The article is issued in the form of presentation presented at symposium

Management of blunt chest trauma

Y.Khater (Cairo, Egypt)

Here are presented features of blunt chest trauma treatment management in critical medicine. Here is indicated, that similar injuries are know from ancient times and some of the treatment methods we can find in ancient Egyptian manuscripts which are written 700-2650 B.C. 3 major injury are separated; lung, heart and other structural units (blood vessels, diaphragm, esophagus). Most common are lung injuries. Use of modern methods of lung ventilation reduced lethal outcomes during such pathology.

Key words: management, chest, trauma

The making of medical history: Medicine made in Egypt

Medicine in ancient Egypt was but one aspect of an advanced civilization.

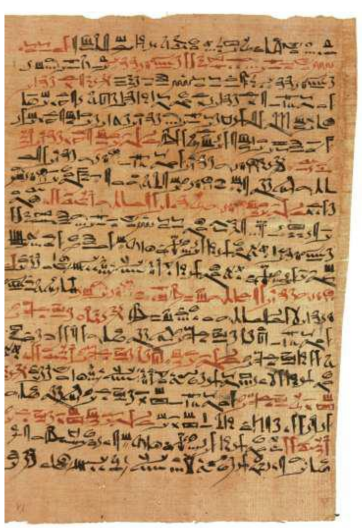
Starting from Imhotep (2650-2600 BC), the legendary physician, architect and vizier who served under theThird Dynasty PharoahDjoser, Egypt marks its contribution of medicine to humanity.

The Oldest Medical Text in the World

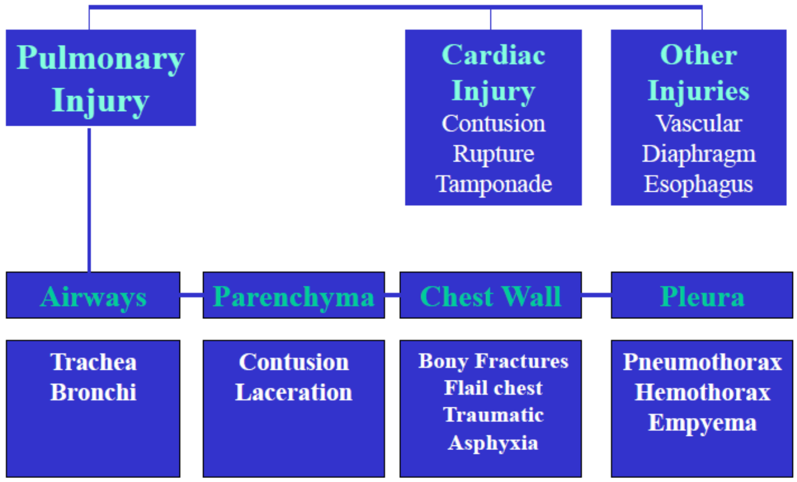
Imhotepis credited with being thefounder of medicine and with beingthe author of the first medical textthe so-called Edwin SmithPapyrus

The surviving papyrus was probablywritten around 1700 B.C. but maybe a copy of texts a thousandyears older.

Edwin Smith papyrus 5 m long–17 pages include 48 surgicalprocedures



Blunt Chest Trauma

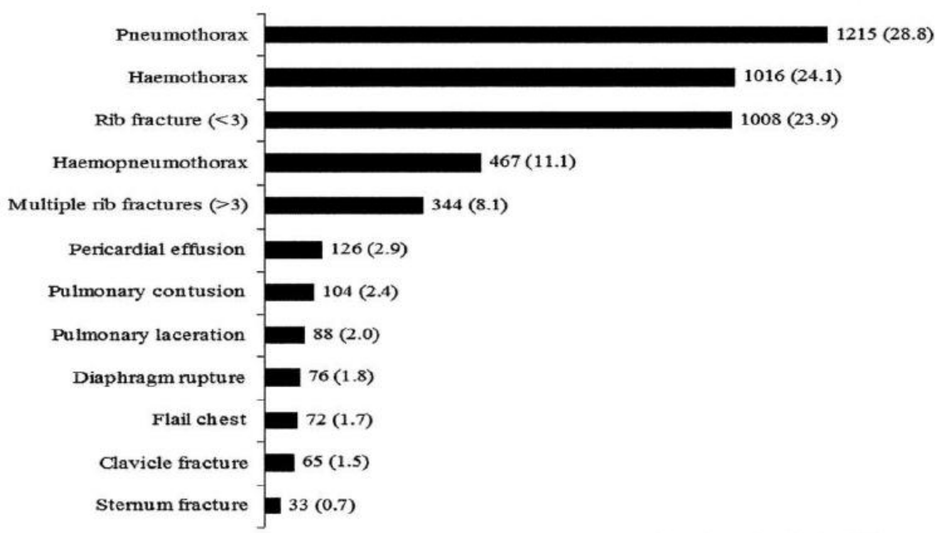


Causes of Chest Injury

Comprehensive analysis of 4205 patients with chest trauma:10-year experience

	Causes	No patients (%)
Blunt injury (n=2775, 66%)	Traffic accidents	1998 (47.5)
	Criminal activity	417 (9.8)
	Falls	222 (5.2)
	Occupational	138 (3.2)
Penetrating injury (n=1430, 34%)	Stab wounds	1001 (23.8)
	Gunshot wounds	315 (7.4)
	Foreign body	114 (2.7)

