

# Brain Death

Understanding the Process,  
Optimizing the Gifts



# Introduction

- Conflicts of Interest
  - None
- Goal:
  - Extend the gifts that each organ donor has to give
    - Increase the number of organs per donor
    - But also:
      - Closure for families
      - Friendships between donor families and recipients
      - Grief processing



# Introduction

- Outline
  - Background
  - The Need and Answer to the Need
    - The Gap
    - Closing the Gap
  - Identifying the patient and the potential
  - Physiology of the brain death process
  - Brain death declaration
  - Organ donor management and successes



# Background

- Trauma Surgeon 2000 - current
  - Anywhere from 3-7 call nights per month
    - 10 – 20 admits
    - 50 curse words / night; 1-2 punches at team by pt
    - Little “thanks”
- Surgical Intensivist 2004-current
  - Director of 20 bed ICU
  - Work on “one” to get “one” better
  - Receive “thanks”





# Background

- AOC (Legacy of Hope)
  - Approached in February 2015
  - Describe their plans for Organ Recovery Center
    - 2 ICU Beds
    - 2 OR suites
    - Bring donors from around the state
  - Goals:
    - Increase organs per donor
    - Improve SRTR
    - Develop protocols to optimize donor management



# Background

- Before LoH Recovery center
  - Drove to hospitals with coordinators
    - Broad range of capabilities at various sites
    - Various “buy-in” from physicians and teams
    - Impressed with the coordinators and abilities to adapt
  - Learned management on site
  - Some literature out there on management



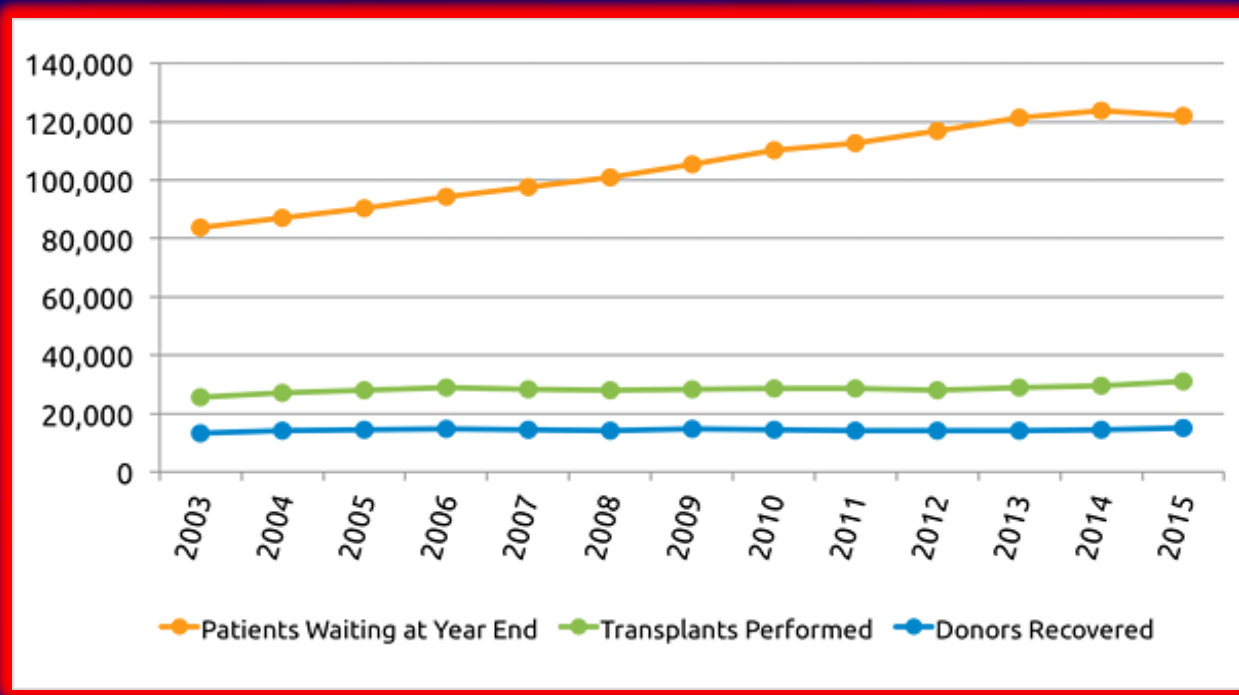
# Background

- LoH
  - Intensivist / Help Direct Organ Recovery Center
    - 2 ICU beds
    - 2 OR's
    - Select ICU RN
    - Coordinators
  - Families!
  - 1 life → 6-7 lives



# The Need

- Challenges Faced:
  - 2.2 million people die each year in US
    - < 1% die in manner to allow organ donation



