AD-A241 877

(1)

AD_____

GRANT NO: DAMD17-91-Z-1030

TITLE: 4TH ANNUAL TRAUMA ANESTHESIA AND CRITICAL CARE SYMPOSIUM

PRINCIPAL INVESTIGATOR: Christopher M. Grande, M.D.

CONTRACTING ORGANIZATION: International Trauma Anesthesia and Critical Care Society
MIEMSS Anesthesiology Department
22 South Greene Street
Baltimore, Maryland 21201

REPORT DATE: July 1, 1991

TYPE OF REPORT: Published Proceedings

PREPARED FOR: U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for public release;
distribution unlimited

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

91-12958

91 10 [illegible]

1 July 1991 Published Proceedings (4/15/91 - 6/15/91)

4th Annual Trauma Anesthesia and Critical Care Symposium
(Held May 2-5, 1991)

Grant No.
DAMD17-91-Z-1030

Christopher M. Grande, M.D.

International Trauma Anesthesia and Critical Care
Society, MIEMSS Anesthesiology Department
22 south Greene Street
Baltimore, Maryland 21201

U.S. Army Medical Research and Development Command
Fort Detrick
Frederick, Maryland 21702-5012

Approved for public release; distribution unlimited

Symposium, Anesthesia, Trauma, RA2

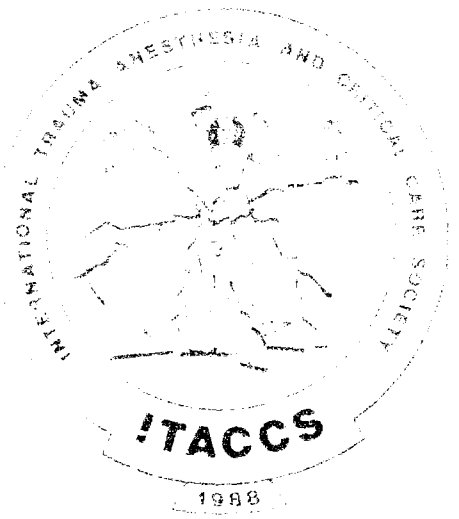
Unclassified Unclassified N/A N/A

4th Annual
Trauma Anesthesia and Critical Care Symposium

May 2–5, 1991
Baltimore, Maryland, USA

Sponsored by

The International Trauma Anesthesia and Critical Care Society



The University of Maryland School of Medicine

SYMPOSIUM EXECUTIVE COMMITTEE

DIRECTOR

Christopher M. Grande, MD
Special Consultant and Chief, Special Projects
Department of Anesthesiology
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Captain, Medical Corps, USAR,
Flight Surgeon and Diving Medical Officer
11th Special Forces Group (Airborne)
1st U.S. Army Special Forces
Executive Director, ITACCS
Editor, Trauma Anesthesia
Editor, Overview of Trauma Anesthesia
and Critical Care, Critical Care Clinics
Baltimore, Maryland

ASSOCIATE DIRECTORS

Peter J.F. Baskett, MB, BCh, FFARCS
Consultant Anesthetist
Department of Anesthesiology
Frenchay Hospital
President, Association of Anaesthestist of
Great Britain and Ireland
President, World Association for Emergency
and Disaster Medicine
Chairman, Bylaws Committee, ITACCS
Lieutenant Colonel, RAMC
Author, Medicine for Disasters
Author, Resuscitation Handbook
Bristol, England
United Kingdom

Brian F. Condon, MD
Colonel Medical Corps, USA
Director, Anesthesia and Operative Services
Walter Reed Army Medical Center
Associate Professor of Anesthesiology
Uniformed Services University of the
Health Sciences
Consultant for Anesthesiology to the
Surgeon General, U.S. Army
Washington, DC

Wolfgang F. Dick, MD, PhD, FFARCS (Hon)
Professor and Chairman for the Clinic of
Anaesthesiology
University Hospital Mainz, Germany
Vice-President, European Academy of
Anaesthesiology
Medical Director, University Hospital Mainz
Secretary, German Association of Intensive Care
and Emergency Medicine
Co-Editor, Der Anasthesist
Managing Editor, Notfallmedizin
(Emergency Medicine)
Advisory Board, Current Anaesthesia Practice
Author/Editor, Paediatric Anaesthesia
(Kinderanasthesie)
German National Representative, ITACCS
Mainz, Germany

Elizabeth A.M. Frost, MD
Professor of Anesthesiology
Albert Einstein College of Medicine/
Montefiore Medical Center
Director, Division of Neuroanesthesia
Editorial Board, Anesthesiology News
Editor, ITACCS Newsletter
New York, New York

Adolph H. Giesecke, MD
Jenkins Professor and Chairman
Department of Anesthesiology
University of Texas
Southwestern Medical School
Parkland Memorial Hospital
Vice President, ITACCS
Editor, Anesthesia for Surgery of Trauma
Dallas, Texas

Vladimir Kvetan, MD
Associate Professor of Anesthesiology and
Critical Care Medicine
Director, Division of Critical Care Medicine
Albert Einstein College of Medicine/
Montefiore Medical Center
Editor, Disaster Management, Critical
Care Clinics
Chairman, ITACCS Disaster Committee
Bronx, New York

Colin A.B. McLaren, MB, ChB, FFARCS
Air Commodore, Royal Air Force
Consultant Advisor Anaesthetics
Royal Air Force
Kelvin House, London
Vice President, Association of Anaesthetists,
Great Britian and Ireland
London, England
United Kingdom

Marzio G. Mezzetti, MD, PhD
Professor, Postgraduate School of Anesthesia and Resuscitation
University of Pavia, Italy
Vice-Chairman, Department of Anesthesia and Resuscitation
Regional Hospital of Varese
PR, Emergency Task Force
Airborne Medical Unit
Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care (SIAARTI)
Italian National Representative, ITACCS
Varese, Italy

Kazuo Okada, MD
Professor and Chairman
Department of Anesthesiology
Teikyo University School of Medicine
Executive Director, Japan Society of Resuscitology
Japanese National Representative, ITACCS
Tokyo, Japan

John K. Stene, MD, PhD
Associate Professor of Anesthesiology
Pennsylvania State University College of Medicine
Director, Perioperative Trauma Anesthesia Services
Department of Anesthesia
Milton S. Hershey Medical School
President, ITACCS
Editor, Trauma Anesthesia
Associate Editor, Overview of Trauma Anesthesia and Critical Care, Critical Care Clinics
Hershey, Pennsylvania

SYMPOSIUM COORDINATORS

Terry Slade Young
Director, Office of International Development
Maryland Insitute for Emergency Medical Services Systems
Member, Education and Training Committee, ITACCS
Baltimore, Maryland

Kimberly C. Ashton Unitas
Program Coordinator
Office of International Development
Maryland Institute for Emergency Medical Services Systems
Member, Education and Training Committee, ITACCS
Baltimore, Maryland

SYMPOSIUM REGISTRAR

Brooks Chenoweth
Administrative Assistant
Office of International Development
Maryland Institute for Emergency Medical Services Systems
Baltimore, Maryland

AD HOC ADVISOR

Williamd R. Anderson, CPA
Executive Director
Shock Trauma Associates, PA
Baltimore, Maryland

We would also like to gratefully acknowledge Leanne Allgaier for her assistance in the production of the Symposium Series.

WE WOULD LIKE TO GRATEFULLY THANK AND ACKNOWLEDGE THE FOLLOWING COMPANIES FOR THEIR SUPPORT OF THIS EDUCATIONAL PROGRAM

1991 EXHIBITORS

AMBU INC.

ARROW INTERNATIONAL, INC.

AUGUSTINE MEDICAL, INC.

BURROUGHS WELLCOME, INC.

CALIFORNIA MEDICAL PRODUCTS, INC.

CIRCON ACMI

COOK CRITICAL CARE

DALE MEDICAL PRODUCTS, INC.

DUPONT MERCK PHARMACEUTICAL

ELI LILLY CORPORATION

FIBEROPTIC MEDICAL PRODUCTS, INC.

GLAXO, INC.

HAEMONETICS CORPORATION

IMPACT

J.B. LIPPINCOTT COMPANY

JANSSEN

LAERDAL

LEVEL 1 TECHNOLOGIES

LIFE SUPPORT PRODUCTS, INC.

MALLINCKRODT SENSOR SYSTEMS, INC.

MOSBY YEAR BOOK

NORTH AMERICAN DRAGER

OHMEDA

ORGANON, INC.

PANAMERICAN TRAUMA SOCIETY

PREFERRED PHYSICIANS MUTUAL

SIEMENS

TONOMETRICS, INC.

U.S. ARMY BIOMEDICAL RESEARCH AND DEVELOPMENT LABORATORY

U.S. ARMY MEDICAL DEPARTMENT

W.B. SAUNDERS

ROOM ASSIGNMENTS

4TH ANNUAL TRAUMA ANESTHESIA & CRITICAL CARE SYMPOSIUM

MAY 2-5, 1991

BALTIMORE, MARYLAND

THURSDAY, MAY 2, 1991

PLENARY SESSION	CONSTELLATION C, D & E
LOTAS LUNCHEON (BY INVITATION ONLY)	DOUGLAS
ITACCS NEWSLETTER MEETNG (BY INVITATION ONLY)	EXECUTIVE BOARD ROOM
ITACCS BUSINESS DINNER/MEETING (BY INVITATION ONLY)	PRATT & CALVERT

FRIDAY, MAY 3, 1991

REGISTRATION	CONSTELLATION FOYER
PLENARY SESSION	CONSTELLATION C, D & E
DISASTER LUNCHEON MEETING (BY INVITATION ONLY)	CHARLES
AIRWAY MANAGEMENT	CONSTELLATION C
SCIENTIFIC POSTERS	CONSTELLATION F
DISASTER/MASS CASUALTY	CONSTELLATION D
SPECIAL CRNA SESSION	CONSTELLATION E
ANNUAL ITACCS GENERAL MEMBERSHIP MEETING (ALL ITACCS MEMBERS)	CONSTELLATION C & D

SATURDAY, MAY 4, 1991

REGISTRATION	CONSTELLATION FOYER
TEXTBOOK MEETING (BY INVITATION ONLY)	DOUGLAS
PLENARY SESSION	CONSTELLATION C, D & E
DISASTER LUNCHEON MEETING (BY INVITATION ONLY)	DOUGLAS
ANESTHESIA EQUIPMENT	CONSTELLATION C
SCIENTIFIC ABSTRACTS	CONSTELLATION E
DISASTER/MASS CASULATY	CONSTELLATION D
SPECIAL CRNA SESSION	BALTIMORE BALLROOM
5TH ANNUAL ORGANIZING COMMITTEE MEETING (BY INVITATION ONLY)	DOUGLAS

SUNDAY, MAY 5, 1991

PLENARY SESSION	CONSTELLATION A & B

4TH ANNUAL TRAUMA ANESTHESIA AND CRITICAL CARE SYSMPOSIUM

MAY 2-5, 1991

BALTIMORE, MARYLAND

PROGRAM

THURSDAY, MAY 2, 1991

7:00 A.M.	Registration and Continental Breakfast
7:30 A.M.	Opening Addresses Christopher M. Grande, MD John K. Stene, MD, PhD

PLENARY SESSION 1

Moderator: John K. Stene, MD, PhD

8:00 A.M.	The Variable Demographics of the Trauma Patient Population Jerry P. Nolan, MB, ChB, FFARCS
8:45 A.M.	Interface of Trauma Anesthesia and Emergency Medicine Peter Oakley, MA, MB BChir
9:15 A.M.	The Anesthesiologist as an EMS Director Joseph J. Colella, MD
9:45 A.M.	**BREAK - VISIT EXHIBITS**
10:15 A.M.	Trauma Anesthesia in Beirut Anis Shehat Baraka, MB, ChB, FFARCS
10:45 A.M.	Trauma Anesthesia in Belgium Herman H. DeLooz, MD, PhD, FCCM
11:15 A.M.	Trauma Anesthesia in Italy Marzio G. Mezzetti, MD, PhD
11:45 A.M.	Trauma Anesthesia in the Soviet Union: An American Perspective Charles P. Kingsley, MD
12:15 P.M.	Panel Session: John K. Stene, MD, PhD, and Faculty
12:45 P.M.	**LUNCH** (on your own) - Visit Harborplace or the Gallery

THURSDAY, MAY 2, 1991 cont.

PLENARY SESSION 2

Moderator: Elizabeth A.M. Frost, MD

2:00 P.M. Perioperative Anesthetic Management of Maxillofacial Trauma
Alexander W. Gotta, MD

2:45 P.M. Perioperative Anesthetic Management of Orthopedic Trauma
Andrew D. Rosenberg, MD

3:30 P.M. **BREAK - VISIT EXHIBITS**

4:00 P.M. Perioperative Anesthetic Management of Opthalmologic Trauma
Margaret M. Libonati, MD

4:45 P.M. Malignant Hyperthermia in the Trauma Patient
Shiela Muldoon, MD, PhD

5:30 P.M. Panel Session: Elizabeth A.M. Frost, MD, and Faculty

6:00 P.M. **Tour of the R Adams Cowley, MD Shock Trauma Center**
Chet I. Wyman, MD
Mary R. Wright

7:30 P.M. **Annual ITACCS Business Meeting**
(Board of Directors and Committee Members Only)

FRIDAY, MAY 3, 1991

7:00 A.M. Continental Breakfast

PLENARY SESSION 3

Moderator: Wolfgang F. Dick, MD, PhD, FFARCS (Hon)

7:30 A.M. Alcohol and Drug Abuse in the Trauma Patient Population
Edward G. Pavlin, MD

8:15 A.M. Economics of Trauma Anesthesia and Critical Care
Zvi J. Herschman, MD

8:45 A.M. Monitoring for Trauma Anesthesia
Kevin K. Tremper, MD, PhD

9:30 A.M. **BREAK - VISIT EXHIBITS**

10:00 A.M. Pharmacokinetic Alterations Secondary to Trauma
Leo H.D.J. Booij, MD, PhD

FRIDAY, MAY 3, 1991 cont.

10:30 A.M. Perioperative Management of Hypothermia in the Trauma Patient
Edward G. Pavlin, MD

11:15 A.M. Perioperative Use of Regional Anesthesia in the Trauma Patient
Alasdair Dow, MB, ChB, MCRP (U.K.) FFARCS, DA

12:00 NOON Panel Session: Wolfgang F. Dick, MD, PhD, and Faculty

12:30 P.M. **LUNCH** (on your own) - Visit Harborplace or the Gallery

2:00 P.M. **SIMULTANEOUS BREAKAWAY SESSIONS**

I. Airway Management-Case Discussions/Skill Stations
II. Scientific Posters
III. Disaster/Mass Casualty/Military Anesthesia: Part I
IV. Special CRNA Session: Part I

3:30 P.M. **BREAK - VISIT EXHIBITS**

4:00 P.M. Simultaneous Sessions Continued

5:00 P.M. Day's Adjournment

5:30 P.M. **Annual MTACCS General Membership Meeting**
(All MTACCS Members)

7:30 P.M. **Social Event - National Aquarium in Baltimore**

SATURDAY, MAY 4, 1991

8:00 A.M. Continental Breakfast - Visit Exhibits

PLENARY SESSION 4

Moderator: Pierre Carli, MD

8:30 A.M. Perioperative Anesthetic Management of Chemical, Biological and Nuclear Warfare Casualties
David J. Baker, M Phil, DM, FFARCS

9:30 A.M. Perioperative Anesthetic Management of the Burn Patient
Anne J. Sutcliffe, BSc, FFARCS, LRPS

10:30 A.M. **BREAK - VISIT EXHIBITS**

11:00 A.M. Perioperative Management of Organ Donors
Ake N.A. Grenvik, MD, PhD

11:45 P.M. Panel Session: Pierre Carli, MD, and Faculty

SATURDAY, MAY 4, 1991 cont.

12:15 P.M. **LUNCH** (on your own) - Visit Harborplace or the Gallery

2:00 P.M. **SIMULTANEOUS BREAKAWAY SESSIONS**

I. Anesthesia Equipment: "Hands-On"
II. Scientific Abstracts
III. Disaster/Mass Casualty/Military Anesthesia: Part II
IV. Special CRNA Session: Part II

3:00 P.M. **BREAK**

4:00 P.M. Simultaneous Sessions Continued

5:00 P.M. Day's Adjournment

SUNDAY, MAY 5, 1991

7:00 A.M. Continental Breakfast

PLENARY SESSION 5

Moderator: Levon M. Capan, MD

7:30 A.M. Trauma Anesthesia: The Maryland Approach
Chet I. Wyman, MD

8:00 A.M. Quality Assessment and Risk Control in Trauma Anesthesia
Brian G. McAlary, MD

8:45 A.M. Postoperative Pain Management for Trauma Patients
Roger S. Cicala, MD

9:30 A.M. **BREAK**

10:00 A.M. Critical Care Transport of the Pediatric Trauma Patient
James I. Gilman, MD

10:45 A.M. Complications of Trauma: Coagulopathy and Embolism
Levon M. Capan, MD

11:30 A.M. Panel Session: Levon M. Capan, MD, and Faculty

12:00 NOON **Closing Remarks - Symposium Adjournment**
Christopher M. Grande, MD

FACULTY

Kenneth J. Abrams, M.D.
Chief Resident
Department of Anesthesiology
Albert Einstein College of Medicine/
Montefiore Medical Center
Pending Coordinator, Trauma Anesthesia
Services
Bronx Municipal Hospital Center
Editorial Board, ITACCS Newsletter
Bronx, New York

Robert Akins, CRNA
Technical Director,
Department of Anesthesiology
University of Kentucky Medical Center
Division of Trauma
Lexington, Kentucky

David J. Baker, M Phil, DM, FFARCS
Surgeon Commander, Royal Navy
Department of Anaesthetics
Royal Naval Hospital
Gibraltar, United Kingdom

Russell Baker, CRNA
Associate Director, Nurse Anesthesia
The Shock Trauma Center, MIEMSS
University of Maryland Medical Systems
Baltimore, Maryland

Anis Shehat Baraka, MB, ChB, DA, MD
Professor and Chariman
Department of Anesthesiology
American University of Beirut
Member, WFSA CPR Committee
Member, Pan Arab Scientific Committee of
Anesthesiology and Intensive Care
Editor-in-Chief, Middle East Journal of
Anesthesiology
Beirut, Lebanon

Charles R. Barton, CRNA
Assistant Professor,
Department of Nurse Anesthesia Education
University of Kansas Medical Center
Chairman, CRNA Liasion Committee, ITACCS
Kansas City, Kansas

Peter J.F. Baskett, MB, BCh, FFARCS
Consultant Anesthetist
Department of Anaesthesiology
Frenchay Hospital
President, Association of Anaesthetists of Great Britain and Ireland
President, World Association for Emergency and Disaster Medicine
Chairman, Bylaws Committee ITACCS
Lieutenant Colonel, RAMC
Author, Medicine for Disasters
Author, Resuscitation Handbook
Bristol, England
United Kingdom

Elizabeth C. Behringer, MD
Instructor in Anesthesia
Department of Anaesthesia
Harvard Medical School
Director, Post Anesthesia Care Unit
Assistant in Anesthesia, Department of Anesthesia
Massachusetts General Hospital
Member, Education and Training Committee, ITACCS
Boston, Massachusetts

Nicholas G. Bircher, MD
Assistant Professor of Anesthesiology
Investigator, International Resuscitation Research Center, University of Pittsburgh
General Member of the Board of Directors, ITACCS
Lieutenant Commander, Medical Corps, USNR
Author, Cardiopulmonary Cerebral Resuscitation
Editor, Emergency Medicine: The Essential Update
Pittsburgh, Pennsylvania

Leo H.D.J. Booij, MD, PhD
Professor and Chairman of the Institute for Anaesthesiology
University Hospital-Nijmegen
Member of the National Health Council (Gezondheidsraad)
Vice-President, National Anaesthesia Education and Examination Committee
Vice-President, Dutch Anesthesia Quality and Safety Committee
Member, International Task Force on Safety in Anaesthesia
President, International and National Scientific Committee-10th World Congress of Anaesthesiologists, 1992
The Hague, The Netherlands
Dutch National Representative, ITACCS
Nijmegen, The Netherlands

Enrico M. Camporesi, MD
Professor and Chairman
Department of Anesthesiology
State University of New York
Health Science Center
Chairman, ITACCS Research Committee
Syracus, New York

Levon M. Capan, MD
Associate Professor of Anesthesiology
New York University Medical Center
Director of Anesthesiology
Bellevue Hospital Center
General Member of the Board of Directors, ITACCS
Editor, Trauma: Anesthesia and Perioperative Care
New York, New York

Pierre Carli, MD
Professor of Anesthesiology
University of Paris, V
Vice-Chairman, SAMU of Paris
Director, Department of Anesthesiology and Critical Care
Hospital Necker
French National Representative, ITACCS
Paris, France

Roger S. Cicala, MD
Assistant Professor of Anesthesiology
University of Tennessee, Memphis
Director of Trauma Anesthesia
Regional Medical Center at Memphis
Memphis, Tennessee

Joseph J. Colella, MD
Director, Departments of Anesthesiology
and Critical Care Medicine
Chief, Department of Critical Care Medicine
Prince George's Hospital Center
President, Maryland-District of Columbia
Society of Anesthesiologists
Maryland Emergency Medical Services Region V
Medical Director
Medical Director, Paramedic Program
Prince George's Paramedic Program
Cheverly, Maryland

John Connelly, CRNA
Senior Nurse Anesthetist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Member CRNA Liasion Committee, ITACCS
Baltimore, Maryland