Clinical and radiological findings



Analysis of Patients Mortality and hospital stay

	Blunt	Isolated	Associated
Mortality (%)	6.8	5.8	17.7
Hospital stay (days)	12.6	10.7	15.3

Pneumothorax

Pulmonary laceration from fx rib. Shear injury of the lung from deceleration

Raised intrathoracic pressure and alveolar leak

Simple, open, tension, occult

Shock, distended neck veins, absent breath sounds

Hyper resonance, deviated trachea

CXR, CT scan, Ultrasound

Decompression: needle or cannula, Large bore chesttube (20% + hemo)- 24h without air leak

Right pneumothorax.

Tension pneumothorax. Mediastinum shift

Hemothorax

Rib fx lacerate vessels or lung parenchyma

Adhesions result in lung lacerations

Great vessels injury

Clinical hemodynamic instability

Tube thoracostomy draining blood

CXR can detect down to 200ml

Ultrasound used but not accepted universally

CT scan if performed

Tube thoracostomy

Thoracotomy 1.7%

10 ml/kg for 1 hour

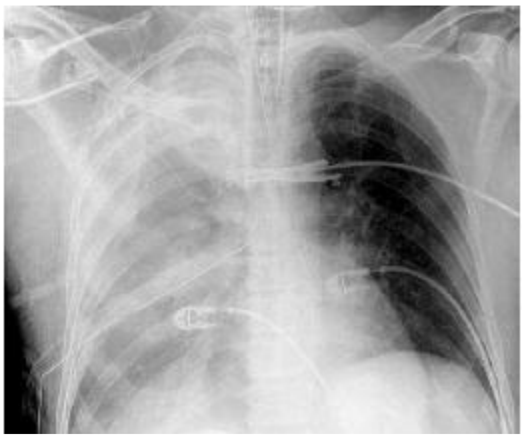
8 ml/kg for 2 hours

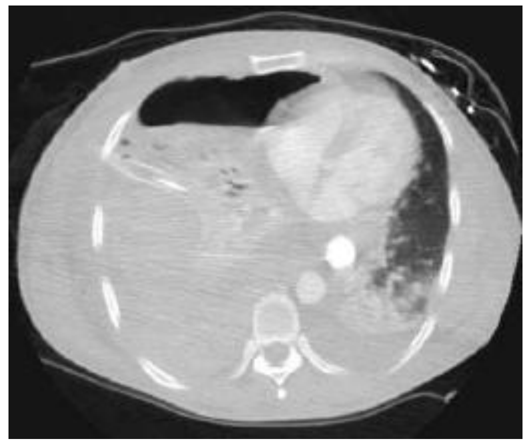
6 ml/kg for 3 hours

Patient deterioration

Failure to resolve 48 h

Thoracoscopy and Video Assisted ThoracicSurgery VATS





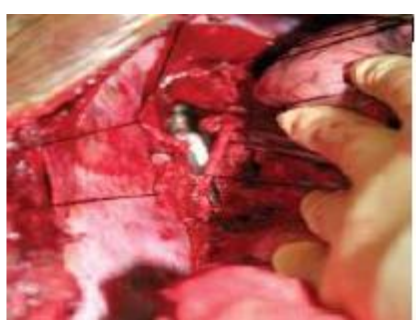
Trachea and Bronchi

Trachea & main bronchi injury usually 2cm of carina.Trachea is fixed between cricoid and carina. Deceleration injury widen carina & tear bronchi

Diagnosis is difficult resulting in complications. Cough, stridor, dyspnea, hemoptysis,Sc. emphysema & voice changesCXR air in mediastinum, fallen lung sign

Bronchoscopy

Control of airway before operative repair or resection.



Traumatic Asphyxia

Thoracic crush injury increases the thoracic & superior vena cava pressure

Breath holding and glottic closure promote further elevation of venouspressure, reversal of venous flow & capillary rupture

Head & neck cyanosis, facial edema, petechiae&subconjunctival hemorrhage

Loss of consciousness, prolonged confusion and seizures

Oxygen administration, positioning & management of associated injuries

Long term outcome is excellent

Rib Fracture

Pain becoming worse with deep inspiration

Point tenderness and associated crepitus

Associated pneumothorax, hemothorax, pulmonary contusionCXR

First ribs: blunt cardiac rupture, bronchial disruption, great vessel tears

Lower ribs: liver, spleen or kidney rupture

Evaluation and management of associated injuries.Adequate analgesia personalized Opioid, PCA, Epidural, Regional block. Aggressive incentive physiotherapy.

