibility for the validity of all materials or for the consequences of their use.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming, and recording, or by any information storage or retrieval system, without prior permission in writing from the publisher.

The consent of CRC Press LLC does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific permission must be obtained in writing from CRC Press LLC for such copying.

Direct all inquiries to CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation, without intent to infringe.

Visit the CRC Press Web site at www.crcpress.com

© 2001 by CRC Press LLC

No claim to original U.S. Government works

International Standard Book Number 0-8493-0072-X

Library of Congress Card Number 2001025798

Printed in the United States of America 1 2 3 4 5 6 7 8 9 0

Printed on acid-free paper

Dedication

This book is dedicated to our wives, Violet and Theresa, for their patience, understanding, encouragement, and support.

Foreword

The medicolegal investigation of death is the most crucial and significant function of the medical examiner within the criminal justice system. The medical examiner's office is primarily concerned with the investigation of violent, sudden, unexpected, and suspicious deaths.

Forensic pathology is the branch of medicine that applies the principles and knowledge of the medical sciences to the many legal issues within the field of law. The medical examiner is responsible for determining the cause and manner of death, identifying the deceased if unknown, determining the approximate time of death and injury, collecting evidence from the body that can be used to prove or disprove an individual's guilt or innocence and to confirm or deny the account of how the death occurred, documenting injuries or lack of them, deducing how the injuries occurred, documenting any natural disease present, determining or excluding other contributory or causative factors of death, issuing the death certificate, and documenting these events through an official autopsy report. This autopsy protocol is a complete medical record based on a thorough and conclusive review of all the facts and information.

Forensic pathology, the science of recognizing and interpreting diseases and injuries in the human body, is the basis of the medicolegal investigation. The medical examiner provides the expert testimony if the case goes to trial.

Forensic Pathology Second Edition, written by Dominick J. DiMaio, M.D. and Vincent J. DiMaio, M.D., provides the reader with more than 75 years of practical, hands-on experience in the essentials of forensic medicine. The material presented in this revised edition continues to be based on the personal experience of two forensic pathologists who are nationally renowned experts in their respective fields. Dominick J. DiMaio, M.D., a retired Chief Medical Examiner of New York City, is currently a forensic consultant. He served as the professorial lecturer in pathology for the State University of New York Health Science Center at Brooklyn.

Vincent J. DiMaio, M.D. is the Chief Medical Examiner for Bexar County in San Antonio, Texas. He serves as a professor for the Department of Pathology at the University of Texas Health Science Center in San Antonio.

The new and revised *Forensic Pathology Second Edition* begins with an overview of the medicolegal investigative systems and then delves into the substance and mechanics of forensic pathology. The authors present the essentials of forensic medicine in a concise, lucid, and comprehensive manner. They omit superfluous, confusing medical terminology and present medicolegal facts pertinent to the many and varied cases discussed, and have added new case histories and current information, bringing this remarkable text into the 21st century. *Forensic Pathology Second Edition* is geared toward medical practitioners, medical students, homicide detectives, medicolegal investigators, prosecuting and defense attorneys, and others interested in forensic pathology.

The first edition of *Forensic Pathology* addressed and corrected the insufficiencies that existed between criminal investigations textbooks and medicolegal investigations textbooks and established a recognized reference standard for medical examiners and homicide investigators. The second edition has been completely revised and expanded to include current statistical information. It has been updated and new photographs have been added, as well as two additional chapters that address the concerns of the medicolegal profession.

The new chapter dealing with “Deaths In Nursing Homes” addresses issues of improper health care resulting in drug overdoses, accidents not involving medication, homicide, and gross negligence. The revised information presents the dynamics involved in evaluating signs of neglect such as contractures, malnutrition, dehydration and the various stages of decubitus ulcers, which provide the practitioner with a frame of reference in a medicolegal determination. The chapter also addresses deaths caused by hospital-bed rails and medical restraints.

The new chapter on “Sudden Deaths During or Immediately after a Violent Struggle Unassociated with an Anatomical Cause of Death” is, without a doubt, an extremely important addition to this text. Deaths involving police or medical personnel who were attempting to restrain a violent or irrational individual are fraught with controversy. The medical examiner and investigator must be cognizant of the necessity for a complete and extensive medicolegal examination. The circumstances leading up to and surrounding the death should be obtained, and any medical records of the deceased should be reviewed. A complete autopsy with microscopic survey of all organs — especially the heart — as well as a complete toxicological screen should be performed. This chapter discusses the evaluation of excited delirium, catecholamine release, potassium and their effects on the heart. Drug actions, alcohol and acute psychotic episodes are covered, along with deaths ascribed to positional asphyxia. The authors present important information on the proper certification of death in these circumstances.