# The Need and Answer to the Need

- Steps to Close the Gap
  - Brain Dead Organ Donation
    - Increase the registered donors
    - Increase the referrals
    - Increase family consent to donation
    - Preserving the chance for organ donation
    - Optimize the donor management
  - Donation after cardiac death
  - Living Related Organ Donation—Locke
  - Xenotransplant—Tector, Eckhoff, Cooper
  - Organ 3-D building/ stem cell therapy



# Identifying the Patient and the Potential

- Increase the referral
  - Timely referral
    - 1998 CMS timely referral rule
      - Notify OPO within 1 hour of 3 findings:
        - No pupil response
        - No cough
        - No gag
        - No response to pain
        - No spontaneous breaths
      - Or change to withdrawal for the goals of care
    - UAB / AOC has created a Cerner notification system





# Identifying the Patient and the Potential

- Increase likelihood of referral
  - Dedicated FSC at level 1
    - Helpful to establish relationship with staff as well as families
    - Detect referrals sooner
    - They are good





# Identifying the Patient and the Potential

- Increase likelihood of family consent
  - Designated requestor
  - Separate “bad news” from “approach”
    - Team can’t care for the patient and then ask for organs—public concern for “they just wanted his/her organs”
    - Important in the grief process
  - FSC assigned to trauma center
  - Family witnessing and understanding the brain death exam
  - The Organ Alliance—key words



# Identifying the Patient and the Potential

- Increase likelihood of organ use
  - GOOD CARE
    - Brain death process is only one type of “injury” to organs
    - Sometimes harder to overcome a decrease in level of care
      - Turning, suctioning, “routine” care
      - “Non-survivable” so....
      - High UOP
      - Hypotension



# Identifying the Patient and the Potential

- Increase likelihood of organ use
  - Catastrophic Brain Injury Guidelines
    - Maintain SBP > 90
      - Consider invasive monitoring and access
      - Vasopressor support
    - Maintain UOP > 1cc/kg/hr and < 300cc/hr
      - Fluid if behind
      - Vasopressin if DI
    - Maintain PaO<sub>2</sub> > 100
    - Maintain pH 7.35 – 7.45



# Identifying the Patient and the Potential

- Increase likelihood of organ use
  - CBIGs
    - Crit Care Med 2012 :
      - Adopt DMG 3.6 organs /donor → >4 organs per donor
        - Would mean 78 more organs transplanted in state of Alabama with our last year referrals
    - JAMA Surg 2014:
      - DMG for ECD 2.1 organs/donor → 3 organs /donor



# Identifying the Patient and the Potential

- Increase likelihood of organ use
  - Intensivist management
    - Some programs have found better outcomes with intensivist management vs transplant surgeon
    - Global perspective rather than organ center interest
  - Dismiss concept—“not a candidate”
    - HIV—Locke and the HOPE Act
    - Hep C
    - Age
    - Markers of “poor organ function”



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - What happens as patient progresses to brain death
  - Defined in 90's, South Africa, animal models
    - EKG, PA cath, Histology, hemodynamics, chemistries, etc
  - Brain death processes
    - Inflammatory changes
    - Circulatory changes (autonomic storm)
    - Metabolic changes
    - Hormonal changes





# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Inflammatory
    - Cytokines, Interleukins, inflammatory pathways
    - TNF, IL-6, IL-8, IL-10, IFN- $\gamma$ 
      - Vasodilation
      - Third spacing
      - Coagulopathy
      - Decrease organ function (donor & recipient)
    - Blood brain barrier disruption (GSW head)
      - Release tissue factor
      - Bleed



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Circulatory Changes
    - EKG
      - Stage 1: parasympathetic stimulation—slight bradycardia
      - Stage 2: Adrenergic stimulation—sinus tachycardia
      - Stage 3: Multifocal ventricular beats
      - Stage 4: Back to sinus, but often see “ischemic changes”
      - Stage 5: Sinus, ST changes resolve, J and T waves



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Circulatory Changes
    - Early changes:  $\uparrow$  SVR and MAP
    - Pre-herniation: fluid shifts to capacitance vessels and lungs
    - Herniation:
      - $\uparrow\uparrow$  SVR
      - $\downarrow$  C.O.
      - MV regurg  $\rightarrow$   $\uparrow$  LA pressure  $\rightarrow$   $\uparrow\uparrow$  pulm edema
    - Post-herniation: circulatory collapse following catechol surg



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Histology/Organ changes
    - Heart fibers damage as result of catechol surge and calcium shifts
      - Contraction band necrosis
      - Mononuclear infiltrate
    - Lungs develop significant edema
    - Kidneys develop ATN
      - Hypoperfusion
      - Energetics



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Metabolic changes
    - Hypothermia
    - Acidosis
      - Renal dysfunction
      - Hyperchloridemia
    - Hypocalcemia
    - Hypophosphatemia