Sternal Fracture

Chest pain, sternal tenderness, ecchymosis & palpable deformity –lateral CXR

Management of associated injuries, pain relief, ECG to exclude cardiac contusion.Rarely operative fixation.

Flail Chest

Three or more adjacent ribs fractured in atleast two places. Flail segment moves paradoxically withrespiratory movements. Careful inspection and palpationCXR, CT-scan.Evaluate underlying lung contusion andassociated injuries.

Anterior: cardiac, great vessels &pulmonary injuries

Lateral: hepatic and splenic injury

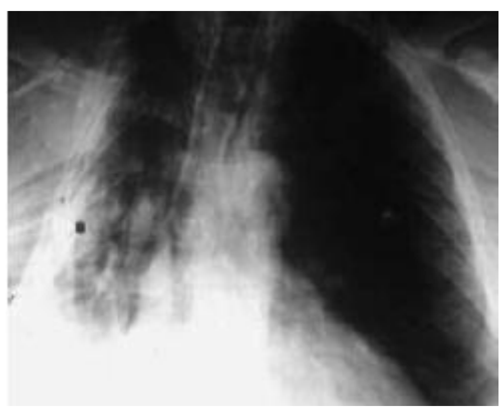
Flail chest on a reconstructed chest CT.

Flail Chest

Respiratory failure

Pendelluft as a result of paradoxical movement.Split lung function proved increasedMV, O2-uptake on the injured side.

Clinical observation: emergency intubationfor impaired oxygenation and not ventilation. Chest wall pain with splinting of fractured ribs. Underlying parenchymal lung contusion.Flail chest is a marker of pooroutcome. Longer LOS in hospital and require more MV.

Management of Flail Chest

Aggressive pulmonary physiotherapy. Sufficient pain control at ribs. Maintenance of intravascular volume within strict limits. Close monitoring for respiratory failure and regional ventilation Victorino et al. Am J RespirCrit Care Med 2004

Selective use of endotracheal intubation and ventilation Richardson et al. Ann Surg 1982Non-invasive MVGunduz et al..Emerg Med J 2005

Surgical stabilization?Weaning failure?

Pulmonary Contusion

Shock waves resulting in stretching and tearing.Poor perfusion that progress to ARDS

Incidence varies between 2.4% to 86% of all, or flail35% in ICU cases. Hypoxemia, tachypnea and hypocapnia, Distress.Forced dehydration and intentional hypovolemiaversus maitenance of intravascular volume withstrict limits. (perfusion-urine-1500ml/day- lassix). Pain control, aggressive physiotherapy & selective use of ventilatory support.

Frequency of Treatment Modalities Used For Blunt Chest Injury

Fluid restriction	74%
Supplemental oxygen	68%
Nasotracheal suction	60%
Intercostal nerve block	28%

Diuretic	21%
Incentive spirometry	31%
Fiberoptic bronchoscopy	12%

Selective Management

Trinkle and richardson 1975

Trinkle et al 1978

Richardson et al 1982

Internal fixation

Clinical distress and flail movement

Until fixation

Selective management

ABG and requirements

Selective management: Outcome of Patients

Distress & paradoxical mvt=internal fixation until fixed

Selective mngt based on ABG and requirements

Total 427

Flail 135, 86% with pulmonary contusion and 95 separate

	Not Requiring Intubation and MV	With MV
Pts not initially intubated	328	99
Successful outcome (survived without serious complications or need for intubation)	318 (96.6 %)	
Failure (required intubation)	10 (3 %)	
Deaths in failure group	1	27

Lung Protection: Patient at Risk of ALI

Diagnosis of ARDS is at a time a challenge

PEEP affect: PaO2/FiO2 and radiography

Diagnosis might not be clear at initiation but may develop later

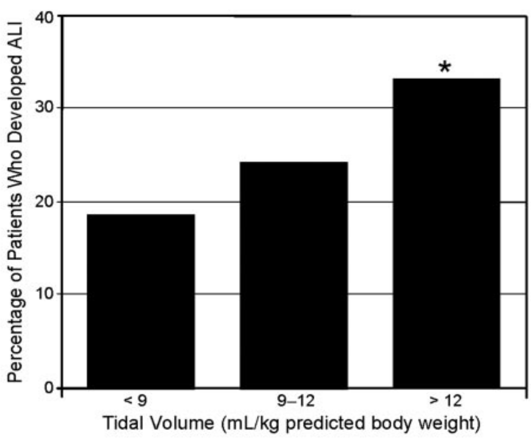
Critical ill patient are at risk: VAP–transfusion-aspiration