Kenneth R. Dauphinee, MD, FRCP(C)
Assistant Professor of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist/Intensivist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Herman H. DeLooz, MD, PhD, FCCM
Professor of Anaesthesiology,
Critical Care Medicine and Emergency Medicine,
Catholic University of Leuven, Belgium
Chairman, Department of Emergency Medicine
University Hospitals of Leuven, Belgium
Chief, Emergency Medical Services System
Leuven, Belgium
President of the Belgium Society of Emergency
and Disaster Medicine
Founding Member and Past-President of the
Belgium Society for Intensive Care Medicine
Editor: Acute Geneeskunde (Acute Medicine),
Belgian National Representative, ITACCS
Leuven, Belgium

Wolfgang F. Dick, MD, PhD, FFARCS (Hon)
Professor and Chairman for the Clinic of Anaesthesiology
University Hospital Mainz, Germany
Vice-President, European Academy of Anaesthesiology
Medical Director, University Hospital, Mainz
Secretary, German Association of Intensive Care and Emergency Medicine
Co-Editor, Kliniche Anaesthesiologie and Intensivtherapie
Co-Editor, Der Anasthesist
Managing Editor, Notfallmedizin (Emergency Medicine)
Section Editor, Current Opinion in Anaesthesiologiology
Advisory Board, Current Anaesthesia Practice
Author/Editor, Paediatric Anaesthesia (Kinderanasthesie)
Author/Editor, Regional Anaesthesia and Obstetrics (Regionalanasthesie in der Geburtshilfe)
Author, Anaesthesia Notebook (Anesthesia Merkbuch)
German National Representative, ITACCS
Mainz, Germany

Yoel Donchin, MD
Senior Lecturer in Anesthesia
Head, Trauma Unit
Hadassah University Hospital
Special Advisor for Anesthesia to the Surgeon General, Israeli Defense Forces (IDF)
Lietenant Colonel, Medical Corps, IDF
Israeli National Representative, ITACCS
Jerusalem, Israel

Alasdair Dow, MB, ChB, MRCP (U.K.) FFARCS, DA
Visiting Assistant Professor
Department of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical Sytems
Member, By-Laws Committee, ITACCS
Editorial Board, ITACCS Newsletter
Baltimore, Marlyand

Elizabeth A.M. Frost, MD
Professor of Anesthesiology
Director, Division of Neuroanethesia
Albert Einstein College of Medicine/ Montefiore Medical Center
Editorial Board, Anesthesiology News
Editor, ITACCS Newsletter
New York, New York

Adolph H. Giesecke, MD
Jenkins Professor and Chairman
Department of Anesthesiology
University of Texas
Southerwestern Medical School
Parkland Memorial Hospital
Vice President, ITACCS
Editor, Anesthesia for the Surgery of Trauma
Dallas, Texas

James I. Gilman, MD
Professor of Anesthesiology and Pediatrics
University of Colorado Health Sciences Center
Director, Intensice Care Unit if
Children's Hospital, Denver
Associate Director, Anesthesiology
Former Director, Pediatric Transport
Denver, Colorado

Alexander W. Gotta, MD
Professor of Clinical Anesthesiology
Vice Chairman for Academic Affairs
Department of Anesthesiology
State University of New York
Health Science Center at Brooklyn
Brooklyn, New York

Christopher M. Grande, MD
Special Consultant and Chief, Special Projects
Department of Anesthesiology,
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Captain, Medical Corps, USAR
Flight Surgeon and Diving Medical Officer
11th Special Forces Group (Airborne)
1st U.S. Army Special Forces
Executive Director, ITACCS
Editor, Trauma Anesthesia
Editor, Overview of Trauma Anesthesia
and Critical Care, Critical Care Clinics
Baltimore, Maryland

Ake N.A. Grenvik, MD, PhD
Professor of Anesthesiology and Surgery
University of Pittsburgh School of Medicine
Director, Multidisciplimary Critical Care
Medicine Training Program
University of Pittsburgh Medical Center
Past President and Founding Member, Society
of Critical Care Medicine
Associate Editor, Textbook of Critical Care
Series Editor, Contemporary Management in
Critical Care Medicine
Pittsburgh, Pennsylvania

Kathleen Hartman, CRNA
Staff Nurse Anesthetist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Zvi J. Herschman, MD
Assistant Professor of Anesthesiology
and Surgery
Mount Sinai Medical School, New York City
Director of Surgical Intensive Care Unit
City Hospital Center at Elmhurst, New York City
Associate Medical Director, Department
of Respiratory Therapy
City Hospital Center Elmhurst, New York City
Consultant in Toxicology, New York City
Poison Control Center
Elmhurst, New York

Mahmood Jaberi, MD
Assistant Professor of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist,
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Murray A. Kalish, MD
Assistant Professor of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
President, Maryland-District of
Columbia Society of Anesthesiologists
Baltimore, Maryland

Vladimir Kvetan, MD
Associate Professor of Anesthesiology and
Critical Care Medicine
Director, Division of Critical Care Medicine
Albert Einstein College of Medicine/
Montefiore Medical Center
Editor, Disaster Management,
Critical Care Clinics
Chairman, ITACCS Disaster Committee
Bronx, New York

Charles P. Kingsley, MD
Chief, Department of Clinical Investigation
Staff Anesthesiologist,
Brooke Army Medical Center
Associate Professor of Anesthesiology
Assistant Clinical Professor
University of Texas at San Antonio,
Health Center
Major, U.S. Army
San Antonio, Texas

Margaret M. Libonati, MD
Associate Director, Anesthesiology
Medical Director, Day Surgery Unit
Wills Eye Hospital
Philadelphia, Pennsylvania

Robert Loeb, MD
Assistant Professor
Department of Anesthesiology
University of California, Davis Medical Center
Sacramento, California

Colin F. Mackenzie, MD
Associate Professor and Director of Research
Department of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Editor, Chest Physiotherapy in the ICU
Baltimore, Maryland

Brian G. McAlary, MD
Assistant Professor of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist and
Education Director
Department of Anesthesiology
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Marzio G. Mezzetti, MD, PhD
Professor, Postgraduate School of Anesthesia
and Resuscitation
University of Pavia, Italy
Vice-Chairman, Department of Anesthesia and
Resuscitation
Regional Hospital of Varese
PR, Emergency Task Force
Airborne Medical Unit
Italian Society of Anesthesia, Analgesia,
Resuscitation and Intensive Care (SIAARTI)
Italian National Respresentative, ITACCS
Varese, Italy

T. Michael Moles, MBBS, DTMH FFARCS, FC Anaes, FHKC Anaes
President,
Hong Kong College of Anaesthesiologists
Chairman, International Coordination
Committee, ITACCS
Member, CPCR Committee, WFSA
Major, RAMC, 10 Bn Parachute Regiment, TAVR
Author, Management of the Injured Patient
Editor, Recent Advances in Anaesthesia,
Immediate and Critical Care
Hong Kong

Shiela Muldoon, MD, PhD
Professor and Chairperson
Department of Anesthesiology
Uniformed Services University of the
Health Sciences
Bethesda, Maryland

Mark T. Murphy, MD
Fellow in Trauma Anesthesia and Critical Care
Massachusetts General Hospital
Harvard Medical School
Major, Medical Corps, USAR
Brigade Surgeon, 187th Infantry Brigade
Member, Education and Training Committee,
ITACCS
Boston, Massachusetts

Jerry P. Nolan, MB, ChB, FFARCS
Clinical Instructor
Department of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Registrar in Anaesthesia
Bristol, Royal Infirmary
Member, Education and Training Committee,
ITACCS
Editorial Board, ITACCS Newsletter
Baltimore, Maryland

Peter Oakley, MA, MBB, Chir, MRCGP, FC Anes
Wellcome Trust Research Fellow and Honorary
Senior Registrar
Nuffield Department of Anaesthetics
John Radcliffe Hospital
Oxford University
Member, Executive Committee,
British Trauma Society
Oxford, England

Michael J. Parr, MB, ChB. MRCP
(U.K.), FFARCS, DA
Visiting Assistant Professor
Department of Anesthesiology
University of Maryland School of Medicine
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Edward G. Pavlin, MD
Associate Professor of Anesthesiology
University of Washington School of Medicine
Attending Anesthesiologist
Harborview Medical Center/Trauma Center
Seattle, Washington

Clayton Petty, MD
Professor of Anesthesiology
Uniformed Services University of the
Health Sciences
Attending Anesthesiologist
National Naval Medical Center
Captain, Medical Corps, USNR
Bethesda, Maryland

Christopher Romanowski, CRNA
Staff Nurse Anesthetist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Andrew D. Rosenberg, MD
Associate Chairman and Attending
Anesthesiologist
Hospital for Joint Disease-Orthopedic Institute
Clinical Instructor
Department of Anesthesiology
New York University School of Medicine
New York, New York

John K. Stene, MD, PhD
Associate Professor of Anesthesiology
Pennsylvania State University
College of Medicine
Director, Perioperative Trauma Anesthesia
Services
Department of Anesthesia
Milton S. Hershey Medical School
President, ITACCS
Editor, Trauma Anesthesia
Associate Editor, Overview of Trauma Anesthesia
and Critical Care, Critical Care Clinics
Hershey, Pennsylvania

Gregory Stocks, CRNA
Staff Nurse Anesthetist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Anne J. Sutcliffe, BSc, FFARCS, LRPS
Consultant Anaesthetist
Birmingham Accident Hospital, England
Member, Council of Association of Anaesthetists
of Great Britian and Ireland
Author, Handbook of Emergency Anesthesia
British National Representative, ITACCS
Birmingham, England
United Kingdom

Pat Taub, CRNA
Associate Director, Nurse Anesthesia
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Kevin K. Tremper, MD, PhD
Professor and Chairman
Department of Anesthesiology
University of Michigan
Editorial Board, Critical Care
Editorial Board, Critical Monitoring
Editor, Oxygen Monitoring, International
Anesthesiology Clinics
Ann Arbor, Michigan

Mary R. Wright
Quality Assessment Coordinator
Department of Anesthesiology
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Baltimore, Maryland

Chet I. Wyman, MD
Clinical Instructor
Department of Anesthesiology
University of Maryland School of Medicine
Attending Physician
Department of Anesthesiology
Department of Critical Care Medicine
Franklin Square Hospital Center,
Attending Anesthesiologist
The Shock Trauma Center, MIEMSS
University of Maryland Medical System
Member, ITACCS Newsletter Committee
Editorial Board, ITACCS Newsletter
Baltimore, Maryland

PLENARY SESSION LECTURES

SESSION I

THURSDAY, MAY 2, 1991

8:00 A.M. - 12:45 P.M.

Moderator: John K. Stene, M.D., Ph.D.

VARIABLE DEMOGRAPHICS OF THE TRAUMA PATIENT POPULATION

Jerry P. Nolan, MB ChB FCAnaes

I. Introduction

II. Source of information

III. Trauma Epidemiology: An International Perspective

- A. Motor vehicle accidents
- B. Homicide
- C. Suicide

IV. Trauma Epidemiology: The United States

- A. Trauma versus other cases of death
- B. The chronological pattern of trauma deaths
- C. Mechanisms of trauma deaths
- D. Variation in population subgroups
  - 1. Sex
  - 2. Race
- E. Geographical variation in the rates of trauma
- F. Epidemiology of non-fatal injuries

V. Epidemiology of selected causes of trauma

- A. Motor Vehicle Accidents
  - 1. Age
  - 2. Sex
  - 3. Type of vehicle
  - 4. Factors influencing the incidence of motor vehicle accidents
    - a. Alcohol

b. Seatbelt use

c. Airbag

d. Motorcycle helmets

B. Homicide

1. Age

2. Sex

3. Geographical variation

4. Race

C. Suicide

1. Method

2. Age

3. Sex

D. Falls

VI. The MIEMSS Statistics

THE INTERFACE OF ANESTHESIOLOGY AND EMERGENCY MEDICINE IN TRAUMA MANAGEMENT

Peter A. Oakley, MA, MB, BChir, MRCGP, FCAnaes

I. The Emergence of Anesthesiology and Emergency Medicine

II. Similarities and Differences between the Two Fields

- A. Environment
- B. Knowledge and skills

III. Involvement of Anesthesiologists and Emergency Physicians in Trauma Care

- A. Possible Roles
  1. Trauma team member
  2. Trauma team leader
  3. Anesthesiologist (per se)
  4. Intensivist
  5. Pain relief physician
  6. Specialist in the treatment of minor injuries
  7. Pre-hospital care physician
  8. Base hospital physician
  9. Critical care transport physician or director
  10. Disaster planning consultant
  11. Disaster management physician
- B. The Trauma Room Environment and Team Care
- C. Working Together in the Trauma Room: Trauma Team

Members

D. Sharing the Same Role in the Trauma Room: Trauma Team Leaders

Responsibilities of the Trauma Team Leader

1. Advise any referring hospital at time of referral.
2. Obtain a history from the paramedics on arrival.
3. Perform "primary" and "secondary" assessments (ATLS).
4. Establish priorities for investigation and intervention.
5. Coordinating team members, ordering procedures, receiving information and resolving disputes.
6. Maintain an overview, avoiding undue involvement in practical procedures but intervening appropriately in critical situations
7. Order fluids, blood and blood products.
8. Order analgesia.
9. Order and interpret investigations, in conjunction with team members, radiologist, etc.
10. Request immediate or urgent surgical intervention, and consult with or refer to other specialists where appropriate.
11. Supervise spinal precautions.
12. Supervise patient transfer and radiological investigation.
13. Arrange disposal, allocating a bed in the appropriate primary specialty, handing over care to the Operating Theater, Intensive Care Unit, or Trauma Ward, and reviewing subsequently to maintain continuity.
14. Inform and explain to the patient and the family.
15. Excuse the team members at the end of the resuscitation, debriefing after difficult cases.
16. Record information for quality assurance, such as

the Revised Trauma Score and the estimated Injury Severity Score.

17. Make a record in the notes and dictate a letter to any referring hospital.

18. Provide clinical education for the team members, during resuscitation itself and at trauma meetings.

E. Sharing the Same Role in the Field

IV. Education and Research at the Interface of Anesthesiology and Emergency Medicine

V. Summary

Both the anesthesiologist and the emergency physician may assume a variety of roles in the management of major trauma. Trauma team leadership and other activities may be shared between two fields, although the anesthesiologist's background in cardio-respiratory support and critical care medicine provides a particularly suitable basis. Nevertheless, there are still some gaps in conventional anesthetic training which the aspiring trauma anesthesiologist/critical care specialist must redress. Just as emergency physicians have benefitted from attachments to anesthetic departments, there is a definite place for an emergency medicine module in trauma anesthesia training.

THE ANESTHESIOLOGIST AS AN EMS DIRECTOR

Joseph J. Colella, Jr., M.D.

I. Introduction

- A. History and development of EMS systems
- B. Organization

II. Medical Accountability

- A. Off-line medical direction
- B. On-line medical direction
- C. Certification
- D. Professional stress syndrome ("burn-out")

III. Prehospital Intervention

- A. Drug therapy
- B. Monitoring
- C. Technical intervention
  1. Airway management and intubation
  2. MAST and volume resuscitation

IV. Medical Incident Reporting

- A. Quality assurance
- B. Retrospective medical control
- C. Decertification and counselling

V. Teaching Initiatives

A. Basic and advanced concepts

B. Continuing medical education (CME) requirements

C. Operating room training in intubation

VI. Community Service Orientation

TRAUMA ANESTHESIA IN BEIRUT

Anis Baraka, M.B.B.Ch., D.A., D.M., M.D., F.C.Anaesth. (Hon.)

I. Problems related to the civil war itself

II. Personnel deficiency (death, exodus, isolation and nervous exhaustion).

III. Deficiency of supplies, particularly oxygen and nitrous oxide.

IV. Workload.

V. Problems of anesthesia in seriously traumatized patients such as:

   a. Respiratory failure

   b. Tetanus

   c. "Full stomach"

VI. Special problems

   a. Postoperative respiratory failure

   B. Tetanus

   c. Gas gangrene

   d. Decompression sickness

TRAUMA CARE IN BELGIUM

Herman H. DeLooz, M.D., Ph.D., FCCM

I. Historical background

   A. Emergency telephone exchanges

   B. The law of July 1964

II. Evolution of the system

   A. Ambulances

   B. Crew

   C. Hospital-based emergency facilities

III. The "Leuven" system

   A. The basic goal

   B. The first "Golden Hour"

      1. The first witness

      2. The EMS system

      3. The emergency physician in pre-hospital trauma care

      4. The Department of Emergency Medicine Trauma Protocol

      5. The Observation Care Unit

         - short term hospitalization

         - short term intensive care

      6. Disaster medicine

IV. Problems and remedies

V. Conclusions

TRAUMA ANESTHESIA IN ITALY

Marzio G. Mezzetti, M.D., Ph.D.

I. Introduction

A. Scope of the problem:

Italy: population 57.5 million

40.0 million in urban areas

17.5 million in rural areas

- 3.2 million accidents
- 1.3/100 cases long term sequelae
- 21,500 trauma deaths
- 900 hospitals

II. Field Services

A. Response time variable from 5-45 minutes

B. Scene-to-hospital time variable from 15 minutes to three hours

C. Level of skill for field provider:

"First Aid Diploma"

D. Volunteers as first responders

E. Specialized teams

- Mobile ICU
- Helicopter team

F. "Emergency department"

- Definition/organization
- Distribution
- Status

G. Summary of problems

- Differences in regional organization
- Lack of "echelons of care" in peripheral areas
- Retrospective study:
  a. 17% of major trauma deaths preventable
  b. Treatment in the field vs. "scoop and run"
  c. Different levels of experience

III. Role of the Anesthesiologist

A. Specialist in anesthesiology and resuscitation

B. Involved in prehospital medicine

IV. Recent Issues

1. Need for adequacy of care
2. Economic costs
3. Trauma center vs. traditional hospital

V. How ITACCS will contribute to improve the situation?

TRAUMA ANESTHESIA IN THE SOVIET UNION: AN AMERICAN PERSPECTIVE

Charles P. Kingsley, M.D.

I. Introduction

- A. General perspective
  - 1. Natural disasters
  - 2. Humanitarian visits
  - 3. Military operations

II. Mission

- A. Planning
  - 1. Casualties
  - 2. Supplies and equipment
  - 3. Transportation

III. Local Constraints

- A. International transportation
- B. Local transportation
- C. Language
- D. Equipment
- E. Supplies
- F. Blood and fluids
- G. Electricity
- H. Repair capabilities
- I. Recovery care
- J. Local customs
- K. Communications

IV. Intensive Care Medicine

A. Fixed facilities

B. Field facilities

V. Conclusions

PLENARY SESSION LECTURES

SESSION II

THURSDAY, MAY 2, 1991

2:00 P.M. - 6:00 P.M.

Moderator: Elizabeth A.M. Frost, M.D.

PERIOPERATIVE ANESTHETIC MANAGEMENT OF MAXILLOFACIAL TRAUMA

Alexander W. Gotta, M.D.

I. Normal Anatomy

- A. Division of facial skeleton into thirds
- B. Maxilla
- C. Mandible

II. Mechanisms of Force Dispersion

- A. Vulnerability of mandible
- B. Vulnerability of maxilla
- C. Nature of blow determines fracture site and extent

III. Common Facial Fractures

- A. LeFort I
- B. LeFort II
- C. LeFort III
- D. Mandibular fractures
- E. Maxillary fractures
- F. Possible involvement of base of skull and cranial vault

IV. Preoperative Evaluation

- A. Common Concurrent Medical Problems
  1. Myocardial infarct
  2. Stroke
  3. Drug Abuse
  4. Alcoholism

5. Neurologic disorder

B. Common Concurrent Surgical Problems

1. Fracture of the skull

2. Intracranial hemorrhage

3. Subdural hematoma

4. Fracture of the cervical spine

5. Fat embolism

6. Pneumothorax

7. Flail chest

8. Cardiac tamponade

9. Cardiac hematoma

10. Ruptured spleen or liver

C. Necessary Laboratory and X-ray Data

V. Airway Assessment

A. Technique of oral intubation

B. Technique of nasal intubation

1. Guided

2. Blind

a. Indications

C. Superior Laryngeal Nerve Block

1. Anatomy

2. Technique

3. Indications

4. Contraindications

VII. Tracheostomy

A. Indications

B. Contraindications

VIII. Choice of Anesthetic Agent and Technique

A. Intravenous Agents

1. Narcotics

2. Ketamine

B. Inhalation Agents

1. Alkanes

a. Cardiac arrhythmias

2. Ethers

C. Local Anesthetics

PERIOPERATIVE ANESTHETIC MANAGEMENT OF ORTHOPEDIC TRAUMA

Andrew D. Rosenberg, M.D.

I. Pelvic Injuries

- A. Mechanism of Injury
- B. Associated problems
  1. Hemorrhage
  2. Pelvic organ injuries
  3. Coagulopathies
  4. Pelvic thrombosis
- C. Case Approach
  1. General vs. regional or combination
  2. Monitoring ("A"-line, central monitoring)
  3. SSEP
  4. Cell Saver
  5. Urine output
  6. Role of MAST
  7. Postoperative pain management

II. Hip Fractures

- A. Dislocations and fracture dislocations
- B. Proximal femoral fractures
  1. Site of Injury
     a. Subcapital

b. Transcervical

c. Trochanteric

d. Subtrochanteric

2. Patient Characteristics

a. Age

b. Concurrent diseases

c. Changes in the elderly (pharmacology and physiology of aging)

3. Case approach

a. Perioperative checklist

b. Preview of systems

c. Role of anesthetic technique

d. Timing of surgery

e. Perioperative management

1. Hypotension

2. Hypertension

3. Cement

4. Pulmonary embolism considerations

f. Postoperative management

III. Thromboembolism

A. Incidence

B. Prevention

1. Medication

2. Lower limb compression devices

IV. Compartment Syndrome

V. Long Bone Fractures

A. Stabilization

B. Fat embolism

1. Incidence

2. Pathophysiology

3. Presentation

4. Diagnosis and treatment

VI. Cervical Spine

A. Incidence

B. Anatomy

C. Injuries

D. Principles of management

1. Stabilization

2. Securing an airway

3. Maintaining adequate ventilation

a. C5 and above vs. C5 and below

b. Pa02, C02

4. Maintaining adequate BP

5. Medications (steroids, succinylcholine)

6. Spinal shock

7. Respiratory considerations:

   Pulmonary edema

8. Circulation:

   a. Autonomic hyperflexia

9. Gastrointestinal

10. Case Approach

    a. Fiberoptic

    b. SSEP

    c. Monitoring

    d. Agents

    e. Positioning

    f. Postoperative considerations

VII. Thoracic Spine

A. 1. General considerations

   2. Associated injuries

B. Case approach

   (see cervical spine injuries)

PERIOPERATIVE ANESTHETIC MANAGEMENT OF OPHTHALMOLOGIC TRAUMA

Margaret M. Libonati, M.D.