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Hormonal changes—whole separate lecture but focus on what you see
    - No perfusion of brain results in no hormones output from hypothalamus/pituitary
    - So all hormones will disappear over time, depending of half life



# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Hormonal changes
    - Vasopressin
      - Acts on 3 different receptors in the body
        - Vasomotor tone, platelets, uterine
        - Anterior pituitary
        - Renal receptor
      - Half life 10 – 35 min
      - Why UOP often picks up at brain death
      - Start infusion early, helps stability and prevent DI
      - I recommend use during apnea test





# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Hormonal changes
    - Thyroid
      - Disappearance complex—different forms and interactions
      - Usually start drip in order to stabilize hemodynamics
      - Thyroid replacement usually increases ability to transplant heart and lungs





# Physiology of Brain Death Process

- Physiology and Pathophysiology
  - Hormonal
    - Stress Hormones: Glucocorticoid/Mineralocorticoid
      - Half life of ACTH 10 min, so within hour of brain death, level low to none
      - Steroids replacement in donor management: helps with adrenal insufficiency and inflammatory changes of brain death
      - In general 1gm load then 1mg/kg BID
      - Addition of steroids probably associated with organ improvement



# Brain Death Declaration

- Various Injuries
  - Overdose
  - Trauma
  - Hypoxia
  - Cardiac arrest
- Common Result: complete and irreversible cessation of brain function
  - Cerebrum only—coma
  - Brainstem only—locked in syndrome



# Brain Death Declaration

- Brain death declaration
  - AL: 2 physicians required
  - Cause of brain death must be known
    - If unknown further testing should be undertaken
    - If unknown, prudent to allow 6-12 hours between exams
  - No confounding meds
    - Testing for levels of meds in system
    - 3.5 – 5 half lives for medication clearance
  - Temp— > 36.5
  - SBP adequate— >100mmHg



# Brain Death Declaration

- Brain death declaration
  - Family present helps—having family present has been shown to increase the consent rate
    - Improves understanding and acceptance
    - Allows them ability to visualize absence of function
    - Talk them thru the testing
      - Educate about spinal reflexes
      - Explain the steps of the exam



# Brain Death Declaration

- Brain death declaration
  - Corneal: no blink in response to stimuli
  - Pupil: no constriction with light
  - Doll's Eye: brain death, eyes move with nose. Non-brain dead, the eyes move opposite of direction of head turn/stay fixed on ceiling
  - Gag: No gag with pharyngeal stimulation
  - Cough: No cough with deep suctioning



# Brain Death Declaration

- Brain death declaration
  - Occulovestibular—there is no fast-twitch eye movement with temp stimulation of vestibule
    - 50cc in each ear
    - Head of bed 30 degrees
    - COWS
    - Watch for response up to 1 minute per ear





# Brain Death Declaration

- Brain death declaration
  - Apnea:
    - Disconnect from vent; tubing with O2 flow distal in trachea
    - Serial ABG to eval for increase in CO2 by 20
    - Absence of any attempt for breath
  - Keys:
    - Hemodynamic support in place/avail
    - If hypovolemia, 500-1000cc prior to exam
    - Preoxygenate 5-10 min
    - Tube size





