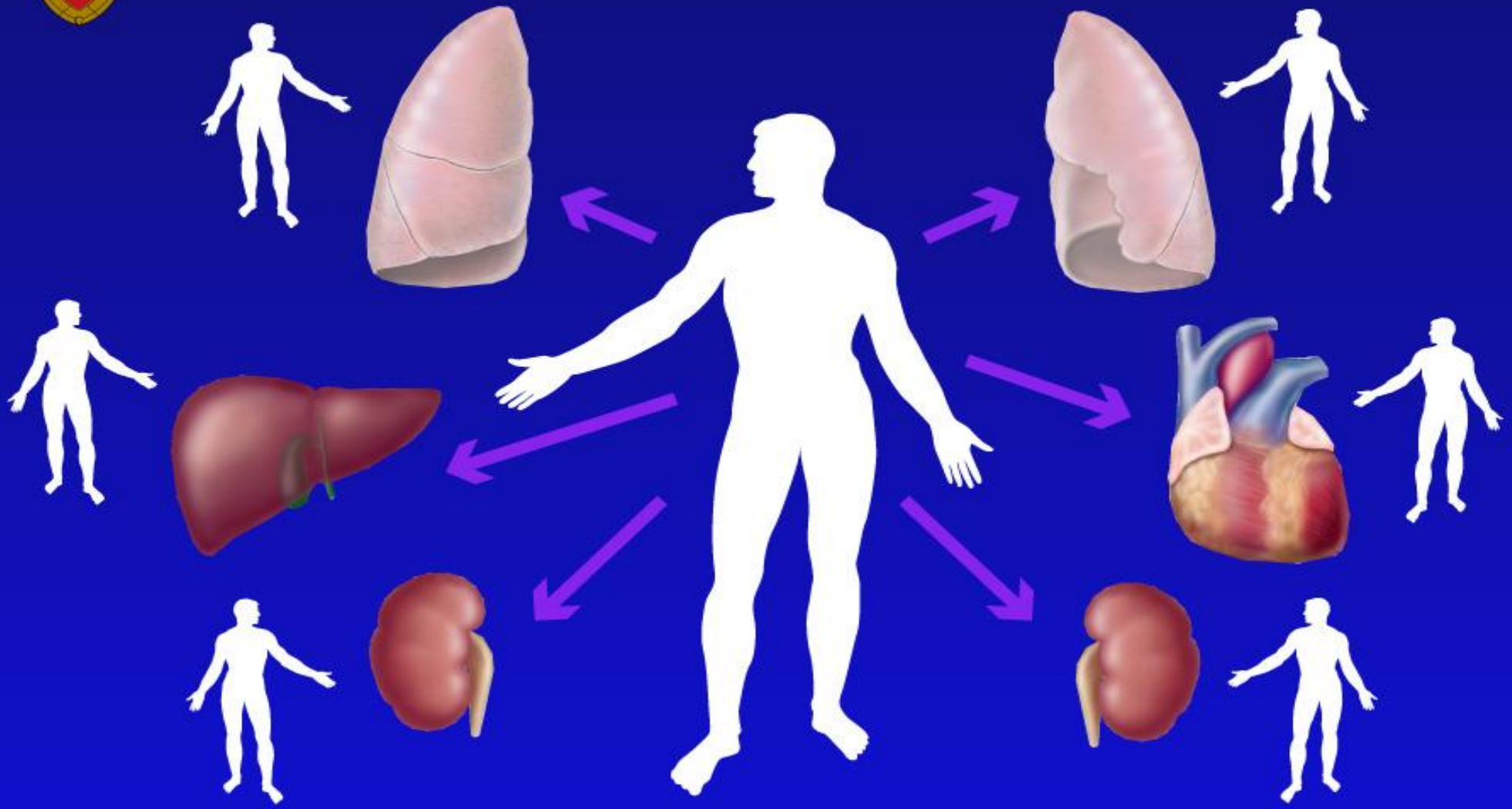
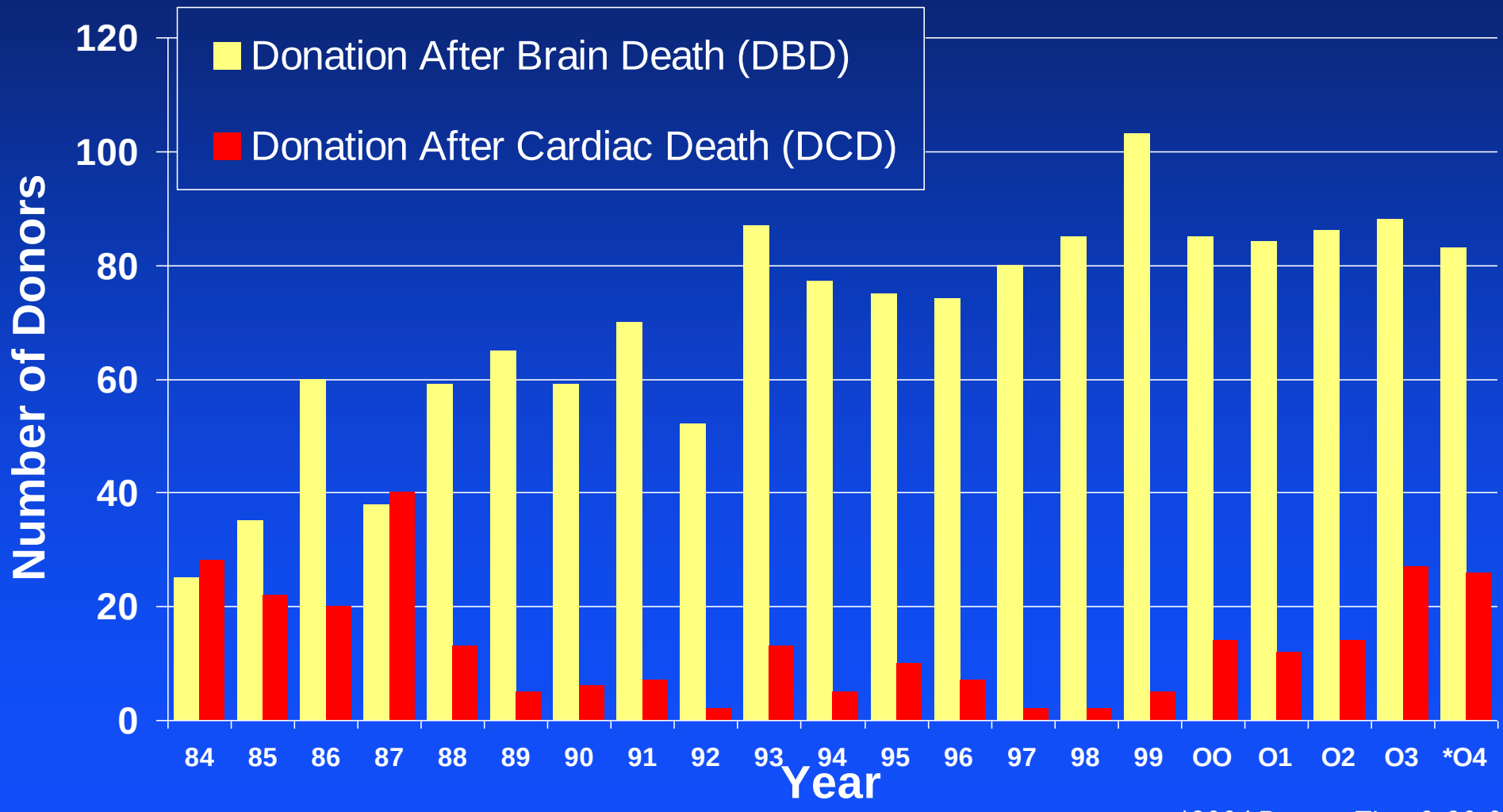
Management of the Potential Organ Donor

Kenneth E. Wood, D.O.
Associate Professor of Medicine and Anesthesiology
Director of Critical Care Medicine and Respiratory Care
Trauma and Life Support Center
University of Wisconsin

Potential Organ Donor Management



University of Wisconsin OPO: Donation After Brain and Cardiac Death



*2004 Donors Thru 9-30-04

University of Wisconsin Hospital Organ Donation Trauma and Life Support Center

- Multi-disciplinary Med-Surg ICU
- 2000 admissions per year SMR 0.64

	2001	2002	2003	2004	Total
OPO Referrals	32	39	46	79	196
Potential Donors	20	16	12	17	65
Consent Rate	100% (18/18)	86% (12/14)	70% (7/10)	94% (16/17)	90% (53/59)
Actual Donors	18	12	7	16	53
Conversion Rate	90% (18/20)	75% (12/16)	58% (7/12)	94% (16/17)	82% (53/65)

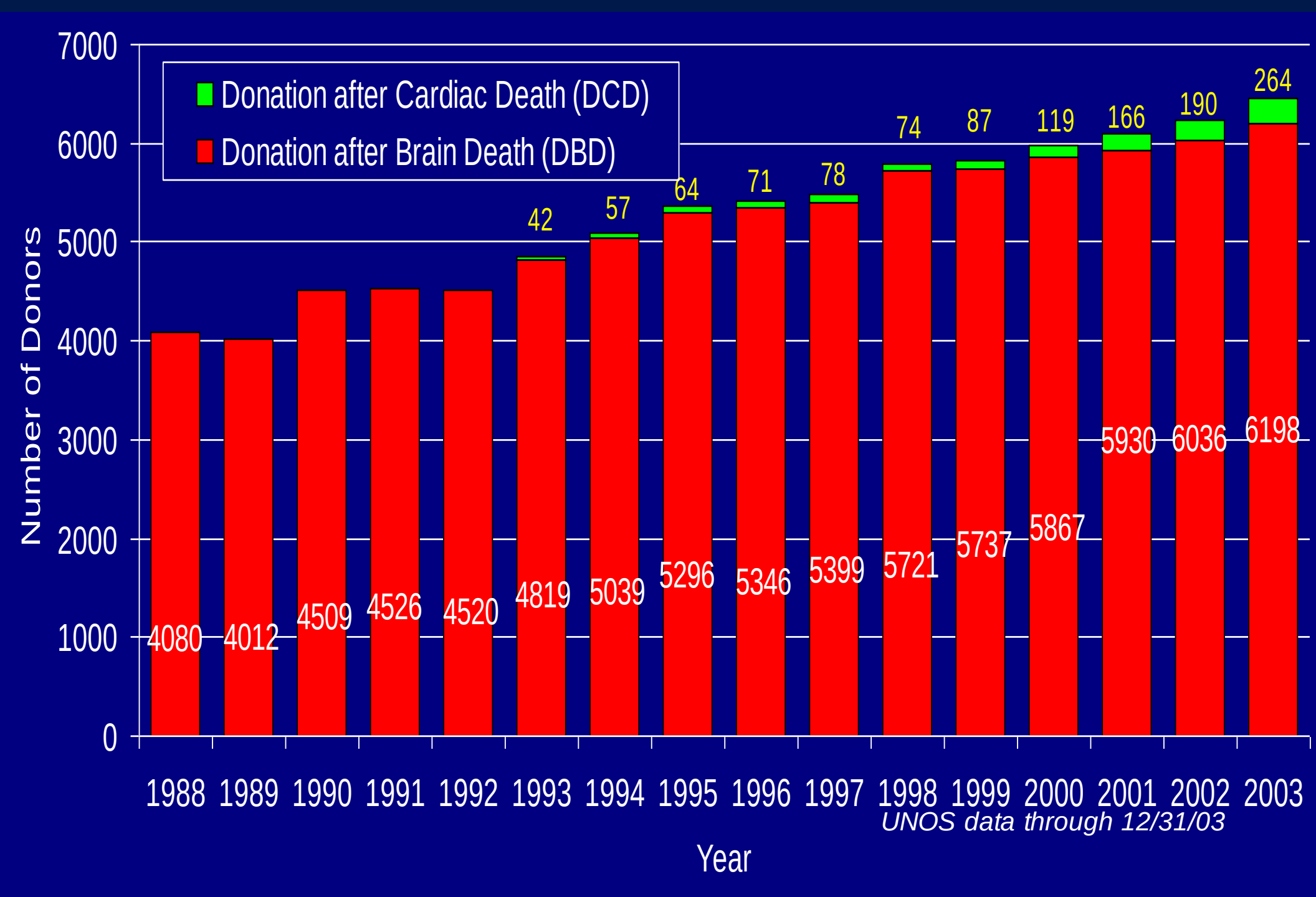
Potential Organ Donor Management Supply - Demand Relationship

- 80,319 patients awaiting transplant
- Waiting list grows by 16% per year

Waiting List

	Average Wait	% Death on List
Heart	350 days	14%
Lung	788 days	12%
Liver	817 days	10%
Kidney	1131 days	5%

HRSA


Donation after Cardiac Death (DCD)
Donation after Brain Death (DBD)
Number of Donors
Year
7000
6000
5000
4000
3000
2000
1000
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
4080 4012 4509 4526 4520 4819 5039 5296 5346 5399 5721 5737 5867 5930 6036 6198
42 57 64 71 78 74 87 119 166 190 264
UNOS data through 12/31/03

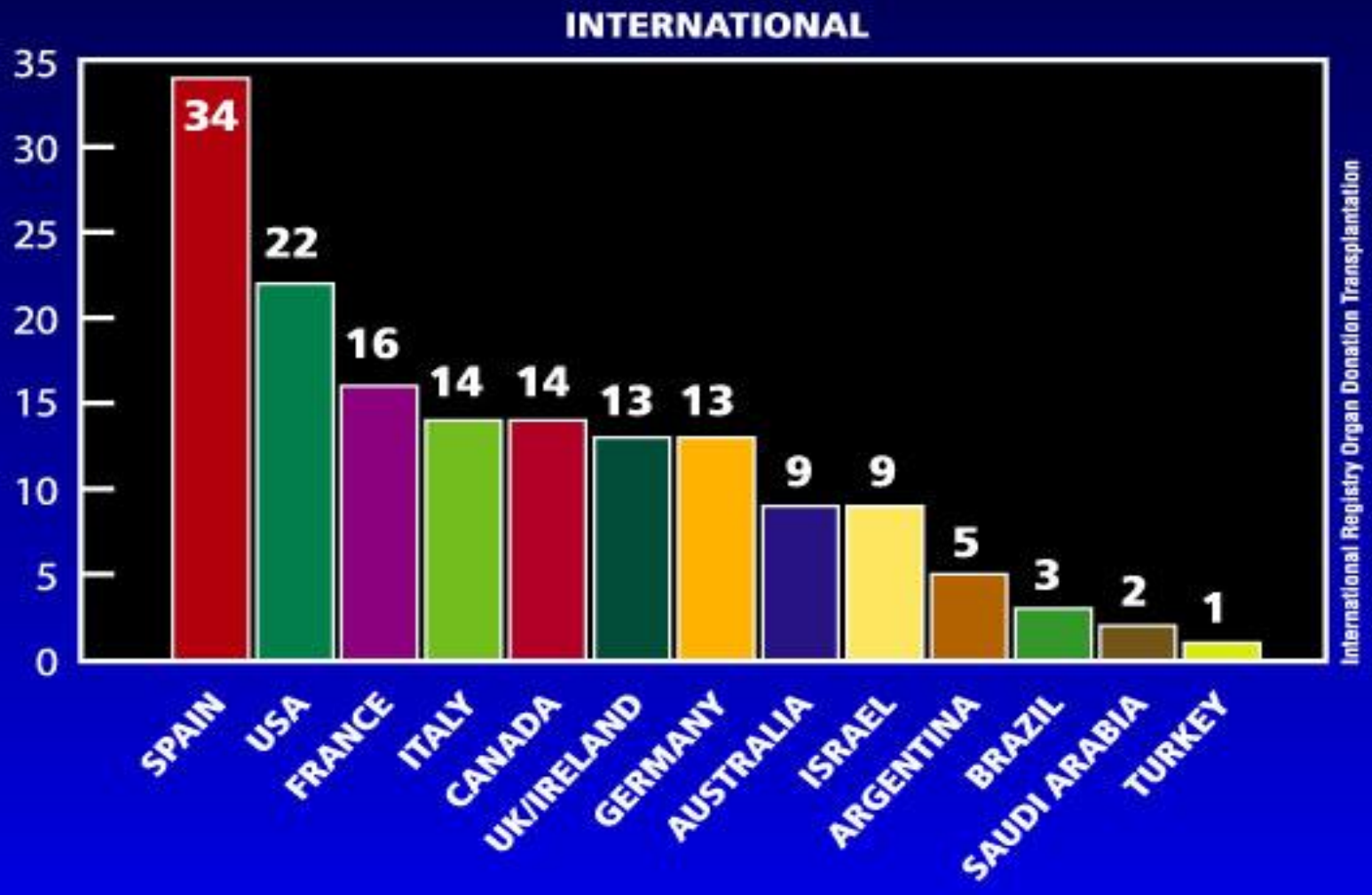
Potential Organ Donor Management

Supply - Demand Relationship

Year	Actual Donors	Lung Donors	%
1997	5477	836	15%
1998	5795	764	13%
1999	5824	778	13%
2000	5986	824	14%
2001	6081	886	15%

HRSA

Annual Rate of Organ Donation 1999
(Donors per million population)