I have known Dominick J DiMaio for more than 30 years. In fact, he was my mentor and instructor in forensic medicine when I was a young homicide

detective in the New York City Police Department. When I retired as commanding officer of The Bronx Homicide, I became a homicide and forensic consultant.

I have continued my professional affiliation with Dr. DiMaio and we have been involved in many consultative investigations over the last 15 years. I have also known his son, Vincent J. DiMaio, M.D. for more than 21 years and have had the privileges of his professional affiliation in the sphere of medicolegal investigations and of editing his excellent edition in this series, *Gunshot Wounds: Practical Aspects of Firearms, Ballistics, and Forensic Techniques*, which is the recognized standard for the interpretation and evaluation of gunshot wounds.

According to the latter, the success of the medical examination and the homicide investigation is assured when a mutual cooperation exists between the forensic pathologist and the homicide investigator. Teamwork is essential. This teamwork is based upon a recognition and appreciation of each other's duties and responsibilities so that all parties can benefit from their contributions and expertise in the professional investigation of sudden death and homicide.

In my professional opinion as an expert in the sphere of practical homicide investigation, *Forensic Pathology Second Edition* is the must-have companion text to *Practical Homicide Investigation: Tactics, Procedures, and Forensic Techniques Third Edition*.

Forensic Pathology Second Edition provides an outstanding insight into the investigation of death and serves as a brilliant guide for any pathologist, investigator, or attorney who lacks the formal training of a board-certified forensic pathologist. This text provides practitioners with a foundation upon which they can build an excellent medicolegal investigation. The authors have provided graphic and descriptive photographs throughout the text that highlight for the reader exactly what to look for and how to handle specific situations. This revision carries this textbook well into the 21st century.

Forensic Pathology Second Edition by Dominick J. DiMaio, M.D. and Vincent J. DiMaio, M.D. continues to be the most comprehensive, definitive, and practical medicolegal textbook on forensic pathology today

Vernon J. Geberth, M.S., M.P.S.
Series Editor - CRC Press, LLC
Homicide and Forensic Consultant
Retired Homicide Commander
New York City Police Department

Acknowledgments

The authors thank Wanda Austin and Gloria Delgado for fending off individuals so that we would have time to think and write. We also thank Suzanna E. Dana, M.D., for reviewing the manuscript, and Vernon E. Geberth, the editor of this series, for giving us the opportunity to write this book. We must also, of course, acknowledge Cain, who initiated this field of endeavor.

From lightning and tempest; from earthquake, fire and flood; from plague, pestilence and famine; from battle and murder and from sudden death, Good Lord deliver us.

Litany

Table of Contents

1 Medicolegal Investigative Systems

- Definition of Death
- Delayed Deaths
- Cause, Manner, and Mechanism of Death
- Sudden, Unexpected Natural Death
- The Coroner System
- The Medical Examiner System
- Operation of a Medical Examiner System
- NAME Accreditation
- References

2 Time of Death

- Livor Mortis
- Rigor Mortis
- Body Temperature
- Decomposition
- Chemical Changes in Body Fluids
- Flow-Cytometry
- Gastric Emptying and Digestion
- Insect Activity
- Scene Markers
- References

3 Deaths Due to Natural Disease

- Cardiovascular Disease
- Coronary Atherosclerosis
- Bridging
- Dissecting Coronary Aneurysm
- Coronary Artery Spasm
- Mechanism of Sudden Death
- Sudden Death: Exercise and Climate
- Hypertensive Cardiovascular Disease
- Cardiomyopathy

Valvular Disease
Coronary Artery Anomalies
Myocarditis
Aortic Dissection
Sudden Death on a Physiological Basis
Deaths Due to Intracranial Lesions
Epilepsy
Nontraumatic Subarachnoid Hemorrhage
Berry Aneurysms
Intracerebral Hemorrhage
Primary Brain Tumors
Meningitis
Reyes Syndrome
Hydrocephalus
Psychiatric Patients
Respiratory System
Epiglottitis
Pulmonary Thromboemboli
Asthma
Pneumonia
Hemoptysis
Spontaneous Pneumothorax of Newborns
Urogenital and Gastrointestinal Tracts
Spleen
Pancreas
Liver
Adrenals
Miscellaneous
Tumor and Trauma
References