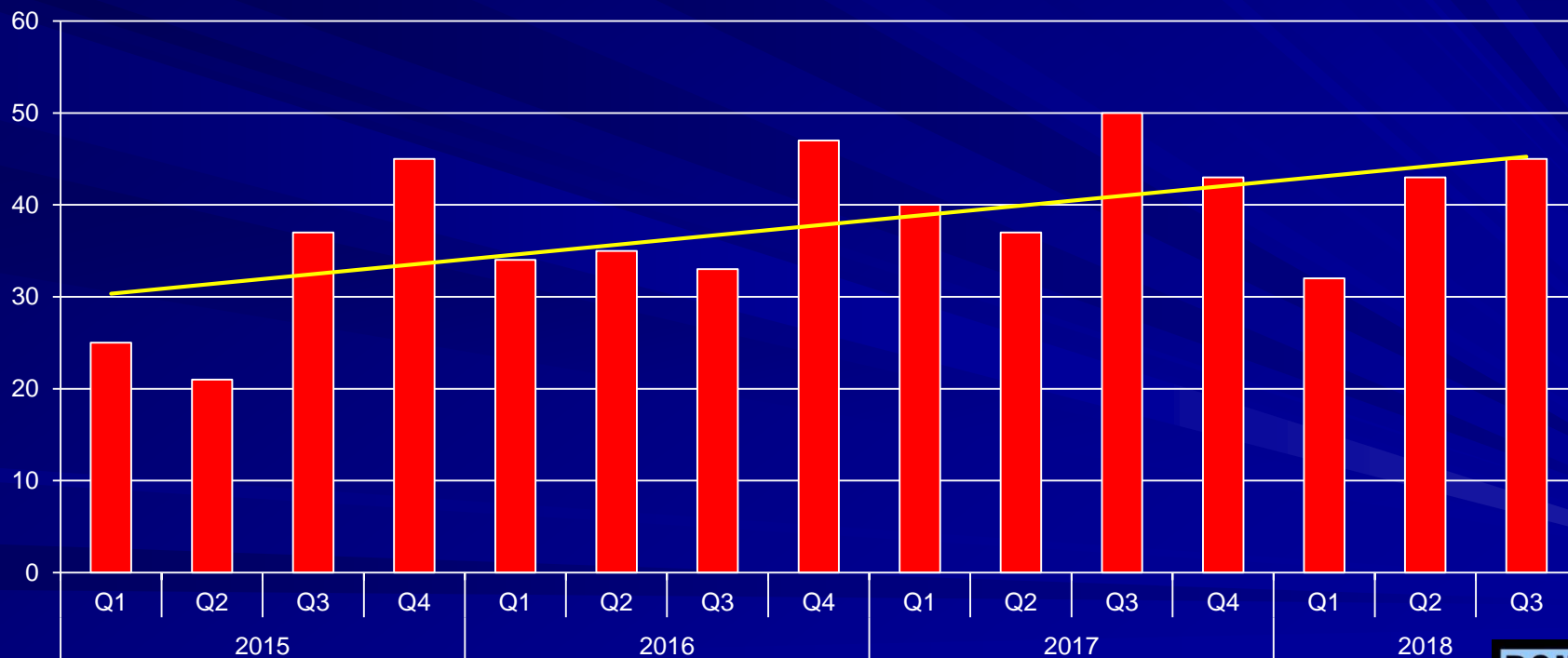
# Donor Management and Successes

- Exciting time at Legacy of Hope
  - Referrals on increase
  - Conversion has been increasing
  - Opportunities to standardize brain death declaration
  - Opportunities to talk around the state