Annual Rate of Organ Donation 1999
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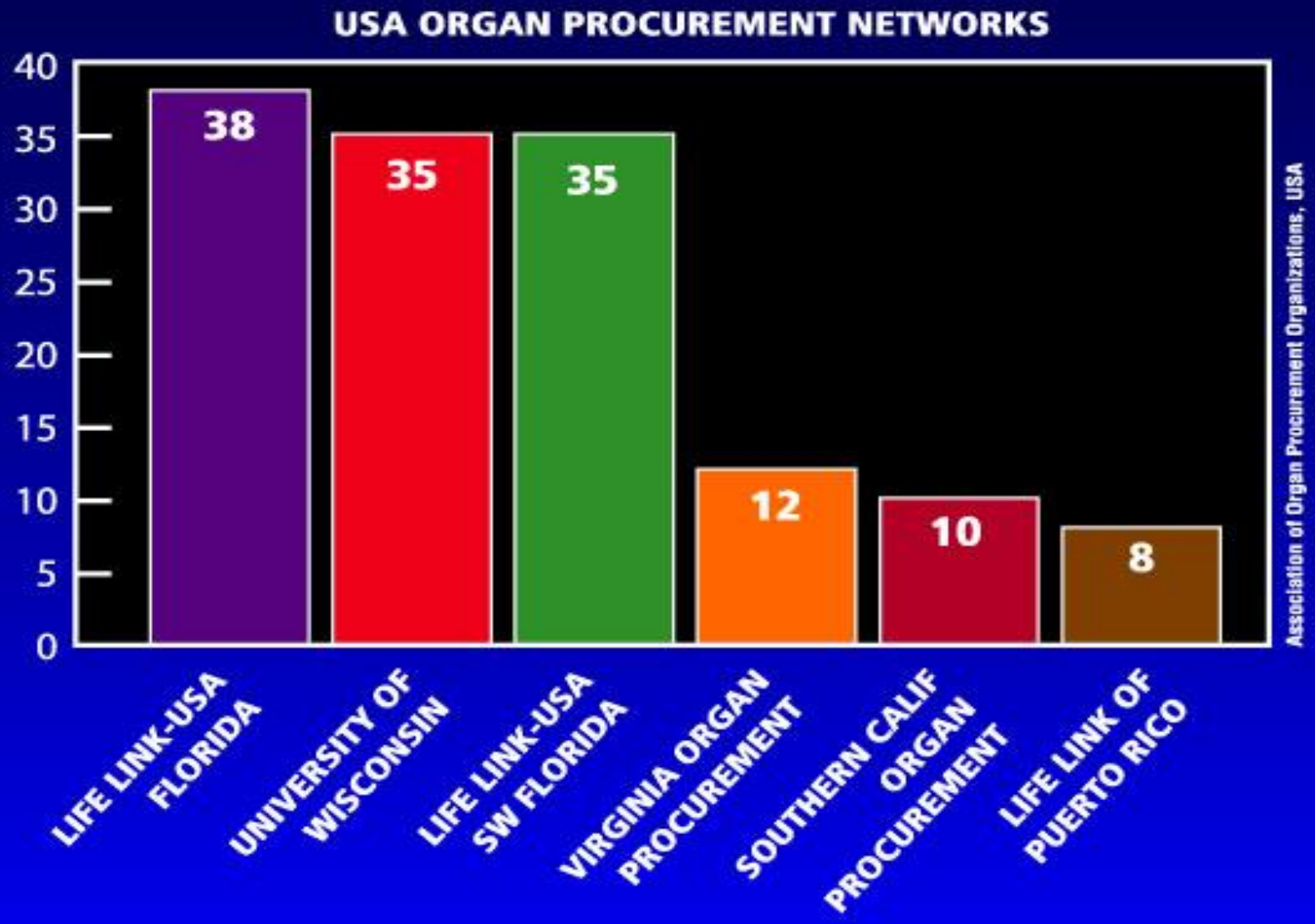
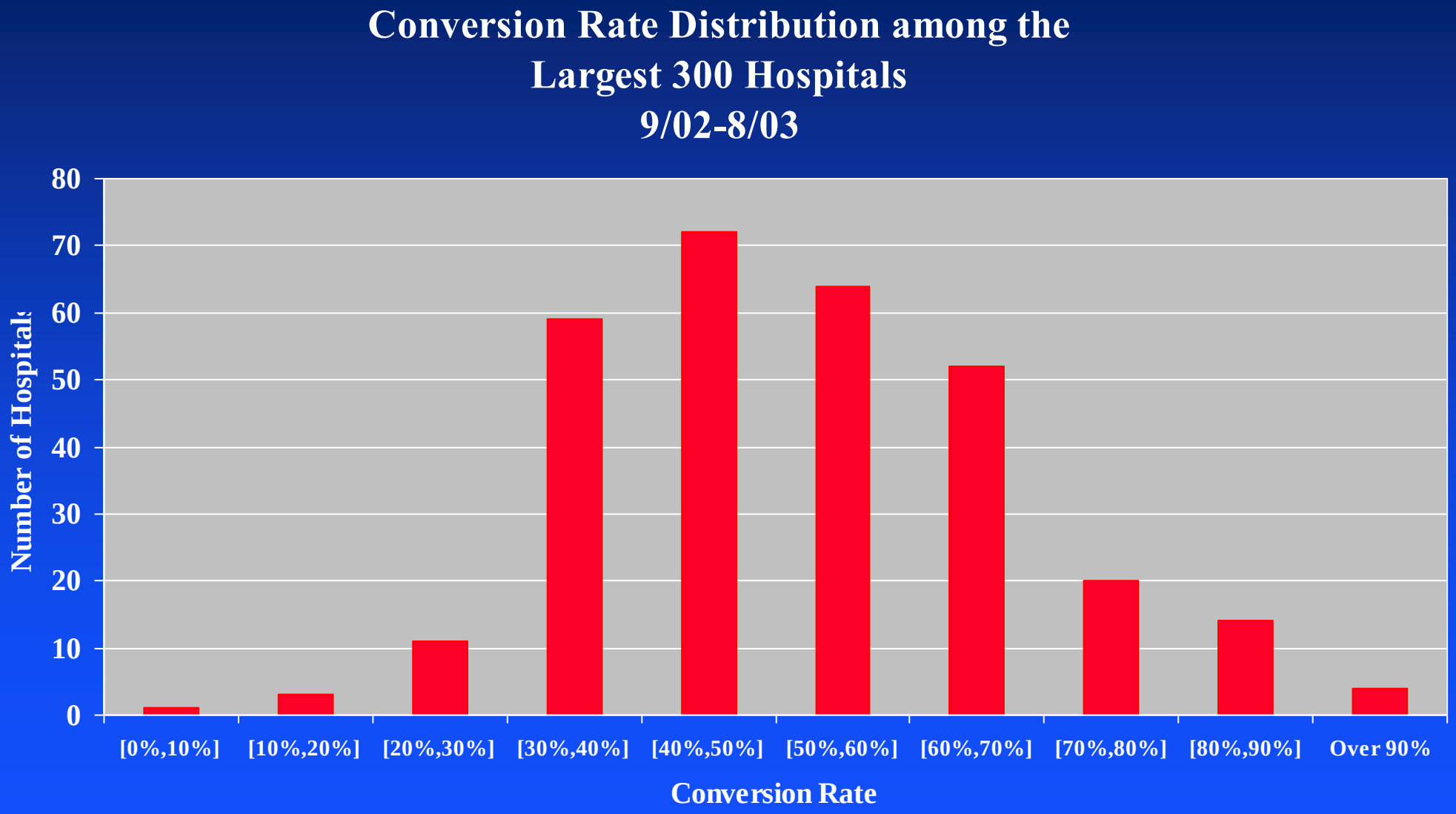
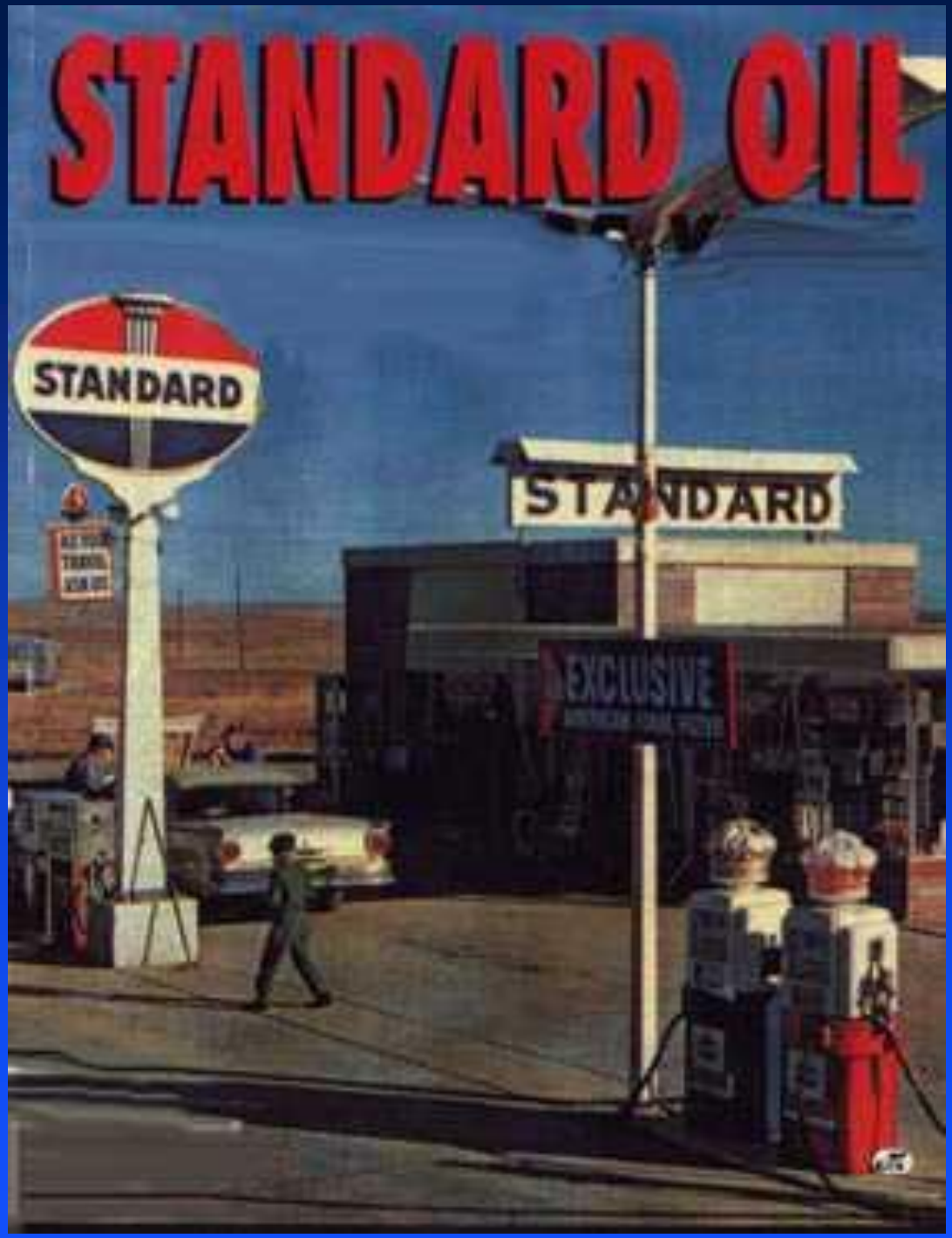


Tremendous Variation in Donation Conversion Rates in 300 Largest Hospitals




STANDARD OIL
STANDARD
STANDARD
EXCLUSIVE

Maximal Utilization and Optimal Management of Potential Organ Donors

- Surveillance to identify patients with severe neurologic injury likely to progress to brain death
- Standardized method for brain death declaration
- Uniform request for consent
- Optimal medical management of donor

Optimal Medical Management of the Potential Organ Donor

- Continued intensity of support
- Focus shift from cerebral protective strategies to optimizing donor organs for transplantation
- Simultaneous critical care to organs of multiple patients
- Critical period
    - Facilitates donor somatic survival
    - Maintains organs to be procured best condition
    - Donor management impact recipient function

Strategies to Maximize Transplantation

Recruitment

- Uniform Anatomic Gift Act
- OPO notification
- Education
  - Public
  - Health System
- Living wills
- Durable power attorney
- Donor cards
- Drivers license
- Presumed Consent
- Required refusal
- Required response
- Required request
- Economic rewards
- Media
- Spanish Model

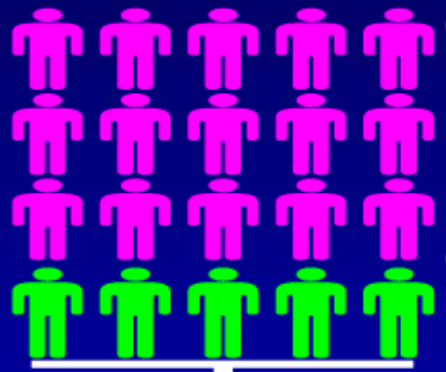
Living Donors

- Family
- Paired exchanges
- Non directed donation

REALITY

DCD ← **Potential Organ Donors** → Marginal Donors

LOSS OF 75% OF POTENTIAL ORGAN DONORS



- Detection & Recognition
- Request and Consent
- Medical Failures

25% OF POTENTIAL ORGAN DONORS REMAIN

Actual Donors

- Procedural Techniques
  - Maximal use/multiple organs
  - Simultaneous procurement
  - Split organs
  - Organ re-use
  - Eliminate organ discard
  - Use of sub-optimal organs
- Preservation Techniques

Successful Transplantation

Maximal Utilization and Optimal Management of Potential Organ Donors

Surveillance

Declaration

Consent

Medical Management

National Survey End of Life Care-ICU

110 institutions with critical care training (74,502 patients)

8.5 % mortality (6303)

6.2% Brain death (393)

93.8% end of life decisions (5910)

26% full resuscitation
failed CPR (1544)
range 4% - 79%

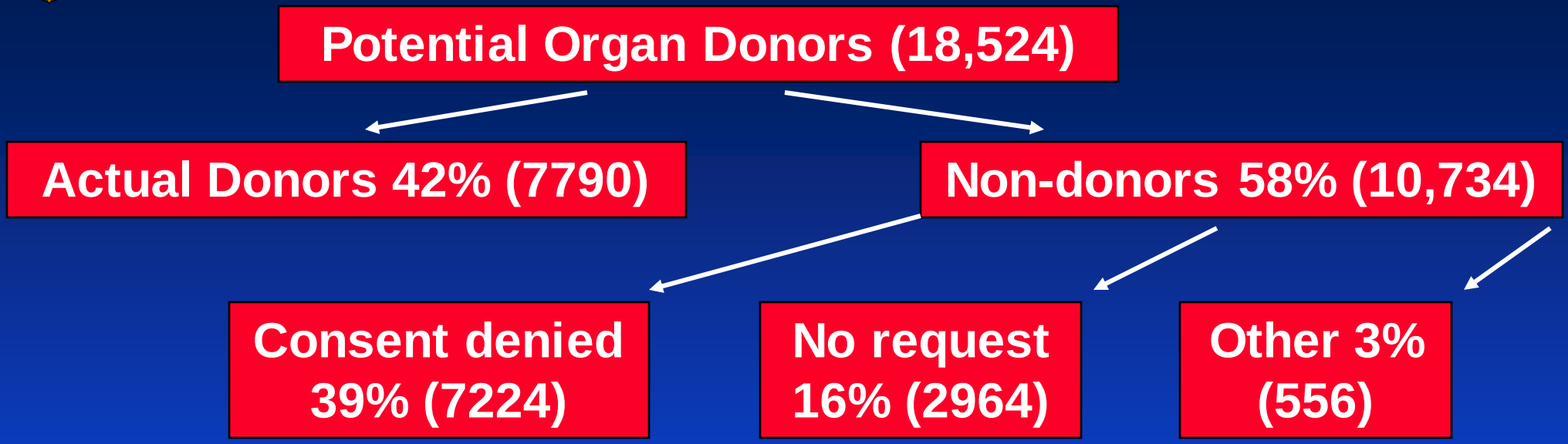
14% withhold (797)
range 0% - 67%

24% DNR (1430)
range 0-83%

36% withdrawal (2139)
range 0%-79%

Prendergast Am J Respir CCM 1998; 158:1163-67

Potential Organ Donors USA



- Med examiner
- Cardiac arrest
- No family

- Referral rate 80%
- Request rate 84%
- Consent rate 54%

(Consent obtained/consent requested 8308/15,550)

- Conversion rate 42%

Sheehy NEJM 2003; 349:667-74

Potential Organ Donors Lost in Maintenance

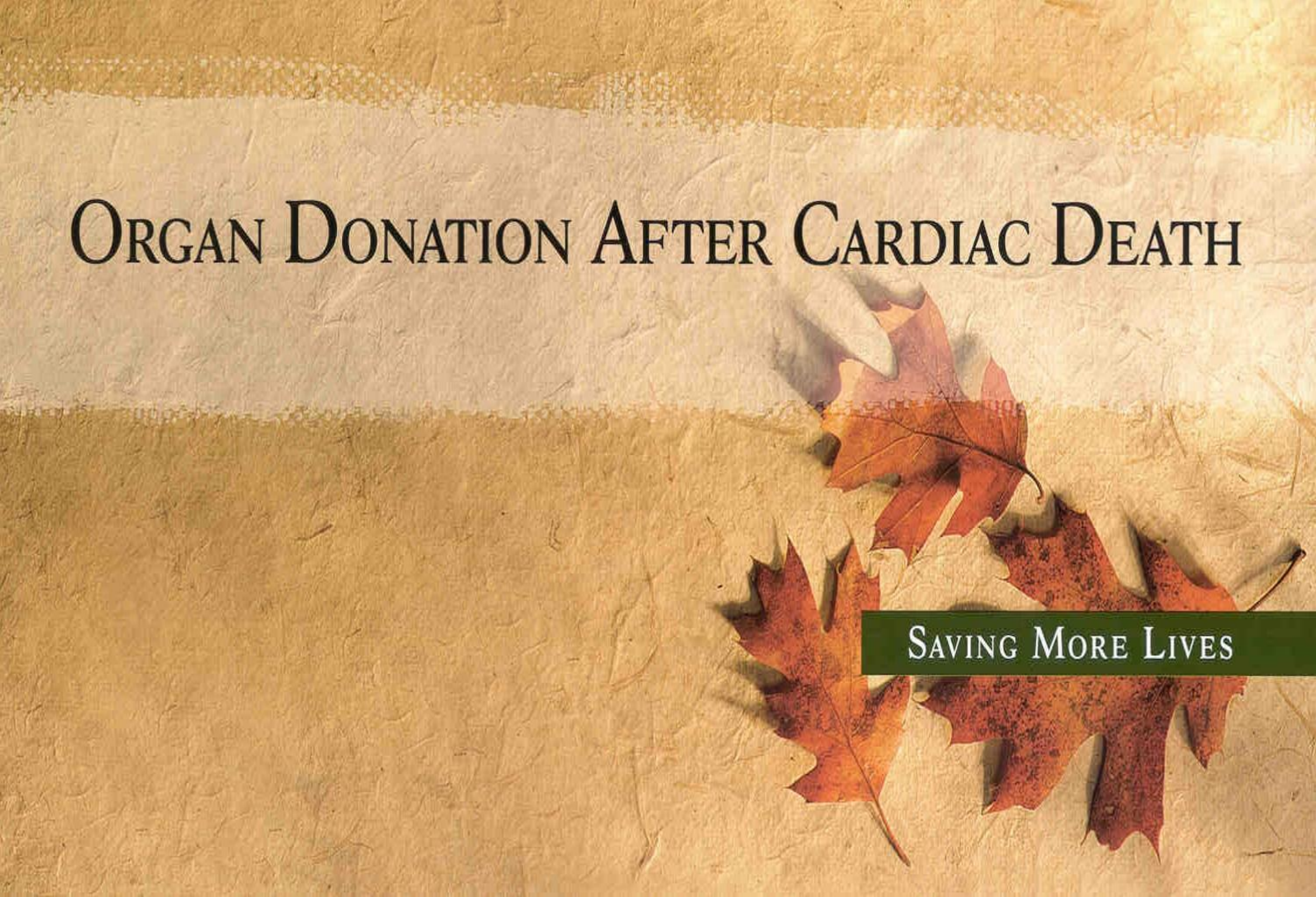
- **Sheehy 2003**
  - Consented donors
    - 94% procured (7790/8308)
    - 6% not procured (518/8308)
      - Med Examiner
      - Cardiac Arrest
  - < 3% potential donors lost medically
- **Literature estimates**
  - 10-25% Lopez Navidad Txp Proceed 1997; 29:3614-16
  - 17% Grossman CCM 1996; 24:A76
  - 8% Nygaard J Trauma 1990; 30:728-32

Potential Organ Donor Pool Hospital Characteristics

- Potential donors per hospital bed
  - ≥ 350 → 0.015; conversion 43.1%
  - 150 – 349 → 0.012; conversion 42.9%
  - < 150 → 0.006; conversion 37.3%
- 19% of hospitals → 80% of potential donors

Sheehy NEJM 2003; 349:667-74

Organ Donation After Cardiac Death



Saving More Lives

Definitions

- Heartbeating cadaver (HBC)
  - Brain dead cadaver
- Non-heartbeating cadaver (NHBC)
  - Death by traditional cardiopulmonary criteria
    - Unresponsiveness
    - Apnea
    - Absent circulation
- Non-heartbeating organ donor (NHBOD)
  - Death by C.P. criteria $\rightarrow$ donor
- Controlled NHBOD
  - Organ procurement follows a death that occurs after a planned withdrawal of life-support

Nonheartbeating Organ Donation (NHBOD) Contemporary Issues

- Are patients dead?
- Practice constitutes active euthanasia?
- Prohibitive conflict of interest for professional and institutions?
- Adequate social support for dying patients and families?
- Whether ethical and illegal practice is preventable?

