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CONTEMPORARY APPROACH PULMONARY HYPERTENSION IN PREGNANCY

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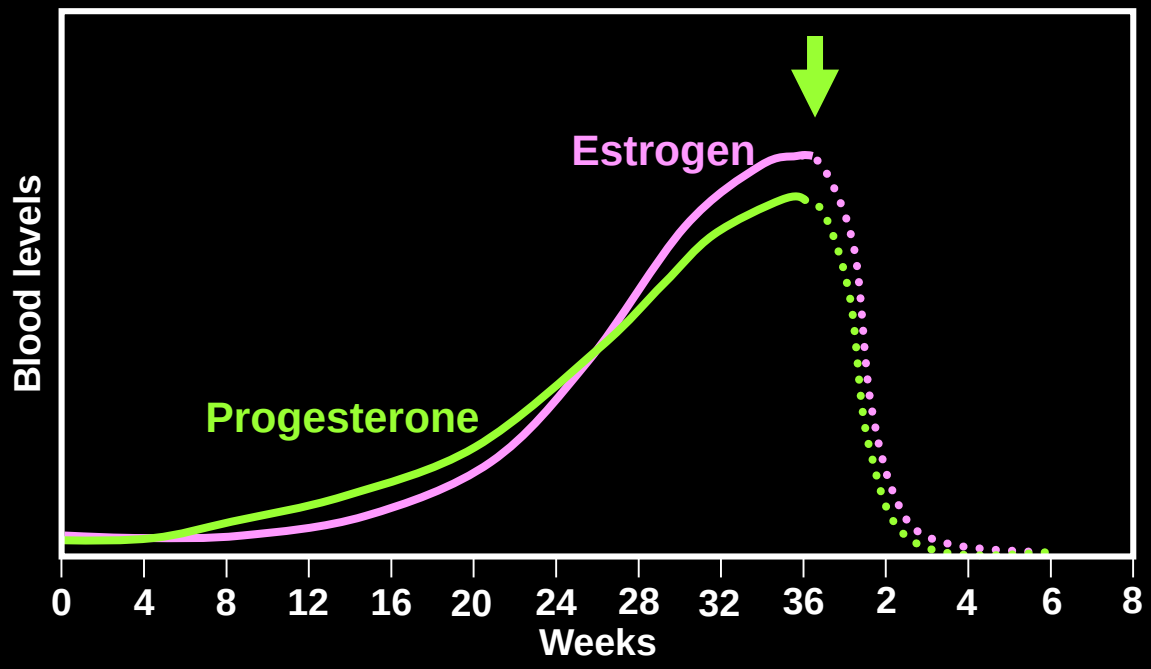
Objectives

Physiological Changes in Pregnancy

Pulmonary Arterial Hypertension (PAH) and Pregnancy Review of literature

Treatment Plan

Physiological Adaptations During Pregnancy



Cardiovascular

Renal

Hematologic

Respiratory

Labor and Delivery

Cardiovascular Adaptations

Blood volume:
40-100% increase in plasma volume (32 weeks)
(skin, breast, uterus, muscle)

“Physiologic anemia”
RBC production increases 20-30%

Cardiac output: Increases 40%
beginning in 1st trimester up to 8 Liters,
through week 36-39

Resting HR increases by 15%

Cardiovascular Adaptations

Stroke volume: Increases by 35%

S3 gallop, split S2, JVD+

Systemic Vascular Resistance Decreases (week 5-32)
Progesterone mediated
Blood pressure decreases
Pulmonary Artery Pressure also decreases

Aortocaval compression due to enlarging uterus
Venous pooling increases 150%
Renal blood flow decreases by 24%
Decreases venous return to right heart

Renal Adaptations

Increase in flow 60-80% by 3rd trimester,
50% increase in GFR
Increases in renin and angiotensin II
Increases sodium and water retention

Hematologic Adaptations

Relative hypercoagulable state
Decrease in Protein S
Increase in Factor I and X
Increase in Protein C resistance