4 Blunt Trauma Wounds

Abrasions
Dating of Abrasions
Contusions
Dating of Contusions
Postmortem Bruising
The Eyes and Eyelids
Decomposed Bodies
Lacerations
Defense Wounds Due to Blunt Force
Determination of Whether a Wound is Ante- or Postmortem

- Fractures of the Face
- Fractures of the the Extremities
- Fractures from Direct Application of Force
- Fractures Caused by Indirect Application of Force
- Pelvic Fractures
- Healing of Fractures
- References

5 Blunt Trauma Injuries of the Trunk and Extremities

- Blunt Force Injuries of the Chest
 - Injury to the Ribs
 - The Sternum
 - The Heart
 - The Aorta
 - Diaphragm
 - Lungs
- Blunt Force Injuries of the Abdominal Viscera
 - Liver
 - Pancreas
 - Spleen
 - Gastrointestinal Tract
 - Kidneys
 - Urinary Bladder
 - Internal Genitalia
- Blunt Force Injuries of the Extremities
- References

6 Trauma to the Skull and Brain: Craniocerebral Injuries

- Impact Injuries
- Soft Tissue Injuries
- Fractures of the Skull
- Contusions of the Brain
- Lacerating, Penetrating, and Perforating Wounds of the Brain
- Epidural Hemorrhages
- Acceleration/Deceleration Injuries
- Subdural Hematomas
- Diffuse Axonal Injury
- Death Due to Cerebral Concussion
- Subarachnoid Hemorrhage

- Vertebral Artery Injury (Laceration)
- Traumatic Injury of the Carotid Artery
- Traumatic Dissection of Intracranial Arteries
- Traumatic Brain Swelling and Edema
- Boxing Injuries
- Occipito-Cervical Injuries
- Lacerations of the Brainstem
- Traumatic Intracranial Aneurysms
- Cerebral Palsy
- References

7 Wounds Caused by Pointed and Sharp-Edged Weapons

- Stab Wounds
- Depth of Stab Wounds
- Appearance of Stab Wounds in Skin
- Stab Wounds from Weapons Other than Knives
- Identifying the Weapon
- Manner of Death
- Stab Wounds by Anatomical Location
- Incised-Stab Wounds
- Physical Activity Following a Fatal Stab Wound
- Force Necessary to Inflict Fatal Stab Wounds
- Postmortem Bleeding
- Incised Wounds
- Incised Wounds of the Neck
- Miscellaneous
- Chop Wounds
- Therapeutic or Diagnostic Wounds
- References

8 Asphyxia

- Suffocation
- Entrapment / Environmental Suffocation
- Smothering
- Choking
- Mechanical Asphyxia
- Suffocating Gases
- Strangulation
- Ligature Strangulation
- Manual Strangulation

Chemical Asphyxiants
Sexual Asphyxia (Autoerotic Asphyxia, Autoerotic Deaths)
References

9 Deaths Caused by Motor Vehicle Accidents

Causes of Motor Vehicle Accidents
Natural Disease as a Cause of Motor Vehicle Accidents
Categories of Motor Vehicle Accidents
Front Impact Crashes
Side Impact Crashes
Rollovers
Rear Impact Crashes
Seat Belts and Air Bags
Air Bags
Motor Vehicle Fires
Motorcycle Accidents
Suicide by Motor Vehicles
Determination of Who Was Driving
Motor Vehicle–Train Accidents
Toxicology in Motor Vehicle Accidents
Pedestrian Deaths
Relationship between Speed at Impact and Injuries
Child Pedestrians
Adult Pedestrians
References

10 Airplane Crashes

Crashes Involving Light Planes
Crashes of Commercial Aircraft
Causes of Crashes
Crash Scene
Crash Patterns
In-Flight Fire
Helicopter Crashes
Hot-Air Balloons
Lightning Strikes
References

11 Sudden Infant Death Syndrome

Incidence of SIDS
Presentation of Cases

Non-Hereditary Nature of SIDS
Diagnosis of SIDS
Etiology of SIDS
Investigation of the Death
Communication with the Parents
References