When is death?

“ No patient who satisfied the triad of apnea, absent circulation and unresponsiveness for at least 2 minutes had a restoration of spontaneous circulation.” (108 patients)

Robinson J Exp Med 1912; 16:291-302
Willins Med J Rec 1924; 119:44-50
Stroud Am Heart J 1948; 35:910-23
Enselberg Arch Int Med 1952; 90:15-29
Rodstein Geriatrics 1970; 25:91-100

SCCM Recommendations

- Informed consent is ethical cornerstone
- Organ procurement must not cause death and death must precede procurement
- Death must be certified by using standardized, objective and auditable criteria following state law
- Care is first and foremost directed towards the dying patient

CCM 2001; 29:1826-1830

NHBOD Special Concerns

- Patient must be certified dead using objective standardized, auditable criteria not different from those utilized for non-NHBOD's

2 minutes recommended < Asystole, Apnea, Unresponsiveness > 5 minutes Not recommended

- No patient may be certified by MD who participates in procurement/transplantation
- Decision to withdraw therapy should preferably be made before and must independent of any decision to donate
- Medications that alleviate pain and suffering are permissible

CCM 2001; 29:1826-1830


THE FASTER
YOU GO,
THE BIGGER
THE MESS.

Maximal Utilization and Optimal Management of Potential Organ Donors

Surveillance

Declaration

Consent

Medical Management

Pathophysiology of Brain Death
Complicating Features

- Variability in definitions of brain death
- Disparity in certification vs tissue death
- No human model available
- Concomitant injuries
- Rate of progression leading to brainstem dysfxn
- Treatment of brain injury causes physiologic changes independent of brain injury

Power Anesth Int Care 1995; 23:26-36

Physiologic Changes Preceding Brain Death

- Significant and devastating physiologic changes prior to diagnosis of brain death
- Process → certification 17-22 hrs
- ↑ Elapsed time ↑ complications - 8% loss potential donors
- Cardiovascular instability 80%
- Diabetes Insipidus 53-93%
- DIC 28%
- CPR 25%
- Arrhythmias 27%
- Hypothermia 4%
- Transfusions 63%
- Pulm Edema 19%
- Hypoxia 11%
- Acidosis 11%
- Seizures 10%

Nygaard Trauma 1990; 30:728-732

Medical Complications in Failed Donors

Complication	Criteria	% Donors
Hypotension	BP < 90 Systolic Pressors	84%
Anemia	Hgb < 10 Transfusion > 2 uPRBCs	68%
Coagulopathy	PT ≥ 16 sec Transfusion ≥ 2 uFFP	58%
Diabetes Insipidus	Urine output ≥ 500 cc/hr need for vasopressin	52%
Hypoxemia	$pO_2 \leq 200$ torr FiO_2 1.0	25%

Grossman Transplantation 1996; 62:1828-31

THE

AMERICAN JOURNAL

OF THE MEDICAL SCIENCES.

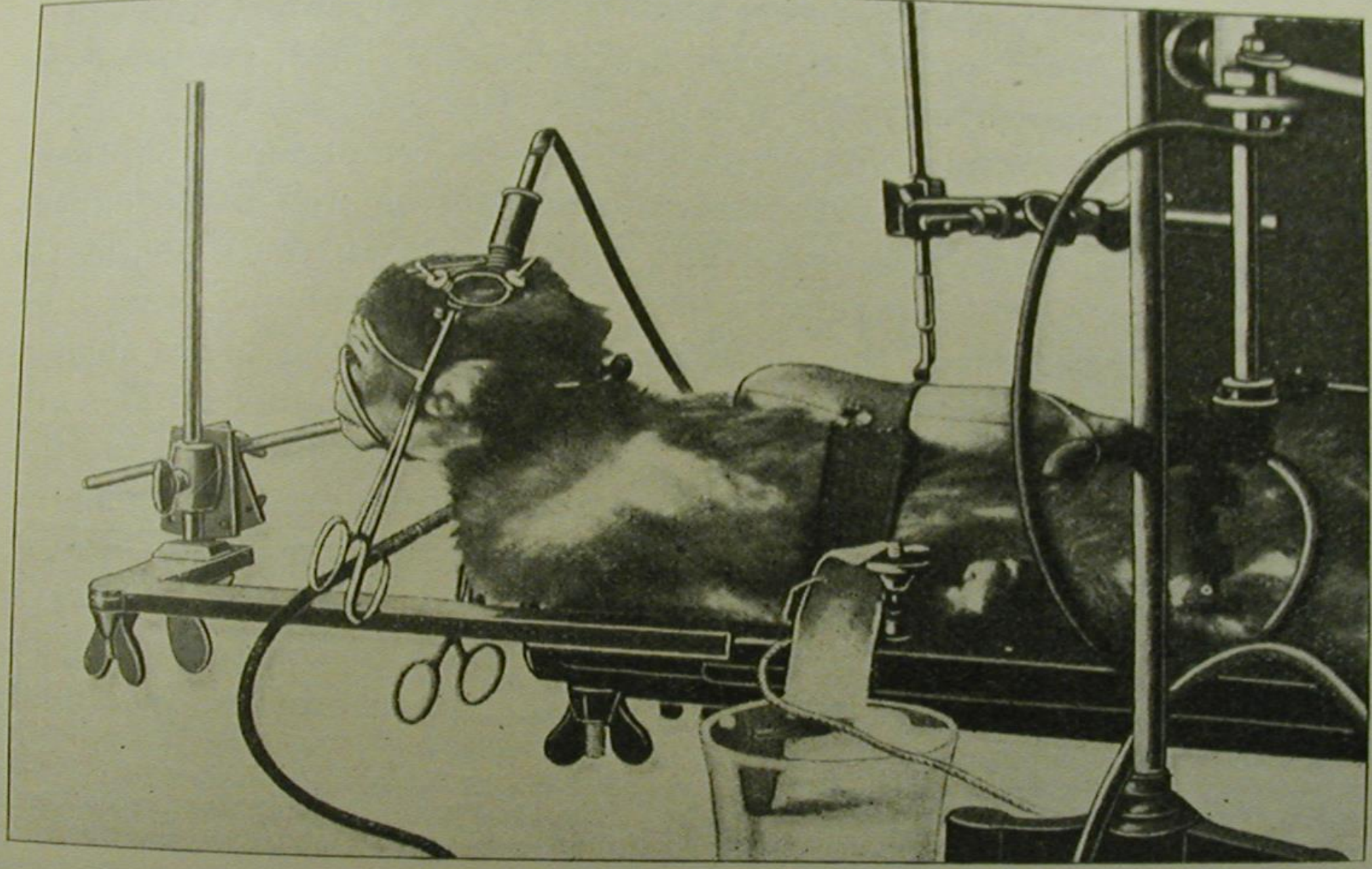
SEPTEMBER, 1902.

SOME EXPERIMENTAL AND CLINICAL OBSERVATIONS CONCERNING STATES OF INCREASED INTRACRANIAL TENSION.[1]

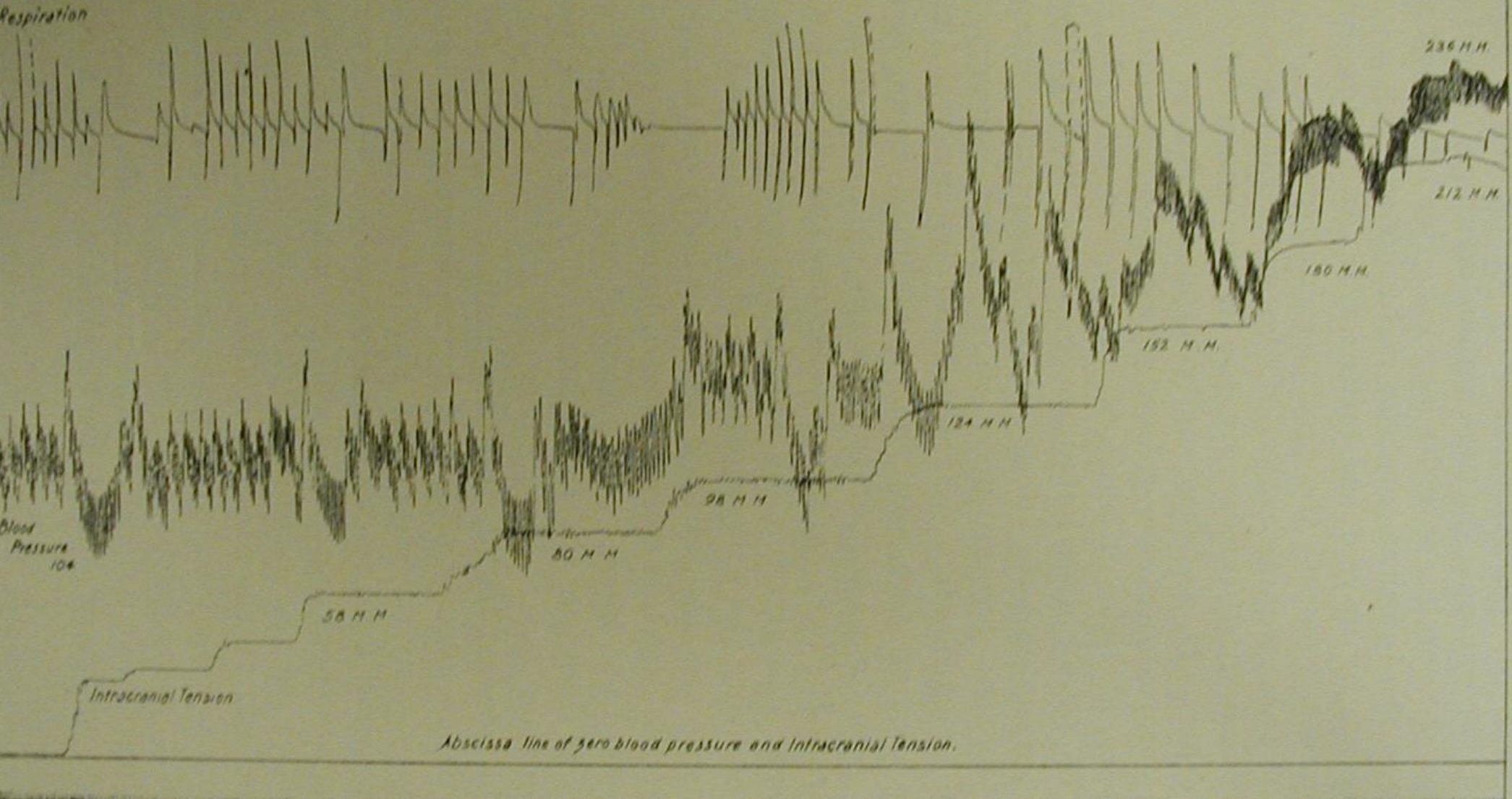
THE MÜTTER LECTURE FOR 1901.

By Harvey Cushing, M.D.,

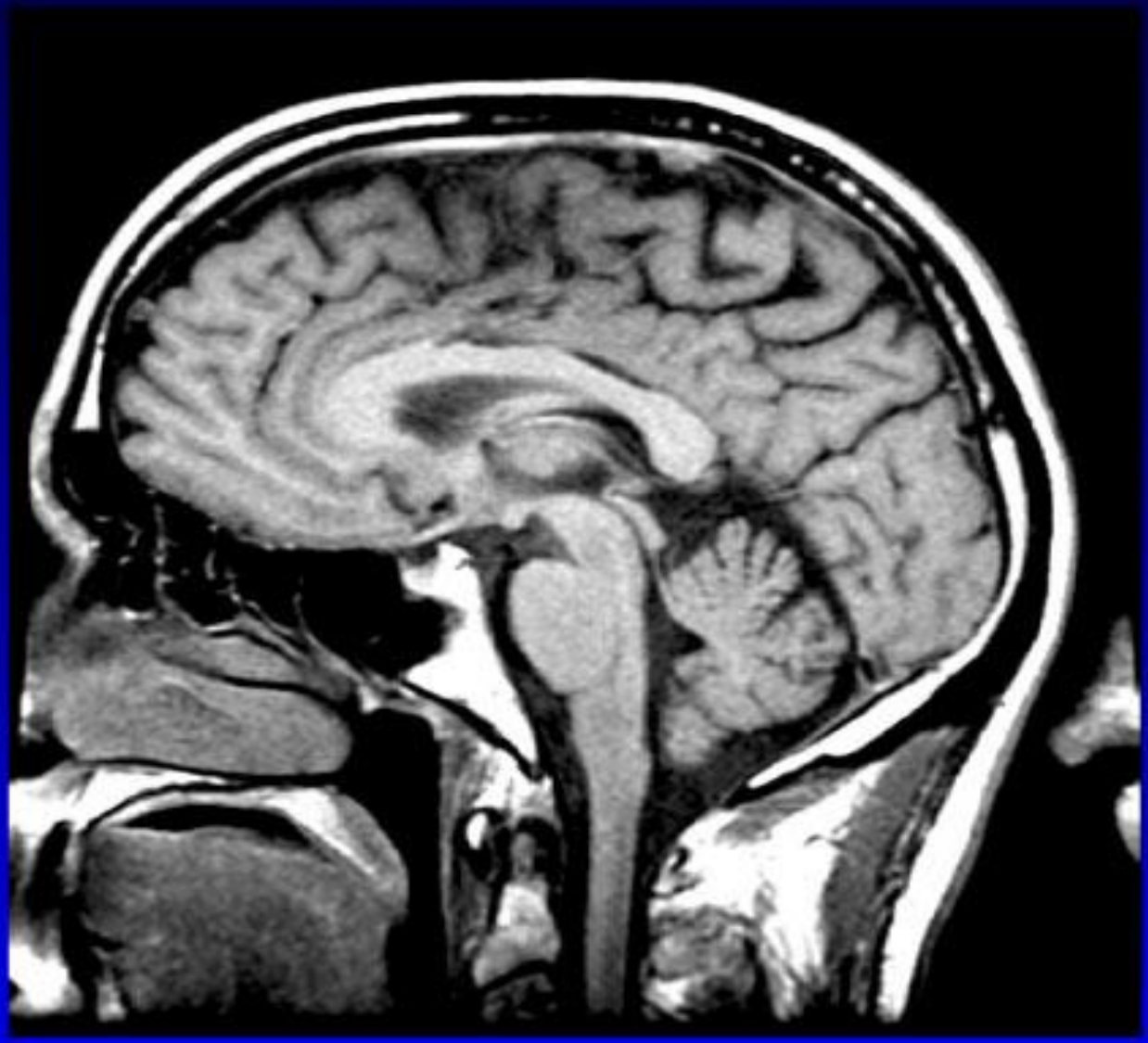
ASSOCIATE IN SURGERY, JOHNS HOPKINS UNIVERSITY.



Photograph showing the cerebral window and local compression apparatus in place during an experiment.


Respiration
Blood Pressure 104
Intracranial Tension
58 M M
80 M M
98 M M
124 M M
152 M.M.
180 M.M.
212 M M
236 M M
Abscissa line of zero blood pressure and intracranial Tension.

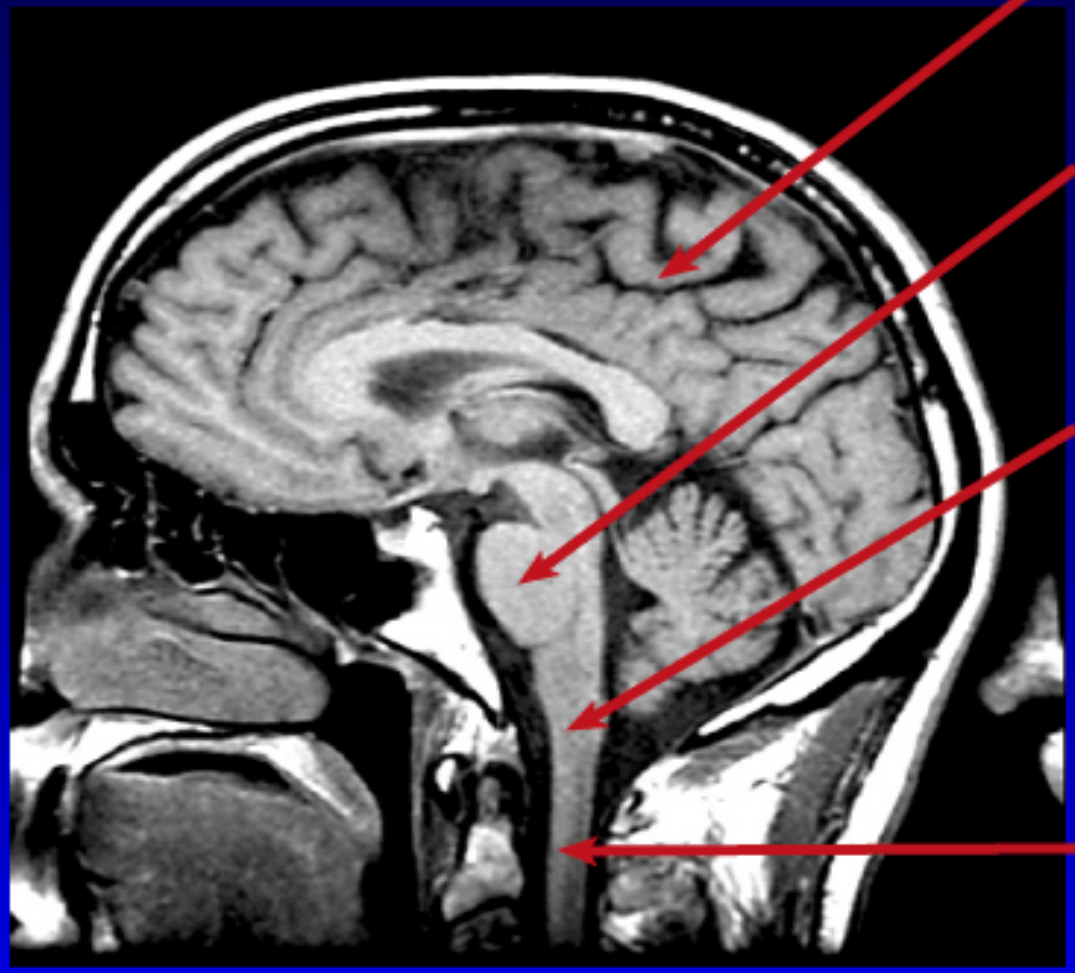
Normal Brain



Progressive Cerebral–Spinal Ischemia "Coning"

Ischemic Distribution | **Physiologic Correlation**

Normal Brain



Cerebrum..... Vagal Activation
- ↓ Heart rate
- ↓ Cardiac output
- ↓ Blood pressure