Patient at Risk of ALI

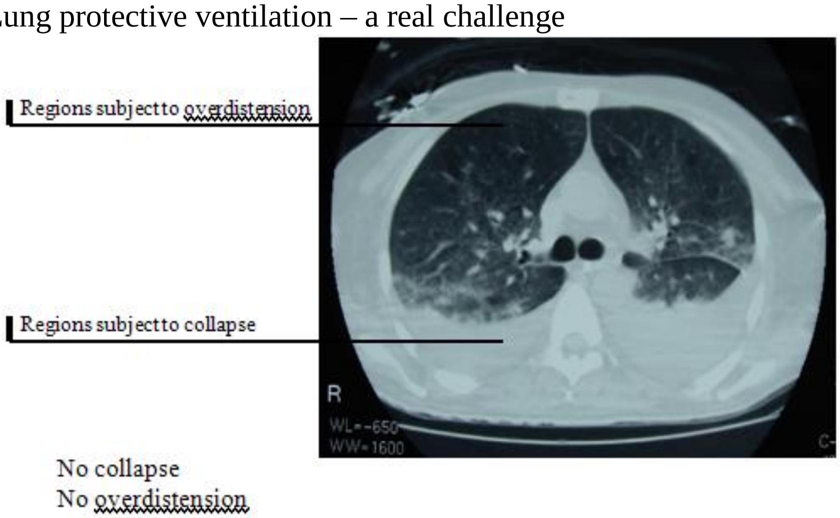
- Gajic examined 332 patients without ALI for the development of ALI.
- Each ml/kg of VT received greater than 6 ml/kg was associated with a 30% increase in the odds of developing ALI.
- Gajic in 3261 patients reported VT > 700ml and Peak Paw> 30 cmH2O independently produce ALI

Gajic et al. (2004) Ventilator-associated lung injury in patients without acute lung injury at the onset of mechanical ventilation. *Crit Care Med*

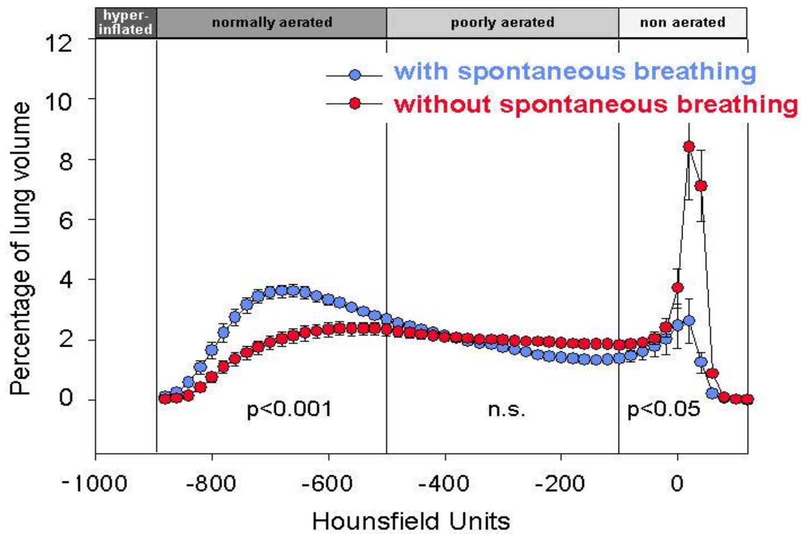
Gajic et al. (2005). Ventilator settings as a risk factor for acute respiratory distress syndrome in mechanically ventilated patients. Intensive Care Med



The need for regional ventilation monitoring
Lung protective ventilation – a real challenge

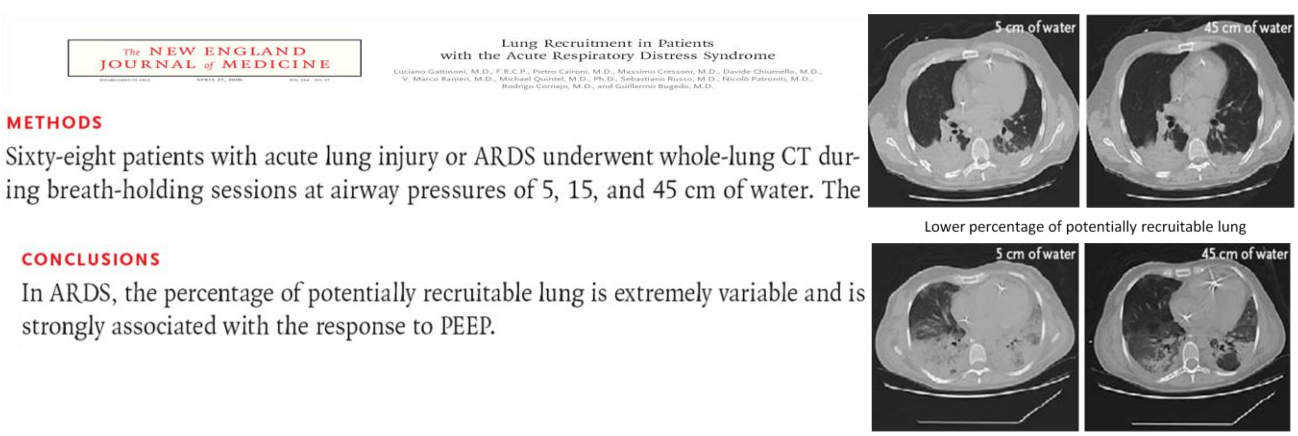


The need for regional ventilation monitoring
Understanding the distribution of aeration