I. Introduction
   - A. Incidence
   - B. Etiology
   - C. Types of Injuries
   - D. Factors determining visual outcome

II. Intraocular Pressure Physiology
   - A. Intraocular contents
   - B. Normal pressures and variations
   - C. Major factors affecting pressure during surgery
     1. Aqueous humor secretion
     2. Vitreous volume
     3. Choroidal blood volume
     4. Extraocular muscle tone

III. History and Physical Examination
   - A. General exam
   - B. Eye exam
   - C. Lab test

IV. Preoperative Preparation
   - A. Sedation
   - B. Pain control
   - C. Premedication
   - D. Fasting

V. Surgical Management

VI. Anesthetic Management

- A. Monitoring
- B. Anesthetic Agents
- C. Muscle Relaxants
  - 1. Non-depolarizing
  - 2. Depolarizing
- D. Anticholinergic
- E. Anesthetic Adjuncts
- F. Guides to management

VII. Potential Problems

- A. Pediatric patients
- B. Geriatric patients

VIII. Conclusion

MALIGNANT HYPERTHERMIA IN THE TRAUMA PATIENT

Sheila M. Muldoon, M.D.

I. Introduction

- A. Definition of the syndrome
- B. Spectrum identified

II. Prevalence and Incidence of MH

III. Clinical Syndrome

- A Fulminant episode

IV. Site of Defect In Skeletal Muscle

V. Genetics

VI. Management

- A. Patient with fulminant episode
- B. Patient with documented history of MH
- C. Patient with a questionable history of MH

VII. Testing

- A. Evaluation of susceptibility, standard tests
- B. Future testing

VIII. Referral Centers

- A. Acute crisis
- B. Consultation

PLENARY SESSION LECTURES

SESSION III

FRIDAY, MAY 3, 1991

7:30 A.M. - 12:30 P.M.

Moderator: Wolfgang F. Dick, M.D., Ph.D.

ALCOHOL AND DRUG ABUSE IN THE TRAUMA PATIENT POPULATION

Edward G. Pavlin, M.D.

I. Introduction

II. The Influence of Alcohol and Drugs on Trauma

- A. Associated incidence on:
  - 1. Homicide
  - 2. Vehicular accident
  - 3. Industrial trauma
- B. Effect of alcohol and drugs on outcome from trauma
- C. The association with head injuries

III. Physiologic Interactions of Acute Intoxication

- A. Alcohol
- B. Narcotics
- C. Cocaine and other stimulants

IV. Aesthetic Drug Interactions

- A. Alcohol
- B. Narcotics
- C. Cocaine and other stimulants

V. Anesthetic Considerations in the Patient with Acute Intoxication

VI. Conclusion

ECONOMICS OF TRAUMA ANESTHESIA AND CRITICAL CARE

Zvi Herschman, M.D.

I. Introduction

II. Eight viewpoints on trauma care:

- A. Anesthesia providing organization (APO)
- B. Government
- C. Private insurance companies (PIC)
- D. Privately-paying patient
- E. "Charity" hospital (CH)
- F. Individual clinician
- G. Trauma patient
- H. Public opinion

III. Three economic scenarios

- A. Fully private - no governmental outlays for patient care
  - 1. Viewpoints
    - A.
    - B.
    - C.
    - D.
    - E.
    - F.
    - G.
    - H.

B. Nationalized health care (fully funded by the government)

1. Viewpoints

A.

B.

C.

D.

E.

F.

G.

H.

C. Current system (government and private payment)

1. Viewpoints

A.

B.

C.

D.

E.

F.

G.

H.

2. RBRVS

a. Effects on current anesthesia income

b. What we can do to make the system work for us.

i. Manpower strategies

MONITORING FOR TRAUMA ANESTHESIA

Kevin K. Tremper, Ph.D., M.D.

I. Introduction

A. 1. Approximately 50 million traumatic injuries occur in the United States each year.

2. 100,000 of these injuries are fatal and ten million others result in permanent disability

3. Trauma is the leading cause of death for patients under 30 years of age

B. 1. Guidelines for monitoring trauma patients are similar to those for monitoring any acutely ill or anesthetized patient

2. Emphasis is placed on some of the special considerations one might have when monitoring an acutely injured patient

3. Primary differences involve the necessity of rapid evaluation and treatment compounded by the inability of obtaining an adequate history, which underscores the necessity for comprehensive and aggressive monitoring

4. Review of monitoring will follow the "ABC's" of acute patient evaluation:

a. Airway: monitors of oxygenation

b. Breathing: monitors of ventilation

c. Circulation: monitors of cardiovascular status

II. Airway/Oxygenation Monitors

A. 1. Subjective assessment of skin color has been used for decades

2. It has been demonstrated to be unreliable even with trained personnel in a controlled setting

B. 1. Ear oximetry was the first noninvasive continuous monitor devised to objectively evaluate a patient's oxygenation. Several of its technical shortcoming have been resolved with the development of the pulse oximeter

C. Pulse Oximeter

1. In less than a decade the pulse oximeter as a monitor of arterial hemoglobin saturation (Sa02) has become ubiquitous throughout the hospital. Its usefulness in monitoring the trauma patient is a logical consequence of its demonstrated usefulness in the operating room and the intensive care unit

2. Several physiologic and technical limitations:

   a. Sa02 as a measure of oxygenation does not completely assess pulmonary oxygen exchange

   b. Oxyhemoglobin dissociation desaturation curve is flat above an oxygen tension of 100 torr

   c. Substantial alveolar-arterial oxygen gradient may exist due to pulmonary pathology without evidence of desaturation

   d. Saturation measurements are excellent for assessing adequacy of hemoglobin saturation but they do not rule-out pulmonary disease

   e. Oxygen transport requires not only saturated hemoglobin, but an adequate hemoglobin concentration itself

   f. Relatively insensitive to anemia down to hematocrits as low as 10% thus, independent measure of hemoglobin or hematocrit is also necessary

3. How a pulse oximeter derives its estimates of Sa02

   a. The pulse oximeter transilluminates tissue with low wavelengths of light (red and infrared). The device measures the ratio of the pulsatile absorbance in red light to the pulsatile absorbance in infrared light. This ratio is then empirically calibrated to Sa02

   b. Calibration curves all range from a ratio of 0.4 when the saturation is nearly 100% to a ratio of 3.4 when the saturation is approximately 0%.

   c. When the absorbance ratio equals one the saturation is approximately 85%

   d. Artifacts are related to the production of a false ratio thus reporting a false saturation:

      i. Substantial light or motion artifact which

may occur in an emergency room setting.

ii. Artifacts may be minimized by covering the sensor and holding the sensor site still to obtain a true tissue absorption signal

iii. Uses only two wavelengths:

- Adult blood is composed of four types of hemoglobin: oxyhemoglobin, reduced hemoglobin, methemoglobin, and carboxyhemoglobin. These last two species are in low concentration except in pathologic states.

- The pulse oximeter deals with blood as though it contains only oxyhemoglobin and reduced hemoglobin and therefore will produce errors in the presence of either carboxyhemoglobin or methemoglobin

- Carboxyhemoglobin is red (as is oxyhemoglobin) and the pulse oximeter reports approximately the sum of oxyhemoglobin and carboxyhemoglobin. A blood sample must be sent to a laboratory for study by a multiwavelength co-oximeter

- Methemoglobin is dark brownish and absorbs both red and infrared light greatly . Its presence forces the light absorbance ratio toward unity and therefore the pulse oximeter's saturation estimate towards 85%

D. Other oxygen monitors have been used to assess the trauma patient. Each continuously monitors oxygenation more at the tissue level than that of the arterial blood:

1. Transcutaneous oxygen sensor (PtcO2)

2. Conjunctival oxygen sensor (PcjO2)

3. Oximetric pulmonary artery catheter (SvO2)

E. 1. Arterial blood gas samples are the "gold standard" of assessing oxygenation, ventilation and acid base status.

2. Recent development in miniature optode technology may allow continuous arterial blood gas monitoring in the future. Currently, these devices are experimental.

III. Breathing/Ventilation and CO2 Exchange

A. Can be subjectively assessed by chest movement and ausculation

B. Confirmed only by arterial blood gas analysis for CO2.

C. Two noninvasive monitors of carbon dioxide. Although each of these monitors displays CO2 data, each is measuring CO2 at different locations and is, therefore, a different physiologic variable:

1. Capnometer (ETCO2)

2. Transcutaneous carbon dioxide monitor (PtcCO2)

3. Normal capnograpm is the tracing of expired CO2 from the airway

4. a. ETCO2 is measured from the sample gas at the end of expiration. End-expired gas is alveolar gas coming from both well perfused alveoli and alveolar dead space (non-perfused alveoli).

b. Usually assumed that the CO2 concentration of pure alveolar gas is very close to the arterial CO2 tension.

c. Since alveolar dead space contains no carbon dioxide he ETCO2 concentration will represe. ar terial CO2 only when there is no alveolar dead space: the difference between an arterial CO2 value and the ETCO2 value is due to the presence of alveolar dead space.

d. The trauma patient may be hemodynamically unstable and therefore have non-uniform pulmonary perfusion. The V/Q mismatch produces alveolar dead space and therefore proportionate increases in arterial CO2 and ETCO2 differences

e. Extreme cases (cardiac arrest): No pulmonary perfusion, the entire lung is alveolar dead space and therefore the ETCO2 value will be theoretically "O". This dependence of ETCO2 on pulmonary blood flow has been used as a way of assessing the adequacy of cardiopulmonary resuscitation.

f. ETCO2 value increases to approach the arterial CO2 value as the patient's cardiac

output increases. In this way, the ETCO2 is being used primarily as a perfusion monitor

5. a. It has been stated that the presence of a capnograph is the most reliable way to assess endotracheal (as opposed to esophageal) intubation. The observation of repeated normal capnographs with each breath is an essential feature of endotracheal intubation in a hemodynamically stable patient.

b. Confusion may arise when the patient is hemodynamically unstable and has been mask ventilated with significant gastric distention. In this situation, there may be significant carbon dioxide in the stomach, and therefore allowing the appearance of an initial capnogram upon an esophageal intubation. This capnograph amplitude should decrease rapidly with each breath as the C02 is washed-out of the stomach.

c. Could be confused with a proper endotracheal intubation in a patient who is in cardiac arrest and therefore not perfusing the lungs.

d. In the arrest situation it is important to confirm intratracheal intubation by methods including direct visualization, chest observation and ausculation, gastric auscultation, pulse oximeter observation, and intraarterial blood gas measurement

D. 1. Transcutaneous carbon dioxide monitor is useful for monitoring changes in arterial C02 in the critically ill

2. Not been applied in the trauma setting due to the technical limitations of calibration and warm-up time.

E. Intraarterial optode may also measure arterial C02 but as stated above it is still in the experimental phase of development.

F. The adequacy of ventilation in the trauma patient should be assessed by clinical observation, continuous capnography, and arterial blood sampling for arterial C02 measurement.

IV. Circulation/Cardiovascular Function

A. Begins with evaluation of pulses, blood pressure, ECG,

urine output and cardiac output

B. Immediate assessment of blood pressure does not insure adequate blood volume and cardiac output but it does imply perfusion of the heart and brain.

C. After blood pressure and cardiac rhythm are established it is important to ascertain the adequacy of intravascular volume and blood flow. In the emergency situation this is not always easy. Routine methods used to measure are:

1. Urine output

2. Postural blood pressure changes

3. Presence of a metabolic acidosis on arterial blood gas analysis.

D. Several continuous monitoring devices have recently been used to assess peripheral perfusion and cardiac output.

1. Transcutaneous and conjunctival oxygen tension monitors:

a. Demonstrated to follow changes in cardiac output during shock and resuscitation from shock.

b. Measure oxygen on the skin surface and conjunctival surface thus they are dependent upon arterial blood oxygenation and tissue perfusion.

c. Both have limitations of requiring calibration and the transcutaneous oxygen sensor requires 10 to 15 minutes of warm-up on the patient's skin surface.

d. Both have been demonstrated to be useful in evaluating acute trauma patient

2. Oximetric pulmonary artery catheter:

a. Provides

i. Intermittent thermodilution cardiac output measurement

ii. Continuous pulmonary artery pressures

iii. Mixed-venous oxygen saturation

b. Supplies continuous and intermittent comprehensive hemodynamic and oxygen transport evaluation. Therefore, the "gold standard" in monitoring the hemodynamic status of any patient.

c. Disadvantages: requires the placement of a pulmonary artery catheter which may not be practical in many situations and too time consuming in others.

E. Noninvasive cardiac output by thoracic bioimpedance:

1. Advocated as a possible means of monitoring the trauma patient.

2. Advantages: noninvasive and continuous and at the same time being easy to apply to the patient

3. Limitations: requires eight ECG electrodes to be placed on the patient and can be disabled by significant patient motion artifact.

F. Precordial and transesophageal doppler have also been advocated as noninvasive measure of cardiac output. Neither of these techniques has been applied to the trauma patient

G. Myocardial Contusion, Myocardial Ischemia

1. ECG: one of the mainstays in monitoring. It has been demonstrated to be relatively insensitive in the detection of myocardial contusion or concussion.

2. CPK-MB fraction: greater than 5% is a myocardial concussion, a contusion is defined as a concussion with an abnormal echocardiogram.

3. 2D Echocardiography: It has been found that approximately 40% of all trauma patients with apparent chest trauma have a myocardial contusion or concussion, while less than 50% will be detected by nonspecific ECG changes.

4. It is currently recommended that CPK-MB fractions be measured on admission and every six hours for the first 24 hours to rule out myocardial damage.

V. Conclusions

1. Lack of history and preparation mandates intitial and continuous monitoring of ABC's

2. Continuous assessment of ABC's using monitoring devices allows any serious changes to be detected early enough to implement appropriate intervention.

PHARMACOKINETICS ALTERATIONS SECONDARY TO TRAUMA

Leo H.D.J. Booij, M.D., Ph.D.

I. Introduction

A. Pharmacodynamics versus pharmacokinetics

B. Pharmacokinetics for nonpharmacokineticists

C. What to do the various parameters mean

II. Influence of trauma on pharmacokinetic parameters

A. Initial volume of distribution

B. Half-life times

C. Plasma Clearance

1. redistribution

2. liver function

3. renal function

III. Clinical Implications

PERIOPERATIVE MANAGEMENT OF HYPOTHERMIA IN THE TRAUMA PATIENT

Edward G. Pavlin, M.D.

I. Introduction

II. Hypothermia in Trauma

- A. Incidence
- B. Contributing factors
- C. Associated features
- D. Outcome

II. Physiologic Effects of Hypothermia

- A. Cardiovascular system
- B. Central nervous system
- C. Distribution of fluids
- D. Hematologic considerations
- E. Shivering

IV. Interaction with Anesthetic Drugs

- A. Anesthetic agents
- B. Fixed agents
- C. Muscle relaxants
- D. Cardiovascular drugs

V. Prevention and Treatment of Hypothermia

- A. Surface warming
- B. Core warming
- C. Treatment of complications

VI. Conclusion

REGIONAL ANESTHESIA IN THE TRAUMA PATIENT

Alasdair Dow, MB, ChB, MRCP, FFARCS

I. Introduction

A. History of regional anesthesia

B. i. Aims

ii. Benefits

ii. Disadvantages

II. Specific Controverseries

A. Epidural/spinal vs. general anesthesia

B. Choice of drugs for epidural/spinal space

C. Epidural vs. intrapleural analgesia for chest trauma

D. Risks of regional anaesthesia and compartment syndrome

E. Upper airway analgesia

III. Possible Future Advances in Regional Anesthesia

IV. Summary

PLENARY SESSION LECTURES

SESSION IV

SATURDAY, MAY 4, 1991

8:30 A.M. - 12:15 P.M.

Moderator: Pierre Carli, M.D.

PERIOPERATIVE ANESTHETIC MANAGEMENT OF CHEMICAL, BIOLOGICAL AND NUCLEAR WARFARE CASUALTIES

David J. Baker, M Phil, MD, FFARCS

I. Introduction

- A. History and proliferation: Recent use and the current threat
- B. The role of the anaesthetist
- C. Why link nuclear, biological and chemical injury?
- D. An integrated approach to wounding

II. Nuclear Events

- A. Nuclear explosion: rapid release of light, heat, blast energy and radiation
- B. Reactor meltdown: release of heat and radiation
- C. Nuclear injuries: burns, blast injury, penetrating and blunt missile injury
- D. Radiobiological syndromes: CNS, gastrointestinal, hemopoietic
- E. Implications for the anesthetist: high casualty load, breakdown of facilities, intercurrent respiratory and electrolyte problems.

III. Definitions of Chemical and Biological Agents

- A. Classical definitions of chemical and biological agents
  1. The unifying concept of the "toxic agent"
  2. The BCW spectrum of toxic agents of warfare
- B. Characteristics of toxic agents
  1. Operational - persistency
  2. Pathophysiological
     - a. Toxicity
     - b. Latency

c. Transmissibility

IV. Special Techniques in Dealing with Toxic Wounding

A. Protection - individual and collective

B. Detection

C. Decontamination

V. Properties of Some Important Agents

A. Lung damaging agents

1. Properties of phosgene

a. Mechanisms of action

b. Signs and symptoms

c. Treatment

B. Vesicant agents

1. Sulphur and nitrogen mustard

a. Absorption and toxicity

b. Pathology

c. Signs and symptoms

d. Respiratory effects

e. Management

C. Nerve agents

1. Structure and properties

a. Toxicology - pharmacology

b. Interactions with acetylcholinesterase

2. Organ effects

a. The eye

b. Respiratory system

c. Skeletal neuromuscular system

3. Signs and symptoms

a. Vapor exposure

b. Liquid exposure

4. Diagnosis

5. Management

a. Carbamate pretreatment

b. First aid

c. Medical treatment

i. Ventilation

ii. Cholinergic blockade

iii. Enzymes reactivation

iv. Benzodiazepines

6. Long-term management and prognosis

D. Cyanide agents

1. Protection

2. Pathophysiology

a. Signs and symptoms

b. Treatment

E. Toxins

1. Classification

a. Neurotoxins

b. Botulinum toxin

c. Signs and symptoms

d. Treatment

VI. Sites of Injury for Toxic Agents

A. Organ systems affected by toxic agents

1. Skin

2. Viscera

3. Blood and cell respiration

4. Central nervous system

5. Peripheral nervous system

6. Eyes

B. The respiratory tract

C. Respiratory center

1. Muscles of respiration

2. Nasopharynx

3. Larynx

4. Large airways

5. Small airways

6. Alveoli

D. The importance of toxic injury to the respiratory system

VII. Anesthesia and Toxic Agent Casualties

1. Types of casualty

2. Preoperative assessment

3. Induction

4. Maintenance of anesthesia

5. Recovery

VII. Pyridostigmine Pretreatment and General Anesthesia

A. Pharmacology of pyridostigmine

1. Protective action against nerve agents

2. Side effects

B. Interactions between pyridostigmine and anesthetic drugs

1. Premedications

2. Induction agents

C. Neuromuscular blockers

1. Depolarizing

2. Nondepolarizing

3. Effects on "train-of-four" monitoring

IX. Anesthesia and Biological Warfare

A. Classification

1. Use of biological agents

2. Routes of entry and disease patterns

3. Problems of latency

B. Protection

1. Physical

2. Medical

C. Anesthetic problems with biological agents

X. Complications of Toxic Injury

A. Respiratory

1. Airway damage

2. Alveolar damage

B. Neurological

XI. Conclusions

PERIOPERATIVE MANAGEMENT OF BURN PATIENTS

Anne J. Sutcliffe, BSc, FFARCS, LRPS

I. Introduction

II. Pathophysiology of Burn Injury

- A. Microvascular integrity
- B. Cardiovascular changes
- c. Metabolic changes
- d. Immunological changes
- e. Altered response to pharmacological agents

III. Clinical Assessment of the Burn Injury

- A. Cutaneous burns
- B. Respiratory burns
- C. Electric burns
- D. Burns in association with other injuries

IV. Resuscitation of the Burned Patient

- A. Control of the airway
- B. Difficulty with breathing
- C. Fluid resuscitation
- D. Monitoring the adequacy of resuscitation

V. Failure to Achieve Adequate Resuscitation

VI. The Advantages and Disadvantages of Early Surgical Intervention

VII. Anesthesia for the Burned Patient

- A. Preoperative preparation and premedication
- B. Induction of anesthesia
- C. Intubation
- D. Maintenance of anesthesia
- E. Monitoring during anesthesia
- F. Reversal of anesthesia

VIII. Pain Relief for the Burned Patient

IX. Analgesia for Burns Dressings

X. Complications of Burn Injury

XI. Intensive Care for the Burned Patient

- A. General aspects
- B. Fluid and nutritional requirements
- C. Cardiorespiratory care
- D. Acute renal failure

XII. Anesthesia for Reconstructive Surgery

XIII. Conclusion

PERIOPERATIVE MANAGEMENT OF ORGAN DONORS

Ake Grenvik, M.D.

I. Historical background

II. Current transplantation frequency

III. Organ needs vs supply

IV. Organ donor categories

V. Evolution of brain death concept

VI. Donor management in the ICU and OR

VII. Organ procurement and preservation

VIII. Allocation of organs

IX. US transplant organization

X. Future expectations

XI. Ethical problems

PLENARY SESSION LECTURES

SESSION V

SUNDAY, MAY 5, 1991

7:30 A.M. - 12:00 P.M.