Pons..... Mixed Vagal and Sympathetic Stimulation (Cushing Response)
- ↓ Heart rate
- ↑ Blood pressure
- Irregular breathing

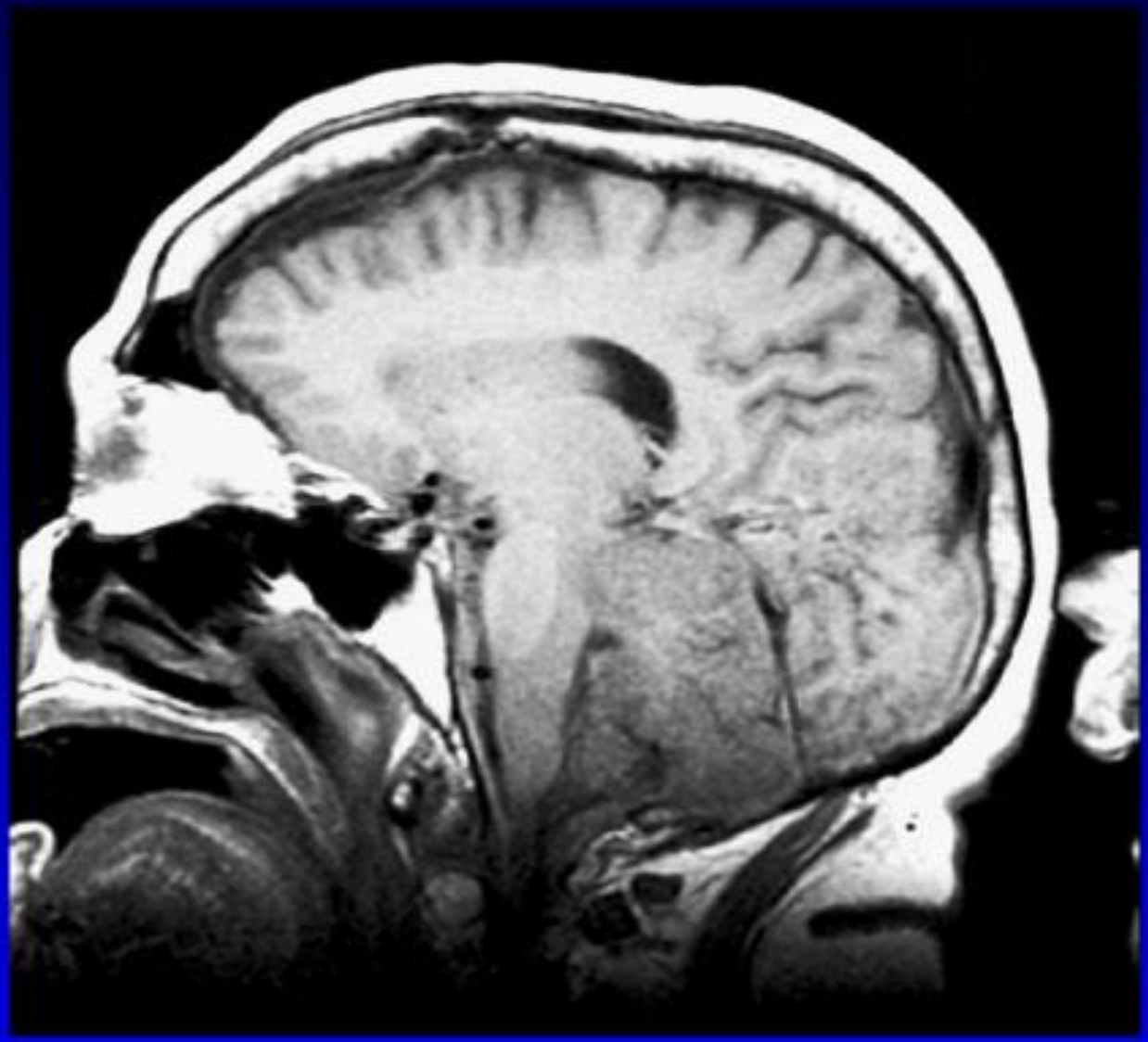
Medulla Oblongata..... Sympathetic Stimulation Only (Autonomic Storm)
- ↑ Heart rate
- ↑ Blood pressure

Hypothalamus Destruction
- Thermoregulatory impairment

Pituitary Destruction
- Endocrine dysfunction?

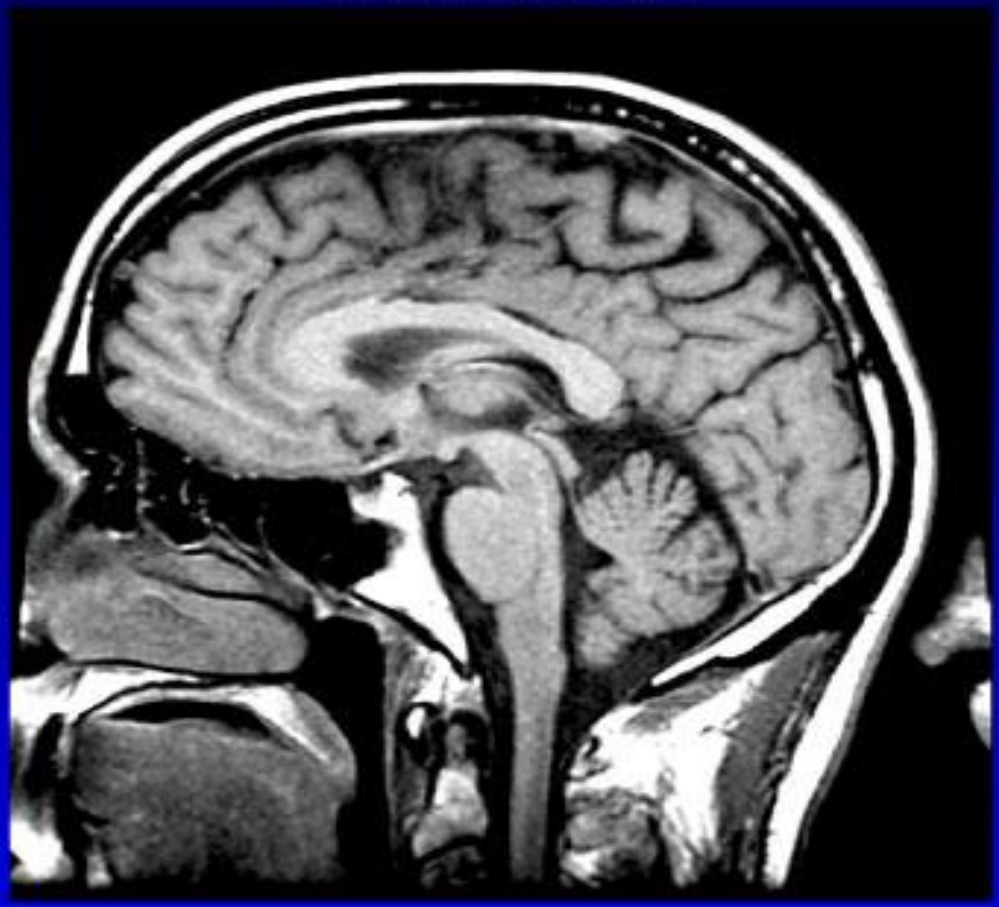
Spinal Cord...Sympathetic Deactivation
- ↓ Heart rate
- ↓ Cardiac ouput
- ↓ Blood pressure

Herniation and Brain Death

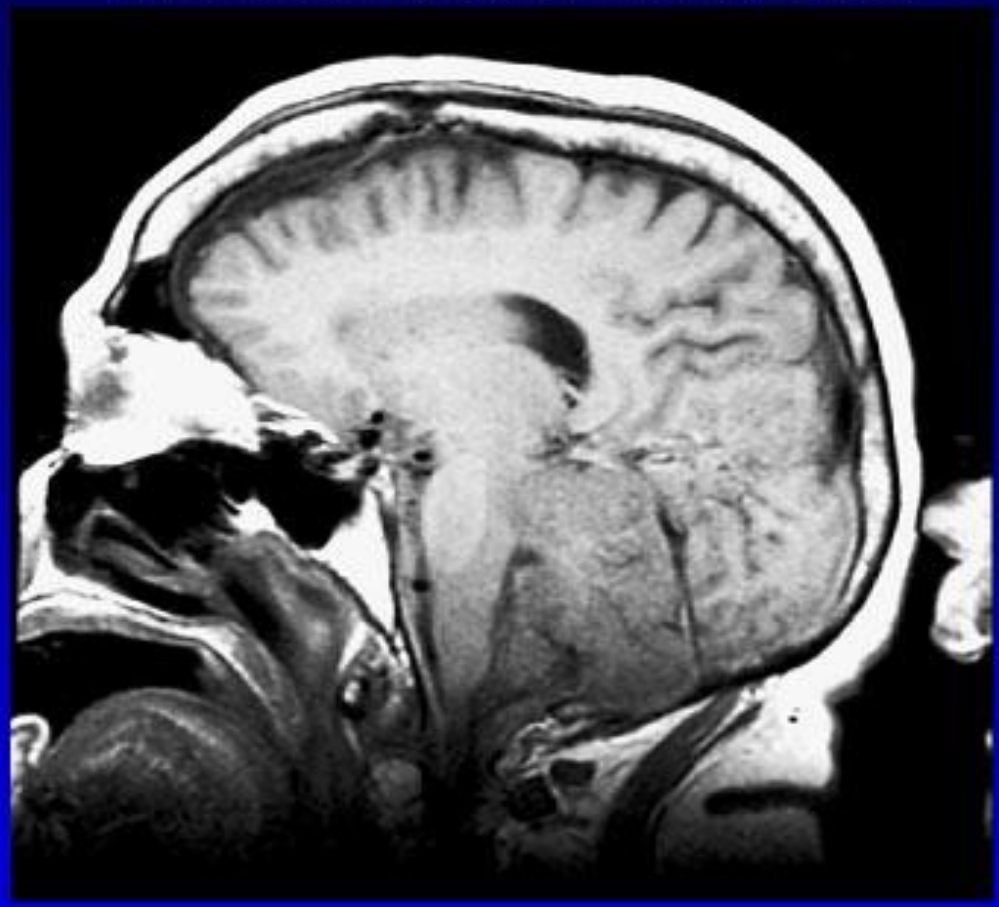


Progressive Cerebral–Spinal Ischemia "Coning"

Normal Brain



Herniation and Brain Death



Pathophysiological Changes Impacting Transplant Graft

Transplanted Organ

- Trauma
- Autonomic storm
- Cold storage
- Transplantation

Ischemia
- → Loss aerobic oxidative respiration
- → Cellular energy loss ATP
- → Ion gradients - Ca^+

↓

Reperfusion

↓

Ischemia-reperfusion injury
- → Oxygen radicals
- → Lipid peroxidation
- → Membrane permeability Ca^+

Background

Brain Death | **Endocrinopathy**

↓

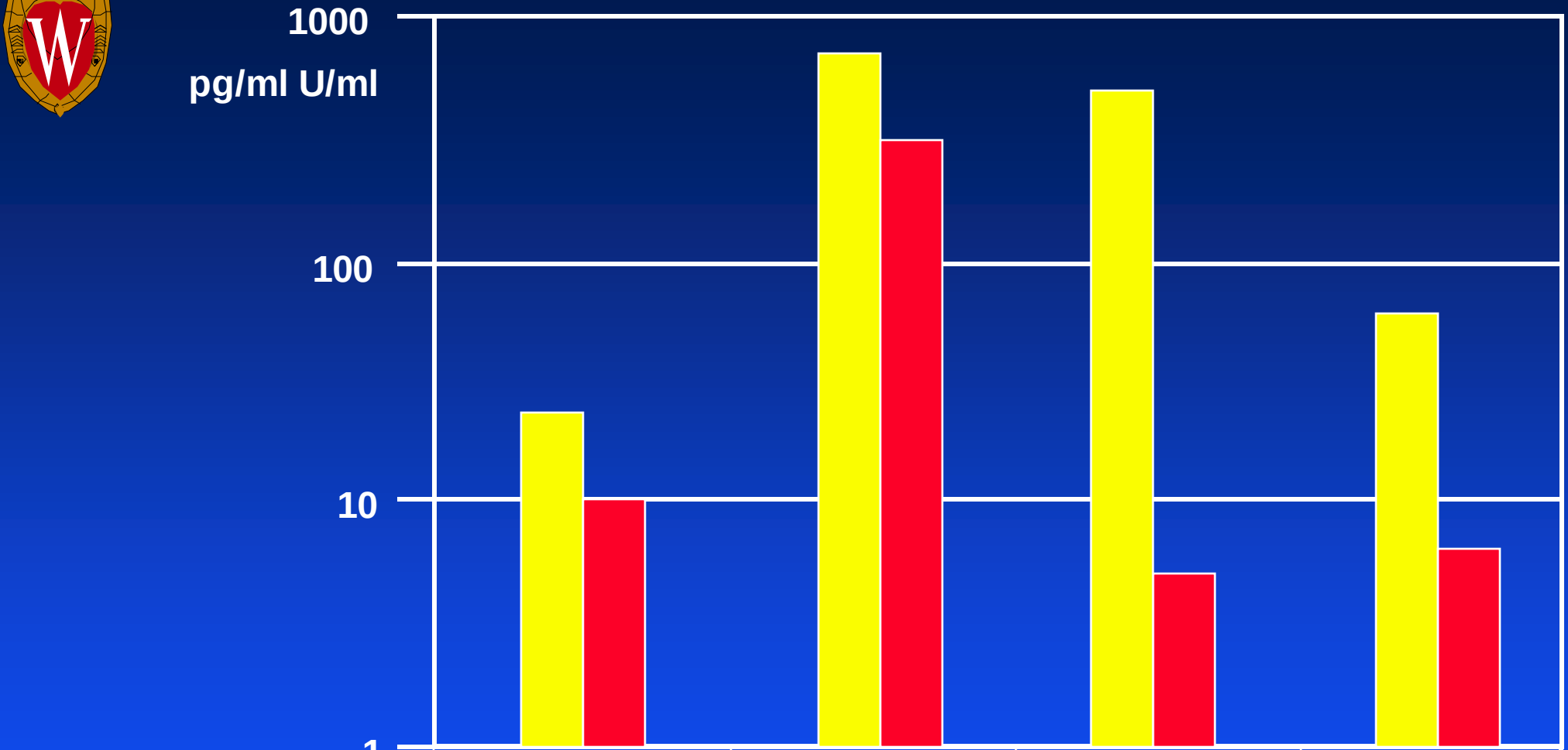
Mitochondria injury

- ↓ Aerobic production ATP
  - → Thyroid hormone
  - → Cortisol
  - → Insulin
- ↓ Organ function

Inflammatory and Immunologic Sequelae of Brain Death

- Upregulation of cytokines and lymphokines
- Widespread microvascular endothelial changes
- Increased expression cell adhesion molecules
- Increased expression of MHC antigens

Cytokine Release in Organ Donors



	TNF alpha	IL2-R	IL-6	IL-8
Cadaver	22.4	856	663	66.5
Living	10.2	348	4.5	5.6

Stangl Txp Proced 2001; 33:1284-85

Pulmonary Donor Inflammation

- Non-traumatic brain death → Open lung biopsy
  → Bronchoalveolar lavage

	Brain Death	Controls
Neutrophil concentration	31.85%	3%
Lavage IL-8	1282 pg/ml	85 pg/ml
Lavage GRO-α	12,588 pg/ml	102 pg/ml
Lung mRNA IL-8	59.7%	27.5%

- Neutrophil infiltration correlated BAL → IL-8
  → GRO- α

Fisher Lancet 1999; 353:1412-13

Donor Inflammation → Recipient Outcome

Donor → **Recipient**

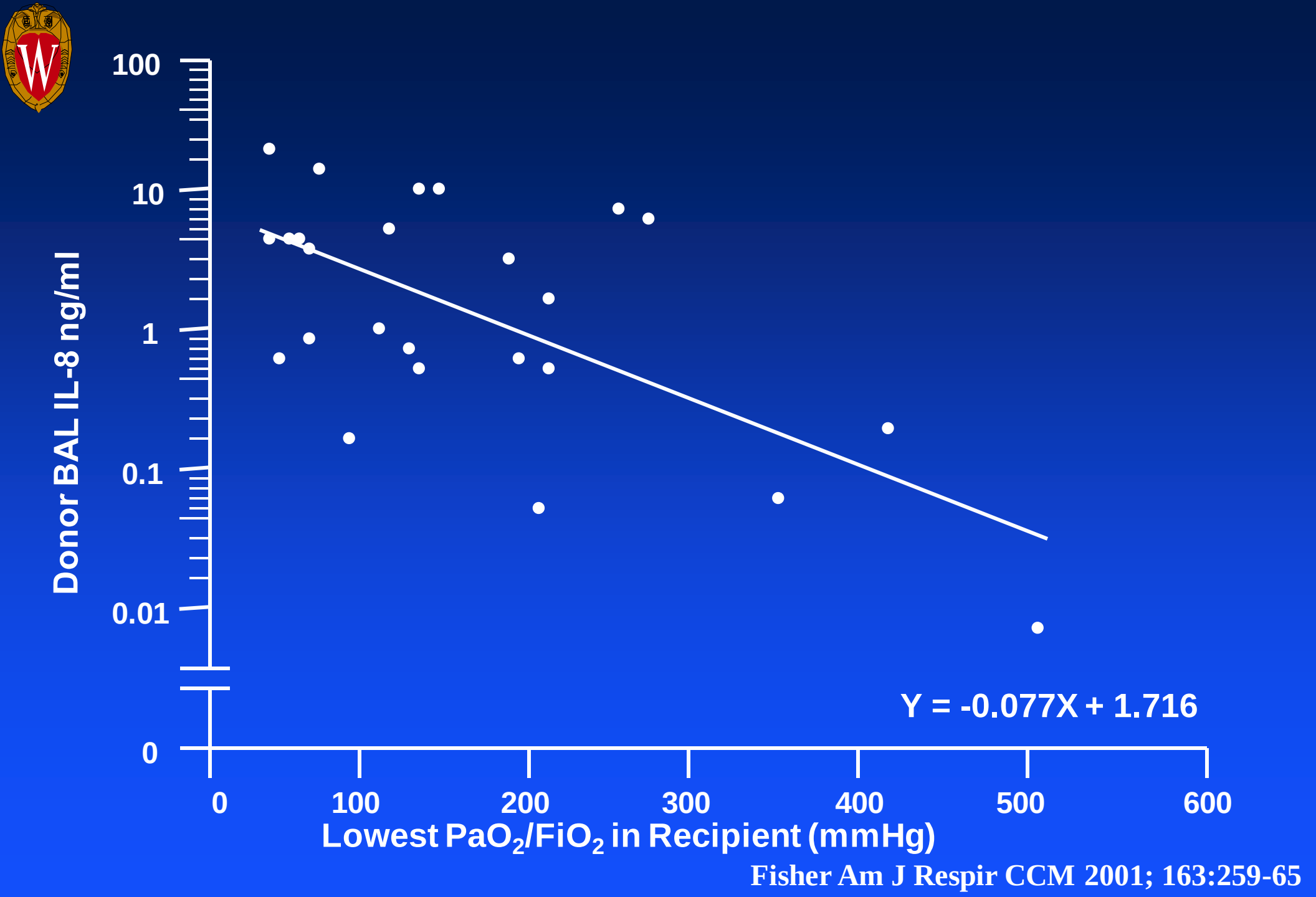
- IL-8 expression
- Neutrophil infiltration