Respiratory Adaptations

Increase in Minute Ventilation, Tidal Volume and Oxygen consumption by 20-40%

Secondary to increase in progesterone

Functional Residual Capacity Decreases 10-25%

CO_2 decreases to 28-32 mEq/L by term

Plasma bicarbonate decreases to 18-21 mEq/L

Dyspnea on Exertion: Biologic hyperventilation

Labor and Delivery

300-500 ml of blood return to circulation with uterine contractions

Preload increases (10-15%) immediately post partum

Further increase in cardiac output in the next 48 hours

Vigorous spontaneous diuresis for initial 72 hours

Ongoing slow diuresis for next two weeks

Normalize hormone levels in 6 weeks

Pregnancy in PH: Literature Review

Time Period	Pregnancies	PH Type	Mortality	
1948-1978 [1]	70	Eisenmenger	30%	
1978-1996 [2]	27	IPAH	30%	}
	73	Eisenmenger	36%	} Overall
	25	oPH	56%	} 38%
1997-2007 [3]	29	IPAH	17%	}
	29	Eisenmenger	28%	} Overall
	15	oPH	33%	} 25%
1999-2009[4]	7	CHD	7%	
	3	iPAH	0%	} Overall
	2	CTD	0%	7%

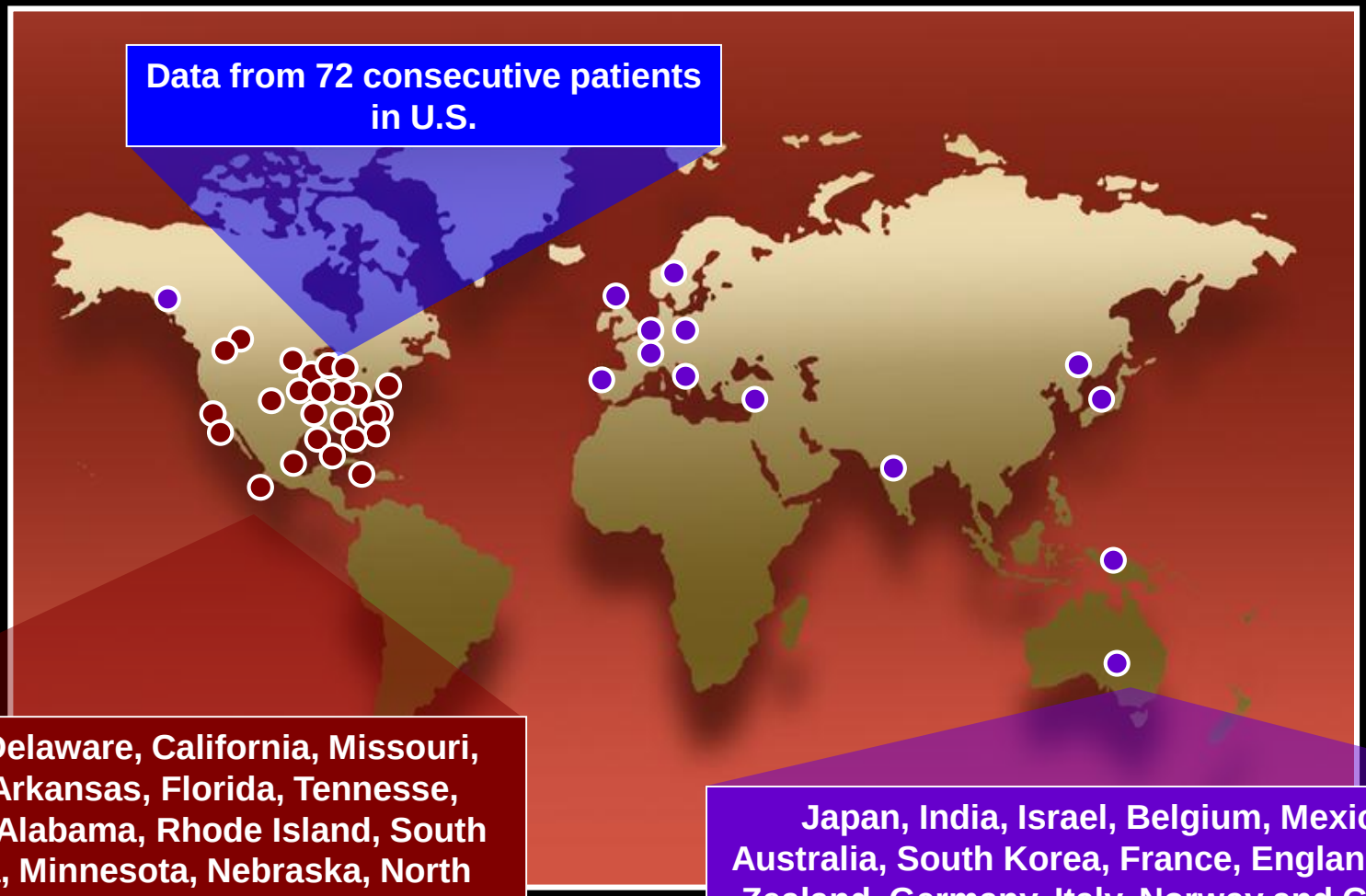
[1]Gleicher N et al. Obst Gyn Surv 1979; 34:721-741, [2]Weiss BM et al. JACC 1998; 31:1650-7, [3]Bedard E et al. Eur Heart J 2009; 30:256-265, [4]Duarte, AG. CHEST 2015;143(5):1330-1336

Can We Prevent Pregnancy Associated Mortality In Women with PAH?