Moderator: Levon M. Capan, M.D.

TRAUMA ANESTHESIA: THE MARYLAND APPROACH

Chet I. Wyman, M.D.

I. Statistics and Demographics

II. Regionalization of Care

- A. Trimodal distribution
  - 1. First peak
  - 2. Second peak
  - 3. Third peak
- B. Hierarchy of facilities: local emergency rooms up to Level 1 trauma centers
- C. Specialty trauma facilites

III. The Trauma Anesthesiologist

- A. First physician to meet the patient
- B. "AMPLE" history approach
  - A - Allergies
  - M - Medications
  - P - Past Medical History
  - L - Last Meal
  - E - Events/environment surrounding incident and scene

IV. Advanced Trauma Life Support (ATLS)

- A. Initiated by anesthesia personnel prior to arriving in the Admitting Area.
- B. System of protocols and priorities:
  - 1. Four phases:
    - a. "Primary Survey" (ABCDE)
      - i. A - Airway

ii. B - Breathing

iii. C - Circulation

iv. D - Disability (Mini-Neuro Exam)

v. E - Exposure

b. "Resuscitation Phase"

c. "Secondary Survey"

d. "Definitive Care Phase"

e. Anesthesiologist is involved in each phase of the perioperative care of the trauma patient

V. Airway Management

A. The first priority

B. Three objectives:

1. Secure an intact airway

2. Protect a jeopardized airway

3. Provide an airway if there is not one.

C. Most early deaths in trauma are due to faulty airway management, either through inexperience or, more importantly, faulty judgement.

D. Manual in-line cervical stabilization (A.K.A. "traction", "immobilization")

E. MIEMSS prospective study, documented neurologic injury not found

F. Surgical airway

VI. Ventilation

VII. Circulation

A. Recognize shock

B. Establish IV lines

C. High volume fluid warmer/infusers

D. Femoral artery puncture

E. Hemorrhage control

1. Direct pressure

F. Unresponsive volume resuscitation

G. Volume replacement

VIII. Secondary Survey

A. Complete physical exam ("head to toe, with tubes and fingers in very orifice") identifies;

1. Coexisting injuries

2. Injuries that may become life-threatening or drastically alter anesthetic management

3. Occult, but possibly serious injuries

IX. Summary Points

A. Early involvement by members of the anesthesia team is essential

B. Total participation in the care of the patient includes making decisions through to perform ancillary testing

C. Low threshold of suspicion of occult injuries that may jeopardize the patient.

D. Protect the cervical spine. Until proven otherwise, all trauma patients with predisposed factors have a cervical spine injury and should be treated as such.

E. Treat shock early and aggressively!

QUALITY ASSESSMENT AND RISK CONTROL IN TRAUMA ANESTHESIA

Brian McAlary, M.D.

I. Introduction

- A. Role of CQI Program
  - 1. Trauma "Prevention"
  - 2. Targeted Education
  - 3. Interdepartmental Dialogue
- B. Role of Risk Control
  - 1. Cost Control
  - 2. Stress Reduction

II. Features of any valid program

- A. Commitment to Excellence vs. Acceptable
  - 1. ability to anticipate problems
  - 2. ability to anticipate and reward excellence
- B. On going vs. Sporadic Monitoring
  - 1. Relevant Generic Screening
  - 2. Meaningful and Changing Indications
    - a. thresholds for evaluation
  - 3. Ability to detect low incidence events
  - 4. Capacity to identify trends
- C. Involvement of all levels
  - 1. Reporting
  - 2. Review / Analysis
- D. Free of Negative Association
  - 1. Anonymous review
  - 2. Instructional emphasis

3. Confidential reporting and filing

4. Easy appeal mechanism

5. Courteous feedback to reporting source

E. Compliance with External Review Bodies

1. Federal

2. State

3. JCAHCO

4. Professional Liability Insurer

F. Meaningful Solutions

1. Effective Administrative Changes

2. Extradepartmental responsiveness

3. Decreased incidence of unwanted occurrences

4. Contribution to credentialing

G. Credibility

1. Intradepartmental

2. Interdepartmental

III. Practical Procedural Concerns

A. Effective Data Collection

1. Involvement of Companion Departments

a. PACU

b. Biomedical

c. Pharmacy

2. Generic Screening Tools

3. Use of Problem Identification Form

a. Description of event or concern

b. List of alternative recommendations

c. Preferred "solution"

d. Option of feedback vs. anonymity

4. Retrospective reviews

B. CQI Coordinator

1. Independent Authority

a. Standard response letters

b. Requesting screening assistance

2. Liaison between departmental and external elements

a. Notification of concern

b. Follow up to CQI Committee

c. Notification of Risk Manager

3. Liaison with CQI Committee and department members

a. Requests for clarification of events/actions taken

b. Accelerates urgent reviews

c. Obtain needed medical records

d. Confidential filing

C. Role of CQI Committee

1. Objective review of all input

2. Makes recommendations

a. refer to Medical Staff bodies

b. policy change

c. counseling/commendation

d. reprimand/suspension

e. no further review

3. Action roles

a. Refers for inclusion in CME

b. Instructional letters

c. Notification of other departments

d. Notification of Risk Manager

IV. Outcome Analysis

A. Problem "solved"

1. Document in CQI minutes

2. Delete indicator

3. "Thank you" letters

B. Problem "remains"

1. Repeat educational effort

2. Attempt alternative solution

3. Notify Director, etc. of residual difficulty

V. Trauma Specific Indicators

A. Pre Hospital Care

1. The requisite "big four"

2. Proper ET placement

B. Admission Phase

1. Use of In line stabilization

2. Appropriate use of blood products

3. Availability of support services

C. Intra-operative Phase

1. Frequency of repeat laboratory studies

2. Temperature control efforts

D. Post-operative Phase

1. Need for prolonged or repeated intubation

2. Fluid management

PERIOPERATIVE PAIN MANAGEMENT FOR TRAUMA PATIENTS

Roger S. Cicala, M.D.

I. Pathophysiology of Acute Pain

II. Principles of Pain Management

III. Methods of Acute Pain Management

- A. Parenteral medications: narcotic analgesics
- B. Parenteral medications: non-narcotic agents
- C. Epidural analgesia
  1. Catheter placement
  2. Epidural administration of narcotic analgesics
  3. Epidural administration of local anesthetics
  4. Selection of agent and monitoring for epidural analgesia
- D. Intrathecal analgesia
- E. Intrapleural analgesia
- F. Peripheral nerve blocks
- G. Cryoanalgesia
- E. Transcutaneous electrical nerve stimulation

III. Analgesia for Patients with Specific Types of Injury

- A. Thoracic injuries

B. Femoral fracture

C. Thermal injuries

IV. Chronic Pain

A. Sympathetically mediated pain syndromes

B. Post amputation pain

CRITICAL CARE TRANSPORT OF THE PEDIATRIC TRAUMA PATIENT

James I. Gilman, M.D.

I. Introduction - Pediatric Perspective

II. Scene Response

A. Assessment

1. Airway/Ventilation/Oxygen
2. CNS/Level of Consciousness
3. Cardiovascular/Pulses

B. CPR/ABC's

C. Vascular Access/Fluids

D. Temperature Control

E. Monitors

1. ECG
2. Pulse Oximeter
3. Temperature

F. Specific Injuries

1. Head
2. Neck
3. Airway
4. Chest
5. Abdomen
6. Extremities

7. Burns

8. Immersion

G. Mast Suit

III. Secondary Transport

A. Adequate Resuscitation

Vital Signs/Perfusion

B. Airway/Ventilation

C. Volume Status/Fluids

1. Crystalloid

2. Colloid/Blood

D. IV Access

1. External Jugular

2. Internal Jugular

3. Subclavian

4. Femoral

E. Foley/NG/OG

F. Immobilize

1. Head/Neck

2. Extremities

3. Restraints

G. Imaging

1. Head-CT

2. Neck-X-Ray/MRI

3. Chest-AP/LAT X-Ray - CT

4. Abdomen - CT, X-ray, DPL

H. Drugs

1. Muscle relaxants

   pancuronium

2. Analgesia/narcotics

3. Sedation

4. Seizure control

5. Pressors

I. Vehicle Considerations

1. Ambulance

2. Rotorcraft

3. Fixed wing

4. Parents

COMPLICATIONS OF TRAUMA: COAGULOPATHY AND EMBOLISM

Levon M. Capan, M.D.

I. Coagulopathy

- A. Physiology of coagulation
- B. Phases of coagulation abnormalities after trauma
- C. Causes of coagulopathy in trauma
- D. Diagnosis
- E. Management

II. Deep Vein Thrombosis

- A. Diagnosis
- B. Prevention
- C. Pharmacologic prevention
- D. Treatment

III. Pulmonary Embolism

- A. Mechanism
- B. Clinical manifestations
- C. Diagnostic tests
- D. Treatment
- E. Anesthetic considerations

SIMULTANEOUS
BREAKAWAY SESSIONS
FRIDAY, MAY 3, 1991

SIMULTANEOUS BREAKAWAY SESSIONS

I. Airway Management-Case Discussions/Skill Stations

Friday, May 3, 1991

2 - 5 p.m.

Moderator: Elizabeth C. Behringer, M.D.

Panelists: Kenneth J. Abrams, M.D.
Mahmood Jaberi, M.D.
Murray A. Kalish, M.D.
Mark T. Murphy, M.D.

Session Agenda

2:00-2:15 p.m **Introduction** - Dr. Behringer

2:15-3:15 p.m. **Case Discussions:**

Dr. Abrams:	*Closed Head Injury*
Dr. Jaberi:	*Gunshot Wound to the Face* *Airway Obstruction Post Motorcycle Accident*
Dr. Kalish:	*Blunt Facial Trauma* *Open Globe Injury*
Dr. Murphy:	*Laryngotracheal Trauma* *Cervical Spine Trauma*

3:15-3:30 p.m. **Questions**

3:30-4:00 p.m. **Break - Visit Exhibits**

4:00-5:00 p.m. **SKILL STATIONS/HANDS ON SESSIONS:**

a. *Cervical Spine Injury in the Trauma Patient*
Drs. Murphy and Behringer

b. *Advanced Airway Management Station*
Drs. Abrams, Jaberi, Kalish, Murphy and Behringer

AIRWAY MANAGEMENT: CASE DISCUSSIONS

CLOSED HEAD INJURY

Kenneth J. Abrams, M.D.

A. **Case Stem**:

A 32-year-old male unbelted passenger involved in a head on collision with a telephone pole. At scene, reportedly alert, AOB, obvious right leg deformity. VS at scene: BP 140/90, P 110, RR 24. Transported to ER with 0_2 via FM, 18 G. RPIV, Philadelphia collar in place, Thomas splint, on backboard.

On arrival in ER, found to be stuporous. VS: BP 150/95, P 118, RR 28, GCS = 11.

The anesthesiologist responds with the trauma team.

B. **Guidelines for Discussion:**

1. Anesthetic considerations in patients with closed head injury.
2. Criteria for early intubation.
3. Intubation techniques.
   a. What options exist?
   b. Sequence for intubation
   c. Useful pharmacology
4. Failed intubation management

C. **References:**

1. Abrams KJ, Nolan JP, Grande CM. Trauma anesthesia and critical care: Anesthesiology's oldest speciality reborn. Anesth Clin. 1991; 9:2, in press.

2. Capon LM. Airway management. In: Capon LM, Miller SM, Turndorf H, eds. *Trauma Anesthesia and Intensive Care*. Philadelphia: JB Lippincott, 1991:43-81.

3. Frost EAM. Perioperative anesthetic management of central nervous system trauma. in: Stene JK, Grande CM, eds. *Trauma Anesthesia*. Baltimore: Williams & Wilkins, 1991:250-265

4. Frost EAM. Anesthesia for patients with head trauma. In: Rogers MC, ed. *Current Practice in Anesthesiology*. Philadelphia: BC Decker, 1991, in press.

5. Grande CM, Stene JK, Bernhard WN. Airway management: considerations in the trauma patient. Crit Care Clin. 1990; 6:1.

6. Howard RA, Matjasko MJ. Management of intracranial hypertension in severe head injury. In: Matjasko MJ, Shin B, eds. *Problems in Anesthesia*, 1990; 4:3.

7. Paly D, Wolf A, Matjasko MJ. Management of severe head injury: The anesthesiologist's role. Probl Anesth. 1990; 4:1.

8. Tabaddor K, Frost EAM. The management of head injury. In: Frost EAM, ed. *Clinical Anesthesia in Neurosurgery*. Boston: Butterworth-Heinemann, 1991:403-438.

GUNSHOT WOUND TO THE FACE

Mahmood Jaberi, M.D.

MR. H.L. DOE #35857
59 y.o. WM
Self-inflicted gun shot wound to face

2.3.91

- From scene to MIEMSS
- Bleeding from facial wounds
- Following commands
- Breathing spontaneously

Transported to MIEMSS:

- On backboard
- Prone position
- Peripheral IV

At time of admission:

- Awake
- Following commands
- Holding the head up
- Bleeding from wounds

Neck was inspected

Induction:

- Lidocaine 100 mg IV
- Succinylcholine 120 mg
- Turned to supine position
- Direct laryngoscopy
- #8 OTT, BBS
- On servo ventilator
- Large bore IVs
- Routine monitoring
- Blood & fluid resuscitation

PMH:

- Pneumonia 1987
- Depression lately

- Tracheostomy in AA
- Followed by head CT
- Then to OR for I + D
- Closure of wounds

Received:

- 8 units PC
- 12 units FFP
- 5200 crystalloids

Since admission:

- 15 trips to OR for
  - I & Ds
  - ORIF mandible
  - Tube feeding placement
  - Orbital floor reconstruction
  - Stabilization of tissues
  - Lat dorsi free flap
  - Pectoralis major myocutaneous flap
  - Omental graft
  - Rib graft

Questions:

- Intubation vs cricothyroidotomy
- Prone vs supine position
- Complication of tracheostomy
- NPO status for repeated surgeries
- Postoperative respiratory support

AIRWAY OBSTRUCTION POST MOTORCYCLE ACCIDENT

Mahmood Jaberi, M.D.

MR. D.R. DOE #36275
22 y.o. WM
Admitted at **1506 (3.16.91)**

- MCA vs car
- Ejected
- Neck hit the side mirror
- No helmet
- Semiconscious

- Brought to MIEMSS on backboard
- 0_2 mask
- Spont. resp.
- IV fluid

At the time of admission:

- Awake
- Oriented X1
- GCS 14/15
- BP: 162/94
- HR: 104/min
- RR: 20/min

- No scalp lac
- PEARL (2 mm)
- Blood in mouth & nares
- Facial lac (R) mental area
- Mandibular tenderness

- Avulsed teeth (incisors)
- Cut upper lip
- Hard palate laceration
- Tongue laceration 5 cm top, 1 cm underneath

- Neck: V-shaped superficial lac
- Trachea midline
- No hematoma
- No hoarseness
- No airway obstruction
- No spine tenderness

Other findings:

- Abrasion (L) arm, deltoid area
- Otherwise negative

- Admission ABG on 21% FIO_2: 89/7.39/39/99/-5/24
- H/H: 13/38.9
- Lytes: Normal
- Coag: Normal

PMH:

- Not remarkable

SH:

- Drug abuse
- Moderate alcohol
- Smoker: one PPD

X-rays

- C-spine X-ray: Normal
- T-spine: Normal
- L-spine: Normal
- Head CT: Normal

1800 (3.16.91)

- Local anesthesia & IV sedation
- Closure of wounds
- Archbars & elastic bandage
- Stable vital signs
- Spontaneous respiration
- Patent airway

0715 (3.17.91)

- Complains of shoulder pain
- Received Demerol 75 mg IM

1200 (3.17.91)

- Dyspnea
- Sense of air hunger
- Diffuse chest pain
- Dizziness
- Confused at times

- Archbars in place with bands
- Patent nares
- PEARL
- Good air exchange at bases
- Diffuse wheezing upper airway
- SaO_2: 94%
- ABG: 77/7.38/45

- Dry
- Well perfused
- Lethargic
- T wave changes on lead III

Impression:

- Partial airway obstruction, secondary to swelling

Orders:

- NPO
- 45° head up position
- Hold narcotics
- 0_2 4 lit/min nasal cannula
- Remove elastic bands

1300 (3.17.91)

- SaO_2 = 100%
- More alert
- Good memory
- Elastic bands removed
- Clear resp sounds
- Oropharynx: minimal swelling
- Uvula in midline

1630 (3.17.91)

- 75% 0_2 by mask
- SaO_2 ≥ 99%

0100 (3.18.91)

- Deterioration of mental status
- Lethargic
- Disoriented
- Confused
- Mildly combative
- No drooling
- Comfortable in upright position

- SaO_2: 99-100%
- BP: 130/85
- HR: 94/min
- RR: 26/min

- HEENT: 3-4 mm nares
- (R) perimandibular hematoma, extending with soft tissue swelling
- Decreased breath sounds at bases
- ABG: 159-7.36-40

- Partial airway obstruction at level of epiglottis secondary to soft tissue swelling

- Nasal intubation
- Sedation
- On ventilator
- TV 950 x SIMV 10
- BP: 170/85 to 130/80
- HR: 107 to 94
- ABG on 50% $Fi0_2$: 228/7.35/44/99/24
- Lytes: Normal
- Coag: Normal

0900 (3.18.91)

- Subepiglottic edema per x-ray
- T Max 100.2

- CT scan
- Significant bleeding from the tongue
- Many areas of hematoma
- No hyoid bone fracture

- Tracheostomy with #8 Shiley fenestrated tube
- In OR under 0_2-air, fentanyl, norcuron, pentothal

Lateral x-ray of neck: 1250 (3.18.91)

- Marked inferior displacement of hyoid bone and a large soft tissue mass impinging upon the anterior aspect of the hypopharynx, completely occluding the airway

Mandibular series:

- Demonstrates a vertical fracture through the (R) mandibular ramus with mild destruction at the fracture site

BLUNT FACIAL TRAUMA

Murray A. Kalish, M.D.

History:

- 19 y/o W male
- Unbelted passenger
- Partial ejection
- Car rolled on patient
- Positive LOC, initially

Clinical Presentation:

- Bleeding upper airway
- Continuous aspiration blood and secretions
- Alert and cooperative
- Breathing spontaneously
- Severe facial deformity
- Mandibular fracture, right

Past Medical History:

- Increased blood glucose "as child"
- Alcohol, socially

Physical Examination:

- VS: BP 110/palpation
  P 60
  R 19
  WT 61 kg
  HT 178 cm

HEENT:

- Bilateral epistaxis
- Multiple upper lip lacs
- Midline hard & soft palate fx
- Mandibular fx
- Multiple dental avulsions
- Left serous otitis media

Neck, Chest, Abdomen:

- Negative

Neurological:

- GCS 15/15

Lab:

- H/H 11.5/34.8
- K 2.8
- Glucose 303

X-ray Studies:

- C-spine, CXR negative
- CT head & face:
  - Bilateral LeFort III
  - Impingement right optic nerve on bony fragment
  - Anterior & posterior sinus fx with pneumocephalus
  - Hard palate fx
  - NOE fx

Ophthalmology Consult:

- Poor blink & enopthalmos OS
- Decrease visual acuity OS, ? macular edema
- Ptosis OD
- Diplopia due to decrease EOM, trauma

Procedures: Took 22 hours

- Tracheostomy
- *Dental impressions*
- Placement of arch bars
- Intermaxillary fixation
- Bicoronal incision
- ORIF bil. naso-orbital-ethmoid fx
- ORIF bil. LeFort I
- Reconstruction orbital floors & medial walls with plates & rib grafts
- Repair facial lacs
- ORIF split palate
- ORIF bil. zygoma

Anesthesia:

- Rapid sequence technique
- In-line neck stabilization
- Thiopental, succinylcholine, IV lidocaine
- Maintenance: vecuronium, fentanyl, midazolam -- isoflurane, sufentanil drip

Hospital Course:

- Multiple additional anesthetics via tracheostomy
- Washouts, IMF adjustments, placement ungual splint, dental extraction, evacuation scalp hematoma

OPEN GLOBE INJURY

Murray A. Kalish, M.D.

History:

- 17 y.o. BM
- Unbelted driver
- Positive LOC
- Difficult extrication

Clinical Presentation:

- Combative
- Mild respiratory difficulty
- Facial pain

Past Medical History:

- Asthma-like symptoms, 1985
- PCP, cocaine, marijuana
- Smokes cigarettes
- Occasional alcohol intake

Physical Examination:

VS:

- BP 80/40-100/70
- P 100
- R 18 mild respiratory difficulty
- WT 70 kg
- HT 175 cm

HEENT:

- Lac. left lateral upper & lower eyelid
- Lac. left temporal-parietal area
- Lac. facial nerve

Neck, Chest, Abdomen:

- Negative

Extremities:

- Lac. right ankle & left wrist

Neurological:

- GCS 12/15

Lab & X-ray Studies:

- Negative

Ophthalmology Consult:

- Lac. left lateral upper & lower eyelids
- Small hole in globe

Procedures:

- Repair of the globe
- Repair of multiple lac.

Anesthesia:

- Patient combative
- Mild respiratory difficulty
- Rapid sequence technique
- In-line neck stabilization
- Thiopental, vecuronium (high dose), IV lidocaine

Hospital Course:

- Release of tarsorrhaphy upper & lower left lid
- Flap reconstruction of left lateral canthoplasty

LARYNGOTRACHEAL TRAUMA

Mark T. Murphy, M.D.

A 43 y.o. intoxicated male was the unrestrained driver of an open jeep. He was ejected from the vehicle after striking a tree at a high rate of speed. In the ER, the patient was obviously intoxicated, following commands and speaking in a grating voice about "getting even." His vital signs were stable with normal respirations. Physical exam was significant for an open right femur fracture and a left radial fracture. His neck was nontender and his cervical spine was "cleared" radiographically.

