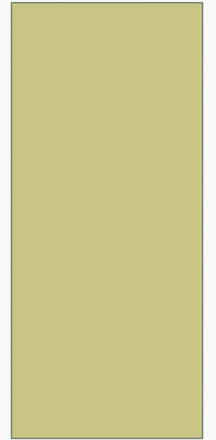




BRAIN DEATH AND ORGAN PROCUREMENT

KIMBERLY ALVA, RN, MSN, ACNP-BC
TRAVIS BRADLEY, RN, MSN, ACNP-BC

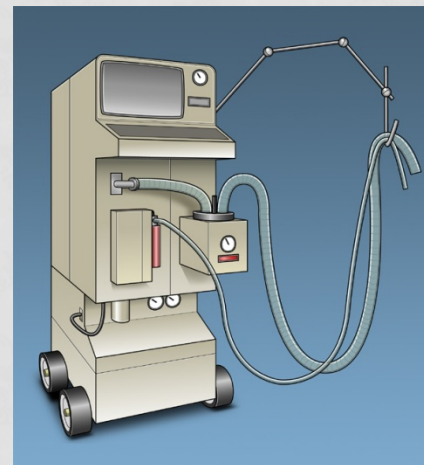
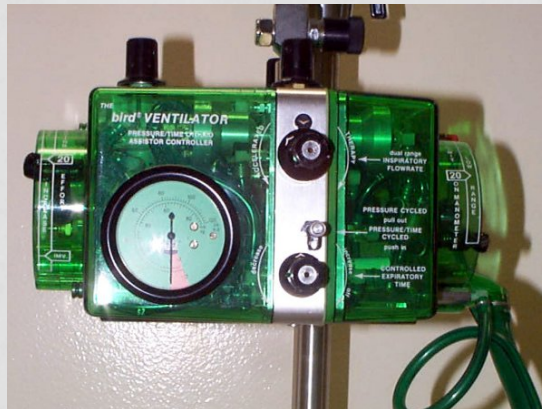


OBJECTIVES

- Describe the Uniform Determination of Death Act
- Identify criteria for brain death
- Describe how to perform a brain death exam
- Identify the pathophysiologic changes during brain death
- Describe criteria for organ donation

HISTORY

- Major improvements in life support came about in the 1960s; evolution of mechanical ventilators from 1955 – 1971
- Harvard released a major report on “irreversible coma” in 1968
- Finland was the first European country to adopt a “brain death” law in 1971



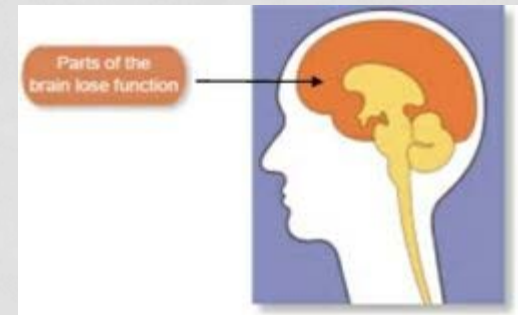
HISTORY

- Karen Ann Quinlan case
 - 22 year old female, overdose of ETOH and diazepam
 - Apnea episode of 15 min ?
 - *Persistent vegetative state*, stable on mechanical ventilation for several months
 - Parents requested termination of life support but hospital refused
 - New Jersey Supreme Court ruled in favor of parents and patient extubated in 1976
 - Died in 1985 of complications of pneumonia

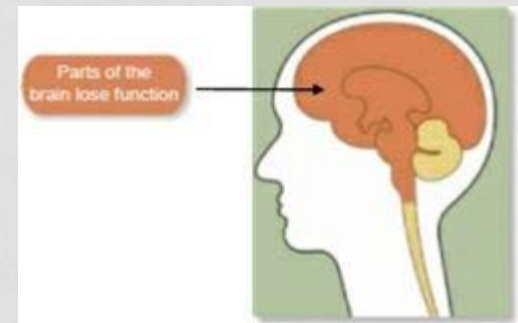


THINGS THAT LOOK LIKE BRAIN DEATH

- Persistent vegetative state
- Minimally Responsive state
- Lock In Syndrome



Vegetative State



Brain Death

PERSISTENT VEGETATIVE STATE

- Is NOT brain death
- Patient has lost their thinking abilities and awareness of their surroundings, but retain non-cognitive function and normal sleep patterns
- Other key functions such as breathing and circulation remain relatively intact
- They do not speak and they are unable to respond to commands.



UNIFORM DETERMINATION OF DEATH ACT

- Presidential Commission in 1981
- EITHER an individual who has sustained irreversible cessation of circulatory and respiratory function
- OR irreversible cessation of all function of the entire brain, including the brain stem
- Patient can be declared dead

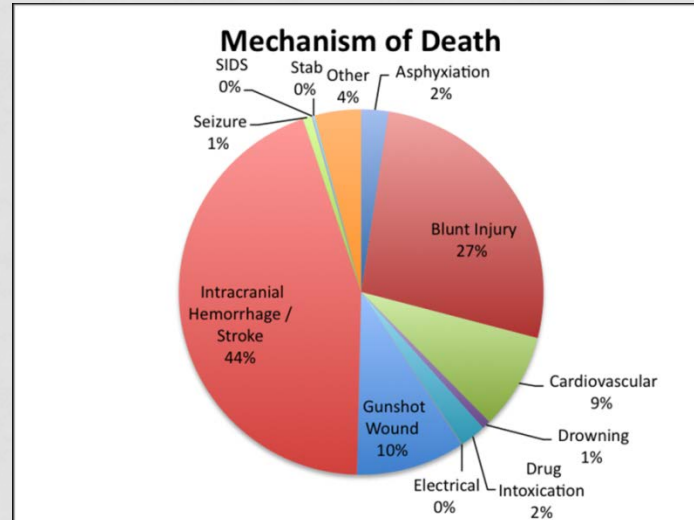


UNIFORM DETERMINATION OF DEATH ACT

- Most states have adopted this Act
- Some states have added their own amendments
- State of California Health and Safety Code, Section 7184
- California requires an independent confirmation by a 2nd physician
- Determination is dependant on "***accepted medical standards***"
- All language is specific to "physician"

EPIDEMIOLOGY

- Of all the deaths in the United States each year, only 1%–2% are brain deaths
- For organ donors the most common cause of brain death are as follows



WHAT DO THESE PEOPLE HAVE IN COMMON??