Our 14 year experience

- 128 consecutive cases of pregnancy with PAH between 2002-2016
  - Characteristics of our population
  - Care provided pre/post-delivery
  - Outcome of our pattern of care

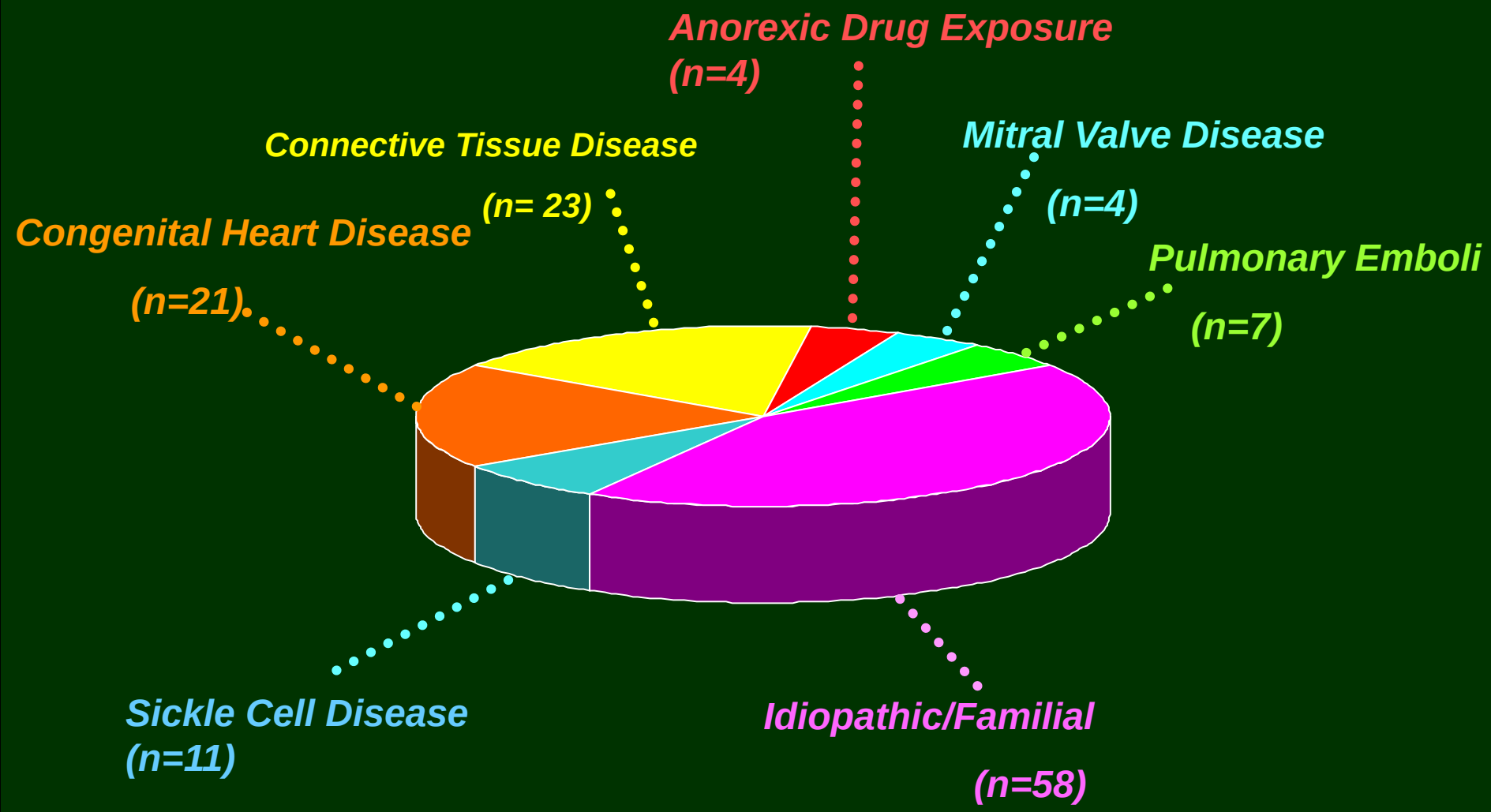
Data from 56 distant consultations



Illinois, Delaware, California, Missouri, Texas, Arkansas, Florida, Tennesse, Georgia, Alabama, Rhode Island, South Carolina, Minnesota, Nebraska, North Dakota, Washington, Colorado, North Carolina, Ohio, Michigan, New York, Indiana, Virginia, Montana