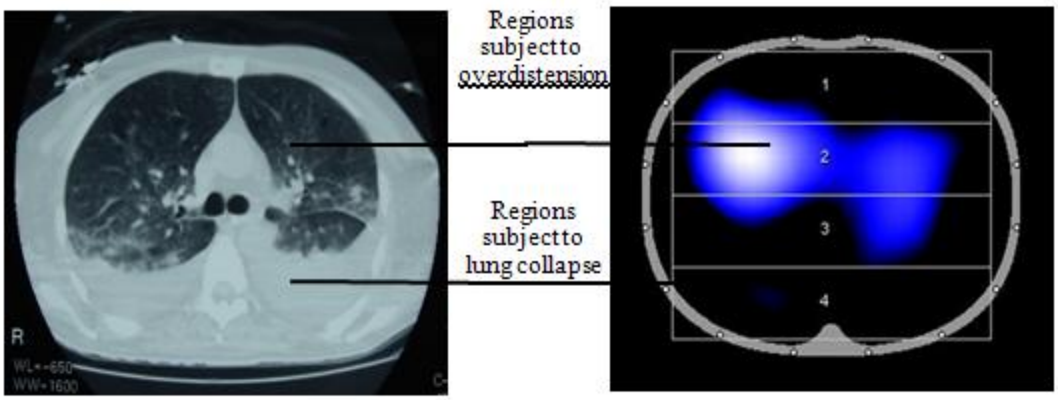
Wrigge H, Zinserling J, Neumann P, Defosse J, Magnusson A, Putensen C, Hedenstierna G. Spontaneous breathing improves lung aeration in oleic acid-induced lung injury. Anaesthesiology 2003; 99:376-384.

The need for regional ventilation monitoring
Individualized information



⇨ **Airway pressures call for individual adjustment**

The need for regional ventilation monitoring
Addressed by Electrical Impedance Tomography

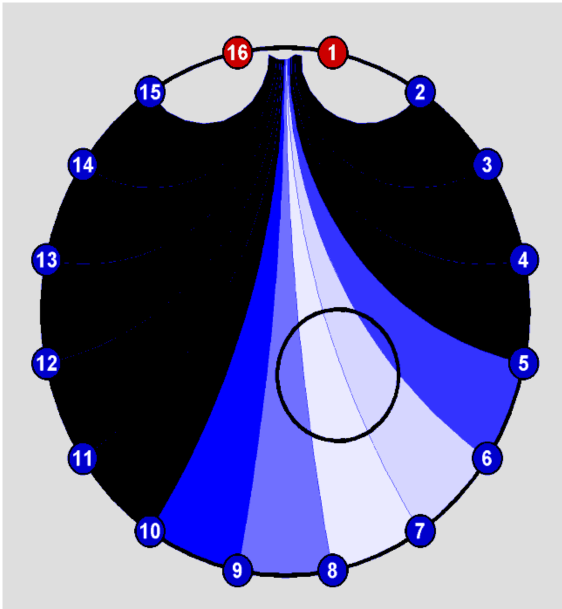


Meier et al. Assessment of regional lung recruitment during PEEP trial based on EIT.
Intensive Care Med 2008
Victorino et al. Imbalances in regional lung ventilation: a validation study on EIT
Am J Respir Crit Care Med 2004
Wrigge H. et al., EIT compared with thoracic CTduring a slow inflation maneuver in models of lung injury,
Crit Care Med 2008

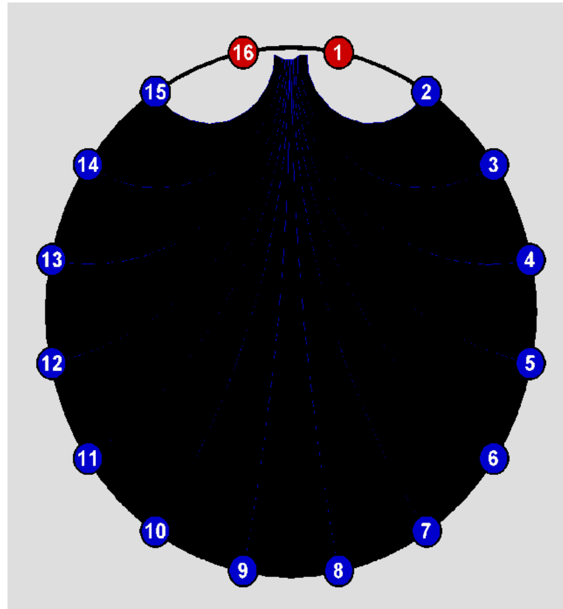
The science of EIT
Bioelectric properties of lung tissue

- Bioelectric properties of lung tissue change with the air content
- Using EIT, impedance changes due to ventilation can be determined
- Impedance measurements are performed using an electrode belt around the patient’s chest