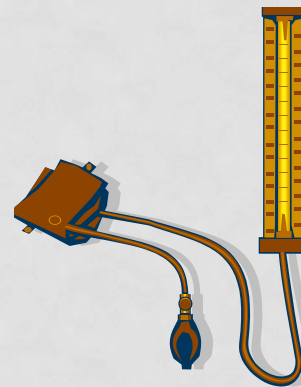
ETIOLOGY OF BRAIN DEATH

Monro-Kellie doctrine

- Cranium is fixed
- Inner components are brain tissue, blood, and CSF
- Constant state of volume equilibrium
 - If one aspect increases, another must decrease to achieve equilibrium

Cushing's Triad

- Result of elevated ICP
 - Bradycardia
 - Irregular respiratory pattern
 - Widening pulse pressure

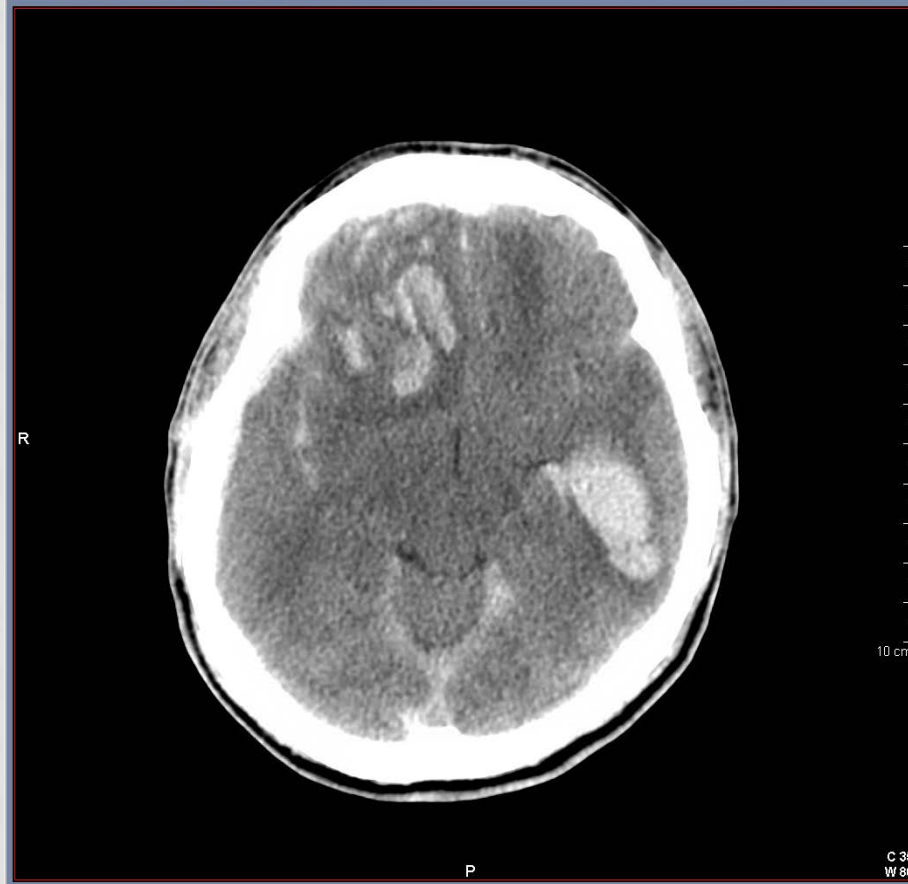


CASE STUDY

- 50-60 year old Hispanic male found down in an alley on Feb 27th ; John Doe, no ID
- PMH: unclear except for ESRD, AV fistula noted
 - Initial labs: Glucose 122, Na 135, K 5.7, BUN 75, Creat 11.8
- Initial Exam
 - No eye opening
 - PEARL, + corneal, + cough, + gag
 - RUE flex, LUE localize, lower extremities withdrew to stimulation

CASE STUDY DAY 1

Web Software (null webvs) - DOETWOZEROONEFOUR JOHN --



Web Software (null webvs) - DOETWOZEROONEFOUR JOHN --



CASE STUDY

- CRRT started emergently for renal failure
- ICP bolt placed by neurosurgery for ICP management
- CRRT maintained for 5 days, ICP stabilized
- Exam slightly improved; best exam intermittently following simple commands on L side
- Transition to intermittent hemodialysis on day 6

CASE STUDY DAY 6

- After 1 hour of HD, acute neuro change
 - Pupils 5 mm and very sluggish
 - Hypotensive
 - Bradycardic
 - Sudden change in respiratory rate
- Current labs:
 - Na 167
 - Serum osmo 358
- Emergency treatment
 - Mannitol 100 mg IVP x 2, 23% NaCl IVP x 1
 - Repeat CT scan

PATHOPHYSIOLOGY OF BRAIN DEATH

- Injury usually follows a rostral to caudal path
- Cerebral cortex is compressed against the inner surface of the skull
- Compromised micro vascular blood flow and dysfunction
- Continued elevated ICP can lead to herniation syndromes
- Terminal brain stem herniation can be caused by trauma, ischemia or infarction, hemorrhage, tumors, or infections such as encephalitis or meningitis
- Anoxic or ischemic injury after cardiopulmonary arrest can also lead to neuronal death



CASE STUDY DAY 6



CASE STUDY DAY 6

- HD stopped
- Pupils down to 3 mm and slowly reactive
- Over breathing ventilator again
- Decision to start CRRT again the next day

CASE STUDY DAY 7

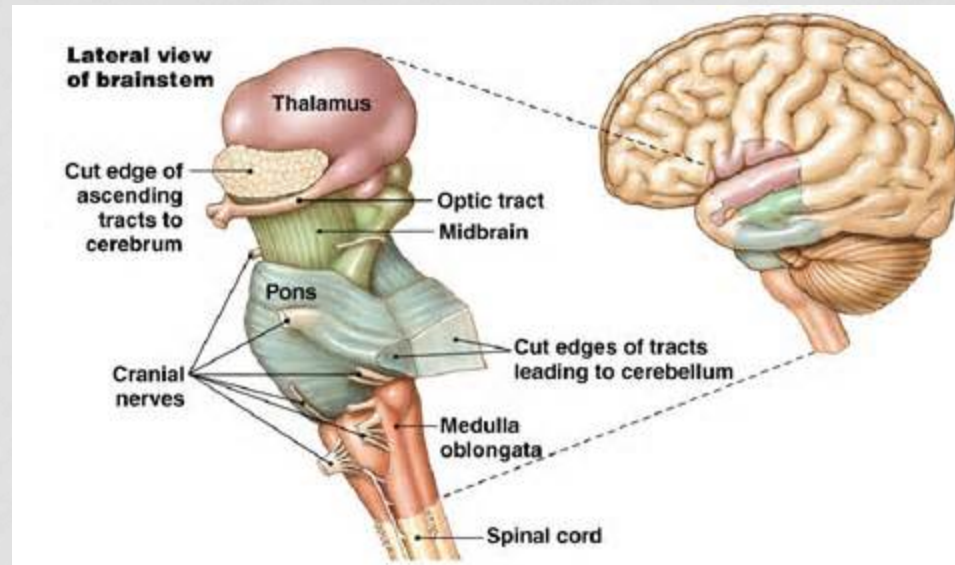
- However, after 4-5 hours of CRRT pt had another acute change in neuro exam
 - Stopped CRRT
 - Gave 23% NaCl
 - Started on levophed for hypotension
 - Stat CT obtained

CASE STUDY DAY 7



3 CARDINAL SIGNS OF BRAIN DEATH

- Coma or unresponsiveness
- Absence of brainstem reflexes
 - Corneal, Pupillary response, cough, gag
- Apnea



CANNOT DECLARE IF...