- Graft Function
- Survival

IL-8 signal in donor correlated with:

- % neutrophils BAL donor
- degree of impairment graft oxygenation
- development of severe early graft dysfxn
- early recipient mortality

Fisher Am J Respir CCM 2001; 163:259-65



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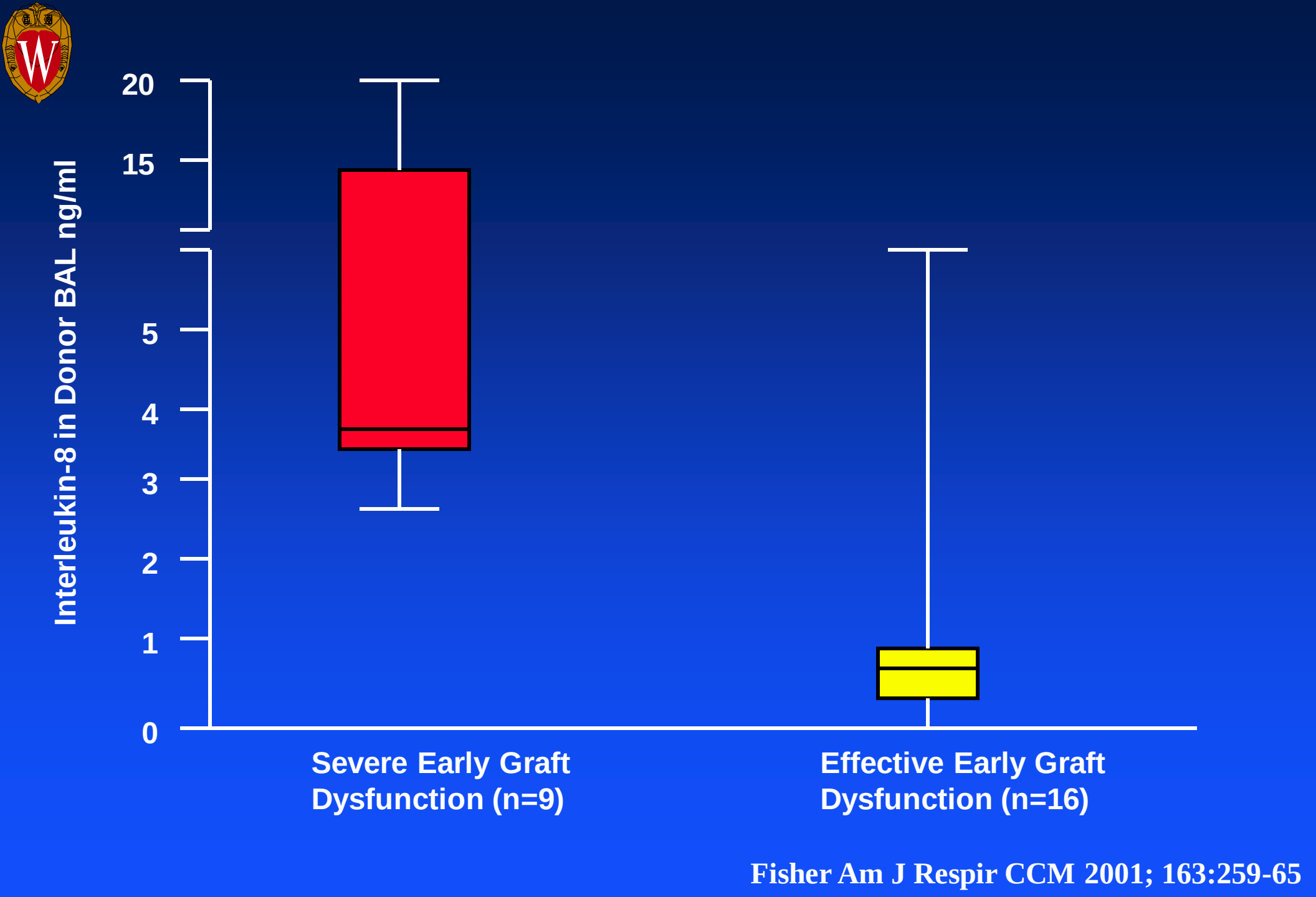

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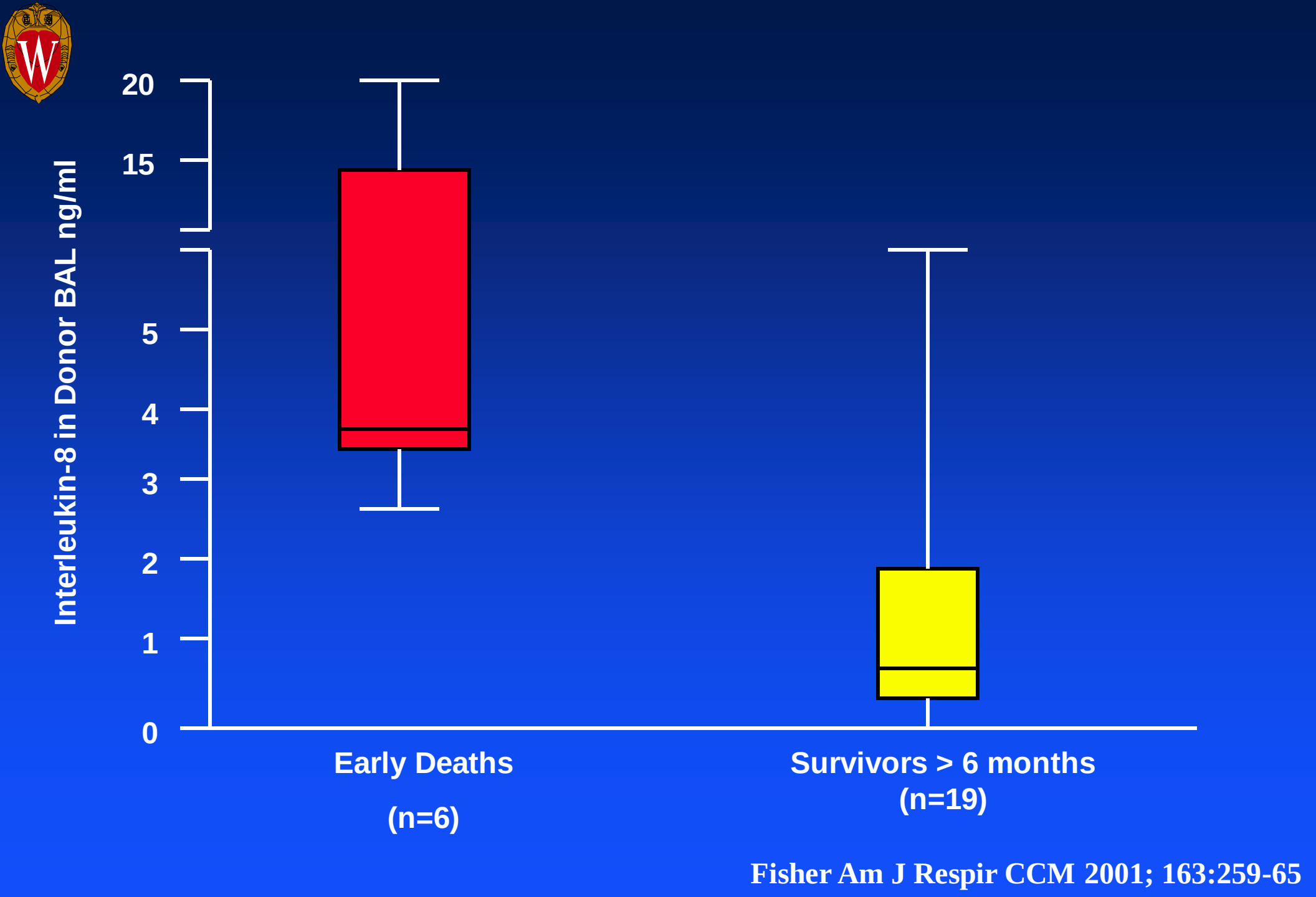
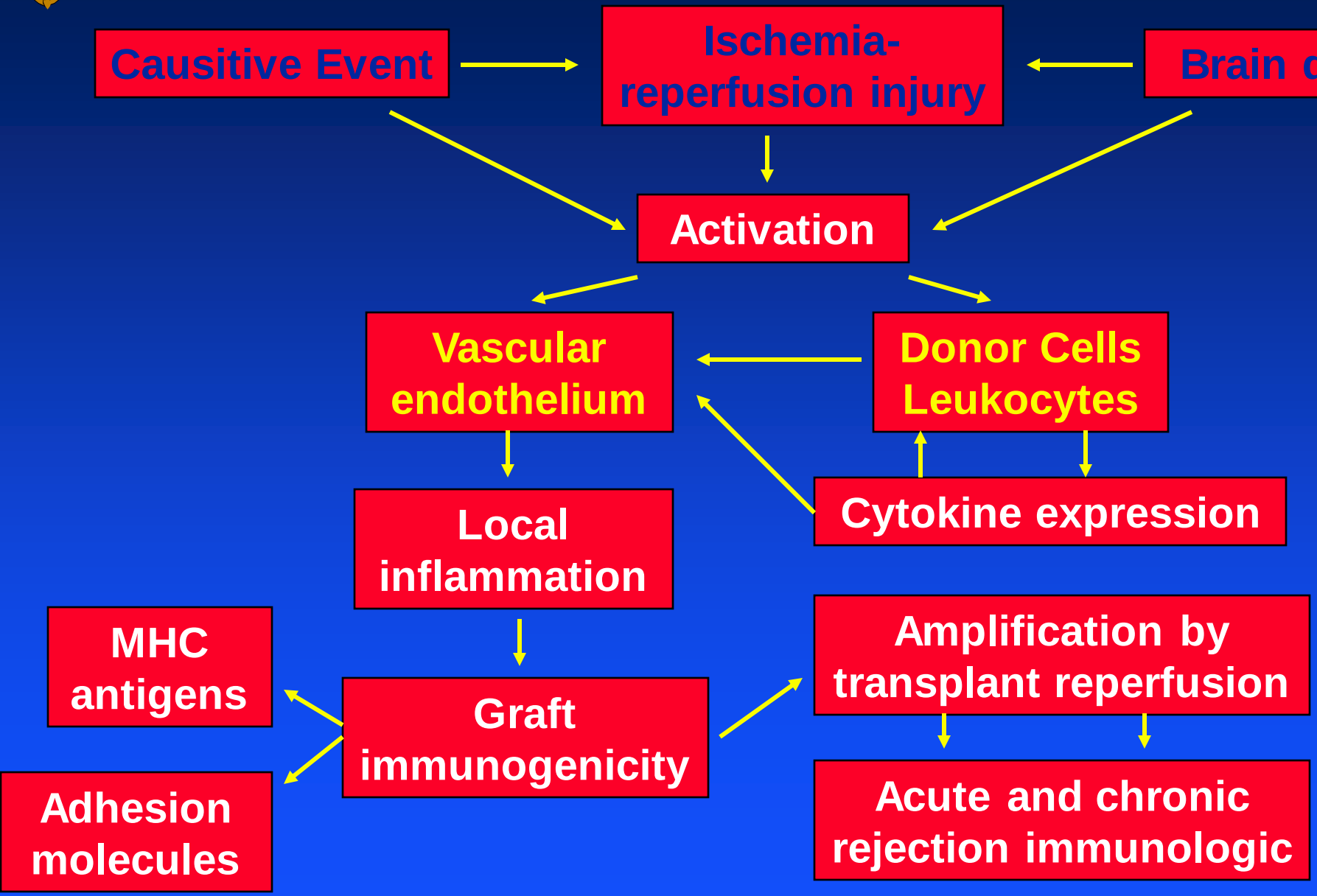


Fisher Am J Respir CCM 2001; 163:259-65

Proposed Pathophysiologic Model



Tome 101. — N° 1. 1959

REVUE NEUROLOGIQUE

MÉMOIRES ORIGINAUX

LE COMA DÉPASSÉ

(MÉMOIRE PRÉLIMINAIRE)

PAR MM.

P. MOLLARET et M. GOULON

Après quatre années de réflexion, nous croyons venu le moment d'ajouter un chapitre nouveau au domaine traditionnel des comas.

Précisons de suite que ce problème du coma dépassé a été mis, l'année dernière, au programme de la prochaine Journée de Réanimation de l'Hôpital Claude-Bernard du 7 octobre 1959, en vue d'une mise au point intégrale.

La présente communication, qui n'a ainsi qu'une valeur préliminaire, peut être offerte, peut-être, en hommage à la XXIII[e] Réunion Neurologique Internationale, qui a accepté de tenir une de ses séances dans le Centre de Réanimation où fut élaboré ce travail. Précisons également que le coma dépassé a déjà conquis droit de cité dans l'important volume qui vient de paraître de H. Fischgold et P. Mathis (*Obnubilations, comas et stupeurs*, Masson édit., Paris, 1959, p. 5 et pp. 51-52) ; nous remercions ces auteurs d'être venus se faire présenter les premiers malades et d'avoir donné place à quelques-uns de nos documents.

Brain Death and Transplantation

“I doubt if any members of our transplant team could accept a person as being dead as long as there was a heart beat”

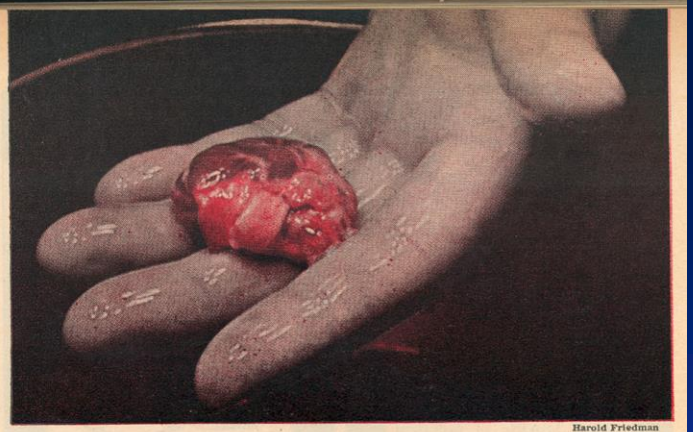
Starzl

“Although Alexandre’s criteria are medically persuasive according to traditional definitions of death, he is in fact removing kidney’s from live donors. I feel that if a patient has a heart beat, he cannot be regarded as a cadaver”

Calue

Ciba Symposium 1966; 54:77


Newsweek
NEW HEARTS FOR OLD
DECEMBER 18, 1967 50c
The Promise and Perils of
TRANSPLANT SURGERY
SERIALS DEPT
MADISON WI 53706



Harold Friedman

WHEN ARE YOU REALLY DEAD?

Doctors can now play God. They can alter the genes, build artificial parts for the body and, as the two remarkable experiments in Cape Town and Brooklyn demonstrated last week, they can even transplant the human heart—the symbol of life itself—from one body to another. Indeed, the photo above shows the hand of a doctor holding the still-viable heart of a three-day-old infant during the transplant operation last week at Maimonides Hospital. But how will the doctors use this power?

"I have a horrible vision," says a public-health official in Washington, "of ghouls hovering over an accident victim with long knives unsheathed, waiting to take out his organs as soon as he is pronounced dead."

When, in fact, is a person dead *enough* to be deprived of a vital organ needed to sustain the life of another human being? Until recently, the moment of death was thought to be the moment when the heart stops beating. But new advances in resuscitation techniques—electrodes that shock the heart muscle into beating again, cardiac massage and chemical treatments—have made that notion obsolete. Now cases of "returning from the dead," as with a GI in Vietnam (Newsweek, Nov. 13), are becoming more and more common. Most physicians demand the ultimate evidence—through use of electroencephalograms—that all electrical activity in the brain has ceased. "You can at least start the heart beating again after it stops," says Dr. Marius Barnard, one of the Cape Town surgeons. "But once the brain is dead, it cannot recover." This, in turn, raises another question: if there is massive brain destruction, but the heart and lungs are kept functioning with mechanical aids, is the body still a human being? Or is it—to use the blunt term of the surgical amphitheater—a vegetable?

"You're dead when your doctor says you are" is perhaps the most accurate definition of death. Death comes, says Dr. Carl Wasmuth, president of the American College of Legal Medicine, when the physician "has done everything to save the patient's life and comes to the point where he feels the patient can't live. Once a man makes up his mind to stop that respirator or cardiac pacemaker, from that minute the patient is dead." To insure that a doctor doesn't pull the plug on a dying patient simply to obtain a needed organ, some specialists urge that the transplanter not be allowed to attend the dying potential donor. Says Dr. Irvine Page, former president of the American Heart Association: "You simply can't go around taking people's hearts out."

Ethics: Indeed, simple humanity would seem to provide more of an ethical obstacle to heart transplants than theology. The Rev. Thomas O'Donnell, S.J., former lecturer in medical ethics at the Georgetown University School of Medicine, regards the heart as an "efficient pump" with no moral significance whatsoever; he believes that the major ethical consideration involved in such cases is approval from the next of kin and an "assurance that the donor is medically dead." Some theologians believe the doctors need not wait that long. Dr. Joseph Fletcher of the Episcopal Theological School in Cambridge, Mass., says speeding up a donor's death, when death is "positively" inevitable, may be justified if the transplant provides another human with valuable life. But Rabbi Immanuel Jakobovits, chief rabbi of the British Commonwealth, disagrees: "Even a fraction of life is precious. Therefore, no one must hasten the death of a donor."

As the state of the transplant art progresses, the moral and theological questions are certain to become more complex. Brain transplants in dogs have already been tried by Dr. Robert J. White of Western Reserve University. Yet in the case of a human brain, scientists are almost certain the recipient would acquire the donor's memory, intelligence, emotions—in short, his personality. Then, who would he be? Himself or the donor?

Newsweek 1967; 70:87

Brain Death Criteria (1967)

"You are dead when your doctor says you are. Death comes when the physician has done everything to save the patients life and comes to the point where he feels the patient can't live. Once a man makes up his mind to stop that respirator or cardiac pacemaker, from that minute, the patient is dead."