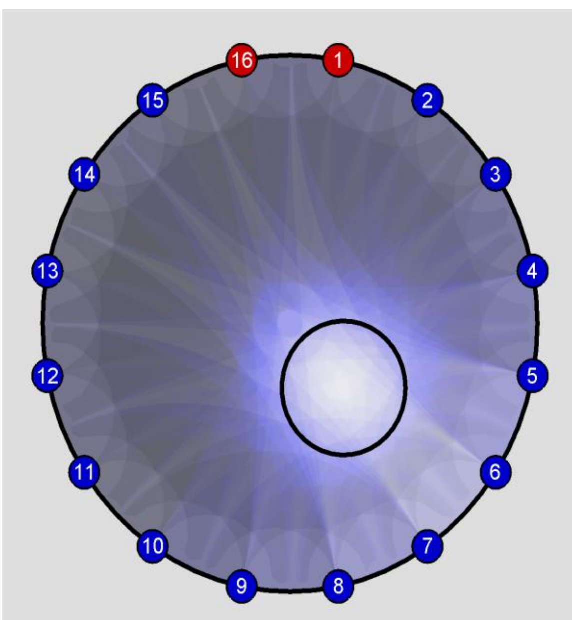
The science of EIT
Image reconstruction



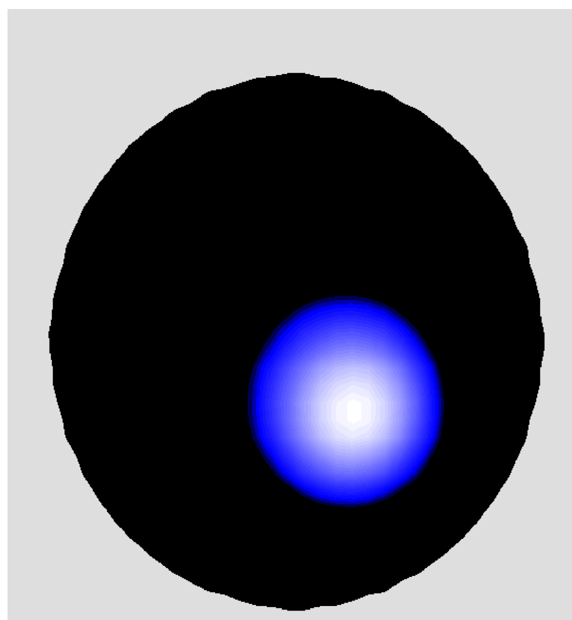
Area of increased impedance
Voltage change due to inspiration



Impedance distribution at the end of expiration (baseline)



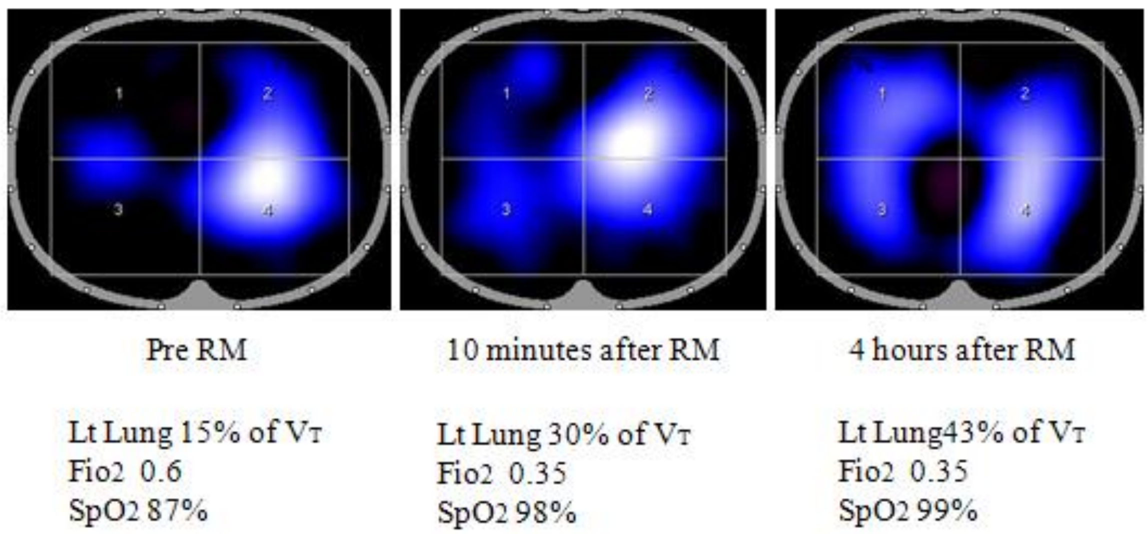
Superimposition of voltage profiles



Resulting image

Bringing EIT to the bedside
Making ventilation visible

Distribution of ventilation pre and post recruitment maneuver (RM)
Tidal image patient with
Pneumonia Sepsis and ARDS



Imbalances in Regional Lung Ventilation
A Validation Study on Electrical Impedance Tomography
Victorino, Amato et al AJRCCM 2004