- Severe electrolyte, acid-base, endocrine disturbance
- Drug intoxication or poisoning
- Core temp $\leq 32^{\circ}$ C (90° F)

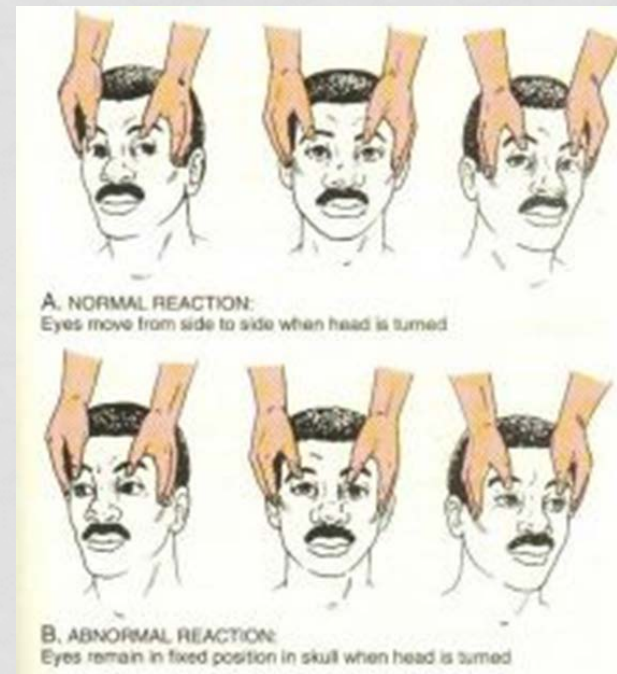


BRAIN DEATH TESTING

- Clinical exam and history
 - Coma and absence of brain stem reflexes
- Oculocephalic Reflex
- Vestibulocular Reflex
- Apnea Testing
- Confirmatory Testing
 - Cerebral Angiogram
 - EEG
 - Transcranial Doppler
 - Cerebral Blood Flow Scan

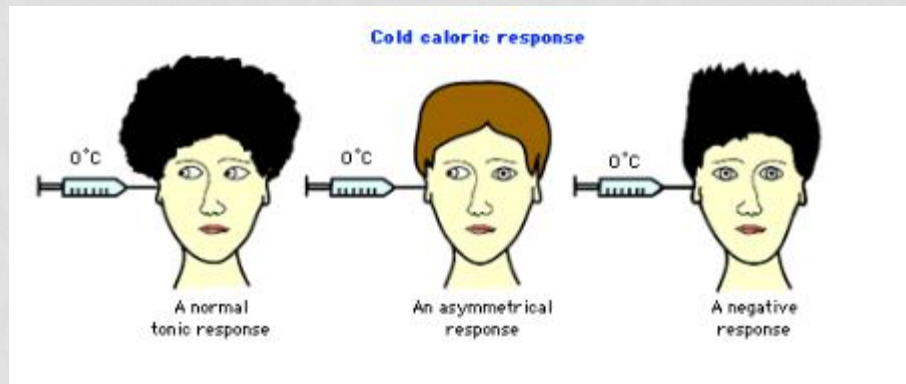
OCULOCEPHALIC REFLEX (DOLL'S EYES)

- Can only be done when assured there is no C-Spine injury
- Rapidly and vigorously turn the head 90 degrees laterally to both sides
- Positive OCR: patient's eyes will deviate from the direction in which the patient's nose is pointing
- Absent OCR: no eye movements occurring in response to head movement



VESTIBULOCULAR REFLEX (COLD CALORICS)

- HOB to 30°
- Instill 50 mL of iced water or saline into the ear over 30 seconds to 3 minutes
- Observe the patient's eye for response for up to 1 minute and then again at 5 minutes
- Repeat in other ear



APNEA TESTING

- Core body temp $\geq 36.5^{\circ}\text{C}$
- SBP ≥ 90 mm Hg
- Euvolemic
- Eucapnea: arterial PCO₂ ≥ 40 mmHg
- Normoxemia: arterial PaO₂ ≥ 200 mm Hg

APNEA TESTING

- Obtain a baseline arterial blood gas
- Disconnect ventilator
- Deliver 100% oxygen, 6L/min down ETT
- Observe for respiratory movements that produce adequate tidal volumes
- Obtain an ABG after 8 minutes
- Reconnect ventilator

INTERPRETING APNEA TEST RESULTS

Positive Apnea Test	Respiratory movements absent Posttest arterial PaCO ₂ ≥ 60 mmHg Supports brain death
Negative Apnea Test	Respiratory movements observed regardless of PaCO ₂ level DOES NOT support brain death, may repeat apnea test
Cardiovascular/Pulmonary Instability	SBP falls below 90 mmHg Arterial oxygen desaturation below therapeutic levels occurs Cardiac dysrhythmia occurs Immediately draw a blood gas and reconnect to ventilator Confirmatory test to finalize determination of brain death
Inconclusive Apnea Test	No respiratory movements are observed Posttest arterial PaCO ₂ ≤ 60 mmHg without significant cardiovascular instability Apnea test may be repeated