He was taken to the OR for orthopedic intervention. After preoxygenation, a rapid sequence induction with cricoid pressure was performed. The cords were well visualized. However, a "clot" was noted between the vocal cords during laryngoscopy. An endotracheal tube would not pass. Desaturation began.

Discussion:

- Differential diagnosis
- Laryngotracheal injuries
  - Presentation
  - Incidence
  - Management
- Treatment decisions/ protocols
  - Head & neck position
  - Direct oral intubation
  - TTJV
  - Flexible fiberoptic bronchoscope
  - Surgical cricothyroidotomy/tracheostomy

References

1. *ATLS Program Instructors Manual*, Chicago, American College of Surgeons, 1988.
2. Mathisen D, Grillo, H. Laryngotracheal trauma. Ann Thorac Surg. 1987; 43:254-62.
3. Fuhrman G, et al. Blunt laryngeal trauma: classification and management protocol. J Trauma. 1990; 30(1):87-92.

CERVICAL SPINE TRAUMA

Mark T. Murphy, M.D.

A 65 y.o. male is one week s/p MVA The injuries he sustained included: subdural hematoma, unstable C3-4 fracture, multiple rib fractures with significant pulmonary contusion and fracture of the left radius.

The patient underwent evacuation of the SDH, splinting of the radial fracture and placement of a Halo device.

Currently, he is in the Neuro ICU intubated with a presumed aspiration pneumonia, PaO_2 80 on 50% FiO_2. The neurosurgical nurse calls to say the ETT cuff has torn.

Discussion:

- Cervical Spine Injury
  - Incidence in the OR/ ICU population
  - Effects on airway management
- Strategies for endotracheal tube change
  - Change under direct vision
  - Change over a stylet
  - Flexible fiberoptic bronchoscope
- Methods of oxygenation

References:

1. Crosby ET, Lui A. The adult cervical spine: implications for airway management. Can J Anaesth. 1990; 37:77-93.
2. Grande CM, Barton CR, Stene JK. Appropriate techniques for airway management of emergency patients with suspected spinal cord injury. Anesth Analg. 1990; 67:714-15.
3. O'Malley KF, Ross SE. The incidence of injury to the cervical spine in patients with craniocerebral injury. J Trauma. 1988; 38:1476-8.

SCIENTIFIC POSTERS

FRIDAY, MAY 3, 1991

2:00 P.M. - 5:00 P.M.

II. SCIENTIFIC POSTERS

SESSION AGENDA

2:00 P.M. ANESTHETIC MANAGEMENT OF PEDIATRIC PATIENTS WITH FOREGIN BODY ASPIRATION
Aleksandra Mazurek, M.D.

2:21 P.M. A WORLDWIDE PEDIATRIC TRANSFER SERVICE - THE FIRST 20 PATIENTS
Marianne Sharpe, RGN

2:42 P.M. DOES SYSTEMATIC CHEST COMPUTED TOMOGRAPHY (CCT) MODIFY MEDICAL MANAGEMENT AFTER SERIOUS CHEST TRAUMA? PRELIMINARY STUDY
J.E. de La Coussaye, M.D.

3:03 P.M. SIMULATED CONTINOUS FLOW VENTILATION VS. T-PIECE VENTILIATION PRIOR TO EXTUBATION
Zvi Herschman, M.D.

3:24 P.M. A VIDEOGRAMME TO INCREASE PEACE-TIME USE OF KETLAR IN SWEDISH WAR ANESTHESIA TRAINING
Eskil Dalenius, M.D., D.E.A.A.

4:00 P.M. END TIDAL CO2 MONITORING DURING PREHOSPITAL CARDIOPULMONARY RESUSCITATION
A. Rosenberg, M.D.

4:21 P.M. COLORIMETRIC END-TIDAL CO2 MONITORING DURING PRE-HOSPITAL CARDIOPULMONARY RESUSCITATION
Pierre Carli, M.D.

4:42 P.M. INDICATIONS FOR ANTI-G MAST PANTS IN FONCTION OF THE ANATOMIC SITES OF VASCULAR LESIONS
J.M. Fon Rouge, M.D.

5:02 P.M. THE FRENCH SANITARY LOGISTICS IN CASE OF MULTIPLE CASUALTY INCIDENTS: A NEW GENERATION OF MOBILE SANITARY UNITS
J.M. Fon Rouge, M.D.

ANESTHETIC MANAGEMENT OF PEDIATRIC PATIENTS WITH FOREIGN BODY ASPIRATION Aleksandra Mazurek, MD, Lauren D. Holinger, MD, Producer: Miroslaw Rogala, Children's Memorial Hospital, Chicago, IL, USA

The purpose of this presentation is to summarize the problems related to foreign body aspiration in children.

The first part of the program discusses epidemiology, symptomotology and diagnosis of the disease.

The second part is focused on anesthetic technique practiced at Children's Memorial Hospital in Chicago together with the demonstration of endoscopic principles. The importance of close cooperation between the anethesiologist and the ENT surgeon is stressed. Post-operative treatment of the child after endoscopy is discussed.

A WORLDWIDE PEDIATRIC TRANSFER SERVICE - THE FIRST 20 PATIENTS

Spencer Kee FFARCS, Marianne Sharpe RGN, Bridget Collier RGN, Aubrey Bristow FFARCS
Careflight Project, St Bartholomews Hospital, London, UK

PURPOSE OF PROJECT

A facility was set up to provide for the transfer of critically ill neonates and pediatric patients worldwide by commercial, private fixed wing and rotary aircraft. The need for the service and its efficacy were assessed.

METHOD

Commercially available equipment was modified to provide a modular transport system that could be moved between aircraft. Liquid oxygen and gel acid power supplies allow for full ITU monitoring over several days. The facility was staffed by specially trained anesthesiologists and pediatric nurses, with other specialists used as necessary.

RESULTS

20 patients were transferred a mean distance of 160 miles (range 25 to 480 miles) within the UK and 3663 miles (700 to 6500 miles) internationally. The mean gestational age of the neonates was 37.6 +- 3.5 weeks and the mean age of the other children 57 +- 55 months at the time of transfer.

Commercial flights were used in 6 cases, executive fixed wing aircraft in 7 cases and helicopters in 11 cases. Several transfers used a combination, one neonate requiring 3 aircraft.

The diagnoses are given in table 1. 12 patients were ventilated in flight. Medical complications, confined to fixed wing, occured in 6 cases. The commonest problem was hypoxia (4 cases). One patient required defibrillation. All complications were successfully managed. 17 patients survived to leave hospital.

CONCLUSION

There is a small but definable need for coordinated pediatric transfers both within the UK and worldwide. It is feasible to provide a level of equipment and staff comparable to a specialist pediatric centre. Seriously ill pediatric patients can be transferred by this means. Rotary flights may be safer than fixed wing flights.

TABLE 1

DIAGNOSIS	NUMBER OF CASES
Prematurity	7
Cardiac abnormalities	6
Tumors	2
Infection	7
Trauma/orthopedics	2
Transplantation	2

DOES SYSTEMATIC CHEST COMPUTED TOMOGRAPHY (CCT) MODIFY MEDICAL MANAGEMENT AFTER SERIOUS CHEST TRAUMA ? PRELIMINARY STUDY.

J.E. de La Coussaye M.D.*, J.J. Estorc M.D.*, J.M. Teissier M.D.**, R. Cohendy M.D.*, P. Richard M.D.*, A. Proust M.D.*, L. Metge M.D.**, F.M. Lopez M.D.**, J.J. Eledjam M.D.*

* Department of Anesthesiology, Critical Care and Emergency.

** Department of Radiology. University Hospital Nîmes, France.

Patients with serious chest trauma require a clinical and radiological evaluation in emergency room. The aim of the study was to precise whether a systematic CCT could modified the medical management of these patients.

Methods : In a prospective preliminary study were included patients with serious chest trauma, as defined by 2 or more preradiologic criteria : blunt trauma, more than 3 rib fractures, flail chest, pleural abnormality, acute respiratory distress, penetrating injury, PaO2 $\leq$ 60 mmHg, heart injury (ECG, echocardiography). Exclusion criteria were : depressed level of consciousness, emergency laparotomy or other major surgery, unstable hemodynamic state. Every patient had 4 portable films in emergency room : high and low voltage AP films, anterior and posterior lateral views. CCT scan was performed (Elscint 2002) from the level of the lung apices through the diaphragm.

Results : Twenty nine patients were included : 24 after traffic accidents, 5 after penetrating injuries.

Type of lesion	Chest x-ray	CCT	Modification in management
Rib fracture	124	136	No *
Flail chest	13	17	No
Sternal fracture	5	9	No
Retrosternal hematoma	1	3	No
Hemothorax	10	32	No
Pneumothorax	18	21	Yes †
Lung contusion	0	12	No
Diaphragm rupture	2	2	No
Mediastinum widening	12	12	No •

* additional rib fractures were found in the same patients ; † one patient requiring anesthesia for peripheral surgery : chest tube ; • none patient had aortic injury, none patient with mediastinal abnormality on CCT had a normal mediastinum on plain film.

Discussion/Conclusion : Except in mediastinal widening where CCT was more accurate than plain film, CCT did modify the management of only one of the 29 patients. CCT showed small pleural effusions and minimal atelectatic areas that never required any specific treatment. In conclusion, CCT induced only 1 modification in the management of serious chest trauma after initial clinical evaluation and chest X-ray with 4 films.

SIMULATED CONTINUOUS FLOW VENTILATION VS. T-PIECE VENTILATION PRIOR TO EXTUBATION Z. Herschman, MD, A. Klapholz, MD, G. Blumberg, RRT, A. Manion, MA, BA, N. Sonnenklar, MD.
Mount Sinai School of Medicine at Elmhurst Hospital Center, Elmhurst, NY, USA.

Introduction. Removing a patient from mechanical ventilation usually proceeds along defined plans of gradual withdrawal from mechanical support. Prior to extubation a patient is often given a trial of breathing through a valveless t-piece system(TP) allowing continuous flow with minimal resistance. This eliminates resistive qualities of CPAP systems found in ventilators employing a demand flow system. These resistive qualities can impose a significant ventilatory workload on patients. This increased workload can result in inaccurate assessment of a patient's ability to ventilate independantly or even cause them ventilatory failure.(1-2) The Puritan Bennett 7200A series ventilator has a computerized module, flow-by (FB), which attempts to mimick a continuous flow system during spontaneous breathing. We evaluated the efficacy of this modality to substitute for TP ventilation prior to extubation in our SICU.

Methods. Twenty-two patients in the SICU had their charts reviewed. Age ranged from 28 to 95 years. The patients were mechanically ventilated post-operatively, they were being weaned from mechanical ventilation by progressively decreasing the rate of mechanically assisted breaths in the SIMV mode and progressively decreasing the amount of pressure support supplied to spontaneous breaths. The patients were then placed on the following settings: 1) CPAP/FB of 20 l/min and flow sensitivity of 3 l/min on an FiO2 of 0.4, 2) CPAP/FB of 10 l/min with the same flow sensitivity and FiO2, 3) humidified TP, FiO2 of 0.4, flow rate 6 l/min. No PEEP was applied to the TP and maximum of 5 cm H2O was used during FB. As per SICU protocol pHa, paCO2, paO2, saO2, Vt and PIF in addition to routine BP, HR and T are measured within a half hour of changing ventilator settings. Cost analysis of instituting the two modalities was derived by summing the costs of disposable supplies and labor costs. The null hypothesis was there was no difference in the measured parameters between the modes of ventilation. All variables were subjected to a 3-level one-way ANOVA with technique (FB10,FB20,TP) treated as within subjects factor.

Results. The analysis revealed a significant effect on PaCO2, $F(2,44)=5.03$, $p=0.01$. Post hoc comparisons revealed the effect was primarily accounted for by the difference between FB20 and TP (PaCO2's=37.61 and 40.12 respectively), $t(22)=2.68$, $p=0.14$. The other post hoc comparisions for this variable failed to reach significance. The ANOVA's conducted on all other variable revealed no significant effects. The cost per application of TP was $13 more than FB.

Discussion. The only statistically different effect was for FB20 and TP. This difference in PaCO2 (37.61 vs 40.12) is clinically insignificant. In a sample month 80 of 136 patients survived removal from mechanical ventilation. At $13 per patient this would save $1040 for the month. We conclude: 1)FB10, FB20 and TP prior to extubation are clinically virtually interchangeable 2) use of the ventilator until extubation allows for failsafe backups should apnea occur, online spirometric data and significant cost control.

References.

1. Hess, D. Perspectives on weaning form mechanical ventilation - with a note on extubation. Resp Care 32 No. 3:167-71, 1987.
2. Schmidt GA, Hall JB. Acute on chronic respiratory failure. JAMA 261 No 23: 3444-3454, 1989.

A VIDEOGRAMME TO INCREASE PEACE-TIME USE OF KETALAR® IN SWEDISH WAR ANESTHESIA TRAINING

Dalenius E., M.D., D.E.A.A., Lagerholm G., Lindahl C., Nathanaelsson K., Norberg K.-A., Rydberg R.
R & D Dept (War), Medical Board of the Armed Forces; Board of Health & Welfare; Parke-Davis/Warner Lambert Scandinavia Ltd; Cue Productions Ltd; Sweden.

In the planning for a war, Sweden probably is hampered by the fact that we have had peace for over 200 years, and so we have to draw heavily on the experience of other countries. Our planning presupposes a total integration of the civilian and military health care resources, of which the former will bear approx 70 % of the total surgical workload, supplemented by field hospitals etc.

The war situation that is judged to bear most resemblances to the swedish is that faced by the british in the Falklands conflict, both in terms of resources and climate. We base our military anesthesia service on a draw over machine similar to the Penlon Triservice with OMV vaporizer, and at present with halothane as the principal drug. The possibility of a serious oxygen shortage is foreseen.

Therefore, a very important drug to include in the planning is ketamine, but at present the peace-time use of this is minute in Sweden as in many other countries. A videogramme was therefore produced jointly by the military and civilian Medical Boards, for use in military as well as civilian training of both physician anesthetists and nurse anesthetists, to make them realize that ketamine has many uses in civilian practise and to increase their openmindedness toward this drug.

This videogramme, in its international version, will be shown and the results in Sweden discussed.

END TIDAL CO2 MONITORING DURING PREHOSPITAL CARDIOPULMONARY RESUSCITATION

A.Rozenberg, M.D, P.Carli, M.D, O.Lamour, M.D., M.Bousquet, M.D., A.Derossi, M.D.
Department of Anesthesiology Hôpital Necker (Pr Barrier) Paris, France

The monitoring of cardiopulmonary resuscitation (CPR) and advanced cardiac life support (ACLS) in the prehospital setting was until recently mainly clinical. End Tidal Carbon Dioxide partial pressure (ETCO2) monitoring had been used for the treatment of cardiac arrest in emergency rooms and hospital wards (1). The aim of this study was to evaluate capnometry in the prehospital setting and compare ETCO2 values obtained in successfully resuscitated and non resuscitated patients.

Methods: with institutional approval 25 consecutive patients were prospectively studied on field after cardiac arrest. CPR was begun by Emergency Medical Technicians and continued with ACLS according to American Heart Association protocols by a medical resuscitation team (including at least one anesthesiologist). As soon as the patient was intubated, ETCO2 was continuously recorded by a portable infrared capnometer (POET Criticare System Inc.). ETCO2 data were analysed by a microcomputer. In order to provide a strict ventilatory control the patient was immediatly connected to a portable mechanical ventilator Patients age, sex, initial cardiac rythm , continuous EKG and circumstances were recorded. A chart of resuscitations efforts with precise timing of drugs administration, clinical status of the patient, duration of prehospital treatment was established. Special attention was focused on bicarbonates administration responsible of misleading ETCO2 increase during CPR (2). The patient was considered as successfully resuscitated if he returned to spontaneous circulation (ROSC) and was alive with stable blood pressure on admission to the hospital. Patients were shared in groups according to the success of resuscitation : group1 resuscitated, group 2 nonresuscitated . Statistical analysis used unpaired student's t test for continuous variables and data were expressed as mean ± SD.

Results : One patient (sucessfully resuscitated) was excluded of the study because of the rupture of the cuff of the endotracheal tube. The 24 remaining patients were 10 in group 1 and 14 in group 2. The two groups were similar except for the initial cardiac rythm (significantly more VF in group 1). The maximum ETCO2 value recorded was higher in group 1 patients (58 ± 14 mmHg) as compared to group 2 (21 ± 5 mmHg) $p < 0.001$. Maximum ETCO2 was observed in group 1 just before the return of spontaneous circulation, time to reach this maximum value was 92 ± 302 sec from the beguinning of the recording in this group. Initial ETCO2 value was higher in group 1 (20 ± 8mmHg) as compared to group 2 (13 ± 8mmHg) $p < 0.05$

We conclude that in the prehospital setting ETCO2 monitoring is simple to perform and is a guide to resuscitation effort.

References :

1- Sanders A.B., Kern K.B., Otto C.W. End-tidal carbon dioxyde monitoring during CPR : a pronostic for survival. JAMA, 1989, 262:1347-51

2- Garnett A.RT., Ornato J.P., Gonzales E.R., Hohnson E.B. End-tidal carbon dioxyde monitoring during CPR. JAMA, 1987 , 257 : 512 - 515

COLORIMETRIC END-TIDAL CO2 MONITORING DURING PRE-HOSPITAL CARDIOPULMONARY RESUSCITATION P.Carli., M.D., A.Rozenberg, M.D., M.Bousquet, M.D., O.Lamour, M.D., A.Derossi, M.D.
Departement of Anesthesiology Hôpital Necker (Pr. Barrier) Paris, France.

End Tidal CO2 partial pressure (ETCO2) monitoring is very usefull during CPR : an acute increase of ETCO2 (washout) demonstrates a return of spontaneous circulation (ROSC) (1). More recently the ETCO2 level during CPR was considered as a pronostic index for survival (2). The FEF CO2 Detector (FENEM Lab. Inc.) is a simple disposable colorimetric device mainly used for the assessment of endotracheal intubation. The aim of this study was to evaluate if FEF could be used as a semi-quantitative ETCO2 assessment during prehospital CPR.

Methods

With institutionnal approuval 8 consecutives patients (6 male, 2 female) with cardiac arrest were prospectively studied on field. CPR was begun by Emergency Medical Technicians and continued with ACLS by a resuscitation team (including at least one anesthesiologist), according to American Heart Association standard guidelines. ETCO2 was continuously recorded by a portable capnometer (POET Criticare Systems, Inc.) and by an FEF CO2 Detector fitted between the endotracheal tube and the breathing circuit. The FEF had a chemically treated indicator strip that colorimetrically reflects CO2 levels. Semi-quantitative ETCO2 was evaluated every 5 minutes according to the FEF 6 possible colors (from 1 = purple ≤ 2.3 mmHg CO2, to 6 = yellow ≥15.2 mmHg CO2). Patients age, sex, initial cardiac rythm, continuous EKG, circumstances and return to spontaneous circulation were recorded. Bicarbonate administration (dose and timing) was precisely noted.

Results

During CPR, 3 out of the 8 patients had a ROSC. For those 3 patients the FEF color was yellow [6] during CPR (ETCO2 ≥ 15.2 mmHg). One patient had a yellow FEF without ROSC. The 3 last patients had beige color [3] during CPR, without ROSC. Relation between FEF color range and capnometry in our study is shown on figure 1.

Discussion

In every patients the rosc was assessed by the FEF color yellow [6]. The only patient with a yellow FEF and no ROSC received bicarbonates just before. However in all patients the FEF was not able to detect hypercarbia : the same yellow color was observed on and after 20 mm Hg of ETCO2. The use of FEF was easy and reliable : in one patient the device was contaminated by epinephrin injected in the endotracheal tube. The device had to be changed to resume the CO2 evaluation. We have previously used infrared capnometer in this settings, but the FEF was more simple, no expensive, and did not need electrical power source. This semi-quantitative colorimetric evaluation, despite of its limitations, showed the ROSC and guided the resuscitation efforts.

References :

1- Falk J.L., Rackow E.C., Weil M.H. End-tidal carbon dioxyde concentration during CPR. N.Engl.J.Med1988;318:607-11

2- Sanders A.B , Kern K.B., Otto C.W. End-tidal carbon dioxyde monitoring during CPR : a pronostic for survival. JAMA, 1989, 262:1347-51

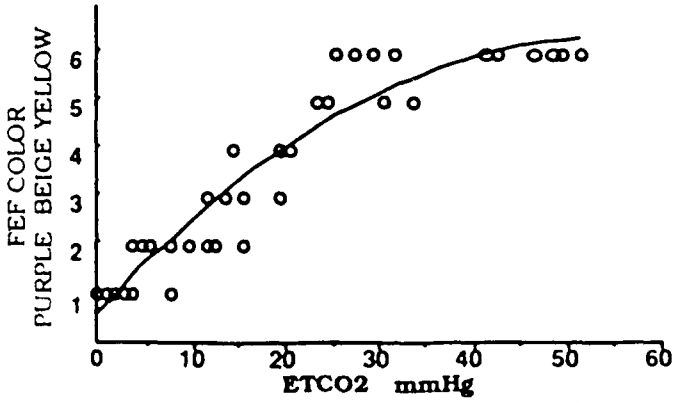


Fig.1 Relation between FEF color range and ETCO2

INDICATIONS FOR ANTI-G MAST PANTS

IN FONCTION OF THE ANATOMIC SITES OF VASCULAR LESIONS.

J.M. Fon rouge MD*, G. Leclerc MD*, J.M. Fontanella MD**,
F. Lakdja MD***, S. Tartière MD*, M. Sabathie MD****
*SAMU 93 Assistance Publique des Hopitaux de Paris
SAMU 03 MONTLUCON * Fondation Bergonie **** Université Bordeaux

The use of MAST pants or flying suit anti-gravity equipment is frequent in the emergency extra-hospital care of severe collapsus patients.