Ten adult patients under mechanical ventilation were recruited
Agreement in estimates of Vt distribution according to EIT versus CT even in smaller ROIs presented acceptable agreement
Considering all ROIs and both electrode-positioning arrangements the bias was less than 1% for all situations. All of the results were below the a priori reproducibility cutoff of 9%.
In conclusion, EIT can reliably assess imbalances in distribution of Vt in critically ill patients. When comparing regional ventilation across different thoracic regions, the quantitative information provided by EIT carries good proportionality to changes in air content—as calculated by dynamic CT scanning

Higher vs Lower PEEP in ALI and ARDS

Systematic Review and Meta-analysis Briel et al. JAMA, 2010
Medline, Embase, Cochrane Central Register of Controlled Trials (1996-2010)
Three trials, including 2299 patients, met eligibility criteria
Assessment of Low Tidal Volume and Elevated End-Expiratory Pressure to Obviate Lung Injury (ALVEOLI) trial

Lung Open Ventilation to Decrease Mortality in the Acute Respiratory Distress Syndrome(LOVS) study
PEEP titrated using PEEP:FIO2 charts
Expiratory Pressure Study (EXPRESS)
PEEP titrated on P plat

Higher vs Lower PEEP in ALI and ARDS

Overall hospital mortality H and L PEEP NS (32.9% vs 35.2%)

ICU mortality reduced H PEEP (28.5% vs32.8%; *P=.01).*

Rescue therapies and rate of deaths following rescue therapy significantly lower in H PEEP.
NS difference in rates of pneumothorax, hospital deaths following pneumothorax, use of vasopressors, or number of days with unassisted breathing during the first 28 days of study.

Higher vs Lower PEEP in ALI and ARDS

ARDS at baseline
H PEEP less likely to die in hospital (34.1% vs 39.1%; P=.049) more likely to achieve unassisted breathing earlier (hazard ratio, P=.01; proportions at 28 days, 64.3% vs 57.8%)
Without ARDS at baseline
death in hospital with H vs L PEEP NS (P=.07; 27.2% vs 19.4%)
hazard ratio for time to unassisted breathing was (P=.04;
proportions at 28 days,70.1% vs 80.9%)

Best Anesthesiologist In History

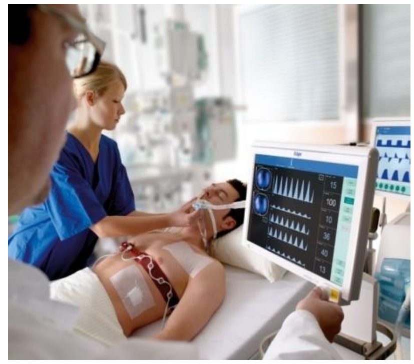
80 millions Anaesthetized
Not Aware of stealing the country
Not feeling pain of humiliation
Fully relaxed
For 30 years

Full safe Recovery

- Outcome of Patients Requiring Intubation
- and Mechanical Ventilation
- Patients initially intubated 99
- Deaths 27, Direct pulmonary injury 10

Bringing EIT to the bedside
Making ventilation visible

Continuous real time visualization of impact of patient care:
Change of ventilator settings
PEEP optimization
Recruitment maneuvers
Patient positioning
Promotion of spontaneous breathing
Tracheal suction
Chest physiotherapy



Non-Hemorrhagic shock

Myocardial contusion, cardiac tamponade, air embolism, MI
EKG   Echocardiography
- Neurogenic
  Isolated head injury? Spinal cord:symp. tone & hypovolemia
  Hypotension without tachycardia & normal pulse pressure
- Tension pneumothorax
  SC. emphysema, absent breath sounds, tracheal shift Hyperresonance to percussion and acute resp. depression

Immediate decompression without radiological confirmation

Hypothermia

- Anesthesia thermoregulation vasodilatation shivering
- Metabolic rate and oxygen consumption 8%/C°
- Low organ perfusion better tolerated
- Increased sympath. tone increased contractility HR BP
- Serious dysrhythmias
- Hypoxic pulmonary vasoconstriction attenuated
- Transcapillary fluid shift worsen hypovolemia
- Blood viscosity is increased
- Platelet dysfunction and thrombocytopenia

Fluid therapy

- Adequate intravascular access
  Central line, peripheral line, intra osseous
- Restoration of circulating volume
  Crystalloid, colloids

- Restoration of oxygen carrying capacity
  RBCs
- Normalization of coagulation
  Fresh frozen plasma, platelets, other components

Fluid therapy
- Acute blood loss is usually underestimated
- Tissue losses amount to 4-8 ml/kg/h
- Crystalloid replacement should be 3 x blood loss
- Most anesthetics increases intravascular capacity

Safer to give too much fluid rather than too little
Lassix in the recovery better than CPR in the theater
Anemia & Dilution thrombocytopenia
Fibrinogen deficiencies & DIC