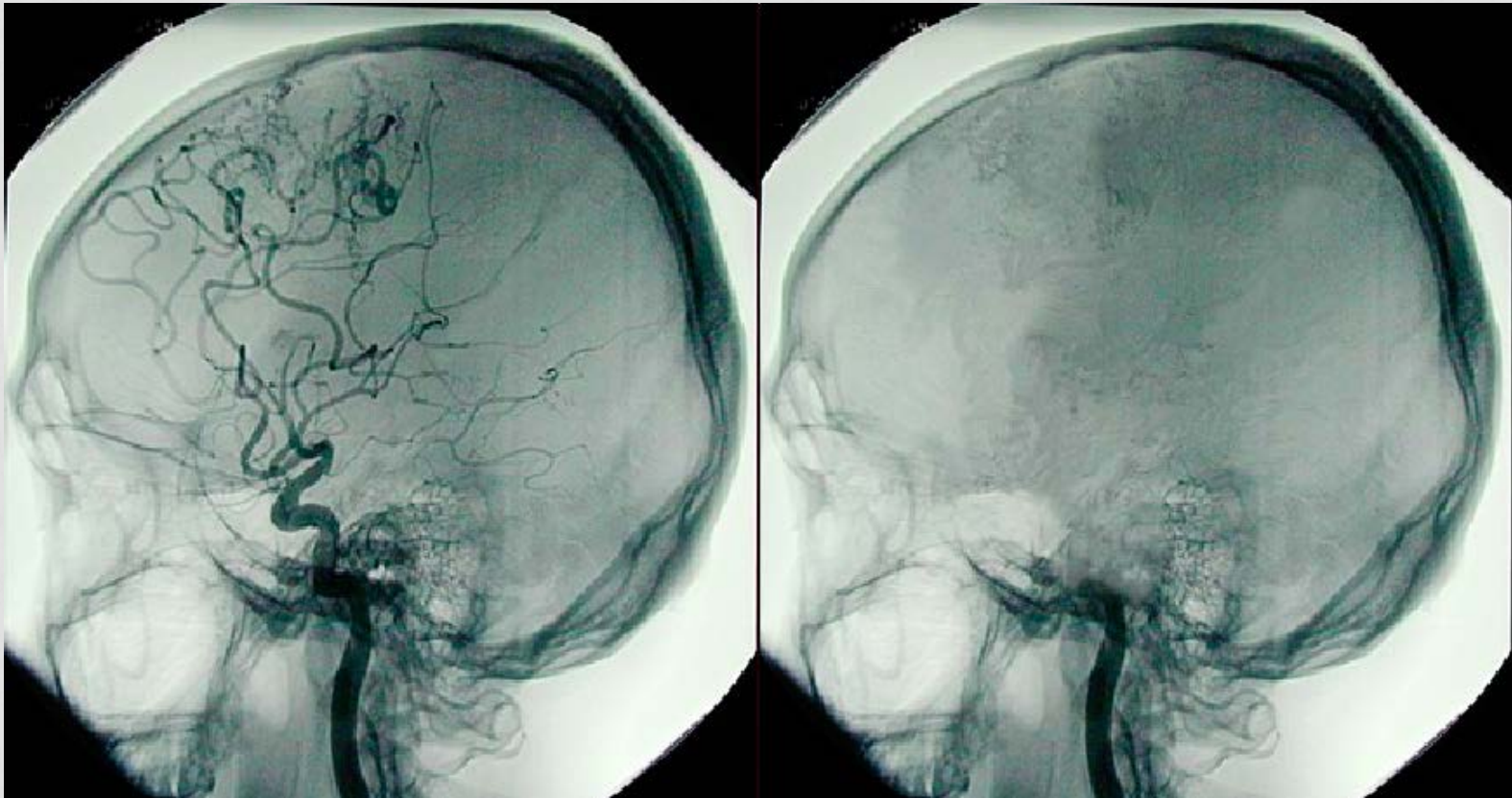
CASE STUDY

- Patients clinical exam consistent with brain death: pupils fixed and dilated, not overbreathing the ventilator, comatose, no cough, no gag, no corneal response
- Patient's oculoccephalic exam consistent with brain death
- Patient's vestibulocular exam consistent with brain death

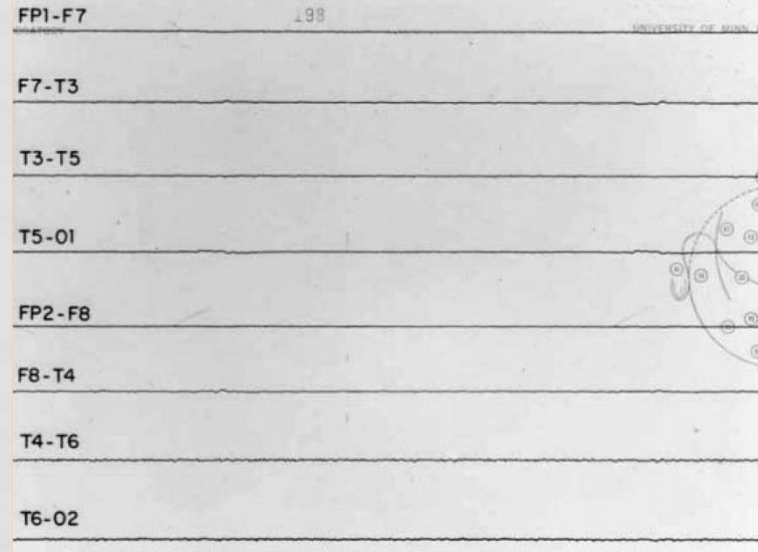
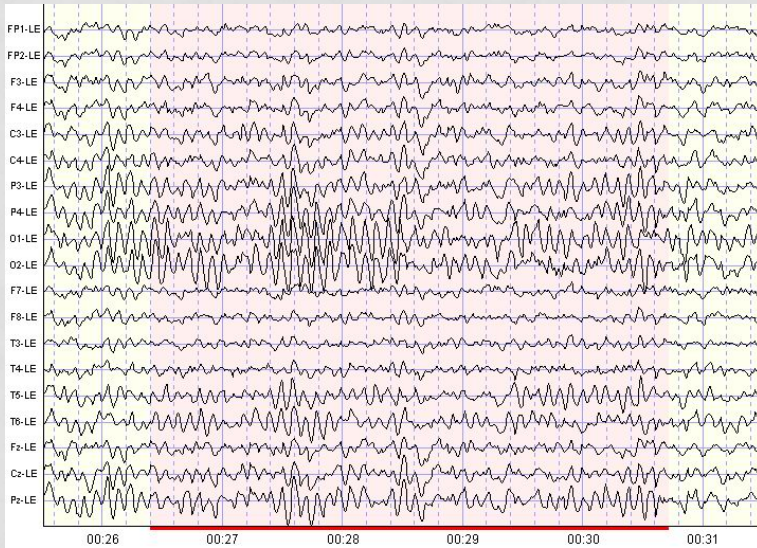
CASE STUDY

- Apnea Test results:
 - Baseline CO2 at 2010 42
 - 2030 60
 - 2035 68
 - 2038 87
- Consistent with brain death
- First exam performed by Neuro Critical Care Intensivist
- Second exam performed by Trauma Surgeon
- Time of Death: 2205