Carl Wasmuth, MD

President, American College of Legal Medicine (1967)

JAMA 1968; 205:337-340

Special Communication

A Definition of Irreversible Coma

Report of the Ad Hoc Committee of the Harvard Medical School
to Examine the Definition of Brain Death

Harvard Ad Hoc Committee Definition of Brain Death (1968)

- Unreceptivity and unresponsitivity
- No movements or breathing
- No reflexes
- Flat EEG
- All of above repeated at least 24 hours with no change
- Exclusion
  - Hypothermia (≤ 90°F or 32.2° C)
  - CNS Depressants

JAMA 1968; 205:337-340

Presidents Commission Ethical Problems Uniform Determination of Death Act (1981)

An individual who has sustained either

1. Irreversible cessation of circulatory and respiratory functions

OR

2. Irreversible cessation of all functions of the entire brain, including the brainstem, is dead

A determination of death must be made in accordance with accepted standards

JAMA 1981; 246:2184-86

Presidents Commission Ethical Problems (1981) Guidelines for Determination of Death

- Cessation
  - Coma with unreceptivity and unresponsivity
  - Absent brain stem function
  - Apnea test $PaCO_2$ > 60 mmHg
  - Absence of decorticate posturing/seizures
- Irreversibility
  - Cause established and sufficient
  - Reversible conditions excluded
  - Persists for appropriate period
    - 6 hrs exam/confirm
    - 12 hrs exam
    - 24 hrs exam
  - Confirmatory studies
    - Cannot adequately test
    - Sufficient cause not established
    - Shorten observation time

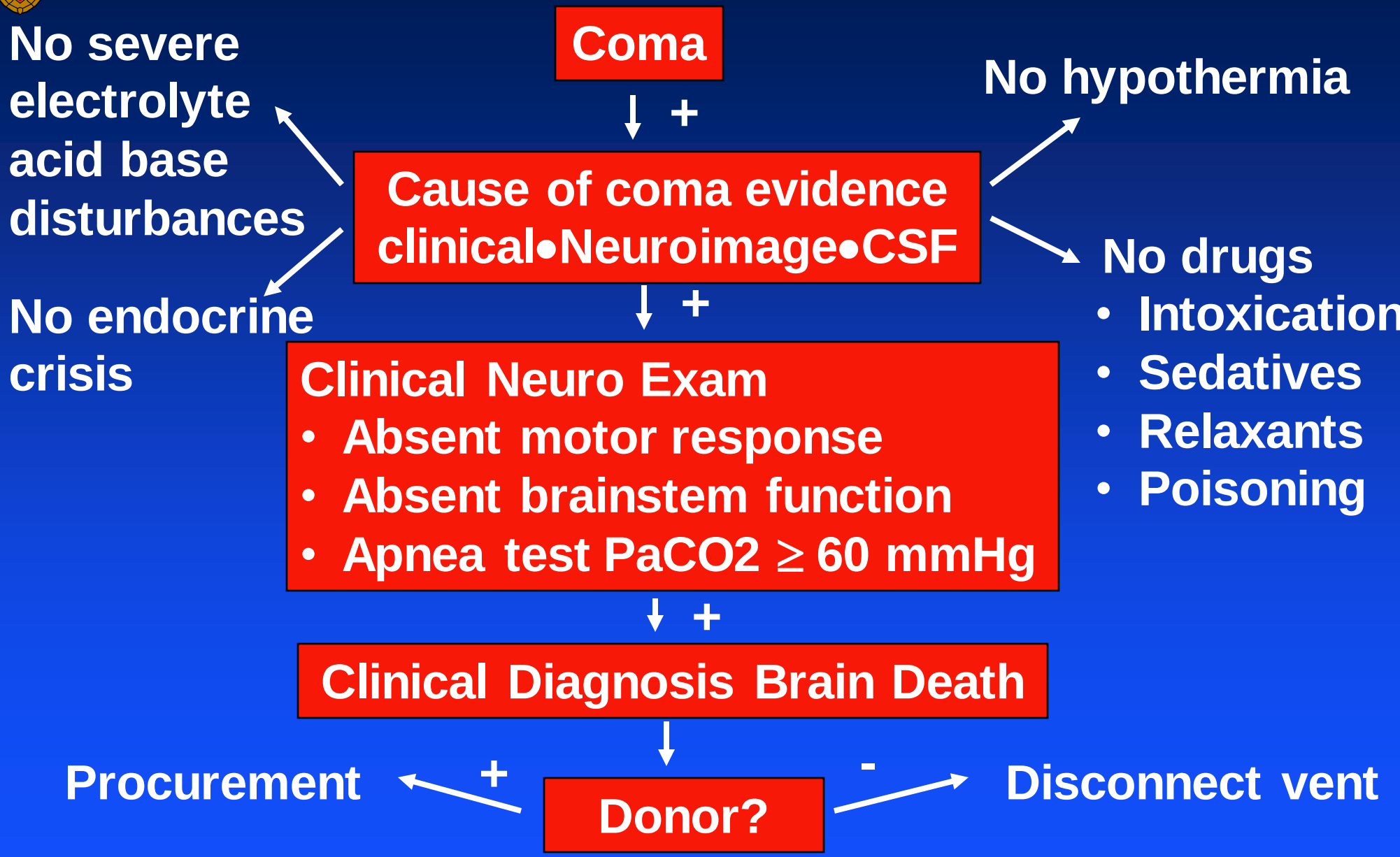
JAMA 1981; 246:2184-86

Brain Death and Organ Retrieval
Health Professionals Knowledge and Concepts

- 63% knew irreversible loss of all brain function was required for brain death declaration
- 69% correctly identified patient with irreversible loss of all brain function
- 35% knew whole brain criterion AND correctly applied to identify patient status
- 38% identified irreversible cortical loss as death (morally permissible to retrieve organs-36%)
- 23% did not favor required request laws (MD's)

Younger JAMA 1989; 261:2205-2210

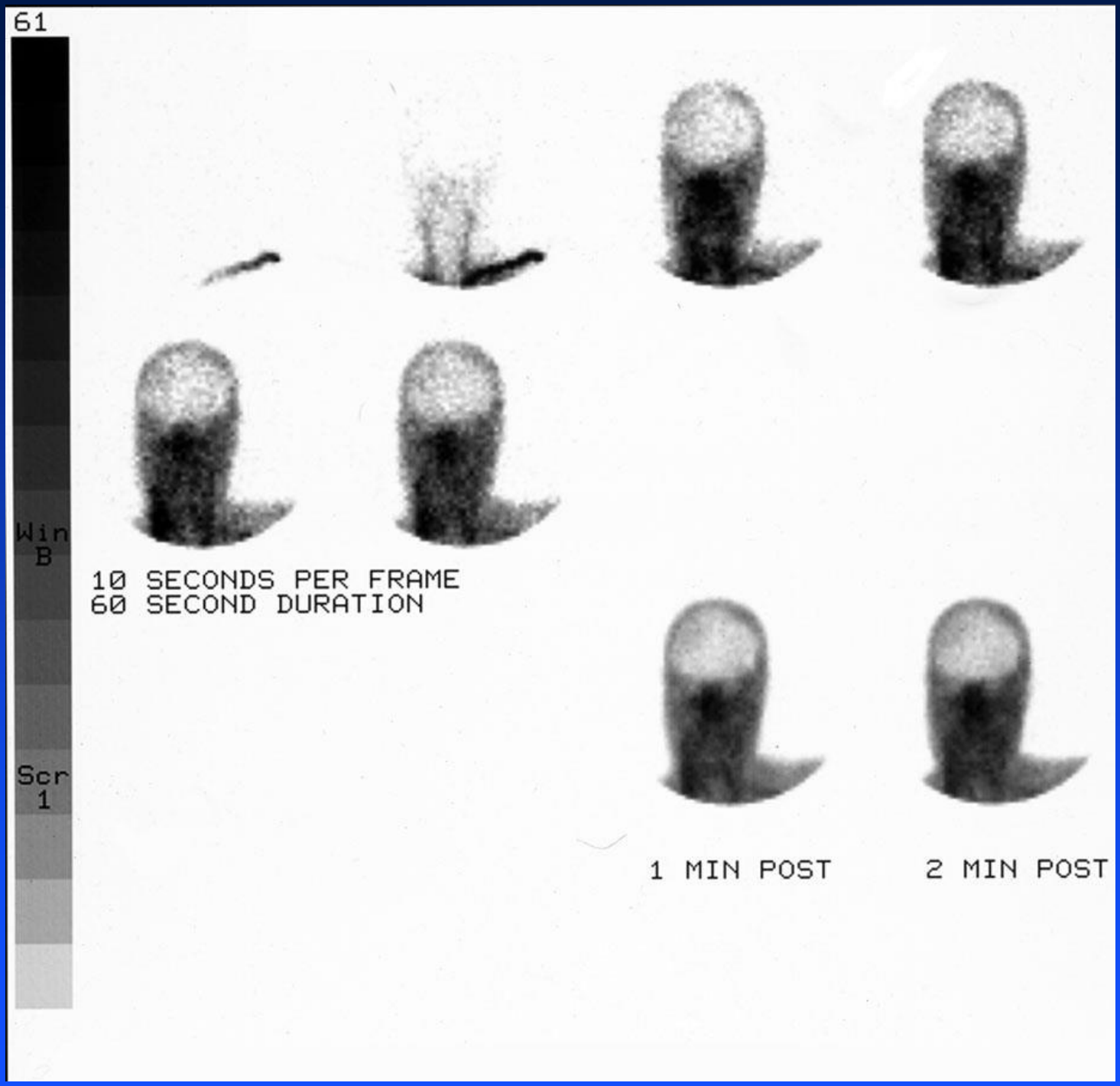
Diagnostic Approach to Brain Death (AAN)

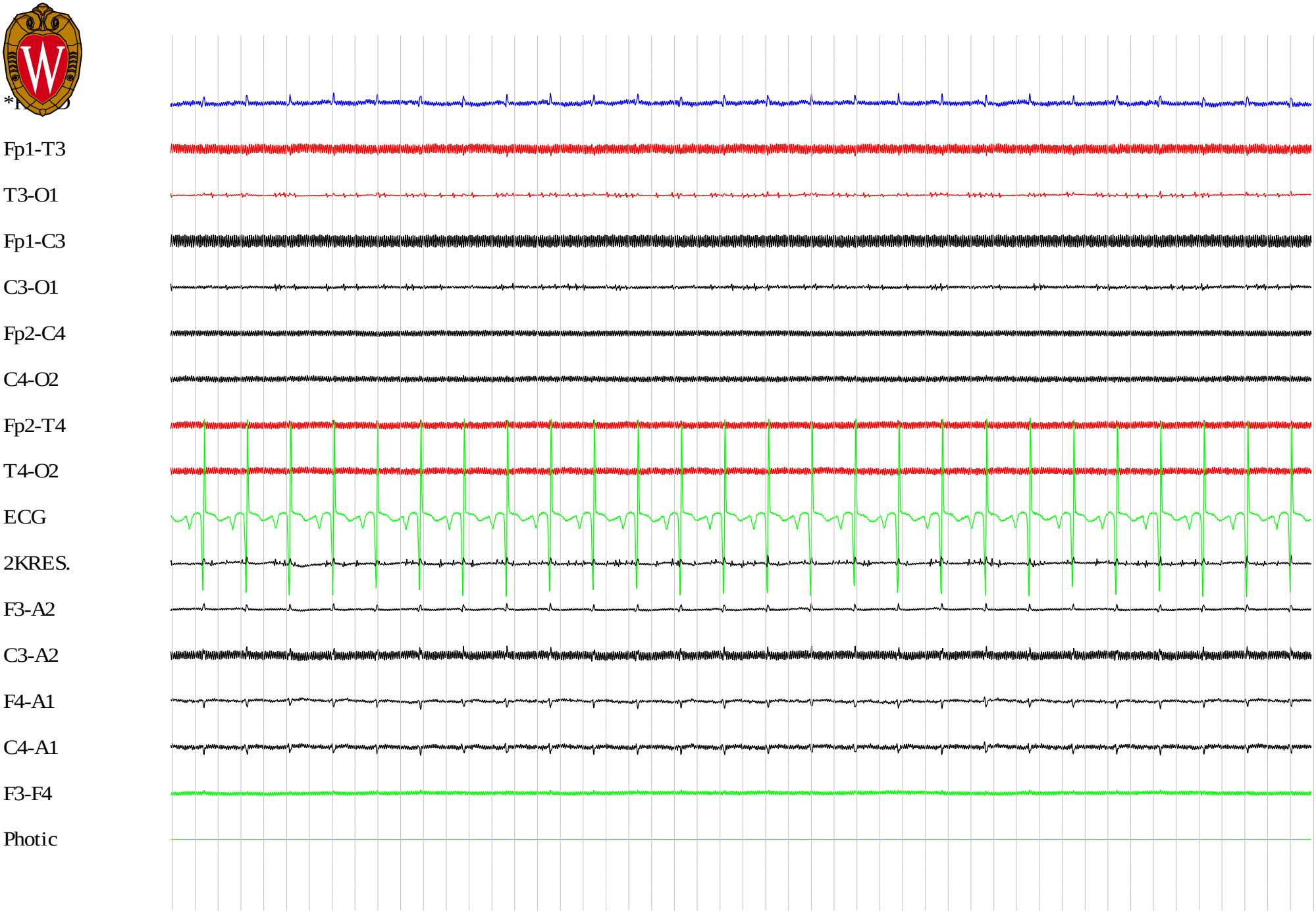


Wijdicks Neurology 1995; 45:1003-11

Confirmatory Studies

A confirmatory study is not mandatory but is needed for patients in whom specific components of clinical testing cannot be reliably evaluated.


61
Win
B
Scr
1
10 SECONDS PER FRAME
60 SECOND DURATION
1 MIN POST
2 MIN POST


*
Fp1-T3
T3-O1
Fp1-C3
C3-O1
Fp2-C4
C4-O2
Fp2-T4
T4-O2
ECG
2KRES.
F3-A2
C3-A2
F4-A1
C4-A1
F3-F4
Photic

Federal Conditions of Participation

- Requires hospitals to notify their local organ procurement organization (OPO) in a timely manner about patients whose death is “imminent”

- Stipulated the use of “designated requesters” to make the request for organ donation and required that any persons who discuss organ donation with families be trained to do so

(COP)(42 CFR Part 482 [HCFA-3005-F]
RIN: 0938-AI95) 1998

Donor Management Structured Approach

	Pre-RBD Protocol	Post RBD Protocol
Potential Donors	141	16
Medical failure rate	13%	0%
Other unsuitability	7%	0%
Organ/potential donor	1.5±0.2	3.3 ±0.6
Eligible donors	113	14
Family refusal	56%	29%
Consent	44%	71%
Organ/eligible donor	1.8 ±0.2	3.4 ±0.6
Time	12.0 hrs.	3.4 hrs.
Charges	$16,645	$6,125

Jenkins World J Surg 1999; 23:644-649

Maximal Utilization and Optimal Management of Potential Organ Donors

Surveillance

Declaration

Consent

Medical Management

Potential Organ Donors Surveillance

Deaths	Potential Donors	%
11,555	741	6.4%

- Request 80%
- Consent 48%

Initial Donation Decisions (55%)

Favorable (58%)		Unfavorable (25%)		Undecided (17%)	
Consent 81%	No Consent 19%	Consent 9%	No Consent 91%	Consent 47%	No Consent 53%

Siminoff JAMA 2001; 286:71-77

Pre-request Factors for Donation

Association

- Patient
  - younger
  - white
  - male
  - trauma
- Family
  - ⊕ belief donation
  - prior knowledge
  - donor card
  - explicit discussions
  - belief pt donate
  - information OK
- HCP
  - Comfort with questions

No Association

- Family education/income
- Hospital environmental variables
- HCP sociodemographics
- HCP attitude towards donation

Siminoff JAMA 2001; 286:71-77

Decision Process Variables

Positive Correlation

- HCP correct initial assessment
- Family raised issue
- HCP (non MD) → OPO
- Conversations/time with OPO
- OPO prior to request
- Discussions → cost, funeral, choice

Negative Correlation

- HCP not caring
- Surprised at request
- Harassed/pressured
- Required to ask

No Correlation

- Overall satisfaction with care
- HCP initial request
- Timing of request
- Belief patient alive after declaration

Siminoff JAMA 2001; 286:71-77

Factors Directly Related to Donation

	OR
Pre-request characteristics	7.68
Optimal request pattern (HCP non-MD → OPO)	2.96
OPO related factors	3.08
Topics discussed	5.22

Siminoff JAMA 2001; 286:71-77

Improving the Request Process

- Most successful requests
  - Private setting
  - Allow family to comprehend death before discussing organ donation (decoupling)
  - Involvement of OPO coordination
- Consent 2.5X higher when all 3 elements present compared to none
- < 1/3 all donation requests included all 3 elements

Gortmaker J Transpl Coord 1998; 8:210-17

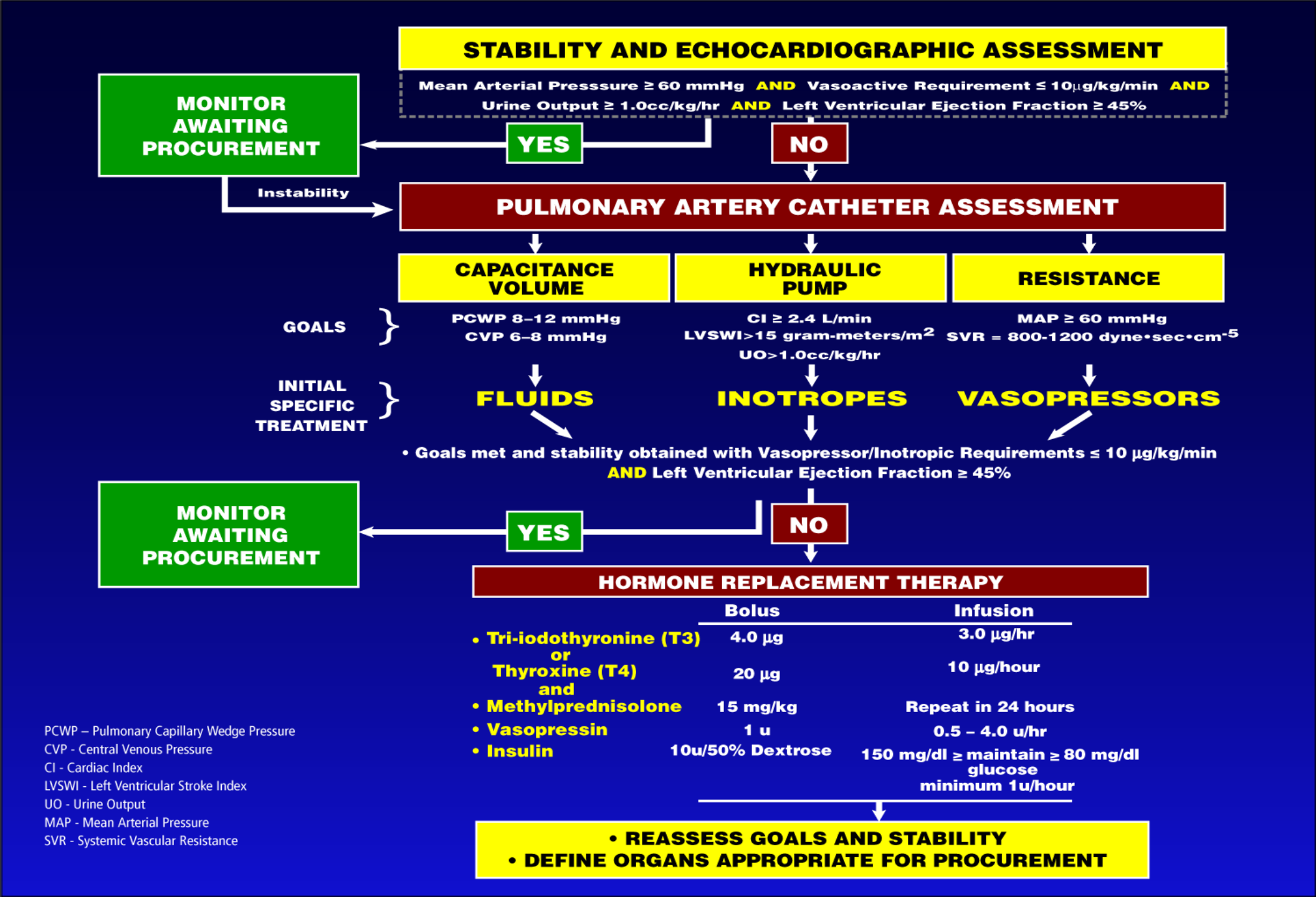
Maximal Utilization and Optimal Management of Potential Organ Donors