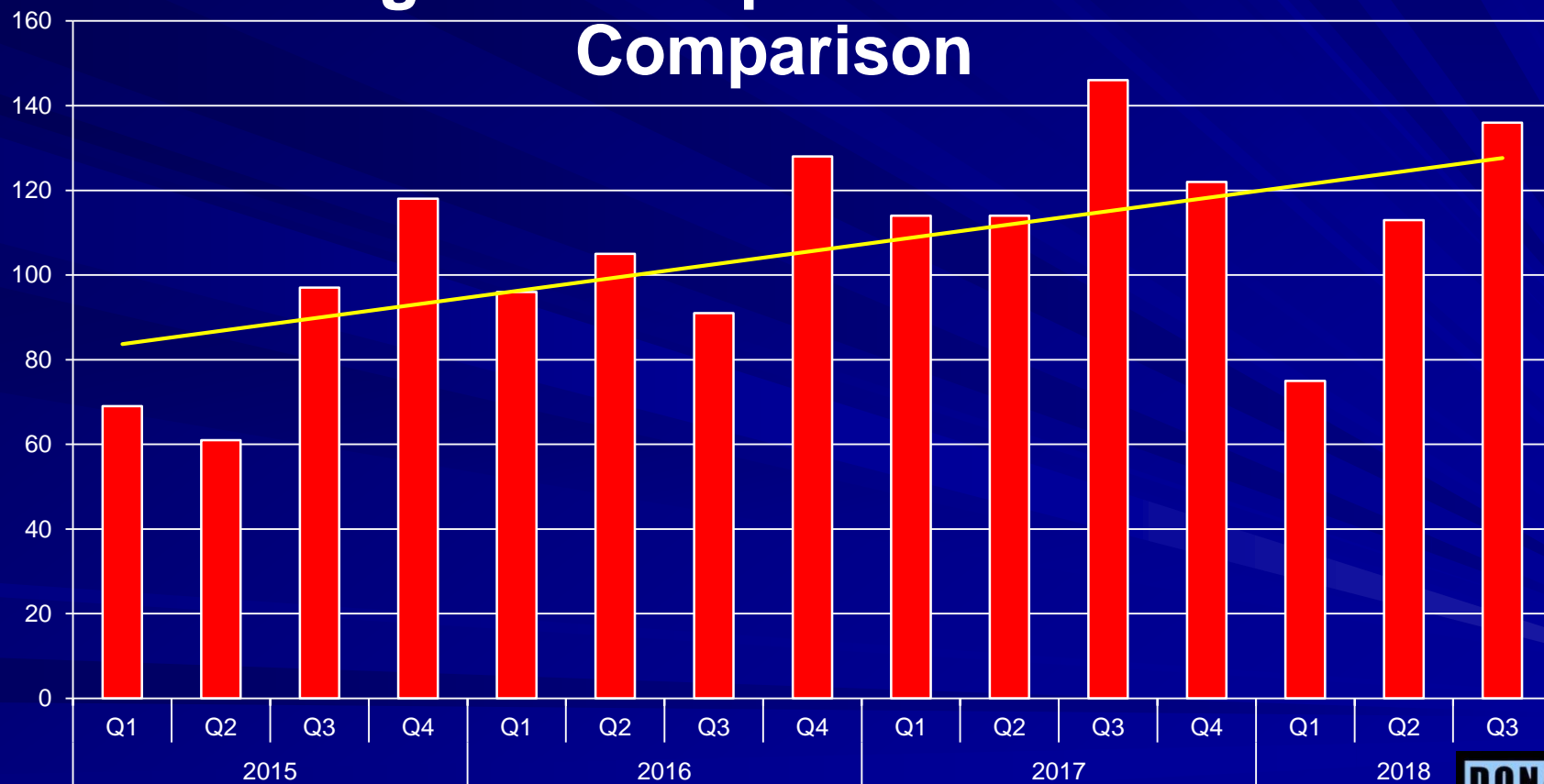
# Donor Management and Success

## Organ Donors – 4 Year Comparison

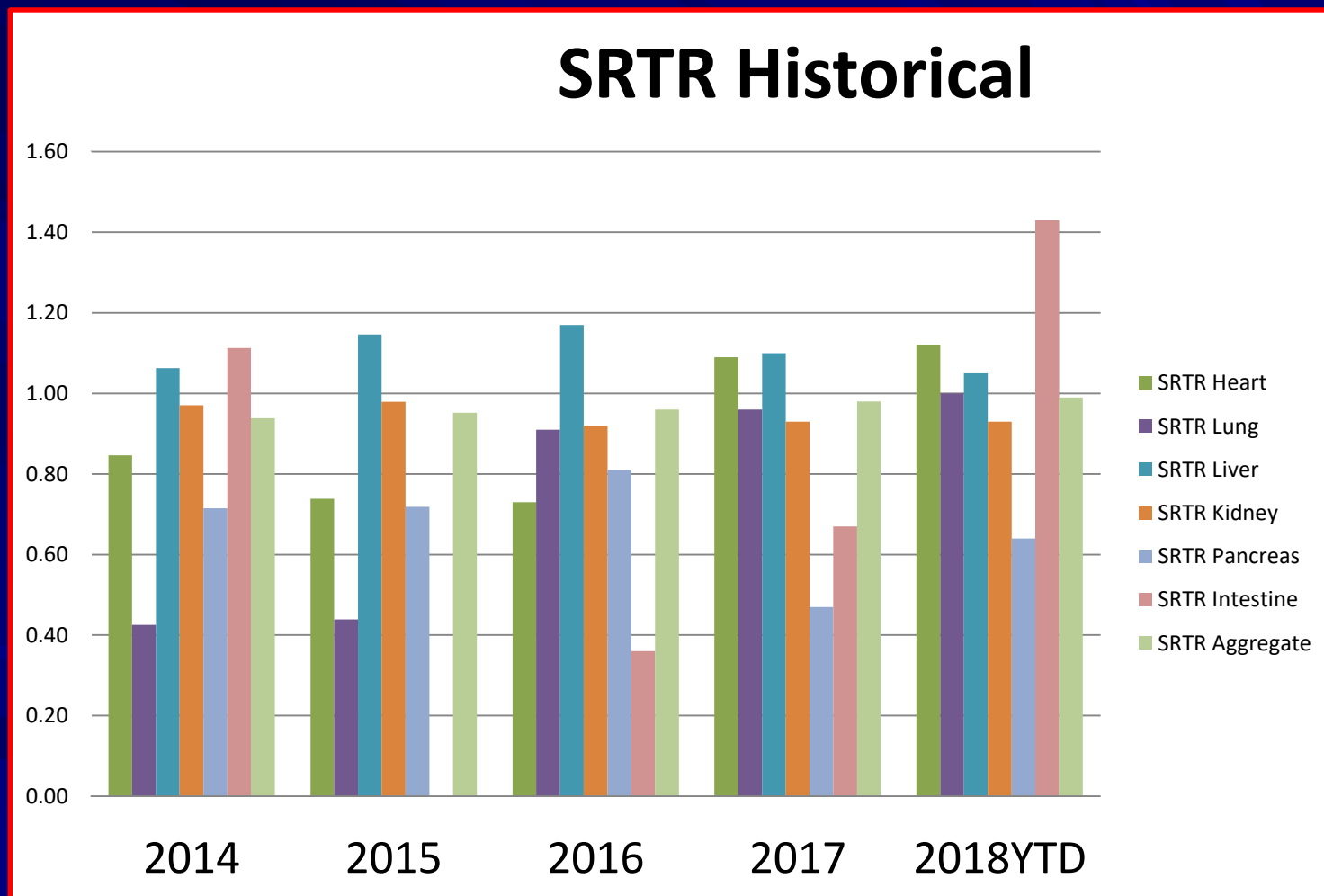


# Donor Management and Success

## Organs Transplanted - 4-Year Comparison



# Donor Management and Success



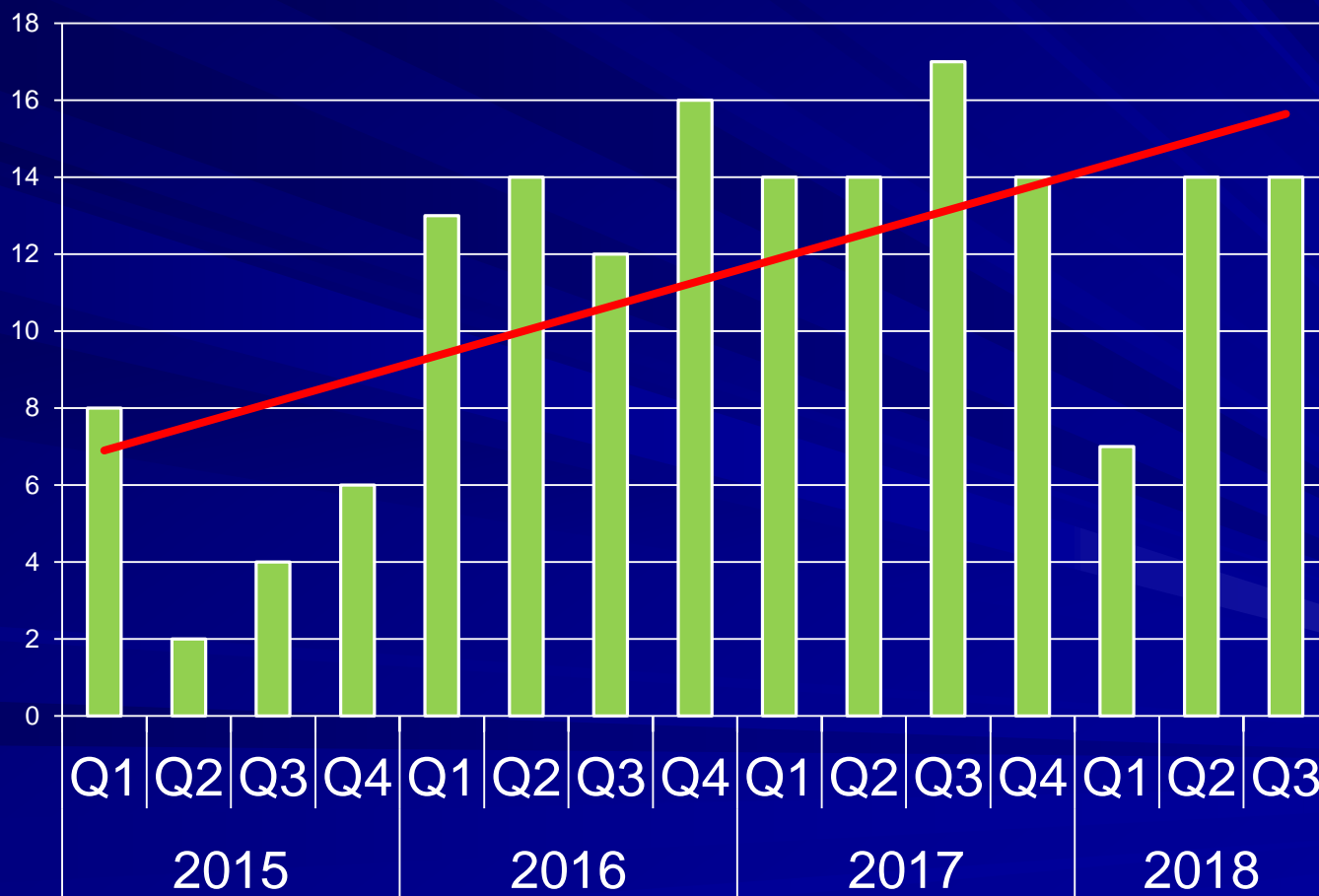
# Donor Management—Subsystem

- Pulmonary
  - Started in 2015, SRTR 0.3 for lungs
    - Only used 30% of lungs predicted to be able to use
  - 2016 – 2017: lungs increased for 19 used to 56 used
  - SRTR for this year  $> 1$  for lungs



# Donor Management—Subsystem

- Pulmonary





# Donor Management—Subsystems

- Pulmonary
  - Challenges faced:
    - Edema—neurogenic and cardiogenic
    - Plugging
    - Aspiration
    - Trauma
  - Means to Overcome challenges:
    - Slow the flow:
      - Law of LaPlace
    - Early and frequent bronchoscopies