CEREBRAL ANGIOGRAPHY

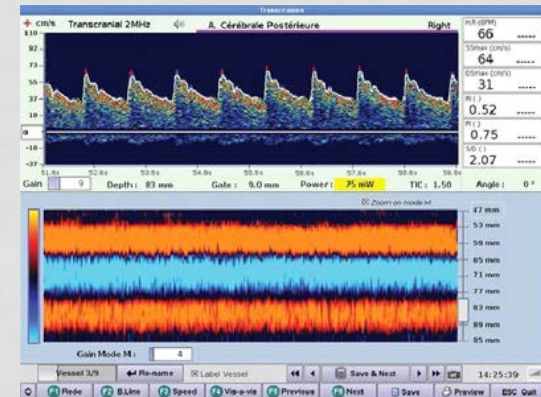


EEG



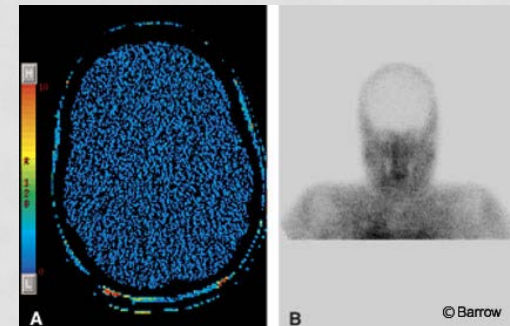
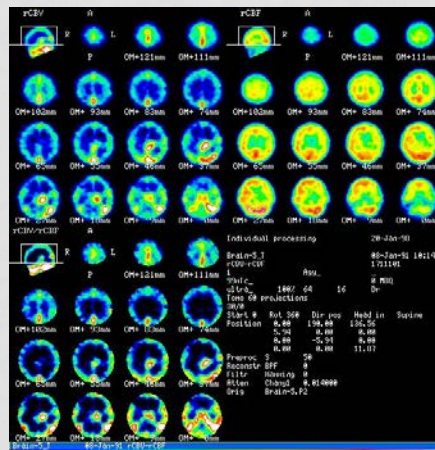
TRANSCRANIAL DOPPLER

- Can be performed at the bedside
- Identifying if there is forward flow of blood
- May be limited by thickness of skull



CEREBRAL BLOOD FLOW SCAN

- Requires transporting patient to radiology
- Inject radioisotope
- Identify if there is isotope uptake in cerebral blood vessels
- No uptake is consistent with brain death



DOCUMENTATION

- Time of death needs to be documented in the medical record by physician(s) performing exam
- Technically time of death is the time that arterial pCO₂ reached target value, or per hospital policy



CEDARS-SINAI MEDICAL CENTER

- Determination of Death Policy
 - A 2nd physician must independently confirm brain death. This should be made as soon as possible after the first declaration, preferable not to exceed 1-2 hours
 - It is recommended that one of the two physicians be a qualified neurologist, neurosurgeon, or been trained in critical care or emergency medicine
 - Both physicians must document all exam findings and procedures used to determine brain death
 - Neither of the two physicians determining brain death shall participate in harvesting or transplanting organs

CEDARS-SINAI MEDICAL CENTER



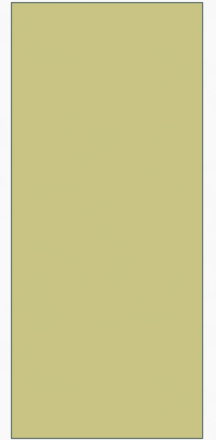
- Determination of Death Policy
 - Patient shall be determined dead after the 2nd physician confirmed findings. Death pronounced at time of note.
 - *Request for Reasonable Effort to Accommodate*
 - Brain death exam may be delayed at the discretion of treatment team to allow family members time for final visits or religious ceremonies
 - Once brain death has been declared, artificial life support may be continued for a brief period, usually a few hours to accommodate family requests
 - If the patient comes from a religious or cultural background where brain death is not accepted, efforts should be made to seek counsel from experts or leaders from those sectors to facilitate a mutually agreeable plan based on state law and hospital policy

APN ROLE

- Legally only a physician can declare brain death
- However, APNs can play an active role in the process including:
 - Family meetings
 - Performing the exams
 - Assisting/educating nursing staff on the brain death procedure
 - Organ procurement process

ETHICAL DILEMMAS

IN BRAIN DEATH



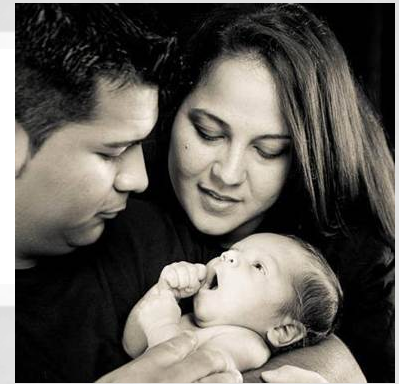
IN THE NEWS



- Jahi McMath

- 13 year old girl admitted to Oakland Children's Hospital December 9th, 2013 for tonsillectomy and sleep apnea correction
- Post procedure suffered cardiac arrest with cerebral edema
- Declared brain dead on December 12th by 3 neurologists
- Family obtained a restraining order against hospital to withdraw ventilator, however patient was declared legally dead by the coroner's office
- Online donations raised \$55,000
- Body was transferred to an undisclosed facility and received trach and PEG