The role of this material is to force back blood from the lower limbs towards the systemic circulation and exert a counter abdominal pressure. This permits an increase in the pre-charge by elevating the central venous pressure. The elevation of the pre-charge pressure appears to be related to the post-charge when the abdominal counter pressure is from 60 to 80 Tor. The increase in the systemic arterial resistance can exclude the peripheral vascular sector by clamping the aorta below the diaphragm (this procedure maintains the arterial pressure and conserves the optimal cerebral vascularization.

The human body can be divided into two zones :

1) A compressible zone lower limbs or abdomen,
2) An incompressible zone (sub and supra diaphragmic thoracic area).

If the compression of the lower limbs is not considered when the patient presents a hypo-volumic collapsus, abdominal compression is required when the clinical diagnosis is in favour of hemorrhaging.

Three different actions using MAST anti-G pants can be defined according to the hemorrhage site :

- In sub-ombilical abdominal lesions involving major arteries or veins, aneurysm of the aorta, extra uterin hemorrhaging the anti-G MAST pants prove to be a vital equipment with few negative effects.
- In lesions that are supra ombilical and below the diaphragm (spleen and liver) the abdominal compression will act indirectly on bleeding, limiting the area of blood collection and pushing the visceral tissues against the diaphragm. The consequences are a counter pressure that will limit bleeding. The negative effects of this technic are primarily on the mechanical aspects of breathing. Assisted ventilation with tracheal intubation should be systematically initiated particularly when the increase in gastric pressure can result in bronchial inhalation, a gastric aspiration tube must be placed. It is necessary to consider a partial or complete diaphragmic rupture and the risk of having an intra-abdominal organs herniation.
- In lesions that are sub-costal and supra-diaphragmatic three diagnoses may be considered :
  - ANEURYSM OF THE THORACIC AORTA = ABSOLUTE CONTRA-INDICATION OF ANTI-G MAST PANTS.
  - RUPTURE OF OESOPHAGIAL VARICES = ABSOLUTE CONTRA-INDICATION OF ANTI-G MAST PANTS because the veinous drainage is sub-diaphragmic.
  - Hemothorax when the drainage is associated with an auto transfusion the indication of anti-G MAST pants is extremely controversial.

In conclusion, anti-G MAST pants represent the technical material of choice in emergency extra-hospital care for patient in severe collapsus. It is important not to underestimate the patients' status even when there appears to be a dramatic improvement. When a lesion is suspected to be severe a thoracic exploration in order to clamp the aorta must be considered and the appropriate vascular filling (liquid support) during the hypo-volimic phase induced by the decompression effects of the anti-G MAST pants.

LA LOGISTIQUE SANITAIRE FRANCAISE FACE A UN AFFLUX DE BLESSES : UNE NOUVELLE GENERATION DE POSTES SANITAIRES MOBILES.

HUFNAGEL G.*, LALANDE G.*, BOLLOTTE B.*, FONROUGE J.M.**, FONTANELLA J.M.*,

* SAMU 03 Centre hospitalier de Montluçon
03109 MONTLUCON cedex FRANCE

** SAMU 93
Centre hospitalier Avicenne
93009 BOBIGNY Cedex FRANCE

Résumé

Les auteurs rappellent l'historique de la stratégie française de médicalisation des urgences et ils décrivent les moyens matériels nouveaux mis à la disposition des équipes de S.A.M.U. pour faire face à un grand nombre de blessés en situation d'exception (accidents routiers graves, ferrovières, aériens, catastrophes naturelles, attentats, etc...). Les postes sanitaires mobiles (P.S.M.) de nouvelle génération sont opérationnels depuis la fin des années 1980. Ce sont de véritables stocks logistiques, dissociables en quatre lots polyvalents (4*25 blessés graves) et deux lots de base (2*200 blessés graves). La couverture du territoire national est en cours de réalisation et comportera à terme 30 P.S.M.. ILs sont conçus pour équiper un ou plusieurs postes médicaux avancés, pour renforcer un potentiel hospitalier en cas de catastrophe ou encore pour être utilisé dans le cadre de l'aide médicale internationale. En cas de conflit l'ensemble des P.S.M. constitue une des bases de la défense sanitaire nationale placée sous l'autorité du haut fonctionnaire de défense au ministère de la santé. Un P.S.M. comporte prés de 6 tonnes de médicaments, solutés, pansements et de matériel médico-chirurgical conditionnés en 150 conteneurs comportant une identification graphique. La gestion informatisée des stocks permet l'entretien et la rotation des matériels périssables. Le P.S.M. est complèté par une remorque, une tente gonflable avec éclairage, chauffage et un lot tactique de radiophonie lui assurant autonomie et mobilité.

THE FRENCH SANITARY LOGISTICS IN CASE OF MULTIPLE CASUALTY INCIDENTS: A NEW GENERATION OF MOBILE SANITARY UNITS

Summary

The authors recall the history of the French strategy in the medical care of emergencies outside the hospital and they describe the new equipment available to SAMU teams to cope with a large number of injuried persons in exceptional situations such as road, air or railway accidents, natural catastrophes, criminal attempts...
This is a new generation of mobile sanitary units operational since the end of the 80'es. They are genuine logistic stocks separable in 4 multi-usage packs (4*25 seriously injuried persons) and 2 base units (2*200 seriously injuried persons). The covering of the French territory is running its course and will be made up of 30 mobile sanitary units. They have been designed to allow for medical actions on the spot, to reinforce hospital potentials in case of disasters, or to be used in an international frame. In case of an armed struggle the whole lot of mobile sanitory units is one of the bases of the national sanitary defence under the authority of the high official of defence of the Health Ministry. A mobile sanitary unit is made up of around 6 tons of drugs, solutions, dressings and surgical materials packaged in 150 boxes with graphic identification. The computerized management of stocks runs the maintenance and the rotation of perishable products. The mobile sanitary unit is completed by a trailer, an inflatable tent with lighting, heating and a tactical radio system to ensure autonomy and mobility.

DISASTER MASS/CASUALTY/MILITARY
ANESTHESIA: PART I
FRIDAY, MAY 3, 1991
2:00 P.M. - 5:00 P.M.

BREAKAWAY SESSION

DISASTER / MASS CASUALTY / MILITARY ANESTHESIA: PART I

Project Leader: M. Parr

Moderators: P. Baskett, Y. Donchin, J. Nolan

The Scenario

The disaster is to take place on the day of the opening game at the Baltimore Orioles Stadium in central Baltimore. It is a warm clear May day. A crowd of 47,000 spectators is present. Before the game begins, a block of one of the mezzanine (middle level) stands, with it's spectators, collapses onto the seating below, a distance of about 28 feet. Casualties include adults and children, the majority of survivors coming from the upper stand who are injured as a result of the fall. The spectators in the lower stand are injured by falling masonry and bodies and most are dead.

The distribution of casualties according to priorities is:

Priority 1: 32 adults and 11 children (urgent therapy required to maintain life)
Priority 2: 64 adults and 23 children (urgent therapy required but no immediate threat to life)
Priority 3: 134 adults (non-urgent therapy required)
Priority 4: >100 dead
>100 apparently not needing any therapy

Teams (2 teams of 4)

2 Police officers
Paramedic
Fire Officer
Director of stadium services
Nurse
2 Physicians

Within the grounds there are 40 police officers whose distribution is controlled by a command post in the stadium. Outside the stadium there are a further 20 police officers, mainly situated at the gates. Also, within the stadium are 4 nurses in 2 first aid rooms situated on the mezzanine and terrace levels and one doctor who is treating a patient with an asthma attack. There are 2 paramedic units on the ground outside the stadium and there are also about 100 ushers around the stadium, some of whom have two-way radios.

The major problems are likely to arise with effective crowd control of 47,000 people attempting to leave the ground; the management and evacuation of large numbers of casualties and

ensuring adequate EMS access while appreciating there may be difficulties with access to the stadium for EMS vehicles.

As the scenario unfolds the leaders will introduce each slide in turn and put the questions to the appropriate individuals. Discussion will be directed by the leaders to cover the following points:

Activation of a disaster plan and ensuring it's effectiveness.

Command and control, incident command system.

Securing the disaster area to ensue rescuer safety.

Ensuring access for emergency medical services.

Extrication and triage.

Transportation and evacuation.

Allocations of resources.

Crowd control involving thousands of people.

Information and Public Relations communication.

Counselling.

Learning from experience.

SPECIAL CRNA SESSION: PART I

FRIDAY, MAY 3, 1991

2:00 P.M. - 5:00 P.M.

IV. SPECIAL CRNA SESSION: PART I

SESSION AGENDA

2:00-2:10 P.M.	OPENING ADDRESS Charles R. Barton, CRNA
2:10-2:40 P.M.	TRAINING OF PREHOSPITAL PERSONNEL: AN ANESTHESIA RESPONSIBILITY Gregory Stocks, CRNA, EMT-P
2:40-3:10 P.M.	CARDIOPULMONARY RESUSCITATION OF THE TRAUMA PATIENT Charles R. Barton, CRNA
3:10-3:40 P.M.	MANAGEMENT OF THE TRAUMA PATIENT WITH A CERVICAL SPINE INJURY Christopher Romanowski, CRNA
4:00-4:30 P.M.	PEROPERATIVE NEUROLOGICAL EVALUATION OF THE TRAUMA PATIENT Robert E. Akins, CRNA, RRT
4:30-5:00 P.M.	MECHANISM OF INJURY: ANESTHETIC IMPLICATIONS Patricia Taub, CRNA

TRAINING OF PREHOSPITAL PERSONNEL: AN ANESTHESIA RESPONSIBILITY

Gregory Stocks, CRNA, EMT-P

I. EMS (Emergency Medical Systems): The Total Concept

A) EMS Act of 1973

1. Provision of manpower
2. Training of personnel
3. Communications
4. Transportation
5. Facilities
6. Critical care units
7. Use of public safety agencies
8. Consumer participation
9. Accessibility to care
10. Transfer of patients
11. Standard medial record keeping
12. Consumer information and education
13. Independent review and examination
14. Disaster linkage
15. Mutual aid agreements

II. Levels of Prehospital Care

A. Basic Life Support (BLS)

1. EMT-A
2. "First Responder"

B. Advanced Life Support (ALS)

1. Paramedic (EMT-P)

III. Anesthesia Involvement in Training

A. Scope of training

B. Liability

C. Ability of providers to learn

D. Anesthesia/prehospital relationship

IV. Summary

CARDIOPULMONARY RESUSCITATION OF THE TRAUMA PATIENT

Charles R. Barton, CRNA

I. Introduction

A. Care of the trauma patient is unique

B. Frequently treatment and resuscitation efforts are required while the diagnosis is still being determined

C. Anesthetic concerns:

1. Assess adequacy of ventilation and perfusion

2. Select proper emergency drugs and anesthetic agents/techniques.

II. Early Resuscitation Efforts

A. Early intubation and appropriate ventilation with adequate FI02

B. Adequate intravenous access and appropriate monitoring

C. Assessment and correction of fluid/blood status

D. Relationship of mechanism of injury to current status

E. Assessment and correction of critical factors, (e.g., tension pneumothorax, pericardial tamponade, disruption of major blood vessels or airway)

III. Principle Drugs During CPR

1. Epinephrine

2. Lidocaine

3. Sodium bicarbonate

IV. Adjunctive Drugs

A. Antidysrhythmics (procainamide, bretylium)

B. Cardiovascular stimulants (norepinephrine, dopamine, dobutamine, ephedrine, isoproteronol, atropine,

calcium)

C. Vasodilators (nitroprusside, nitroglycerine, trimethaphan)

D. Beta-blockers (propranol, esmolol)

E. Diuretics (furosemide, ethacrynic acid)

F. Anticonvulsants (barbiturates, benzodiazepines, phenytoin)

V. Fluid Management/Resuscitation

A. Crystalloids, colloids

B. Packed RBCs, component therapy

VI. Invasive Monitoring

A. Arterial line

B. CVP

C. PA catheter

D. Intracranial bolt

MANAGEMENT OF THE TRAUMA PATIENT WITH A CERVICAL SPINE INJURY

Christopher Romanowski, CRNA

I. Mechanism of injury

- A. Blunt trauma
  - 1. Motor vehicle accidents (MVA)
  - 2. Fall victim
  - 3. Sports-related injury (e.g., diving, football,etc.)
  - 4. Industrial accident
- B. Penetrating trauma
  - 1. Shooting
  - 2. Stabbing
  - 3. Environmental hazards
- C. Congenital anomalies

II. Classification of C-Spine Injuries

- A. Musculoligamentous
- B. Vertebral
- C. Age groups

III. Signs and Symptoms of C-Spine Injuries

- A. Central nervous system (CNS)
- B. Cardiac
- C. Pulmonary

IV. Protocols and Treatment of C-Spine Injuries

- A. CNS
- B. Cardiac

C. Pulmonary

V. Management of the Airway in C-Spine Injury

A. Immobilization

1. C-Collar

2. In-line traction (AKA, "stabilization", "immobilization")

3. "Scoop" board

4. Gardner-Wells tongs

5. Halo vest

6. Open reduction/internal fixation (ORIF)

B. Securing the Airway

1. Different techniques and rationale

a. Awake vs.asleep

b. Nasal vs. oral

c. Fiberoptic

2. Equipment

3. Medications

4. Sequence of events

PREOPERATIVE NEUROLOGIC EVALUATION OF THE TRAUMA PATIENT

Robert E, Akins, CRNA, RRT

I. History

- A. Events preceding the incident
- B. Factors about the changing nature of the patient's neurologic state.

II. Observation of the Results of the Resuscitation

- A. Mental status
- B. Respiratory pattern
- C. Movement of extremities

III. Physical Exam

- A. Scalp
- B. Neck
- C. Mental status
- D. Cranial nerves
- E. Motor and sensory system
- F. Reflexes

IV. Neck Injury

- A. Lateral cervical spine x-ray
- B. If the patient is awake and alert range of motion can be tested.

V. Mental Status Evaluation

- A. Speech
- B. Memory calculation
- C. Spatial orientation
- D. Reading

E. Affect

VI. Cranial Nerve Examination (CN2->12)

A. Monitoring the pupillary response

1. Pupil shape

2. Speed of response to light.

B. Cold-water caloric testing (CN3,6,8)

C. Corneal stimulations (CN5,7)

D. Pharyngeal stimulation (CN9,10)

E. Shoulder shrug (CN8)

F. Tongue stimulation (CN12)

VII. Peripheral Stimulation

A. Sensory and motor fibers

B. Strength of the reaction is graded.

VIII. Tone and Reflexes

A. Confirms existence of neurologic deficit.

IX. Follow-up

A. Repeat every 5 to 10 minutes

B. Prevent permanent neural damage.

MECHANISM OF INJURY: ANESTHETIC IMPLICATIONS

Patricia Taub, CRNA

I. Introduction

A. Importance of Knowledge of:

1. Mechanism of injury
2. Patterns of injury

B. Etiology of Trauma

1. Penetrating
2. Blunt
3. Mixed
4. Deceleration
5. Other

II. Penetrating Injuries

A. Etiologies of penetrating injuries

1. Stab wounds
2. Gunshot wounds

B. Characteristics of Penetrating Injuries

C. Anatomical Considerations

1. Central nervous system
2. Neck
3. Thorax
4. Abdomen

5. Extremities

III. "Blunt" Trauma

A. Forces involved

B. Indications of Major Blunt Injuries

C. Etiologies of Blunt Trauma

1. Motor vehicle accidents

a. Motorcycle accidents

b. "Pedestrian struck"

2. Deceleration injuries

a. Terminal velocity

D. Anatomical Considerations

1. Central nervous system

2. Neck

3. Thorax

4. Abdomen

a. "Seat belt syndrome"

5. Extremities

IV. Anesthetic Implications

A. Prolonged surgery

B. Impact on body systems

a. cardiovascular

b. respiratory

c. central nervous system

C. Choice of Anesthetic Agents

V. Conclusion/Summary

SIMULTANEOUS
BREAKAWAY SESSIONS
SATURDAY, MAY 4, 1991

ANESTHESIA EQUIPMENT: "HANDS-ON"

SATURDAY, MAY 4, 1991

2:00 P.M. - 5:00 P.M.

BREAKAWAY SESSION

ANESTHESIA EQUIPMENT: "HANDS-ON"

Faculty: Drs. Petty, Kingsley, Loeb

Objective: To acquaint anesthesia providers with portable and stationary anesthesia machines which are used in caring for trauma patients.

Dr. Clayton Petty will provide an overall view of desirable safety features for anesthesia machines. He will emphasize the practical features which can be incorporated into field anesthesia machines. The United States Anesthesia Field Machine will be used to show the principles of conception, design, and manufacture required to provide an anesthesia apparatus for a specific need.

Dr. Charles Kingsley will emphasize the simplicity and effectiveness of portable anesthesia apparatus. He will discuss the elements of draw-over vaporizers. He will delineate the place of draw-over vaporizers, the practical application of their long-term use, and the need for mobility of the units.

Dr. Robert Loeb shall review the present state-of-the-art in portable and stationary ventilators designed for anesthesia. He will emphasize working principles of the ventilators. Evaluation will be given of new portable ventilors and their practical value in the field situation.

A "hands-on" session will allow anesthesia care providers to examine a wide variety of anesthesia machines. Representatives from anesthesia machine manufacturers will have portable and stationary anesthesia machines on display. Drs. Petty, Kingsley, and Loeb will be available to answer questions and assist in the demonstration of anesthesia machines.

SCIENTIFIC ABSTRACTS

SATURDAY, MAY 4, 1991

2:00 P.M. - 5:00 P.M.

II. SCIENTIFIC ABSTRACTS

SESSION AGENDA

2:00 P.M. SELF-EXTUBATION: A TWELVE-MONTH EXPERIENCE IN AN URBAN TRAUMA CENTER
Marc F. Domsky, D.O.

2:11 P.M. THE USE OF A FIBEROPTIC LARGYNGOSCOPE IN TRACHEAL INTUBATION OF TRAUMA PATIENTS WITH IMMOBILIZED CERVICAL SPINE
Yves Lambert, M.D.

2:22 P.M. CONTINUOUS ARTERIO-VENOUS REWARDING: A NEW TREATMENT FOR HYPOTHERMIA
Larry M. Gentilello, M.D.

2:33 P.M. COST VERSUS EFFECTIVENESS ? THE FENEM CO2 CONTROVERSY IN THE UK
D.J. Wilkinson, M.D.

2:44 P.M. THE EFFECTS OF PROPOFOL ON MYOCARDIAL CONTRACTILITY AND FUNCTION IN HYPOVOLEMIC SWINE
Charles P. Kingsley, M.D.

2:55 P.M. THE IMPORTANCE OF BASE DEFICIT IN TRAUMA PATIENTS
I. McConachie, MB, FFARCS

3:07 P.M. ELECTROLYTE CHANGES AFTER BLUNT TRAUMA AND FLUID RESUSCITATION
I. McConachie, MB, FFARCS

3:17 P.M. THE EFFECT ON OXYGEN DELIVERY AND CONSUMPTION OF WITHDRAWING NEUROMUSCULAR BLOCKADE IN CRITICALLY ILL INTENSIVE CARE PATIENTS
Kenneth J. Power, M.D.

3:28 P.M. HYPOMAGNESEMIA IN SICU SUBPOPULATIONS
Zvi Herschman, M.D.

4:00 P.M. ENHANCED EFFICACY OF REMOVAL OF THEOPHYLLINE BY CAVHD
William Chiang, M.D.

4:11 P.M. EFFECTS OF PROPOFOL SEDATION ON ICP, CBF VELOCITY AND EEG IN SEVERE HEAD INJURED PATIENTS
Vincenzo Fodale, M.D.

4:22 P.M. JEHOVAH'S WITNESS: THE TRAUMA
Ian Darling, M.D.

SELF-EXTUBATION: A TWELVE-MONTH EXPERIENCE IN AN URBAN TRAUMA CENTER

M. Domsky, D.O., K. Dauphinee, M.D., B. McAlary, M.D.
Maryland Institute for Emergency Medical Services Systems, Baltimore, MD., USA

Although endotracheal intubation is a common occurrence in the critical care unit, there is a paucity of literature regarding one of its most life-threatening complications, self-extubation. We retrospectively evaluated the incidence, clinical features, and outcomes of self-extubations in our Multi-Trauma Unit. In a 12 month period, 584 mechanically ventilated patients (Male-421; Mean Age 39.9±19.5 yrs.) were admitted. Eighty-one self-extubations occurred in 73 patients: a 13.9% incidence. Mean intubation period before self-extubation was 7 days. A disproportionate number (64.2%) of self-extubations occurred between the hours of 7pm and 7am. While the nurse to patient ratio remained the same during all times, there were fewer hospital personnel present during both the evening and night shifts.

Ninety-one percent of the self-extubated patients received intravenous sedation within 4 hours of the event, and fifty-four percent of the patients were restrained. None of the patients had received muscle relaxants. Nine of the self-extubations (11%) appeared to have been accidental, occurring while patients were coughing or during patient repositioning, while the other seventy-two appear to have been secondary to patient effort. There was a significant difference in the number of patients with a diagnosed head injury GCS<12 and CAT scan confirmed)in the self-extubated group versus those in the non-self-extubated group (56.8% vs. 43.7% respectively $p<.03$). Of the eight patients that extubated themselves twice, five had head injuries. Fourteen of the sixteen self-extubations in this group occurred between the hours of 7pm and 7am. Forty-eight of the eighty-one episodes of self-extubation required re-intubation (59.2%) for respiratory insufficiency that was clinically evident within 30 minutes; another two patients were re-intubated within 6 hours. Only one patient developed an arrhythmia with associated hypotension post extubation.