# Donor Management—Subsystems

- Pulmonary
  - Means to overcome challenges
    - Prone positioning
    - Optimal PEEP to maintain alveoli open
    - Anti-Inflammation regimen
    - Accurate In/Out balance for timing of diuresis



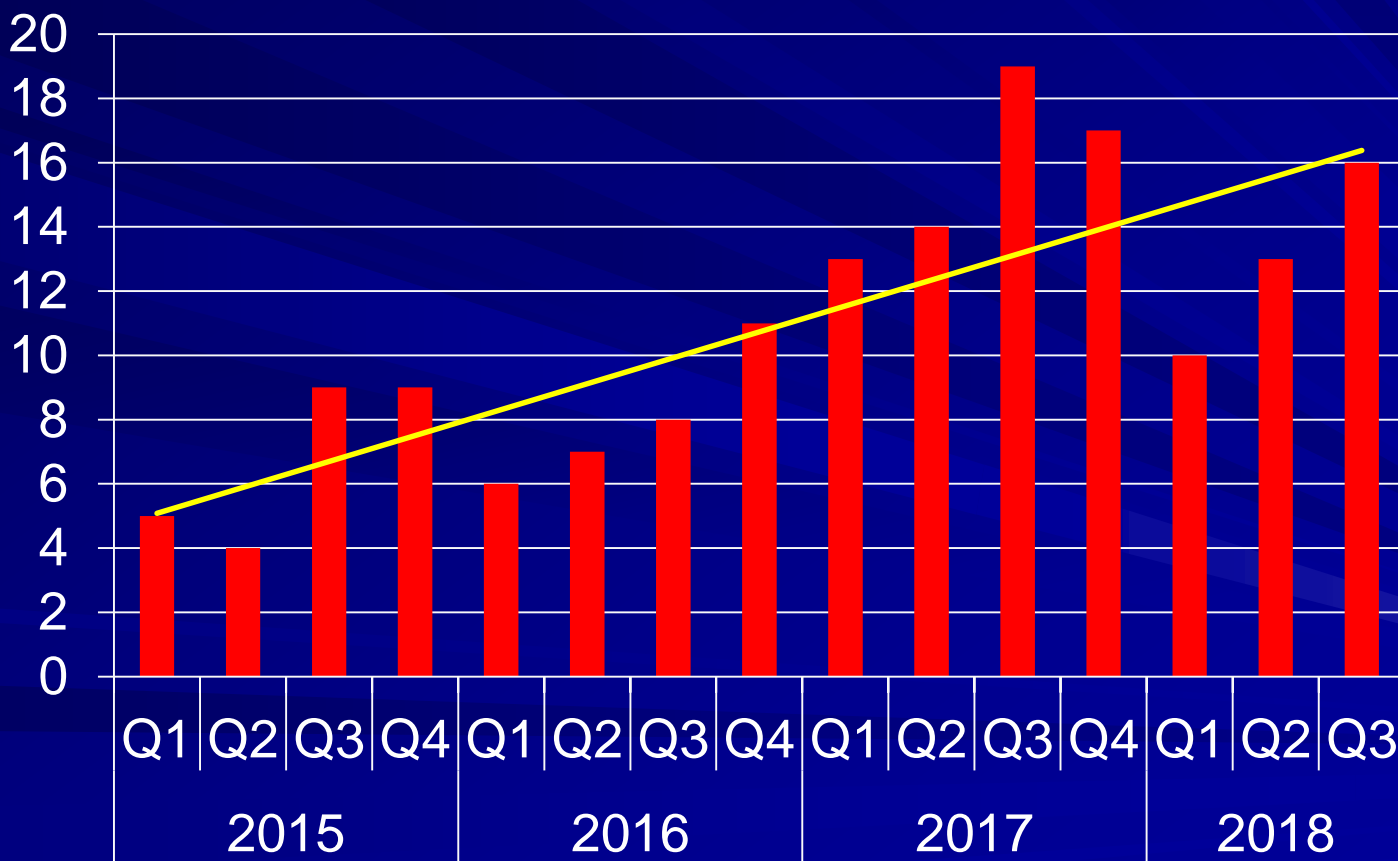
# Donor Management—Subsystems

- Cardiac
  - SRTR 0.72 in 2015
  - In 2017 pursued our cardiac recruitment
  - 2017- 2018, more than doubled number of hearts
  - For 2019, cardiac SRTR approx 1.2



# Donor Management—Subsystems

- Cardiac



# Donor Management—Subsystems

- Cardiac
  - Challenges Faced:
    - CADz
    - LVH
    - Dysfunction: EF 20-35%
      - Males 18-30 and females > 50
      - Neurogenic Myocardial stunning
        - Reverse Takotsubo pattern
        - Catechol driven process



# Donor Management—Subsystems

- Cardiac
  - In 2017, initiated an estrogen regimen along with our other hormone replacement
    - Steroids
    - Insulin / Glucose
    - Thyroid replacement
    - Estrogen
    - Optimize volume status