IN THE NEWS



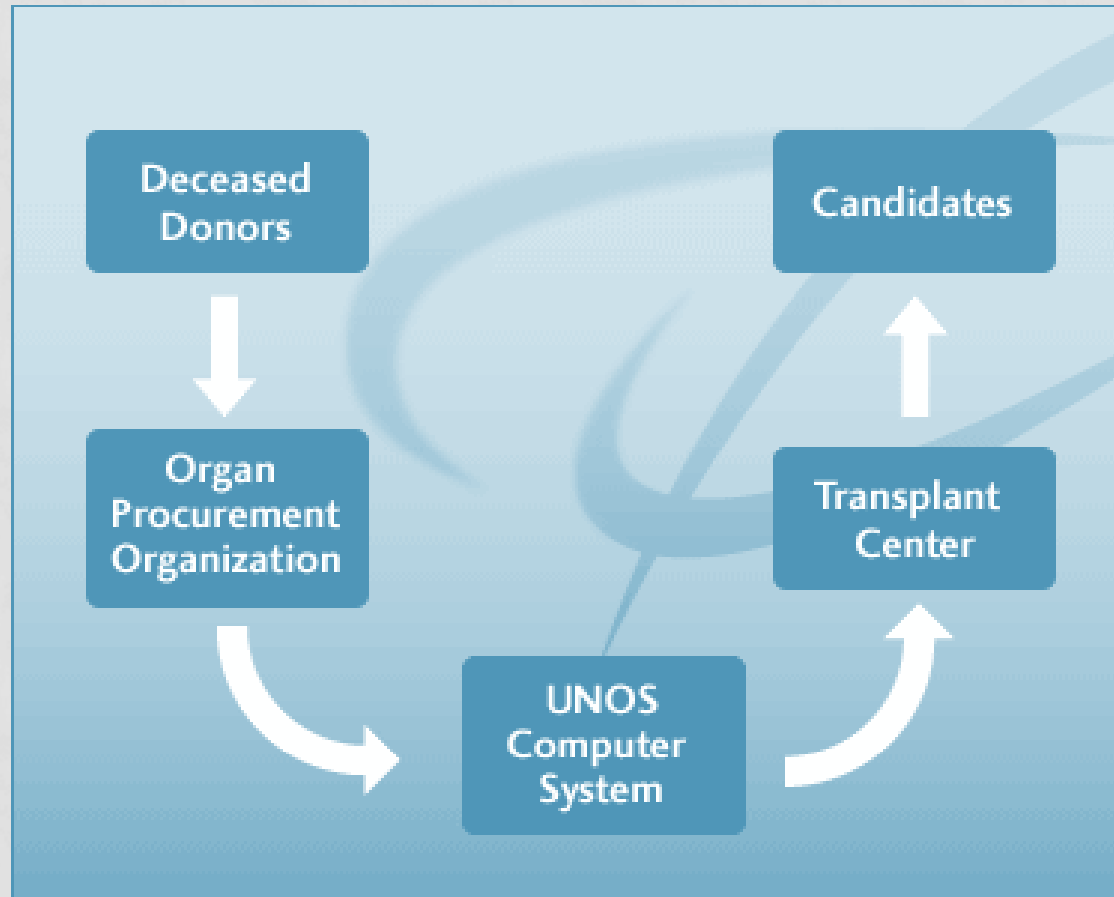
- Marlise Munoz
 - Young female, married, with one child already
 - Husband and wife were paramedics in Texas
 - 14 weeks pregnant
 - Found unconscious on kitchen floor November 26th, by husband, possible Pulmonary Embolus
 - Declared brain dead
 - Hospital stated state law required them to keep body alive to sustain fetus (although arguments were made that fetus not viable)
 - Husband sued and won, and life support removed on January 26th, 2014

CASE STUDY

- Cedars local organ procurement organization was notified (One Legacy)
- Organ procurement coordinator dispatched to Cedars-Sinai to evaluate case
- As patient was unrepresented, special permission was obtained from hospital administration for organ donation

ORGAN DONATION

ORGAN DONATION PROCESS



WHEN TO REFER FOR ORGAN DONATION

- Every death must be called within 1 hour and within 1 hour of the following:
 - Ventilator Dependent with one or more of these triggers:
 - GCS ≤ 5
 - Loss of one or more brainstem reflexes: ie pupils fixed/dilated, no corneals, no gag, no cough, etc.
 - Initiating discussions for: end of life, withdrawal of support, change in DNR status

TYPES OF TRANSPLANTATION

- Brain Dead-cessation of neurological function, heart continues to beat, on ventilator
- Donation after Cardiac Death Criteria: on ventilator, not brain dead, family/MD decide to discontinue ventilatory support
- Both these groups can donate organs and tissue
- Patients who reach cardiac death are potential tissue donors only



HOW DOES IT ALL WORK?

- The Department of Health and Human Services contracts with the United Network for Organ Sharing (UNOS) – they are responsible for working with 58 federally designation Organ Procurement Organizations, in matching donor organs with recipients
- Hospitals call the OPO to notify them if a patient dies or is likely to die
- As part of it's Conditions to Participate, Medicare mandates this notification to happen

ORGAN PROCUREMENT ORGANIZATIONS

- The Organ Procurement Organization (OPO) is responsible for
 - Deciding appropriateness of potential organ donor
 - Approaching the family regarding donation
 - Obtaining written consent from the family for organ donation
 - Clinical management of patient (donor), once written consent has been obtained for organ donation

CASE STUDY

- Permission obtained by hospital administrator for organ donation
- Even though patient had End Stage Renal Disease he was still a viable donor candidate



CONTRAINDICATIONS TO BEING AN ORGAN DONOR

- Over 80 years of age
- Active metastatic cancer
- HIV infection
- Sickle cell anemia
- Prolonged hypotension or hypothermia
- Disseminated Intravascular Coagulopathy