Japan, India, Israel, Belgium, Mexico, Australia, South Korea, France, England, New Zealand, Germany, Italy, Norway and Canada

Etiology of Pulmonary Arterial Hypertension (n=128)



Subject Population

128 patients delivered 135 babies

# of Patients	# of Pregnancies	# of Babies
1	1	2
1	3	3
5	10 (2 pregnancies/patient)	10
121	121 (1 pregnancy/patient)	120*
128	135	135

*MD recommended termination @ 22 weeks

Subject Population

120 patients – PAH diagnosed after pregnant

8 patients had elective pregnancies =

15 babies

*1 = 3 pregnancies

* 5 = 2 pregnancies

* 2 = 1 pregnancies

RESULTS : Deliveries

Anesthesia : 129 epidurals, 6 general

118 vaginal deliveries (87%)

17 C-section deliveries (13%)

* **1 set of twins**

9 infants on ventilator
(2 from vaginal deliveries & 5 from C-sections)

* **1 termination at 22 weeks by MD advice**

No maternal or infant deaths

Pharmacotherapy

3 - Sildenafil only

15- PDE 5 Inhibitor and Tyvaso

52 - IV Prostacyclin and PDE 5 Inhibitors

58 - IV Prostacyclin only

Other pharmacologic agents used in this population of patients

Inhaled vasodilators

- *Nitric Oxide*
- *Epoprostenol*

Antiarrhythmics

- *Diltiazem*
- *Amiodarone*
- *Digoxin*

Diuretics

- *Furosemide*
- *Torsemide*
- *Bumetinide*

Anticoagulants

- *Warfarin*
- *Enoxaparin*

Inotropes

- *Dobutamine*
- *Digoxin*
- *Dopamine*

Other

- *KCL*
- *Magnesium*
- *Procardia*
- *Norvasc*

Care Delivery team

Team Leader: Cardiology / Pulmonary
Manages Mother's RV function and Medications

Echo Technician

Maternal Fetal Medicine Specialist
Neonatologist
Cardiac and OB Anesthesia

Labor and Delivery Staff
Critical Care Nursing Staff
Respiratory Therapy Staff

TREATMENT STRATEGY

Initiate pharmacologic therapy

Immediately and aggressively

Most need IV Prostacyclin therapy

Everyone must work together

***recommend one physician manages diuretics**

Physician managing PAH dictates timing of delivery based on frequent assessments of Right Ventricular Function

TREATMENT STRATEGY

Extensive patient education and clearly outline risks

Drugs unfamiliar to obstetrician are used

C-Section only for absolute obstetric indication

Delivery 36th week at the latest

TREATMENT STRATEGY

DELIVERY ROOM

Slow onset epidural by obstetric/cardiac anesthesia

Careful management of fluids during labor/delivery

No prolonged Valsalva manueuvers

Most do not need PA (Swan Ganz) catheter

Count every milliliter of fluids in and out

Foley catheter before leaving delivery room

To Critical Care Unit on Pulmonary Hypertension Service

TREATMENT STRATEGY

POST DELIVERY

Every 4 hour Intake/output for 72 hours

7-9 liters net negative output by 72 hours

In Critical Care Unit until discharge

Home on low-dose diuretics X 7 days

Follow closely – see in office within 1 week post-partum; stable after 6-8 weeks

HIGHEST RISK TIMES

16 -18 weeks

26 - 28 weeks

34 - 36 weeks

Up to 72 hours after delivery

10 days after delivery

TODAY

We can deliver most successfully

Appropriate Counseling

Significant respect for right ventricular function

Pregnancy IS NOT recommended in patients with *PAH* of any etiology

FUTURE

Requires complex team management

Requires a tertiary care center experienced with infusion prostacyclin therapy in collaboration with high-risk maternal fetal medicine and anesthesia

Which drugs?

Will PAH occur in the offspring?

DO NOT WITHHOLD
PAH TREATMENT
BECAUSE OF PREGNANCY

ERA's are contraindicated

In 2016,
we can prevent most of the mortality
associated with pregnancy and PAH