Surveillance

Declaration

Consent

Medical Management


STABILITY AND ECHOCARDIOGRAPHIC ASSESSMENT
Mean Arterial Presssure ≥ 60 mmHg AND Vasoactive Requirement ≤ 10μg/kg/min AND
Urine Output ≥ 1.0cc/kg/hr AND Left Ventricular Ejection Fraction ≥ 45%
MONITOR AWAITING PROCUREMENT
YES
NO
Instability
PULMONARY ARTERY CATHETER ASSESSMENT
CAPACITANCE VOLUME
HYDRAULIC PUMP
RESISTANCE
GOALS
PCWP 8–12 mmHg
CVP 6–8 mmHg
CI ≥ 2.4 L/min
LVSWI>15 gram-meters/m2
UO>1.0cc/kg/hr
MAP ≥ 60 mmHg
SVR = 800-1200 dyne•sec•cm-5
INITIAL SPECIFIC TREATMENT
FLUIDS
INOTROPES
VASOPRESSORS
• Goals met and stability obtained with Vasopressor/Inotropic Requirements ≤ 10 μg/kg/min
AND Left Ventricular Ejection Fraction ≥ 45%
MONITOR AWAITING PROCUREMENT
YES
NO
HORMONE REPLACEMENT THERAPY
Bolus
Infusion
• Tri-iodothyronine (T3) 4.0 μg 3.0 μg/hr
or
Thyroxine (T4) 20 μg 10 μg/hour
and
• Methylprednisolone 15 mg/kg Repeat in 24 hours
• Vasopressin 1 u 0.5 – 4.0 u/hr
• Insulin 10u/50% Dextrose 150 mg/dl ≥ maintain ≥ 80 mg/dl glucose minimum 1u/hour
• REASSESS GOALS AND STABILITY
• DEFINE ORGANS APPROPRIATE FOR PROCUREMENT
PCWP – Pulmonary Capillary Wedge Pressure
CVP - Central Venous Pressure
CI - Cardiac Index
LVSWI - Left Ventricular Stroke Index
UO - Urine Output
MAP - Mean Arterial Pressure
SVR - Systemic Vascular Resistance

Hemodynamic Management

STABILITY AND ECHOCARDIOGRAPHIC ASSESSMENT

Mean Arterial Presssure ≥ 60 mmHg **AND** Vasoactive Requirement ≤ 10μg/kg/min **AND**
Urine Output ≥ 1.0cc/kg/hr **AND** Left Ventricular Ejection Fraction ≥ 45%

YES → **MONITOR AWAITING PROCUREMENT**

NO → **PULMONARY ARTERY CATHETER ASSESSMENT**

Instability → **PULMONARY ARTERY CATHETER ASSESSMENT**

	CAPACITANCE VOLUME	HYDRAULIC PUMP	RESISTANCE
GOALS	PCWP 8-12 mmHg CVP 6-8 mmHg	CI ≥ 2.4 L/min LVSWI>15 gram-meters/m^2 UO>1.0cc/kg/hr	MAP ≥ 60 mmHg SVR = 800-1200 dyne•sec•cm^{-5}
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AND
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YES → **MONITOR AWAITING PROCUREMENT**

NO → **HORMONE REPLACEMENT THERAPY**

PCWP – Pulmonary Capillary Wedge Pressure
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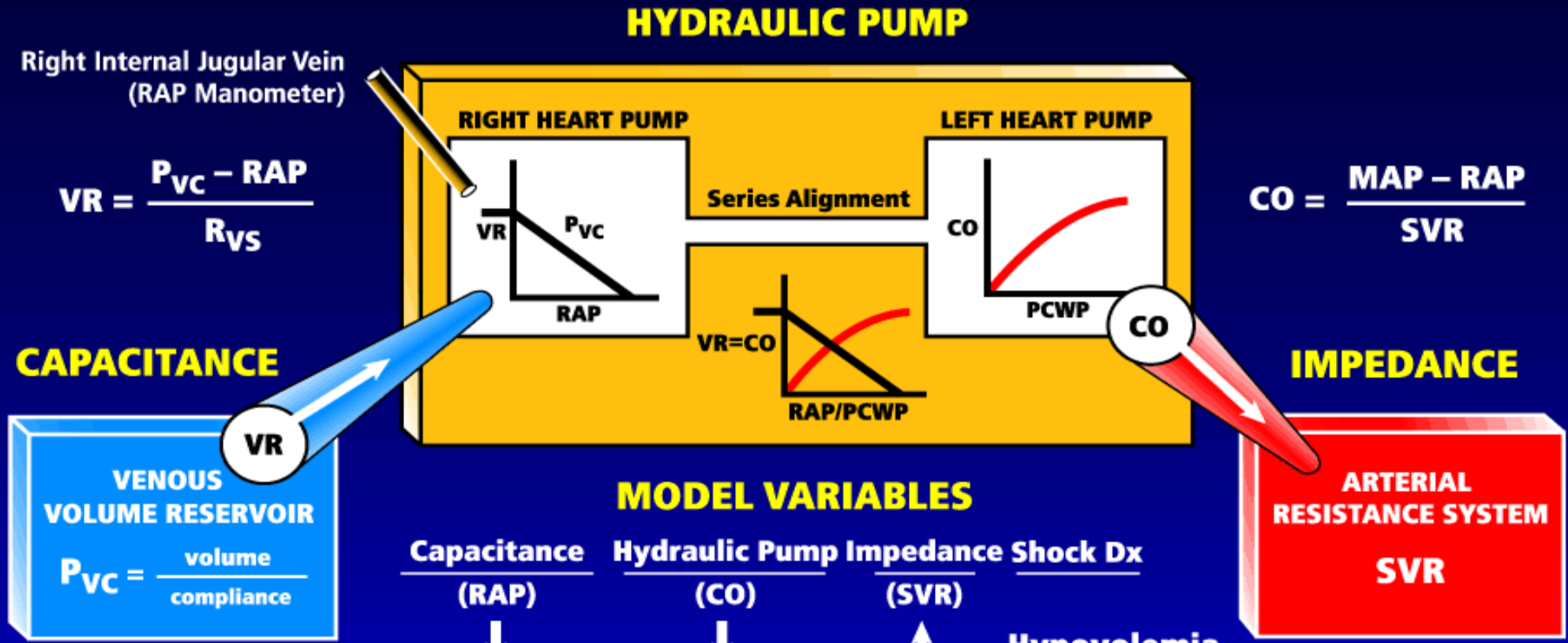
Time to dust it off and take it for a spin

Three Compartment Circulatory Shock Model



$$VR = \frac{P_{VC} - RAP}{R_{VS}}$$

$$CO = \frac{MAP - RAP}{SVR}$$

$$P_{VC} = \frac{\text{volume}}{\text{compliance}}$$

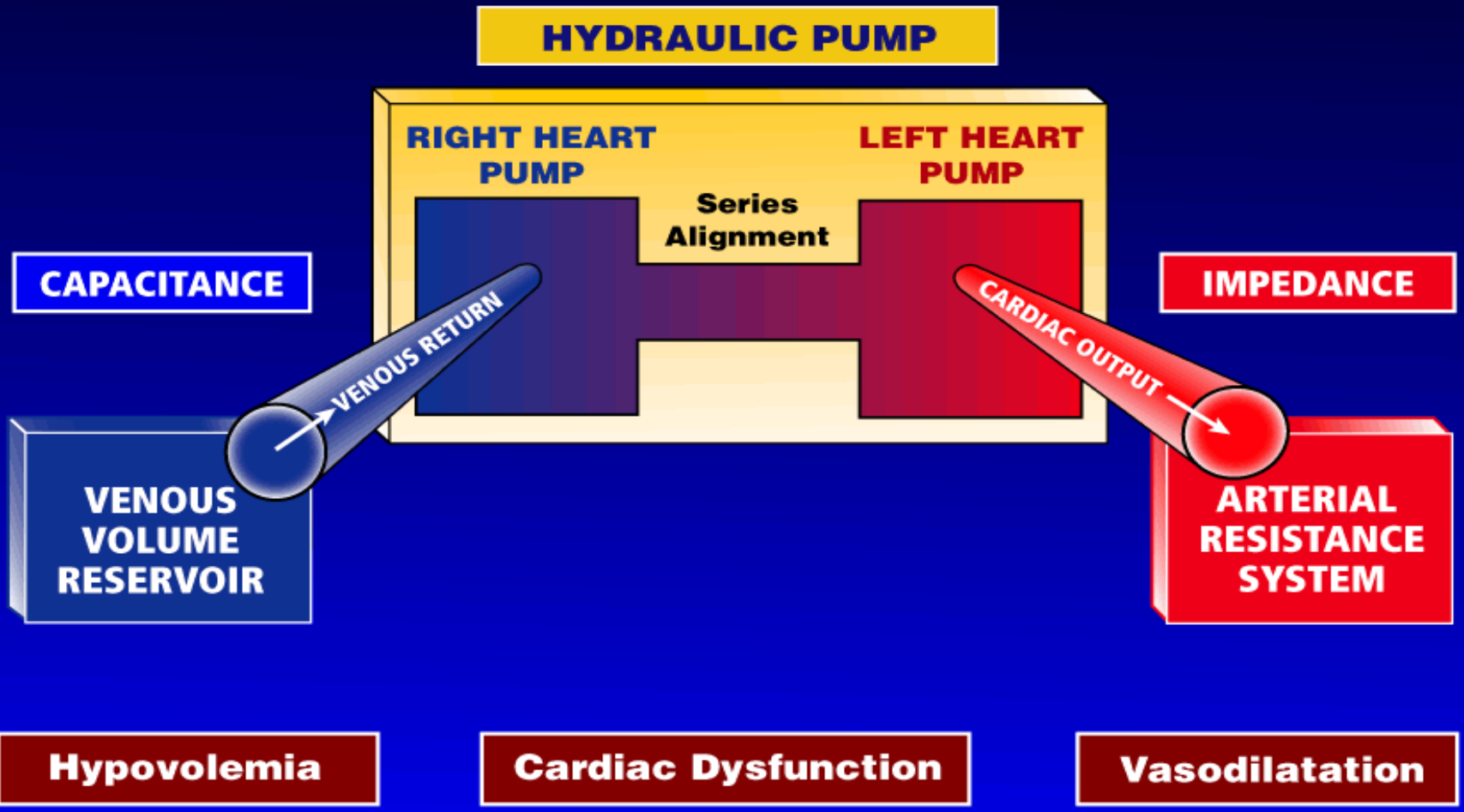
MODEL VARIABLES

Capacitance (RAP)	Hydraulic Pump (CO)	Impedance (SVR)	Shock Dx
↓	↓	↑	Hypovolemia
↑	↓	↑	Biventricular Failure 2° LV Failure
→	↑	↓	Sepsis
↑	↓	↑	Major PE

VR = Venous Return
P_{VC} = Pressure Venous Capacitance
RAP = Right Atrial Pressure
R_{VS} = Resistance Venous System

MAP = Mean Arterial Pressure
CO = Cardiac Output
SVR = Systemic Vascular Resistance
LV = Left Ventricle

Evaluation of Hypotension in the Potential Organ Donor



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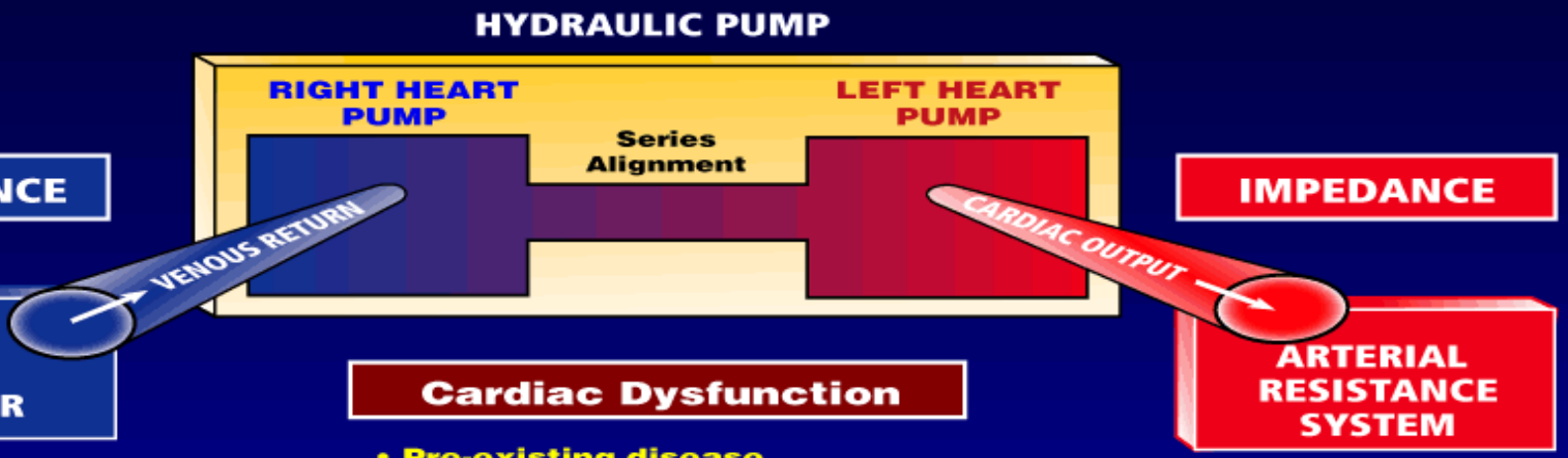


Hypovolemia

- **Absolute**
  - Initial injury
    - Inadequate resuscitation
    - Third spacing
    - Decreased intravascular oncotic pressure post crystalloid resuscitation
  - ICP treatment dehydration
    - Fluid restriction
    - Urea
    - Diuretics
    - Mannitol
  - Hyperglycemia induced osmotic diuresis
  - Diabetes insipidus
  - Hypothermic "cold" diuresis
- **Effective**
  - Venodilatation
    - Loss vasomotor tone and pooling in venous capacitance bed
    - Rewarming of hypothermia

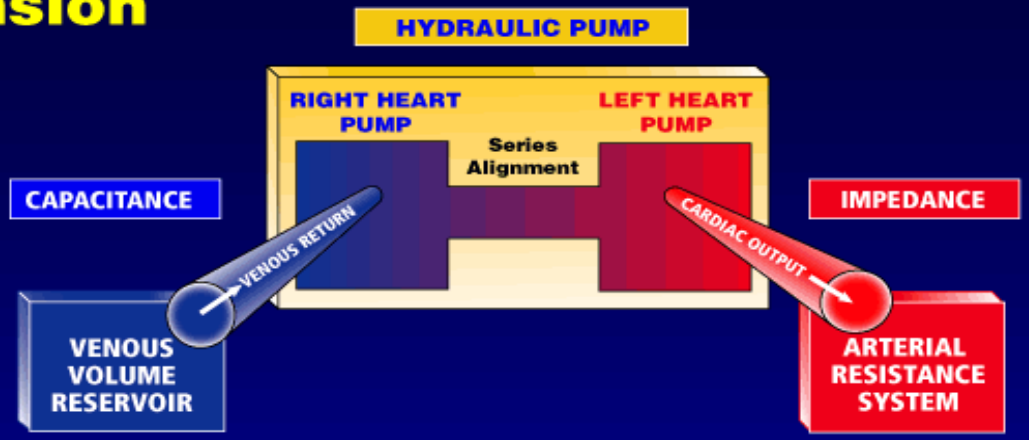
Cardiac Dysfunction

- Pre-existing disease
- Initial injury
  - Myocardial contusion
  - Pericardial tamponade
  - Myocardial ischemia/infarct
- Brain death process
  - Catecholamine-Ca damage
  - Ischemia-reperfusion injury
- Metabolic depression
  - Acidosis
  - Hypothermia
  - Hypophosphatemia
  - Hypocalcemia
  - Hypoxia
  - Endocrinopathy of brain dead
- Volume overload CHF
- Arrhythmias
  - Catecholamines
  - Ischemia
  - Hypokalemia
  - Hypomagnesemia

Vasodilatation

- Spinal shock
- Catecholamine depletion
- Loss of vasomotor control and autoregulation
- "Relative" adrenal Insufficiency of trauma/ critical illness
- Endocrinopathy of brain death
- Acquired sepsis

Evaluation of Hypotension



Hypovolemia

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- **EFFECTIVE**
  - Venodilatation
    - Loss vasomotor tone and pooling in venous capacitance bed
    - Rewarming of hypothermia