In conclusion, self-extubations are more likely to occur between the hours of 7pm and 7am, and in those patients with a diagnosed head injury. Since most patients had been restrained and/or given sedation, we also concluded that extubations will occur despite these precautions. The majority of our self-extubated patients required re-intubation almost immediately for impending respiratory arrest. There were no deaths and only one arrhythmia. Our experience suggests that although self-extubation is a serious complication, it can be managed safely with few negative sequelae.

THE USE OF A FIBEROPTIC LARGYNGOSCOPE IN TRACHEAL INTUBATION OF TRAUMA PATIENTS WITH IMMOBILIZED CERVICAL SPINE. *Y. Lambert*, M.D., and B. Riou, M.D.
Departments of Anesthesiology, C.H.U. Henri Mondor, Créteil, and C.H.U. Pitié-Salpétrière, Paris, France

Trauma patients with unstable cervical spine are at high risk of spinal cord injury, which requires cervical spine immobilization until definitive surgical fixation. Tracheal intubation is often difficult in these patients. We describe the use of a new fiberoptic laryngoscope in trauma patients with immobilized cervical spine.

Ten consecutive trauma patients were selected. All patients were scheduled for orthopedic surgery because of an unstable cervical spine, and were treated, using cervical spine immobilization (halovest or hard collar). Anesthesia was induced with thiopental and fentanyl, and muscle relaxation was achieved using vecuronium bromide. Direct laryngoscopy was difficult leading to the use of the fiberoptic laryngoscope (Bullard, Circon ACMI, Stamford, CT). In the first 6 patients we used a stylet to band the tracheal tube just above its cuff, reproducing the curve of the laryngoscope blade. Intubation with this technique follows five steps : 1) introduction of the laryngoscope blade and visualisation of the vocal cords ; 2) introduction of the tube with its stylet just above the laryngoscope blade; 3) placement of the tube between the vocal cords under fiberoptic vision ; 4) adequate placement of the tube into the trachea ; 5) withdrawal of the stylet and the laryngoscope. A special introducing stylet (Lis-A adult introducing stylet, Circon ACMI) was used in the four last patients. Before tracheal intubation, preoxygenation was administered. Each attempt lasted no longer than 2 min, and further attempts were separated by face mak ventilation with oxygen for at least 1 min.

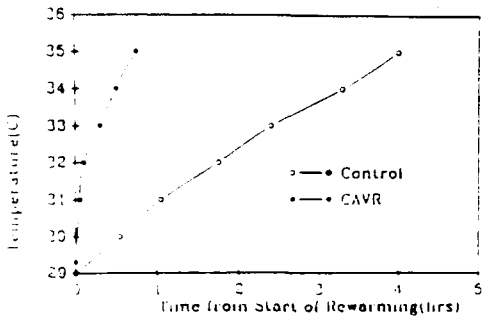
Tracheal intubation was successful at the first attempt (duration 35 to 105 sec) except in one patient. In this patient, tracheal intubation was unsuccessful at the two first attempts, because adequate placement of the tube into the trachea, the stylet being maintained, was impossible. At the third attempt (35 sec), tracheal intubation was successful using the nasal route under the fiberoptic laryngoscope control. One patient had uncomplete and another patient had complete neurologic deficit prior to induction of anesthesia. The deficit was judged unchanged in the recovery room in these two patients, and no neurological deficit occurred in the 8 remaining patients. No complication was observed and no recall of tracheal intubation was noted. Tracheal intubations with the introducing stylet which was used in the four last patients, were considered to be easier than those previously performed.

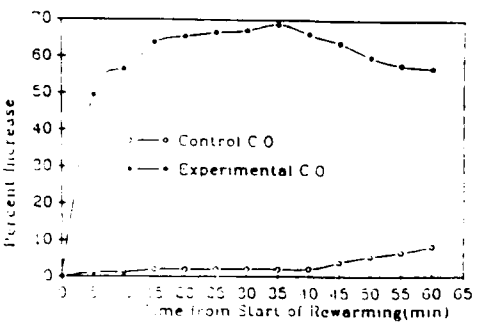
The fiberoptic laryngoscope enables a rapid, non-invasive, and oral technique for tracheal intubation, without modilization of the cervical spine. Its other advantages are a lower cost and a higher rubustness compared with fiberoptic bronschospe.

CONTINUOUS ARTERIO-VENOUS REWARMING: A NEW TREATMENT FOR HYPOTHERMIA

L.M. Gentilello,[1] V. Cortes, Moujaes S, C.H. Ho, M. Viamonte, T.L. Malinin, G.A. Gomez
From: Departments of Surgery, University of Miami/Jackson Memorial Medical Center, Miami, Fla., and [1]Harborview Medical Center, University of Washington, Seattle, WA.

We evaluated a technique for treating hypothermia that achieves rapid extra-corporeal rewarming without heparin or pump assistance. Hypothermia to 29.5°C was induced in eight anesthetized dogs and thermistors placed in the pulmonary artery, liver, bladder, esophagus, rectum, muscle, and skin. Four experimental animals were rewarmed using continuous arterio-venous rewarming (CAVR). This technique uses a commercially available Rapid Fluid Warmer that is modified by bending the upright arm 90°, thereby placing the counter-current heat exchanger in a horizontal position at bed height. Femoral arterial and venous catheters were connected to the inflow and outflow side of the heat exchanger, creating a fistula through the heating mechanism. External rewarming (EW) was used in four controls. Bleeding time (BT), coagulation profile (PT,PTT,TT) and cardiac output (CO) were measured serially during rewarming. In three additional animals xyphopubic celiotomy and bilateral thoracotomy incisions were made and held widely open with retractors. Core temperature fell to 31°C at two hours without active cooling.





Core temperature (T) rose significantly faster with CAVR than with EW (p=.00001). Average time to rewarming was 45 min, vs. 4 hrs in controls. CAVR improved T, CO, BT and coagulation profile faster than any method yet reported not requiring heparin or pump assistance. Haptoglobin, platelet, fibrinogen, and fibrin split product levels were unaffected. During sham major abdomino-thoracic surgery resolution of hypothermia occurred at 20 minutes and was maintained for an additional two hours with CAVR, despite unchanged heat losses. The application of CAVR warrants further investigation with clinical trials.

COST VERSUS EFFECTIVENESS ?THE FENEM CO2 CONTROVERSY IN THE UK

Wilkinson DJ, Hayes M, Denman WT. Department of Anaesthesia, St. Bartholomews Hospital, London EC1A 7BE. UK.

The Fenem end tidal CO2 detector has been recently shown to rapidly and successfully differentiate between oesophageal and tracheal intubation(1). It has also been shown to be a valuable aid in the management of cardiopulmonary resuscitation, by providing an indication of the effectivenss of chest compressions and also the return of spontaneous circulation(2). Its light weight and simple design make it of particular value for paramedical use at all resuscitations outside the hospital where more conventional capnography is impractical. The Fenem end tidal CO2 detector is a colorimetric monitor which, when exposed to carbon dioxide in expired respiratory gas, becomes more acidic and the indicator changes colour. Problems with its use have occurred when drugs have been directly instilled into the tracheal tube during cardiopulmonary resuscitation(3) (In accordance with the British Resuscitation Council guidelines). Both adrenaline (1:10000, Ph - 3.33 and lignocaine (PH 1.72) caused a permanent colour change of the indicator which was identical to that produced by carbon dioxide. Its routine use in resusitation in the UK has been limited by its cost (£14 (25$) per unit) at a time of considerable financial restraint in our health service. To increase its availability in our teaching hospital to every resuscitation box and in the Accident and Emergency Department would necessitate an initial outlay of £2000 and then a further £3920 per year, as we deal with approximately 280-300 resuscitations per year. This cost was considered excessive by hospital administrators and health care professionals alike. We believe this financial argument is invalid. By indicating successful tracheal intubation in the operating room and effective external cardiac massage during resuscitation it may help to reduce hypoxic insults which can lead to vegetative survival. The cost of caring for vegetative survival being astronomically more than the cost of this device.

(1)Denman W, Hayes M, Higgins D, Wilkinson DJ. The Fenem carbon dioxide device. Anaesthesia 1990; 45: 465-467

(2)Higgins D, Hayes M, Denman W, Wilkinson DJ. Effectiveness of using end tidal carbon dioxide concentration to monitor cardiopulmonary resuscitation. Br Med J 1990; 300: 581

(3)Muir JD, Randalls PB, Smith GB. end tidal CO2 detector for monitoring cariopulmonary resuscitation (Letter) British Medical Journal 1990; 31: 41

THE EFFECTS OF PROPOFOL ON MYOCARDIAL CONTRACTILITY AND FUNCTION IN HYPOVOLEMIC SWINE

J. Baeuerle, M.D., C.P. Kingsley, M.D., J.A. Ward, Ph.D., D. Williams, and J. Hinds
Anesthesia Service and Department of Clinical Investigation,
Brooke Army Medical Center, Fort Sam Houston, Texas 78234-6200

Introduction. Anesthetic induction is a crucial aspect of trauma patient care and a significant challenge for anesthesia providers. Propofol is a new intravenous anesthetic with the advantages of rapid, smooth emergence from anesthesia, short duration and lack of accumulation. This study assesses the effects of propofol on myocardial contractility, afterload and cardiac output by measurement of the end-systolic pressure-dimension relationship (1) and hemodynamics in a hypovolemic swine model.

Methods. Under an approved animal use protocol, ten Yorkshire swine weighing 15-25 kg were anesthetized and instrumented with arterial and pulmonary artery catheters for pressure, hemodynamic and blood gas monitoring. Through a median sternotomy, sonomicrometer crystals were placed in the anterior and posterior left ventricular wall (AP dimension) and a 5 mm Konigsberg pressure transducer was placed through the apex of the left ventricle (LV). An umbilical tape was placed around the inferior vena cava (IVC) to vary preload. The animals were splenectomized to minimize the effects of autotransfusion. The instrumentation was exteriorized and the incisions approximated. Signals were amplified using a polygraph recorder, A/D converted at 200 Hz and analyzed on an IBM-AT compatible computer using locally developed software. Pressure-dimension (PD) loops were obtained while occluding the IVC. End-systolic elastance (Ees) was calculated as the slope of the linear regression line through the series of end-systolic pressure-dimension points during the IVC occlusion. Baseline control (BC) hemodynamics and PD loops were obtained. Animals were then hemorrhaged to a MAP of 40 mmHg and allowed to recover for 10 minutes to simulate a hypovolemic state. New Ees and hemodynamic measurements were then made at this new hemorrhage control state (HC). Propofol (5 mg/kg) (2) was given as an i.v. bolus. Pressure-dimension (PD) loops and hemodynamic data were measured at 1, 5, 15 and 30 minutes (P1, P5, P15 and P30) after injection. At the end of the experiment, animals were euthanized with T-61. Data was analyzed with a repeated measures ANOVA and a Bonferroni corrected t-test (two-tailed). A p value <0.05 was considered statistically significant.

Results. Table 1 summarizes the results. The changes in Ees were statistically significant between the BC and HC states and the HC and P1 states. Mean arterial pressure (MAP) was significantly decreased at P1, P5 and P15. Cardiac index (CI) and HR were significantly different between the HC and BC states. The HR at P15 and P30 was also significantly different from the HC value. Systemic vascular resistance (SVR) and CI were not changed significantly as a result of propofol administration.

Discussion. This study indicates that myocardial contractility as assessed by a load insensitive index, Ees, in hypovolemic swine is initially depressed by propofol and returns to hemorrhage control values. Mean arterial pressure (MAP) is significantly reduced by propofol although there is no net effect on CI. This study supports the notion that propofol is myocardial depressant as assessed by a load-insensitive measure and a reduction in dosage or avoidance of propofol in the acutely hypovolemic patient is advised.

Table 1. Effect of propofol on myocardial contractility and function in hypovolemic swine (N=10)

	Ees mmHg/mm	SVR mmHg/ml	MAP ml mmHg	CI l/min m^2	HR beats/min
BC	23.8*	51.2	88.0	2.7*	124.1*
HC	48.2	62.3	72.1	1.8	141.9
P1	29.1*	39.9	40.0*	1.5	126.7
P5	34.9	44.6	46.4*	1.5	133.2
P15	32.4	48.0	52.9*	1.6	123.4*
P30	40.2	50.7	56.9	1.7	120.8*
MSr	199.74	413.86	202.48	0.13	194.24

* Significantly different from HC values

Note: Mean residual sum of squares (MSr) is equivalent to a pooled variance within groups.

References.

1. Suga H, Sagawa K, Shoukas AA: Load independence of the instantaneous pressure-volume ratio of the canine left ventricle and effects of epinephrine and heart rate on the ratio. Circ Research 32:314-322, 1973.
2. Glen JB: Animal studies of the anesthetic activity of ICI 35,868. Br J Anaesth 52:731-741, 1980.

THE IMPORTANCE OF BASE DEFICIT IN TRAUMA PATIENTS

I. McConachie MB, FFARCS(Eng), Visiting Anesthesiologist
W. N. Bernhard MD, Acting Director Anesthesiology Department
R. Adams Cowley Shock Trauma Centre, Baltimore Md.

Trauma specialists recognise that resolution of lactic acidosis is dependent on restoring organ perfusion and have used correction of base deficit (BD) as an easy, repeatable and relatively non-invasive method of monitoring response to resuscitation therapy (1).

This patient from the Shock Trauma Centre (STC) illustrates the concept. The initial base deficit was severe, correlating with low Hb and an unobtainable Mean Arterial Pressure (MAP) (initially via cuff, later via arterial line) implying large volume of blood loss. As volume replacement continued BD normalised associated with return of Hb and MAP to normal.

Serial							
	BD	-7.5,	-7.5,	0,	-1.5,	-2,	+0.5
	Hb	8.6	9.6	11	10.8	11.1	12.4
	MAP	?	60	113	87	94	122

30 blunt trauma patients admitted to STC with a mean Injury Severity Score (ISS) of 22.3 were investigated. As part of the admission protocol arterial blood samples were obtained within 5 minutes of admission. In the 30 patients studied the mean BD on admission was -4.7 (SD 4.96, range - 16.5 -> + 1.5). The relationships between ISS and admission BD and Hb were determined. Correlation coefficients are shown below.

BD & Hb	+0.62
BD & ISS	-0.442

The correlation between admission BD and severity of injury (ISS) was poor indicating that admission BD is not an accurate index of severity of injury as reflected by the Injury Severity Score. However the ISS is an anatomical reflection of severity of injury (2) whereas BD reflects pathophysiology. BD may prove more useful as a guide to severity of injury when linked with other variables. For example, recent studies at the STC have shown that combining admission BD with Glasgow Coma Scale was a useful predictor of outcome (3).

There was a moderate correlation between admission BD and admission Hb i.e. degree of blood loss. It is probable that the correlation would have been excellent between BD and change in Hb but obviously the pre-injury Hb is not known in these patients.

In summary, admission BD on its own is not a totally accurate guide to severity of injury but is useful as a guide to degree of blood loss and as an indicator of progress and adequacy of resuscitation.

References

1) Davis JW, Shackford SR, Mackersie RC, Hoyt DB. Base Deficit as a Guide to Volume Resuscitation. J Trauma 1988 : 28 : 1464 - 1467.
2) Baker SP, O'Neill B, Haddon W Jnr et al. The Injury Severity Score: A method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974 : 14 : 187 - 199.
3) Siegel JH, Rivkind AL, Dalal S, Goodarzi S. Early Physiologic Predictors of Injury Severity and Death in Blunt Multiple Trauma.
Arch Surg 1990 : 125 : 498 - 508.

ELECTROLYTE CHANGES AFTER BLUNT TRAUMA AND FLUID RESUSCITATION

I.McConachie MB, FFARCS(Eng), Visiting Anesthesiologist
W.N. Bernhard MD, Acting Director Anesthesiology Department
R. Adams Cowley Shock Trauma Centre, Baltimore Md.

Biochemical changes were investigated in 30 blunt injury patients admitted to the Shock Trauma Centre (STC) with a mean Injury Severity Score of 22.3. Blood samples for analysis were drawn within 5 minutes after admission and after 12 hours of resuscitation. Mean volumes of crystalloid (Normal Saline and Ringer's lactate) and packed red cells administered were each 15.6L. Samples were analysed for Na, K, Cl, Urea and Glucose. Results are shown as Mean
SD
Range. Normal STC range is also shown.

	Admission	Post Resuscitation	Normal Range
Na	137.8 2.47 131 - 142	139.3 3.45 139 - 149	135 - 148 mmol/l
K	3.89 0.427 3.1 - 4.8	4.05 0.671 2.9 - 5.6	3.6 - 5.0 mmol/l
Cl	107.2 5.04 98 - 120	112.1 5.21 99 - 124	98 - 108 mmol/l
Urea	15.04 5.49 8 - 25	12.61 5.01 5 - 26	6 - 20 mg/dl
Glucose	185.1 69.0 95 - 396	167.0 38.78 104 - 291	70 - 110 mg/dl

There were no clinically significant changes in Na, K, Cl or Urea following injury in these patients. Previous studies have suggested that abnormalities of K are common. Blood sugar was elevated after injury which is expected from the hormonal and metabolic changes following injury.

Following resuscitation with large volumes of Na containing crystalloids and blood, Na was still normal. Mean K was normal but the range shows that individual patients had mild abnormalities unlikely to be clinically important. However, mean Cl after resuscitation was clearly high presumably due to the high chloride content in N saline. Hyperchloraemia is known to contribute to metabolic acidosis and may be limited by substituting other more balanced fluids than N Saline, such as Ringer's Lactate.

In summary, electrolyte changes after blunt injury and resuscitation with large volumes of electrolyte containing fluid were uncommon in this study and are probably of little clinical significance.

THE EFFECT ON OXYGEN DELIVERY AND CONSUMPTION OF WITHDRAWING NEUROMUSCULAR BLOCKADE IN CRITICALLY ILL INTENSIVE CARE PATIENTS

K J Power, M S Nielsen, T E Woodcock. Department of Anaesthesia and Intensive Care, Southampton General Hospital, Great Britain.

Neuromuscular blocking drugs (NMB's) are frequently used in the intensive care unit particularly to facilitate the ventilation of patients with respiratory failure. It is often assumed that their use will reduce wasted oxygen consumption in situations where oxygen flux may be critical.

Patients and Methods

Eleven patients with pulmonary artery catheters in-situ were studied when the decision to stop relaxants was made on clinical grounds. Full neuromuscular blockade was confirmed using a peripheral nerve stimulator prior to stopping the infusions of atracurium or vecuronium. A full haemodynamic profile was taken including cardiac output measured in triplicate by the thermodilution technique. Arterial and mixed venous blood samples were taken for oxygen content determination, using a reflection oximeter (American Optical Corporation) for the direct measurement of the haemoglobin saturation. Neuromuscular blockade was allowed to wear off spontaneously and this was confirmed by a full return of the train of four and the absence of fade. During this period all other aspects of the patients' treatment were unchanged. There were no changes in F_IO_2 or ventilatory parameters, and no alterations in the infusion rates of vasoactive drugs or volume expansion. Infusions of sedative agents were continued at a constant rate. Two patients were excluded from the statistical analysis; one due to a reduction in inotrope therapy and the other on account of a large induced diuresis. When neuromuscular blockade had worn off a further haemodynamic profile was taken and the O_2 content of the arterial and mixed venous blood again determined.

Oxygen delivery, DO_2, was calculated from the formula: $DO_2 = Qt \times CaO_2$. and oxygen consumption, VO_2, from: $VO_2 = Qt\ (CaO_2 - CvO_2)$.

where Qt = Cardiac output

CaO_2 = Arterial oxygen content

CvO_2 = Mixed venous oxygen content

Student's t-test for paired data was applied to the results from nine patients to obtain the standard error of the mean of the differences. The results are shown on table I.

TABLE I OXYGEN DELIVERY AND CONSUMPTION DURING AND AFTER THE WITHDRAWAL OF NEUROMUSCULAR BLOCKADE

	NMB	POST NMB	DIFFERENCE	(S.E.)*
Cardiac Index (l/min/m^2)	3.7	3.73	0.3	(0.1) N/S
Cardiac Work Index (Kg m)	5.42	5.42	0	(0.36) N/S
pO_2 (mmHg)	83.6	99.1	15.5	(6.94) N/S
Oxygen Delivery (ml/min/m^2)	531	543	12	(16.5) N/S
Oxygen Consumption (ml/min/m^2)	112	113	1	(5.2) N/S
Extraction Ratio (%)	22.3	22.3	0	(1.0) N/S

* Students' t-test for paired samples.
Standard error of the mean of the difference.

Abbreviations : NMB = Neuromuscular Blockade
Post NMB = Following the withdrawal of Neuromuscular Blockade

No consistent difference could be demonstrated for a change in DO_2 or VO_2 consequent upon the cessation of neuromuscular blockade. Six of the patients had a diagnosis of sepsis and five of these demonstrated the phenomenon of delivery dependant oxygen consumption with the rise or fall in delivery being reflected by a corresponding change in consumption.

It is suggested that once neuromuscular blocking agents are no longer required for a specific indication or to achieve effective ventilation in non-complaint lungs then withdrawal can be contemplated independent of oxygen flux considerations.

HYPOMAGNESEMIA IN SICU SUBPOPULATIONS Z. Herschman, M.D., J. Wang, M.D., M. Ho Lee, M.D., and A. Manion, M.A.
Mount Sinai School of Medicine at Elmhurst Hospital Center, Elmhurst, New York, USA

The incidence of hypomagnesemia has been evaluated in MICU and postoperative SICU patients.(1,2) We evaluated the incidence of hypomagnesemia in 4 sub-populations of SICU patients to determine if any would be more likely affected.