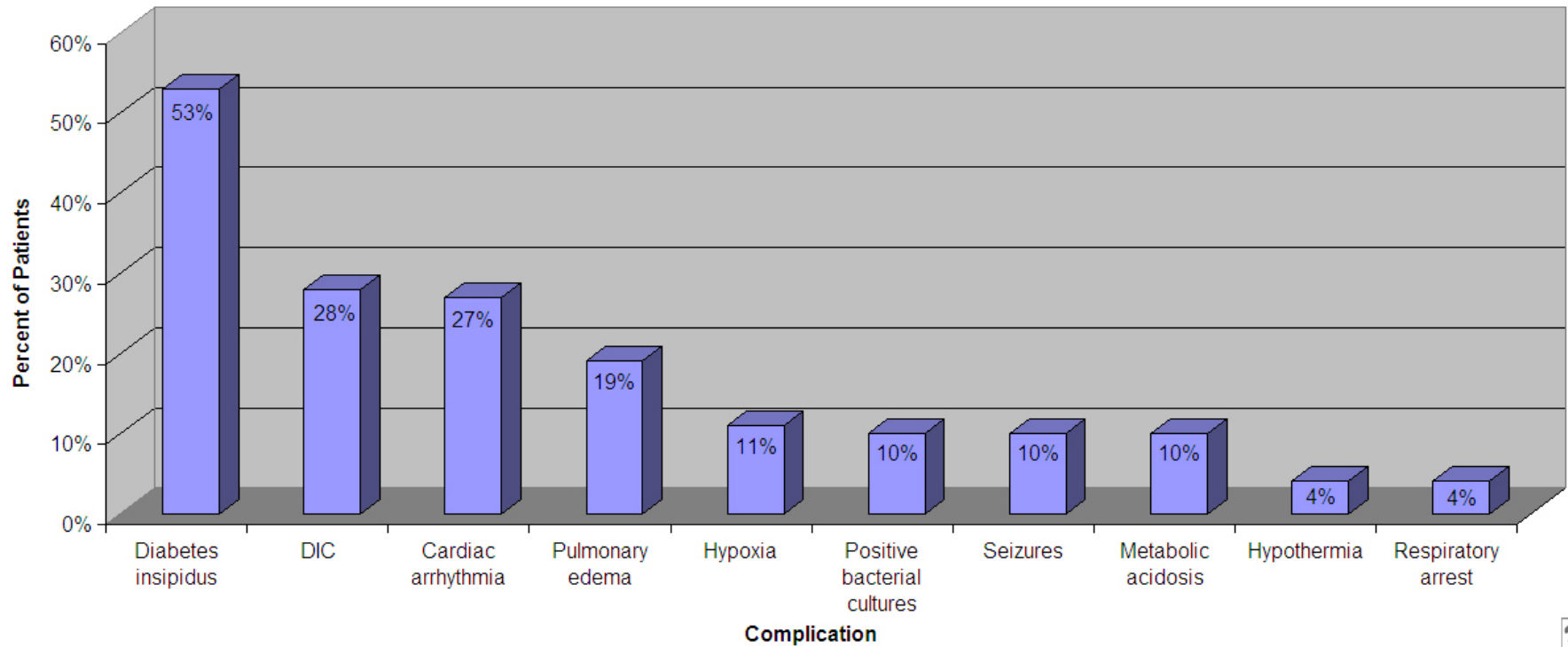
RELIGIOUS CONSIDERATIONS

- Most religions support organ donation
- Involve spiritual leader of religious group in the process
- Judaism – concerns revolve around concept of death, burial delay and concerns over mutilating the body
- Shinto (Japan) faith believes once the body is dead it is impure, therefore the recipient of such a organ would have bad luck
- Jehovah Witnesses – prohibits transplantation. Blood from one person cannot enter body of another person. However, bloodless transplantation is permitted.

MANAGING AN ORGAN DONOR

- A shift occurs from saving a life to preserving organs in order to save many lives
- Is clinically managed by the OPO along with the hospital clinical staff (MDs, NPs, RNs, RT, Pharmacy)
- Protocol driven
- Managing a brain dead patient is a lot of work!
- Hemodynamic instability is the hallmark of brain death
- Management revolves around providing as much hemodynamic stability as possible to improve organ viability for transplantation

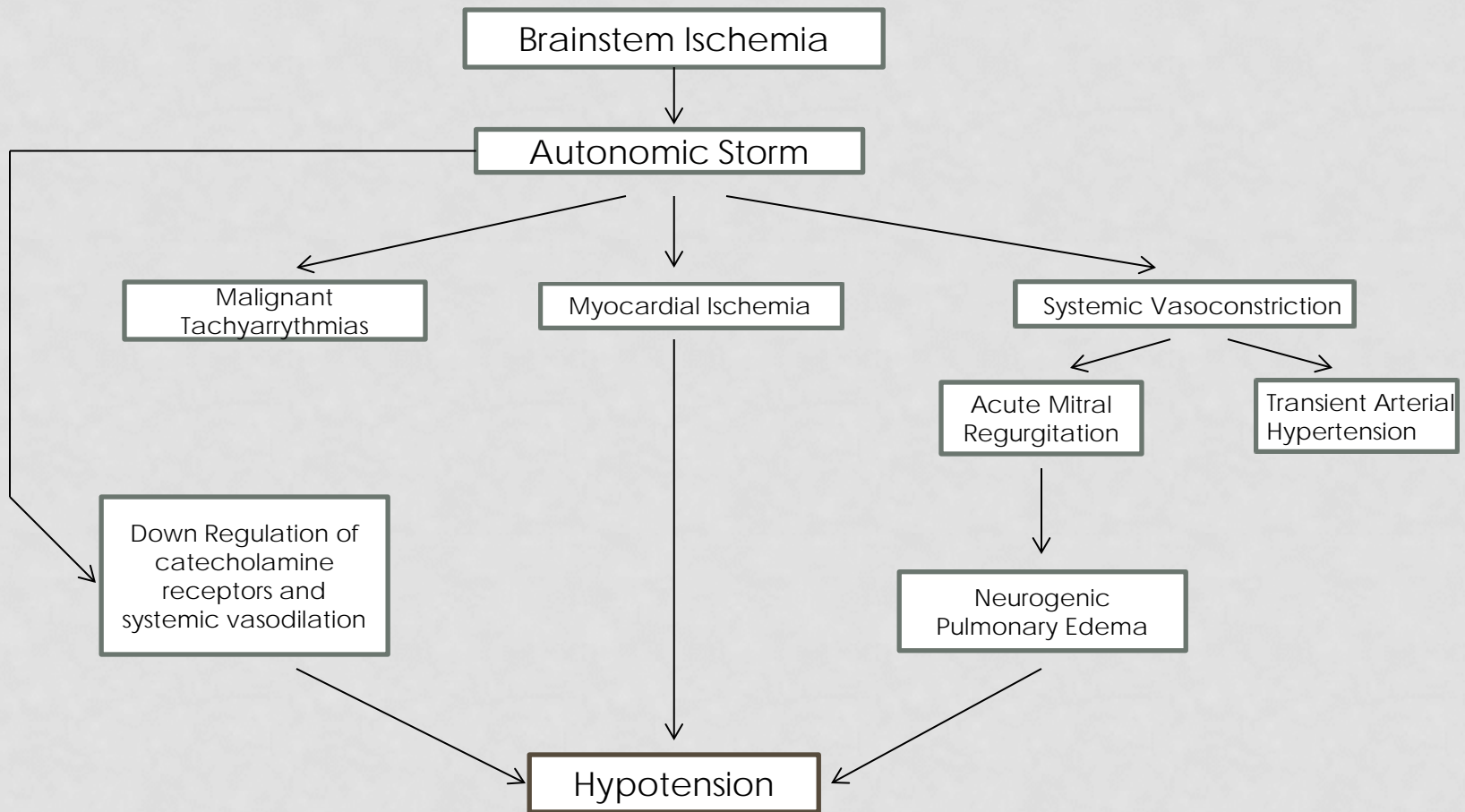
COMPLICATIONS SEEN IN ORGAN DONORS



BRAIN DEATH PATHOPHYSIOLOGY

- Autonomic Storm
- Hypothalamic Failure
- Problematic Pituitary
- Thyroid Dysfunction
- Cardiovascular Irritability
- Neurogenic Pulmonary Edema
- Hematologic Dysfunction

BRAIN ISCHEMIA



HYPOTHALAMIC FAILURE

- Difficulty regulating consistent temperature
 - Hypothermia
 - Hyperthermia
- Vasodilatation
 - Cannot vasoconstrict, therefore cannot shiver
- DONOR MANAGEMENT:
 - Use core temperature
 - Attempt to regulate temperature with warming or cooling blanket

PROBLEMATIC PITUITARY

- Brain death leads to reduction of pituitary hormones (ACTH, TSH, LH, GH, vasopressin, oxytocin)
- Antidiuretic hormone stops being produced – Diabetes Insipidus
 - Hypovolemia
 - Electrolyte imbalances
- Donor Management:
 - DDVAP
 - Bolus/Maintenance IVFs
 - Monitor electrolytes closely