Antagonistic Competing Organ Interests

Fluid Status

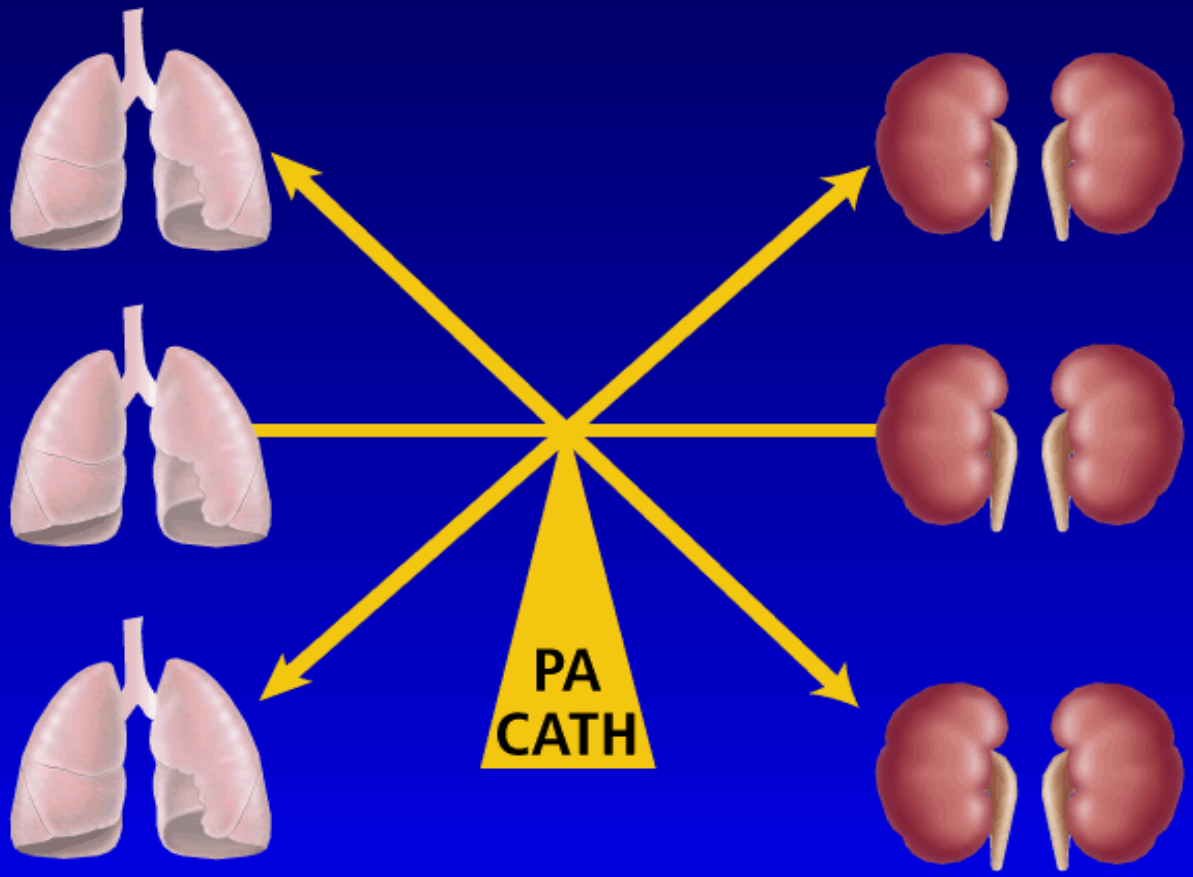
Organ Outcome

Dehydration

Over-hydration

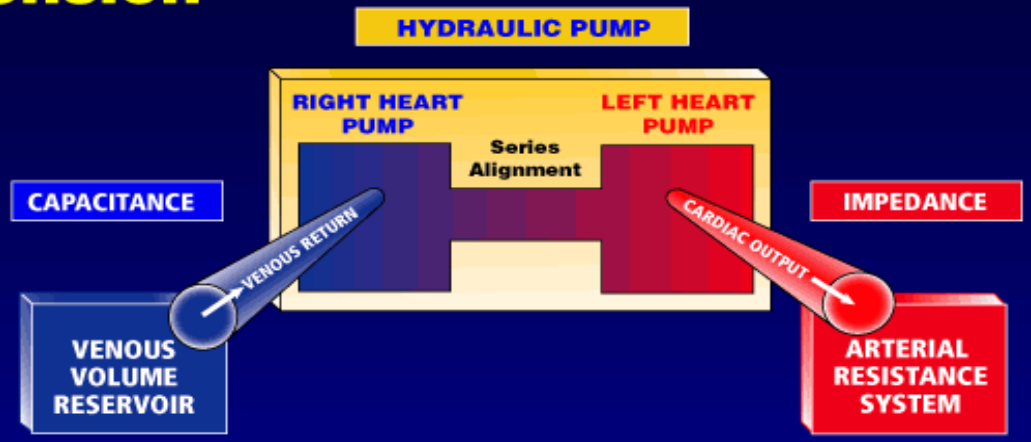
GOOD

POOR



Adopted from Ali Critical Care Clinics 1994;12:655-671

Evaluation of Hypotension



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Donor Catecholamine Use

	None	One	Combo	4 yr Survival Hazard Ratio
Kidney (1489)	8.7%	58.1% (Dopamine 94%)	33.2% (Dopa/Dobut 49%) (Dopa/Norepi 22%) (15% > 2 agents)	0.85*
Liver (755)	9.4%	60.3%	30.3%	0.90
Heart (720)	8.3%	63.1%	28.6%	1.26*

- Immunomodulatory effect
- Organ variance

Schnuelle Transplantation 2001; 72:455-63

Hemodynamic Management

STABILITY AND ECHOCARDIOGRAPHIC ASSESSMENT

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Hemodynamic Management

HORMONE REPLACEMENT THERAPY

	Bolus	Infusion
• Tri-iodothyronine (T3)	4.0 µg	3.0 µg/hr
or		
Thyroxine (T4)	20 µg	10 µg/hour
and		
• Methylprednisolone	15 mg/kg	Repeat in 24 hours
• Vasopressin	1 u	0.5 – 4.0 u/hr
• Insulin	10u/50% Dextrose	150 mg/dl maintain 80 mg/dl glucose minimum 1u/hour

- REASSESS GOALS AND STABILITY
- DEFINE ORGANS APPROPRIATE FOR PROCUREMENT

Potential Organ Donor Management

Hormonal Therapy (Human)

T_3- Cortisol- Insulin

	Standard (26)	Hormone (21)
Unsuitable TXP	20%	0%
Dopamine ug/Kg/min	14 → 19	27 → 13
CV Fxn	→	↑ 2x Cardiac output
EKG abnormal	Persisted	Improved
MAP	→	56mmHg →86mmHg (↑ 53%)
CVP	→	11mmHg → 7mmHg (↓ 35%)
HR	→	67 → 91 (↑ 35%)
HCO_3 Required	↑ 100%	↓ 95%
Lactate	NR	5.1 → 2.4 (↓ 52%)
Temp	→	33^0 → 36^0

Novitzky Transplantation 1987; 43:852-

Rescue Hormone Therapy

≥ 10ug/kg/min Vasoactive Support

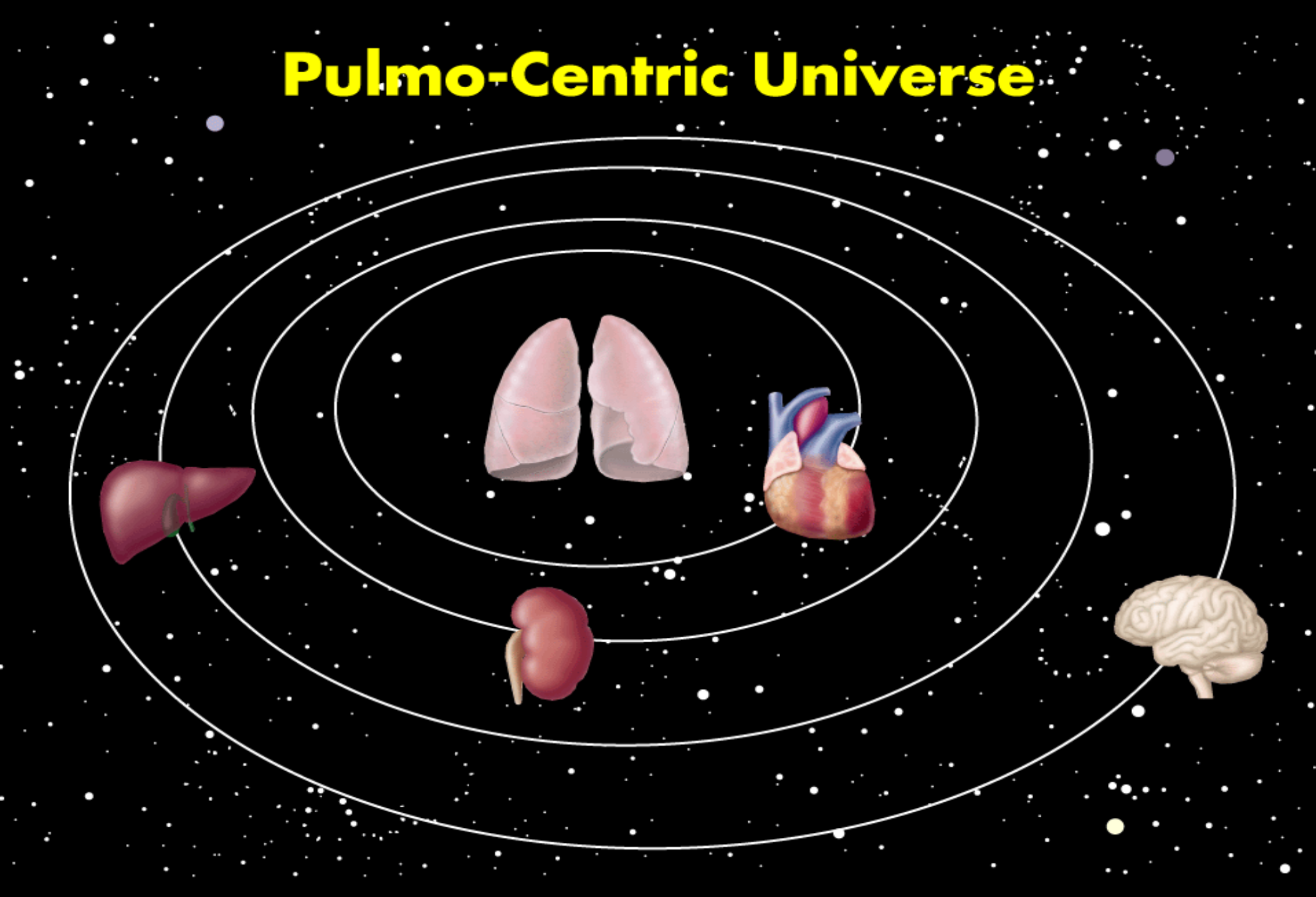
- 1 ampule 50% dextrose – 20 u insulin
- 2 grams methylprednisolone
- 20 μg levothyroxine → infusion 10 μg/h

	PRE	POST
Vasopressor ug/kg/min	11.1	6.4
Heart rate beats/min	120	113
Oxygen consumption ml/min/m²	107	123
Oxygen extraction %	16	18

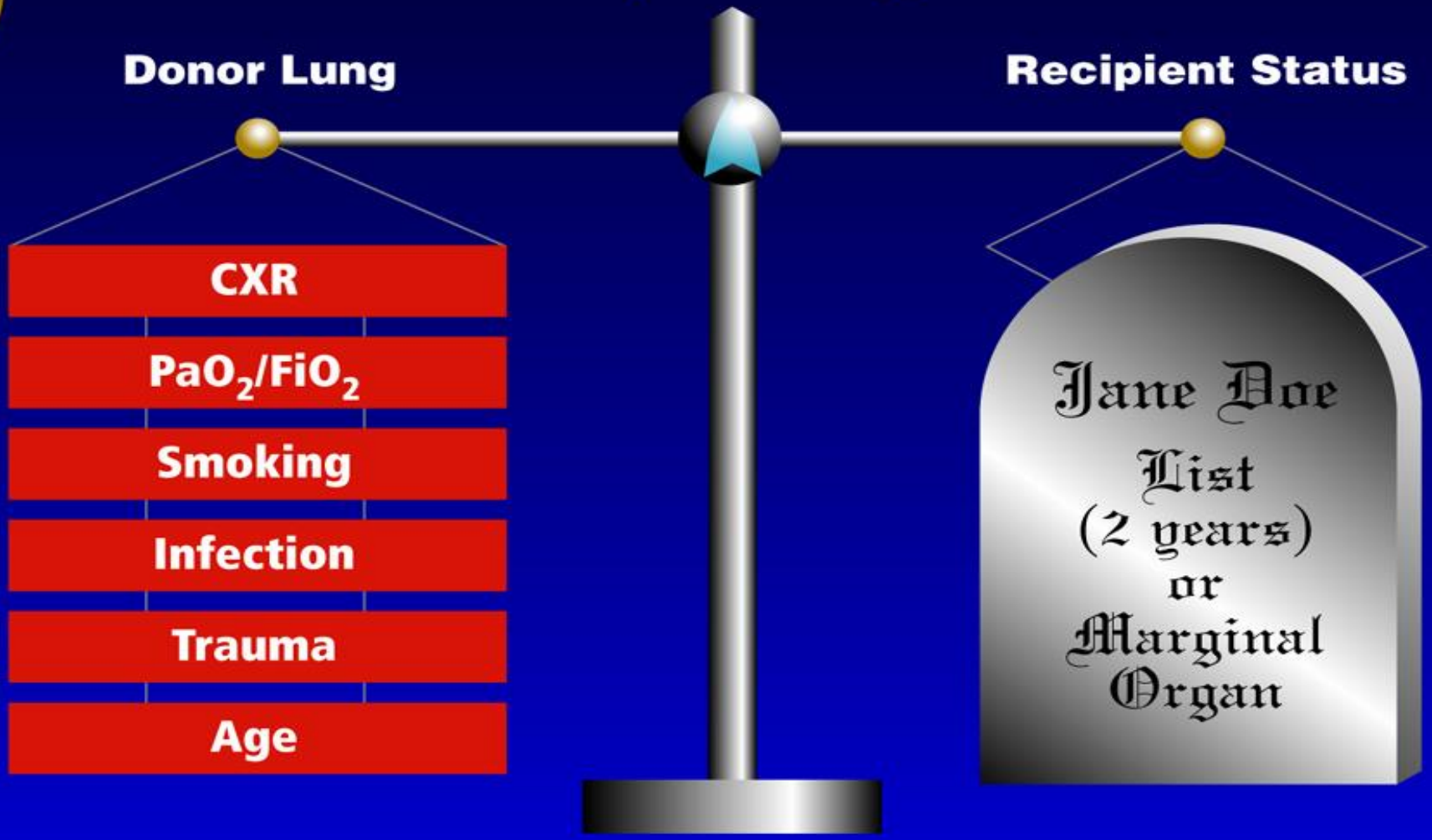
- Vasopressors → Reduction → All (4 hours)
  → Cessation → 53%
- No cardiovascular collapse

Salim Arch Surg 2001; 136:1377-80

Pulmo-Centric Universe



Marginal Lungs



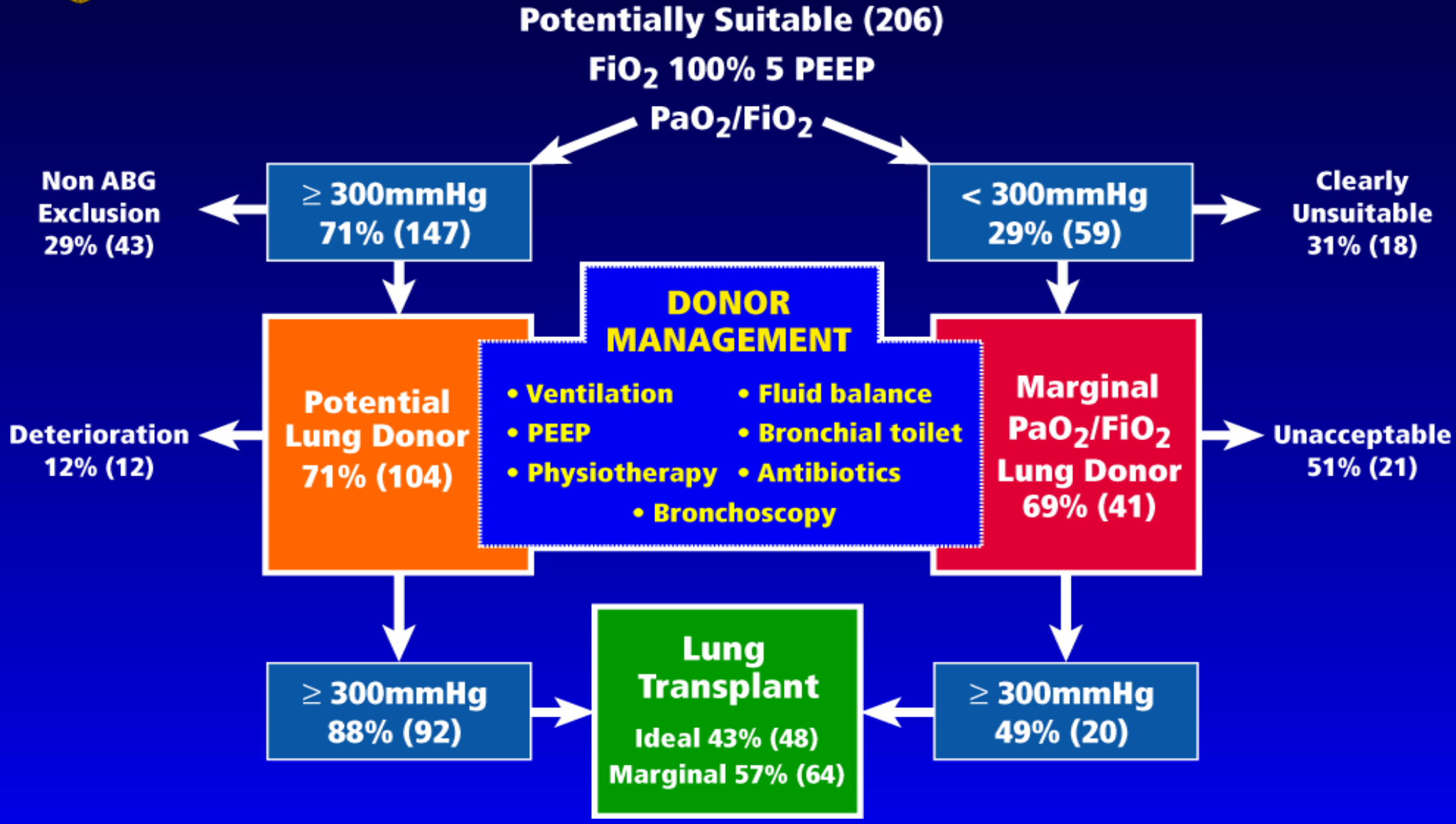
Challenges

- Develop indices to quantify/qualify degree of lung injury
- Identify reversible causes of dysfunction
- Define interventions to successfully modify unacceptable lungs

Marginal vs Ideal Donor Lung Studies

Study	Outcome early	Outcome 6 months	Outcome 1 year	Outcome 2 years	Post-op vent	A-a post op	A-a 24 hrs	ICU LOS	Hosp LOS	OR Complications	ICU Complications	PFT 1 yr
Kron 93	=											
Shumway 94		=	=									
Sandaresan 95	=	=	=	=	=	=	=					
Gabby 99	=	=	=	=		=	=	=				
Bhorade 00	=		=		=				=	=	=	=
Straznicka 02	=		=					=				

Maximizing Utilization for Lung Transplant



Gabbay AmJ Resp CCM 1999;160:265-271

Aggressive Lung Resuscitation

- Educational changes
  - Didactic curriculum
  - Procurement

Management Protocols

	1992	1993
Tidal Volume	10 cc/kg	15 cc/kg
PEEP	5 cm	5 cm
Suctioning	Q 2 hr	Q 1 hr
CVP	10-12 mmHg	6-8 mmHg
Successful Procurement	15.8% (21/133)	31.8% (49/154)

Cummings J Txp Coord 1995; 5:103-106

Multidisciplinary Management Lung Donors

Management Strategies

- consensus standardized orders OPO txp
- early bronchoscopy
- early ventilator management
- early hemodynamic monitoring
- early corticosteroids, thyroxine
- emphasis upon colloid
- judicious use vasoactive support
- early and continuous access to transplant pulmonologist

Follette Txp Proced 1999; 31:169-70

Aggressive OPO Management

13% Unacceptable

Management		Pre-OPO	Procurement
• Invasive monitoring	PaO_2 / FiO_2	103	463
• Methylpred	FiO_2	86%	100%
• Fluid restriction	CVP	11.3 mmHg	6.7 mmHg
• Titrated inotropes	Net Fluid	4.1 L	- 1.7 L
• Bronchoscopy	Dopamine	15 μg/kg/min	5.2 μg/kg/min
• Diuresis	Abnormal	77%	0%

Straznicka J Thorac CV Surg 2002; 124:250-58

Brain Death and Organ Retrieval

Technology is no longer the rate limiting factor in human organ transplantation. Rather, it is the ability to obtain organs from suitable donors which depends largely on the attitude and commitment of health professionals…need to increase the quantity and expand the content of education and discussion among health professionals…without it, the transplant enterprise may not fulfill its potential to benefit the living.

Younger JAMA 1989; 2205-2210


"That's all Folks!"