# Donor Management—Subsystems

- Liver
  - Very good utilization rate
    - Aggressive centers in this region
  - Challenges to organ utilization
    - Hep C
    - Fatty liver / cirrhosis
    - Hypernatremia
    - Reperfusion injury



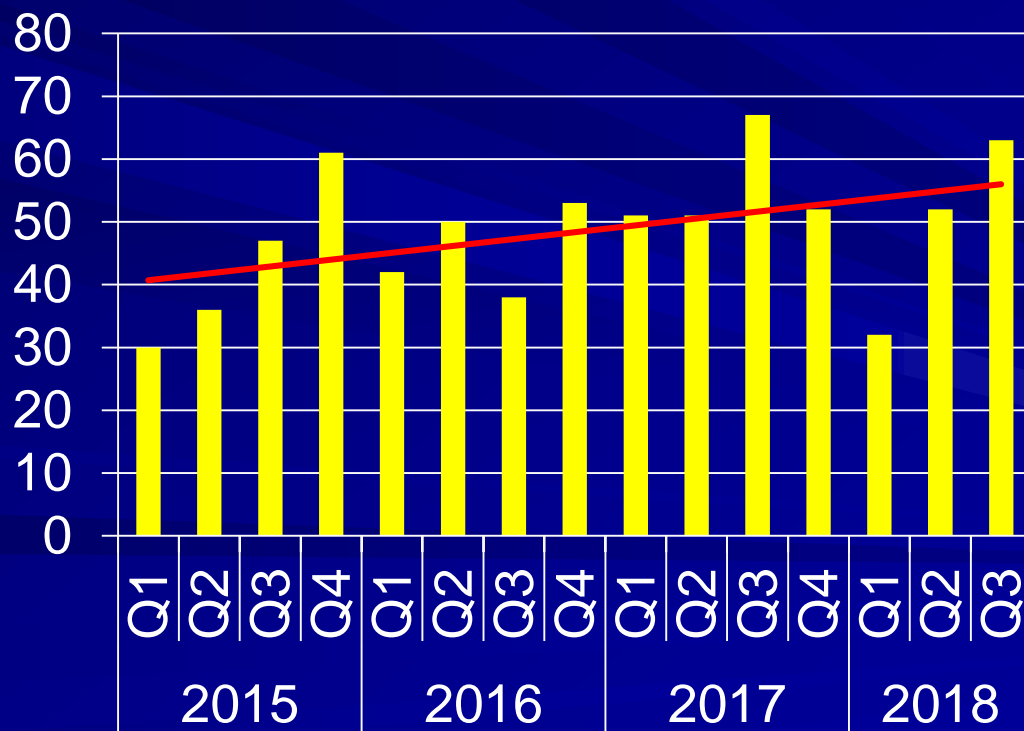
# Donor Management—Subsystems

- Liver
  - Means to overcome challenges
    - Hep C treatment
    - Hypernatremia
      - Hypotonic fluid
      - Vasopressin to prevent DI
    - Reperfusion injury
      - Dextrose containing fluid
        - Most donors NPO last few days
        - Glycogen depleted
        - Cells have no glucose reserve → develop acidosis



# Donor Management—Subsystem

- Renal
  - Despite increasing number of kidneys placed last few years, trend lower than other organs



# Donor Management—Subsystem

- Renal
  - Challenges to organ utilization
    - ATN
      - Hypotension experienced by donors
      - Code time
      - Contrast from imaging
      - Hypovolemia due to DI
      - Microthrombosis in setting of GSW head



# Donor Management—Subsystems

- Renal
  - Means to overcome challenges
    - Can't reverse ATN, but need to prevent further insults
    - Hypothermia protocol
      - Niemann, NEJM, 2015
        - Study ended early due to benefit in hypothermia group
        - Decrease delayed graft function 39% → 28%
    - Dopamine
      - Am J of Transplantation 2004, improved 1 year graft function
      - Am J of Transplantation 2017



# Donor Management—Subsystems

- Renal
  - Means to overcome the challenges
    - Microthrombosis
      - Pulled data of early 2018—cases we missed kidneys, many had microthrombosis present (even 13 yo )
      - Most had breach blood brain barrier
      - Most with parameters of DIC
      - Began Heparin protocol—flat rate (500u/hr)
        - Breached blood brain barrier
        - Sudden drops in platelet
        - Elevated DIC labs





# Extending the Gift of the Donor

- The need is great—You can help
  - Increase referral
  - Improve usable organs
    - Good care helps
    - CBIG's
  - Improve family consent
    - Present for brain death exam
    - Don't pre-approach
  - Improve organ function
    - Understanding physiology, better support the donor



# Extending the Gift of the Donor

- Questions