Airway Management
Indications to secure airway
- Apnea
- Obstruction
- Chest trauma with hypoventilation
- Combativeness requiring sedation
- Head injury GCS < 9
- Shock
- Cardiac arrest
- Post resuscitation hypoxia
- General anesthesia

Anesthetic Drugs for Endotracheal Intubation

Condition	Hypnosis	Relaxant	Analgesia	Amnesia
GCS=3 unresponsive	none	none	none	none
Cardiac arrest	none	none	none	none
Shock SBP<80 20-30% hypovolemia	none	succinyl 1m g/kg vecuronium 0.3 mg/kg	Pentanyl 0.5-1mg/kg	Midazolam 1-2mg if BP increases

A survivor with recall better than a dead

Condition	Hypnosis	Relaxant	Analgesia	Amnesia
Hypotension SBP 80-100	Thio 1ml/kg Eto 0.1mg/kg Ket 1mg/kg	Succynil 1mg/kg Vecuronium 0.3 mg/kg	Fentanil 1 ug/kg	Midazolam 1-2mg
Head inj GCS=4-9 Hhypertension	Thiopental 3-5mg/kg Etomidate 0.3mg/kg	Vecuronium succinyl	Fental 1-2 ug/kg Sufenta 0.1-0.2 ug/kg	None hypnotic will suffice
Combative BP normal or elevated	Thiopental 3-5mg/kg Etomidate 0.3 mg/kg	Vecuronium succinyl	Fentanyl 1-2ug/kg Sufenta 0.1-0.2ug/kg	None hypnotic will suffice

Advanced Trauma Life Support

A	Airway obstruction Cervical spine injury	Airway and CNS injuries Full stomach and ileus Hypovolemia	ETT Fiberoptic Tracheostomy Cricothyroid pressure
B	Impending respiratory Failure	Hypoxic and hypercarbic	Lung protection Selective ventilation
C	Hemorrhagic and Non-hemorrgagic shock	Cardiovascular Neurogenic Tension Pneumothorax	Fluid therapy Immediate decompression

Management of the Trauma Patient

- Highest challenge of our specialty
  - Critically ill patient
  - Multiple injuries
  - Surgical diagnosis unknown
  - Nature of the procedure unknown
  - No time for invasive monitors
  - Volume resuscitation not complete
  - Anesthetize, paralyze, monitor, and resuscitate

Morbidities in the Management of Chest Trauma

Morbidities	Patients (%)
Atelectasis	616 (14.6)
Respiratory failure	232 (5.5)
Adult respiratory distress syndrome	138 (3.2)
Clotted haemothorax	39 (0.9)
Bronchopleural fistula	20 (0.4)
Empyema	14 (0.3)

Diagnostic Implications of Patient Presentation

Clinical presentation	Diagnostic implication
Chest wall pain & tenderness	Rib or sternal fracture
Persistent air leak from chest tube	Trachiobronchial injury, pulmonary lacerations
Progressive infiltrates and hypoxemia	ARDS, pulmonary contusion, pneumonia
Hemodynamic instability	Hemorrhagic shock, tension pneumothorax, hemothorax, blunt cardiac inj with or without tamponade
Sepsis syndrome	Missed esophageal injury, pneumonia, empyema
Unresolving pneumonia	Bronchial injury

Diagnostic Implications of Chest Radiographic Findings

Radiographic abnormality	Diagnostic implication
Rib fractures Injury	Flail chest, underlying visceral
Soft tissue air	Pneumothorax
Air/fluid in pleural space	Pneumothorax, hemothorax
Persisting pneumothorax or air Pulmonary infiltrate	Tracheobronchial tear, mediastinal laceration Pulmonary contusion
Indistinct diaphragm	Ruptured diaphragm
Abnormal mediastinum	Thoracic aortic injury

გულ-მკერდის დაჟეჟილობის მენეჯმენტი.

იჰატერი (კაირო, ეგვიპტე)

მოტანილია გულ-მკერდის დაჟეჟილობის მკურნალობის მენეჯმენტის თავისებურებები კრიტიკულ მედიცინაში. მითითებულია, რომ მსგავსი ხასიათის

დაზიანებები ცნობილია უძველესი დროიდან და ზოგიერთი მკურნალობის შესახებ ჩვენ შეგვიძლია ვნახოთ ძველ ეგვიპტურ ხელნაწერებში რომელიც შედგენილია ჩვენს წელთაღრიცხვამდე 700-2650 წლის წინ. გამოყოფილია 3 ძირითადი დაზიანება, ფილტვების, გულის და სხვა სტრუქტურული ერთეულების (სისხლძარღვები, დიაფრაგმა, საყლაპავი). ყველაზე ხშირია ფილტვების დაზიანება. ხელოვნური სუნთქვის მოდერნური მეთოდების გამოყენებამ ხელი შეუწყო ლეტალობის შემცირებას აღნიშნული პათოლოგიის დროს.

გასაღები სიტყვები: მენეჯმენტი, გულ-მკერდი, ტრამვა.