THYROID DYSFUNCTION

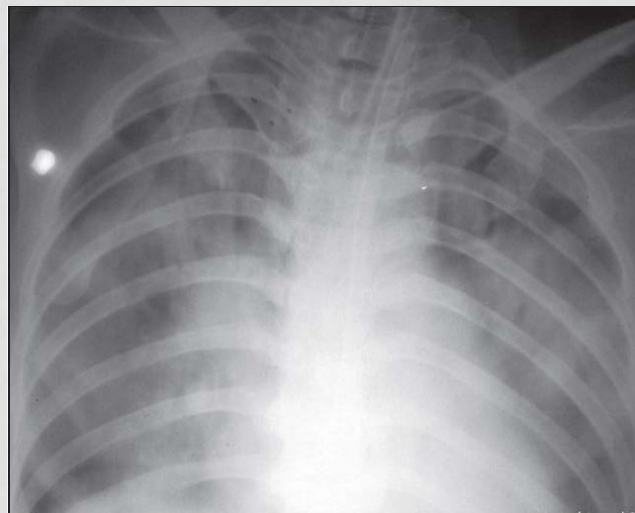
- Lack of T3 & T4 production
- Cardiac instability
- Variable blood pressure
- Donor Management:
 - "T4 protocol", use of steroid, T4, insulin & D50
 - Monitor potassium levels
- Reduces need for vasopressors
- Improves organ viability

CARDIOVASCULAR IRRITABILITY

- Try to maintain cardiac stability of donor
- "Rules of 100"
 - SBP >100
 - HR <100
 - UO >100 cc/hr
 - PaO₂ >100
- Need to maintain euvolemia
 - CVP = 10-12 mm Hg
 - Bolus if needed (colloid helps prevent pulmonary edema)
 - May need dopamine, neosyn, vasopressin,

NEUROGENIC PULMONARY EDEMA

- Catecholamine release makes lungs susceptible to injury by increasing capillary permeability to inflammatory mediators
- Can lead to less procurement of lungs for transplantation



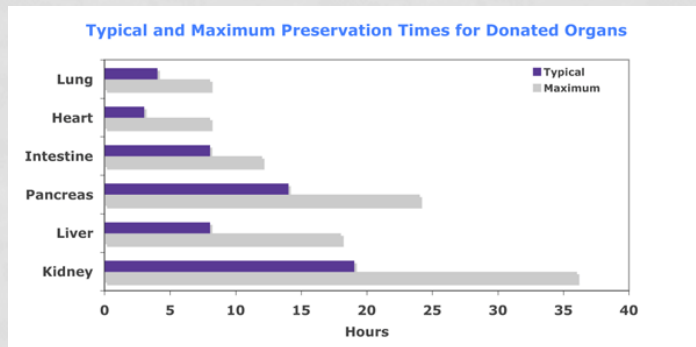
HEMATOLOGIC DYSFUNCTION

- Development of coagulopathy, possibly even DIC
- Correct coagulopathy with factors/blood products



TRANSPLANTATION LIST

- Donor taken to OR
- Procurement teams procure organs- based on organ viability
- Taken to recipient hospital
- Transplantation occurs



CASE STUDY

- On March 11, 2014, John Doe became an organ donor
- His liver was allocated
- His heart, lungs, and kidneys were declined
- He is an unsung hero!

" A hero is someone who has
given his or her life to
something bigger than
oneself."

Joseph Campbell

ORGAN ALLOCATION

- Organs are allocated (given) according to strict rules that take into account physical matching, tissue and blood type matching, medical criteria, waiting time, severity of illness, etc.
- The allocation system is blind to name, race, sex, and wealth
- The allocation rules have been developed over many years of deliberation by physicians and other transplant professionals, transplant candidates and recipients, donor families, and representatives of the federal government
- To review the policies refer to the Policy Management section on the UNOS website at <http://www.unos.org>.

TRANSPLANT RECIPIENTS



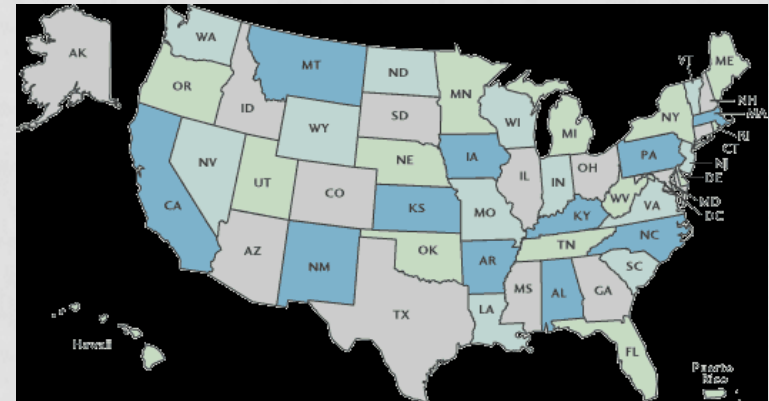
DATA ON MARCH 10, 2014

- Waiting list candidates 121,523 as of today 8:51pm
- Transplants January - December 2013 28,951 as of 03/07/2014



IN THE USA AS OF MARCH 10, 2014

- All Organs 132,496
- Kidney 106,977
- Liver 16,424
- Pancreas 1,194
- Kidney / Pancreas 2,092
- Heart 3,828
- Lung 1,668
- Heart / Lung 49
- Intestine 264



IN CALIFORNIA AS OF MARCH 10, 2014

- All Organs 22,699
- Kidney 18,710
- Liver 3,094
- Pancreas 83
- Kidney / Pancreas 279
- Heart 303
- Lung 184
- Heart / Lung 11
- Intestine 35



DONOR FAMILY AND RECIPIENT CONTACT

- Letters from either can forward through the OPO
- Anonymity is maintained unless both parties agree to meet



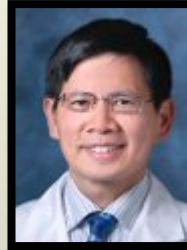
HELPFUL WEBSITES

- U.S. Government Information on Organ and Tissue Donation and Transplantation
<http://www.organdonor.gov/index.html>
- American Academy of Neurology
<https://www.aan.com/Guidelines>
- Donate Life
<http://donatelife.net/register-now/>

Our Neuro-Critical Care Team



Asma Moheet, MD
Neuro Intensivist



Wengui Yu, MD
Director, Neuro Intensivist



Ana Beesen, MD
Fellow



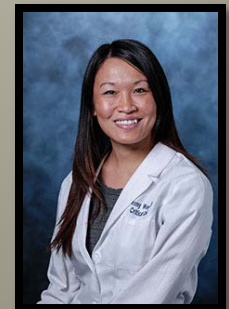
Michael Su, MD
Fellow



Kimberly Alva, MSN, ACNP
Nurse Practitioner



Travis Bradley, MSN, ACNP
Nurse Practitioner



Peony Wong, MSN, ACNP
Nurse Practitioner