Four patient populations were evaluated; patients suffering multiple trauma (T) (n-31), closed head injury (CH) (n=23), preoperative neurosurgical patients (CN)(n=22). Initial serum magnesium level (Mg, in mg/dl) was obtained upon admission to the SICU. Mg level was subjected to a one-way ANOVA with group treated as the independant variable with 4 levels (T,CH,PN,CN). Newman-Keuls tests (α =0.05) were done as post hoc comparisons when significant differences were obtained. Frequency of low Mg(< 1.5) was evaluated using a X^2 test. Analysis of covariance (ANCOVA) with age, total serum calcium (Ca), creatinine (Cr) and phosphorus (P) were also performed (serum values in mg/dl).

The frequency of Mg<1.5 was significantly associated with group. Thirty-two percent of CN and 39% of T patients were hypomagnesemic whereas only 4% of CH and 9% of PN patients were hypomagnesemic, X^2 (n=83)=7.75,p=0.05. Mean Mg for CN, 1.7, was slightly lower than for the other groups (Ch=1.9, T=1.9, PN=1.8). These differences failed to reach statistical significance (F(3,85) 1). ANCOVAs with age, Cr and P treated individually as covariants failed to reveal any significant effects. Ca did covary with Mg in a significant fashion (F=4.43 p=0.04). There was no ECG evidence of conduction abnormalities in any of the hypomagnesemic patients. Only 2 hypomagnesemic patients died, 1 each in the CN and T groups (table). As the majority of T and postoperative patients were mechanically ventilated it was impossible to discern any effect of Mg on ventilation.

We conclude hypomagnesemia occurred in a significant proportion of CN and T patients, more often than in MICU patients (20%)(1) and less often than the 61% seen formerly in postoperative patients. CH and PN patients were not as likely to suffer hypomagnesemia. We recommend routine evaluation of MG in general surgical and multiple trauma patients upon admission to the SICU and replacement as clinically dictated. As Mg and Ca covaried, Ca levels should be followed as well, individual clinicians should decide if total or ionized calcium is more suitable to their setting. Though we had no patients manifesting conduction abnormalities we cannot determine if this was due to other electrolyte abnormalities or administered medications. We believe the number of deaths make it injudicious to comment upon any effect Mg may have on outcome.

Table.	T	CH	CN	PN
Deaths/Total	3/31	5/23	2/22	0/11
Low Mg/Deaths	1/3	0/5	1/2	0

1. Reinhart RA, Desbiens NA: Hypomagnesemia in patients entering the ICU. Crit Care Med 1985; Vol 13, No. 6; pp506-7.

2. Chernow B, Bamberger S, Stoiko M, et al: Hypomagnesemia in Patients in Postoperative Intensive Care. Chest Feb. 1989; pp391-397.

ENHANCED EFFICACY OF REMOVAL OF THEOPHYLLINE BY CAVHD W. Chiang,MD,Z.Herschman, MD. NYC Poison Control Center, New York, NY, USA.

Introduction.Continuous arterio-venous hemofiltration-dialysis (CAVHD) has been proven effective in managing fluids and electrolytes in the critically ill. Recent reports have demonstrated therapeutic substances can be removed by CAVHD however the low hourly clearance limits its applicability to treating drug intoxication.(1,2)

Methods.Heparinized canine blood was mixed with aminophylline (approximately 30mg in 0.6 l) and held at a height of 100cm. After arteriovenous-filtrate priming with 1.0 l of heparinized normal saline(NS) and either NS or 25% albumin to prime the dialysate-filtrate side of the cartridge(approximately 50cc) the blood was infused through the hemofilter (Amicon 20) in the usual fashion. Samples for theophylline concentration were taken towards the end of the infusion from arterial (A), venous (V), and the filtrate (F) ports. The venous blood was then returned to the arterial side and reinfused, no effort was made to replace volume lost as filtrate. This process was repeated 5 to 6 times. Sieving coefficient(SC) was calculated as 2F/(A+V). Statistical analysis was performed using a single-tailed t-test with $p<0.5$ indicating statistical significance.

Results.Results are summarized in table 1. For all episodes albumin as dialysate was much more efficient at removing theophylline than was NS. The difference between sieving coefficients was statistically significant. This is especially true if the first set of values are disregarded as these values seem to be out of character with the rest. The reason for this disparity is likely a result of residual priming solution in the system.

Discussion.Albumin may enhance drug removal by increasing protein binding sites or by removing more tainted filtrate. The filtrate concentrations of theophylline were greater. Though not quantified the volume of filtrate from the albumin treated filter was about 3 times greater. We conclude the efficacy of CAVHD for theophylline removal can be enhanced using albumin as the dialysate.

References. 1. Domoto DT, Brown, WW, Bruggensmith P. Removal of Toxic Levels of N-Acetylprocainamide with Continuous Arteriovenous Hemofiltration or Continuous Arteriovenous Hemodiafiltration. Ann Intern Med 1987;106:550-552. 2. Golpher TA, Bennett WM. Drug Removal by Continuous Arteriovenous Hemofiltration. Med Toxicology 1988;3:341-349.

Table 1.

Arterial		Venous		Ultrafiltrate		SC
A1	16.5	V1	32.3	F1	7.8	.32
A2	18.2	V2	19.1	F2	17.1	.94
A3	22.2	V3	21.7	F3	12.8	.58
A4	21.2	V4	21.1	F4	13.4	.63
A5	21.0	V5	21.8	F5	13.9	.65
Alb A1	38.1	AlbV1	32.4	AlbF1	11.3	.32
Alb A2	28.4	AlbV2	28.0	AlbF2	29.3	1.04
Alb A3	28.8	AlbV3	27.6	AlbF3	33.1	1.17
Alb A4	27.2	AlbV4	26.0	AlbF4	33.0	1.24
Alb A5	26.2	AlbV5	25.9	AlbF5	29.5	1.13
Alb A6	26.5	AlbV6	25.9	AlbF6	29.9	1.14

Means of the SC for the 2 dialysate solutions are 0.62±0.22 & 1.01±0.34 for saline and albumin respectively, $p<0.05$. If the first set of results for saline & albumin are eliminated, means becomes 0.70±0.16 and 1.14±0.07 respectively, $p<0.001$.

EFFECTS OF PROPOFOL SEDATION ON ICP, CBF VELOCITY AND EEG IN SEVERE HEAD INJURED PATIENTS

S.Montanini,M.D.,L.B.Santamaria M.D.,V.Fodale,M.D.

Institute of Anesthesiology and Intensive Care,University of Messina, Messina - Italy.

Patients with severe head injury in intensive care require sedation as part of the treatment (Aitkenhead,1989; Farling 1989).

PURPOSE OF STUDY: The purpose of this study is to value the effects of propofol sedation on intracranial pressure (ICP), cerebral blood flow (CBF) velocity and EEC mapping of severe head injured patients admitted into Intensive Care Unit and submitted to controlled hyperventilation.

METHODS: A group of twelve head injured patients (age 43.2+15.1 years, weight 65+8.3 Kg), with intracranial hypertension, tracheal intubation and connected to ventilator, were admitted in the study.
Glasgow Coma Scale on admission ranged between 5 and 8 (mean 6.2).
Sedation (20-84 hours) was performed with i.v. continuous infusion of propofol 1-3 mg/Kg-1/h.
Continuous ICP monitoring was obtained by optical-fibre catheter, EEG mapping by Life Scain and CBF velocity by transcranial doppler measured in middle cerebral artery.

RESULTS: Mean propofol dosage was 1.6 mg/Kg-1/h. Continuous ICP monitoring demonstred a steady reduction (21-25%) of pre-treatment values. Similar reduction was observed in CBF velocity measuring. EEG mapping pointed out a reduction of beta Waves and an amplitude increase of theta and delta waves, indicative of a good sedation.

CONCLUSIONS: We came to the conclusion that sedation with propofol in severe head injured patients with intracranial hypertension provides a satisfactory sedation level and has therapeutic properties.
Furthermore, propofol provides rapid sedation lightening with possibility of frequent and objective evaluations of neurological status.

AITKENHEAD A.R.: "Analgesia and sedation in intensive care" British Journal of Anaesthesia, 1989, 63, 196-206.
FARLING P.A.,JOHNSTON J.R. and COPPEL D.L.: "Propofol infusion for sedation of patients with head injury in intensive care" Anaesthesia, 1989, 44, 222-226.

JEHOVAH'S WITNESS: THE TRAUMA

Ian Darling, M.D., Jagdip B. Shah, M.D., Richard L. Keenan, M.D.
Department of Anesthesiology, Medical College of Virginia, Richmond, VA 23298, USA

Patient is a 25 year old female Jehovah's Witness presented to the Emergency Room after being involved in a motor vehicle accident. Initial blood pressure in the ER was 60 mmHg and HR 140/min. She was alert, oriented, and refused blood. Oxygen by mask and fluid resuscitation with crystalloid was started through a 16 g I.V. and an 8.5 Fr RSCV cordis, the systolic BP rose to 110. Neck injury was ruled out by x-ray. A DPL was grossly positive and the patient was taken immediately to the OR. On the way to OR she was asked repeatedly if she would accept blood and refused; however, she would accept "human synthetic protein". She was induced in rapid sequence with cricoid pressure and oxygen, etomidate, sucinyl choline, lidocaine and intubated. Standard and customary monitors were applied. For maintenance of anesthesia fentanyl, midazolam and vecuronium were used. Five minutes after induction she went into EMD. Chest compressions were started and epinephrine 1 mg was administered. Albumin 5% was administered aggressively and after 5 minutes BP was noted in the 70's. The abdomen was opened with gross blood observed. A complex tear of the right lobe of the liver with almost complete fracture line was identified. At this time BP again began to drop, a second 8.5 F cordis was placed and continued colloid resuscitive measures administered. The aorta was cross clamped just below the diaphragm and the liver packed off with return of BP to the 100's. Several attempts to remove the aortic cross clamp were made with resulting BP's in the 50's and 60's. Dopamine was started and atropine, $NaHCO_3$ and Ca chloride administered. ABG; PaO_2 344 mmHg, $PaCo_2$ 30 mmHg, PH 7.08, Hg 1.7 gm/dl. It was decided that the liver could not be repaired without fatal blood loss, therefore, the abdomen was packed and closed. BP on leaving the OR was still in the 60's. Total fluids administered in the OR were 7750 ml, 5% albumin and 3000 ml LR. The patient was ventilated in the PACU. A repeat Hgb was 0. The patient expired after 2.5 hours in the PACU with phenylnephrine and dopamine drip. Exanguination caused her death in less than four hours following fatal injury.

Treatment usually not accepted by Jehovah's Witnesses 1) blood; 2) auto transfusion; 3) albumin; 4) fresh frozen plasma; 5) platelets; 6) cryoprecipitate; 7) stromal free Hgb.

Treatment acceptable to Jehovah's Witnesses 1) synthetic colloid; 2) fluosol; 3) hyperbaric oxygen with or without hypothemia; 4) MAST Trousers.

Additional pharmacological acceptable modalities 1) Erythropoetion; 2) DDAVP; 3) Vitamin K; 4) amino caproic acid.

These people claim to be religious but not litiginous. They certainly pose a challenge as they seek modern medical assistance. Meticulous surgical technique aimed at saving each drop of blood is probably the single most important aspect of a good outcome.

DISASTER MASS/CASUALTY/MILITARY ANESTHESIA: PART II

SATURDAY, MAY 4, 1991

2:00 P.M. - 5:00 P.M.

BREAKAWAY SESSION

DISASTER / MASS CASUALTY / MILITARY ANESTHESIA: PART II

Project Leader: A. Dow

Moderators: K. Dauphinee
V. Kvetan
M. Moles

Description:

The session is to examine the primary and secondary responses to a mock, table-top disaster. The disaster is to be a train wreck, that occurs somewhere outside of Baltimore, and involves a considerable number of injured people (both adults and children).

There will be two "teams", who will provide suggestions and ideas for the management of the disaster as it unfolds on the screen before them. Each of these teams will consist of 5 health care professionals, who are either playing their own, or another role, from real life. the two teams are not in direct competition with each other, but it is intended that their answers should complement each other.

The scenario, and the questions that accompany it, will be presented by three team "leaders", who will take it in turn to question the team layers. The team leaders are all people who have extensive experience in disaster medicine. The project leader will control the flow of the disaster, and will be responsible for starting and ending the proceedings at the appropriate time and will control the double slide projector that is used to present the events of this mock disaster.

The intention of the session is to convey some of the problems that can occur during a real disaster, and to show how a planned approach to management can result in a better outcome for the injured. There are no "right" or "wrong" answers that the team players are expected to provide, merely some guidelines along which they may go. This should be an instructive and useful exercise for the audience and the team players, and will provide some suggestions for future mass casualty management.

SPECIAL CRNA SESSION: PART II

SATURDAY, MAY 4, 1991

2:00 P.M. - 5:00 P.M.

IV. SPECIAL CRNA SESSION: PART II

SESSION AGENDA

2:00-2:30 P.M.	ADVANCED AIRWAY INTERVENTIONS IN THE TRAUMA PATIENT John Connelly, CRNA
2:30-3:00 P.M.	NEW AGENTS, NEW CHOICES FOR MANAGING POST ACUTE TRAUMA SURGERY PATIENTS Charles R. Barton, CRNA
3:00-3:30 P.M.	THORACIC SPINAL INJURIES OF THE TRAUMA PATIENT Kathleen A. Hartman, CRNA
3:30-4:00 P.M.	BREAK
4:00-4:30 P.M.	FAMILY FOCUS IN PAIN MANAGEMENT OF THE TRAUMA PATIENT C. Russel Baker, CRNA
4:30-5:00 P.M.	METHODS OF CAPNOGRAPHY Robert Akins, CRNA, RRT
5:00 P.M.	CLOSING REMARKS Charles R. Barton, CRNA

ADVANCED AIRWAY INTERVENTIONS IN THE TRAUMA PATIENT

John J. Connelly, CRNA, CRTT

I. Introduction

A. Elective, controlled conditions: Airway mismanagement remains the leading cause of death and longterm cerebral damage.

B. Emergent conditions: Inability to provide adequate oxygenation is associated with an even higher incidence of morbidity and mortality.

C. Anesthesia care providers are the recognized experts in airway management and therefore have the responsibility of employing any number of skills to establish and maintain oxygenation and prevent hypoxic injury.

D. Options and considerations when oral or nasal translaryngeal intubation is unsuccessful or not possible and bag mask ventilation cannot be established will be discussed.

II. Decision Tree Algorithm Approaches to Trauma Airway Management

III. Methods

A. Digital

B. Retrograde

C. Fiberoptic-guided

D. Needle cricothyroidotomy

E. Cricothyroidotomy

IV. Considerations

A. Equipment

1. Uncomplicated

2. Accessible

3. Familiarity

B. Complications:

1. Esophageal perforation
2. Subcutaneous air
3. Hemorrhage
4. Barotrauma

NEW AGENTS, NEW CHOICES FOR MANAGING POST-ACUTE TRAUMA SURGERY PATIENTS

Charles R. Barton, CRNA

I. Introduction

A. 1. Use of anesthetic agents in the acute, often unstable trauma patient is limited to drugs known cardiovascular stability

2. Includes agents that do not promote histamine release or reduce cardiac output.

B. 1. Trauma patients frequently return for numerous follow-up procedures that may include debridement and "wash-outs" (jet lavage) of wounds, plastic and orthopedic reconstruction procedures and a wide variety of short procedures.

2. Post-acute trauma surgical patients are generally stabilized and fluid resuscitated at the time of repeat surgical procedures, thus the anesthetist has greater latitude in the selection of anesthetic agents.

3. The goal for the anesthetic management is to administer agents that provide a smooth induction, adequate intraoperative hypnosis, analgesia and amnesia and a rapid, pleasant emergence with early, clear mentation.

II. Evaluation of the Trauma Patient Undergoing Repeat Procedures

A. Evaluation of laboratory and radiographic data

B. Evaluation of respiratory and hemodynamic status

C. Evaluate complicating factors, (e.g., fever, coagulation status, factors affecting gastric emptying)

D. Status of current narcotic/antibiotic use by patient

III. New Agents - Advantages, Disadvantages and Precautions

A. Propofol for induction and maintenance

B. Ketorolac for basic and supplemental analgesia

C. Appropriate use of fentanyl analogs

D. Strategies for reducing post-anesthesia nausea and vomiting

E. Use of current agents and adjuncts in conjunction with newer agents

THORACIC SPINAL INJURIES OF THE TRAUMA PATIENT AND PAIN MANAGEMENT

Kathleen A. Hartman, CRNA

I. Introduction

A. Historical perspective

B. Trauma philosophy

C. Current statistics

II. Mechanisms of Injuries

A. Patient profile

III. Surgical Intervention

A. Harrington rod instrumentation

B. Posterior pedicle screw instrumentation

IV. Patient Assessment

A. Hemodynamics

B. Respiratory physiology

V. Anesthetic Considerations

A. Perioperative

1. Cardiovascular considerations
2. Invasive monitoring

B. Postoperative Management

VI. Pain Management

A. Pharmacological considerations
1. Drug choice
2. Drug route

B. Regional Techniques

C. Indications

D. PECA

E. Precautions

VII. Conclusion

FAMILY FOCUS IN PAIN MANAGEMENT OF THE TRAUMA PATIENT

C. Russel Baker, CRNA

I. Introduction

A. Pain is commonly linked to injury and tissue damage.

B. Postulated that the CNS is able to exert control over the sensory input.

1. Cutaneous sensory input activates the nociceptive system

2. Nociceptive input is modified by:

a. Psychological factors

b. Social factors

II. Acute Pain

A. In general there is a relationship between injury and pain.

1. This relationship is highly variable.

2. Injury may occur without pain and pain may occur without injury.

B. Acute pain serves to warn of potential or acute tissue damage.

1. Severe uncontrolled pain may augment the patient's physical problems

2. Severe unabated pain may also cause changes in an individual behavior.

3. Constant pain inhibits recovery and rehabilitation.

III. Psychological Factors Affecting Acute Pain Responses

A. Pain is always a psychological event.

1. Early acute phase: sensory factors predominate.

2. Over time, persistence of the pain experience is determined less by the initial pain producing cause and more by the psychological variables.

3. Pain behaviors ll be induced, maintained, and reinforced by environmental rewards.

B. Anxiety is the psychological variable most reliably related to high levels of pain.

1. Trait anxiety

2. State anxiety

3. Trait anxiety seems to be the strongest predictor of post-operative pain.

IV. Family Systems Theory

A. Provides a frame-work to view symptom development as reflecting disturbances within the family system.

B. Central to systems thinking is the balance between forces, when the balances is disrupted, systems develop.

C. Counterbalancing life forces

1. Individuality - more intellectual functioning

2. Togetherness - more emotional functioning

D. Fusion in a relationship can both provide a relief from and be a source of anxiety.

1. The more intense the relationship fusion, the more unstable the relationship and the more the chronic anxiety generated by the relationship.

2. Relationships with a high degree of fusion generate many problems, little reserve is then left to deal with other problems.

3. When the family system's ability to adapt is exceeded, then acute and chronic symptoms appear.

4. Anxiety can be controlled by diverting attention to a third party.

5. The grater the anxiety and the greater the un-differentiation, the greater the likelihood of a system developing.

E. Better functioning families experience less chronic anxiety, have more emotional reserve, require less use of stabilizing mechanisms, and experience fewer acute and chronic problems.

V. Family Functioning and Symptom Development

A. Acute disease processes that seem to be influenced by general family dynamics are:

1. Asthma

2. Post-cardiotomy psychosis

3. Tuberculosis

4. Abdominal pain in children

5. Accidents

6. Chronic pain

B. Family characteristics which contribute to the onset of psychophysiologic disorders:

1. Over involvement

2. Enmeshment

3. Collusion

4. Rigidity

C. Symptoms of the patient may fulfill the emotional needs of other family members.

D. A patient's illness may stabilize the system by focusing the family pathology and allowing improved functioning in other areas.

E. Anxiety is related to family functioning. The anxiety can be displaced to a symptom, this lessens anxiety, since energy is invested in the symptom rather than the precipitating stress.

F. Family's involvement in the development of pain behaviors:

1. Pain behaviors may be learned and other family members reinforce the behaviors.

2. Pain used to express a variety of negative emotions.

3. It is through pain and suffering that caring behavior is maintained.

G. Pain, as a behavior, is always communication; as a

communication tool the messages are indirect and masked with no specific referent pain may be used to express:

1. Tensions and frustrations

2. Mental suffering

3. Anger, powerlessness, martyrdom

4. To punish or be punished

5. To seek or avoid intimacy

H. Poor family functioning is not responsible for poor medical condition or increased levels of pain; but, that medical condition or pain and family functioning influences each other in a circular fashion.

METHODS OF CAPNOGRAPHY

Robert Akins, CRNA, RRT

I. Specifications

A. Concentrations ranging from 0 - 15%

B. Accuracy= +/-10% of reading or +/-3 mmHg

C. Response rapid enough to capture all phases of the ventilatory cycle

II. Mass Spectrometers

A. Magnetic sector type (e.g., PPG SARA)

1. Samples are sequenced by a mechanical multiplexer.

2. Electron source ionizes gas

3. Magnetic field creates an ionic "spectrum".

4. Individual collector electrometer plates count the number of molecules.

5. Counts from all the electrometers are summed and assumed to be the total gas.

6. Only molecules that hit a collector plate will be counted in the summation.

7. Volatile anesthetic agents all have molecular weights such that they would be deflected past the end of the electrometers.

III. Infrared Absorption

A. Polyatomic molecules all have known amounts of vibrational motion.

B. Black body infrared course, sample cuvette, and infrared detector, are functional parts.

C Problems

1. Close proximity of the absorptive peaks of carbon dioxide and nitrous oxide make detection of each gas difficult.

2. Drift radiation emitted from the source must be

accounted for dynamically.

3. Precision interference filters measure absorption in narrow bands of the spectrum.

4. Infrared detectors are faster responding than mass spectrometers.

5. No physical change in the structure of the molecule occurs.

IV. Raman Spectroscopy

A. Exciting electrons in molecules to a higher energy state.

B. A particular gas will have a distinctive photon emission.

C. All gases used in anesthesia today have a know Raman emission spectrum.