12 Neonaticide, Infanticide, and Child Homicide

Neonaticide
Infanticide and Child Murder
Battered Baby Syndrome
The “Impulse” or “Angry” Homicide
“Gentle” Homicides and the Lethal Variant of
Munchausen’s Syndrome by Proxy
Miscellaneous Causes of Child Deaths
Radiological Evidence of Child Abuse
The Shaken Baby Syndrome
Unintentional Causes of Intracranial Hemorrhage
References

13 Fire Deaths

Burns
Severity of Burn Injuries
Deaths Caused by Fire
The Burned Body
Smoke Inhalation
Inhalation Injuries
Identification of the Deceased
Causes of Fires
Homicide by Fire
Self Immolation
Scalding Burns
Chemical Burns
Microwave Burns
Miscellaneous
Flash Fires: Fires Involving Flammable
Hydrocarbon Liquids
Flashover
References

14 Carbon Monoxide Poisoning

Mechanism of Action

Deaths from Motor Vehicle Exhaust

Survival Time

Outdoor Deaths Caused by Carbon Monoxide

Carbon Monoxide Deaths from Sources Other than Exhaust

Decomposition and Carbon Monoxide

Signs and Symptoms of Carbon Monoxide Poisoning

Fatal Levels of Carbon Monoxide

Suicide or Accident

Autopsy Findings

References

15 Death by Drowning

Physiology of Drowning

Autopsy Findings

Tests for Drowning

Drownings in Bathtubs

Scuba Divers

References

16 Electrocutation

Mechanism of Death

Fractures Caused by Electrocutation

Involuntary Movements Caused by Electricity-Induced

Contraction of Muscle

Autopsy Findings

Manner of Death

Lightning

References

17 Hyperthermia and Hypothermia: the Effects of Heat and Cold

Heat Stroke

Malignant Hyperthermia

Miscellaneous Causes of Hyperthermia

Saunas

Exercise, Body Temperature, Humidity and Exhaustion

Hypothermia
Hypothermia in Water
Hypothermia on Land
References

18 Rape

The Living Rape Victim
Rape-Homicides
Transport of the Body
Examination of the Body
Trace Evidence Recovery from the Hands
Examination of the Clothing
The Body
Hair
Evidence of Sexual Intercourse
Bite Marks
Homosexual Rape
DNA Analysis
Short Tandem Repeats
Combined DNA Index System
Mitochondrial DNA Analysis
References

19 Emboli

Gas Embolism
Fat Embolism Syndrome
Amniotic Fluid Emboli
References

20 Topics in Forensic Pathology

Primary Cardiac Arrest during Exercise
Starvation
Anaphylactic Deaths
Injury of the Eye Caused by Acids and Alkalis
Death in the Dental Chair
Maternal Mortality: Criminal Abortion
Abortifacient Drugs
Local Abortifacient
Instrumentation

Stillborn Infants
Traumatic Lesions of Birth
Water Intoxication
Vitreous
Electrolyte Disorders
Blast Injuries
Intra-Operative Deaths
References

21 Nursing Home Deaths

Drug Overdoses
Accidents Not Involving Medications
Homicides
Suicides
Gross Neglect of Patients
Signs of Neglect
Contractures
Malnutrition
Dehydration
Decubitus Ulcers
Homicide by Decubitus Ulcers
Deaths Caused by Hospital Bed Side-Rails
Deaths Caused by Medical Restraints
References

22 Sudden Death During or Immediately after a Violent Struggle

Excited Delirium
Catecholamine Release
Potassium
Effects of Catecholamines on the Heart
Actions of Drugs
Alcohol
Endogenous Mental Disease: Acute Psychotic Episodes
Natural Disease without Anatomical Manifestations
Deaths Ascribed to Positional Asphyxia
Certification of Death
Pepper Spray
References

23 Interpretive Toxicology: Drug Abuse and Drug Deaths

Collection of Tissue for Analysis

Tissue Analyses

Analysis

Toxicology Screens

Deaths

Ethyl Alcohol

Methyl Alcohol

Isopropanol

Ethylene Glycol

Phencyclidine (PCP)

Heroin

Propoxyphene

Fentanyl

Cocaine

Methamphetamine and Amphetamine

Miscellaneous Narcotics

Inhalants

Lead

Iron

Lye (NaOH)

Arsenic

Cyanide

Strychnine

Digoxin, Succinylcholine, and Insulin

Antidepressants

Mixed Drug Overdose

Barbiturates

References

Appendix

The Forensic Autopsy

The Autopsy Report