

Challenging Neonatal Cases



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Challenging Neonatal Case

- Birth resuscitation challenge
- Cardiac arrest challenge
- Ventilatory control challenge
- Renal challenge



History

- 340 day gestation
- Breach presentation
- 6:35 pm began stage II
- 8:26 pm arrival at hospital
- 8:33 pm anesthesia induced
- 8:48 pm on table
- 9:00 pm surgery started
- 9:08 pm delivered via c-section
 - 155 min stage II
 - 35 min general anesthesia

Birth Resuscitation

- Birth
 - Intubated, ambu ventilation RA
 - HR 60, ETCO₂ 38
 - HR 50, ETCO₂ 65
 - Epinephrine 1 ml IV
 - HR 140, ETCO₂ 56
- 2 min
 - Arrival NICU
 - ETCO₂ 62



Birth Resuscitation

- 3 min
 - HR 155
 - Began O₂ on ambu
- 4 min
 - ETCO₂ 65, HR 112, cyanosis
 - Poor perfusion – pulse, fill, tone, cold legs
- 5 min
 - HR 168
 - PVCs
 - HR 163

Birth Resuscitation

- 7 min
 - ETCO₂ 81
 - HR 142
- 8 min
 - Temp 100.4
 - 82/39(56)162; HR 158
- 12 min
 - ETCO₂ 85
 - HR 153

Birth Resuscitation

- 15 min
 - Spontaneous respiration
 - IV catheter
 - Dextrose
 - Fluid bolus
- 17 min
 - HR 52 – 108 (irregular)
 - ETCO₂ 62
 - 1 ml epinephrine
 - Dobutamine/ vasopressin begun
 - Defibrillation clip

Birth Resuscitation

- 24 min
 - Slow PLR
 - No palpebral response
 - HR 66, RR 55, ETCO₂ 42
 - Action:
 - Increased inopressors
 - Assisted ventilation
- 28 min
 - HR 65
 - ETCO₂ 36



Birth Resuscitation

- 28 min
- pH 6.891
- P_{CO_2} 70.7
- P_{O_2} 217.3
- SAT 98.5
- Lac 16.2
- BE -19.3
- HCO_3 13.5
- Ambu
- ADV 47%



Birth Resuscitation

- 29 min
 - Spontaneous leg movement
 - Spontaneous breaths
- 31 min
 - ETCO₂ 28
 - 1 ml epinephrine
- 32 min - 123/56(70)94; 81
- 34 min
 - ETCO₂ 23
 - 2nd IV line
 - Began dobutamine / vasopressin

Birth Resuscitation

- 35 min
 - HR 130
 - ETCO₂ 25
- 38 min
 - ETCO₂ 27
 - RR 51
 - HR 115
- 42 min – 3rd catheter in
 - Dextrose 33
 - PCV 36, TP 3.2
 - 1st bolus liter
 - Inopressors

Birth Resuscitation

- 46 min
 - HR 155
 - ETCO₂ 29
- 49 min
 - Dobutamine off
- 51 min
 - Dobutamine on

Birth Resuscitation

- 59 min
- pH 7.160
- P_{CO_2} 31.9
- P_{O_2} 254
- SAT 99.1
- Lac 17
- BE -15.7
- HCO_3 11.1
- Ambu
- ADV 5.8%



Birth Resuscitation

- 55 min
 - 2nd I bolus began
 - HR 173
- 69 min - temp 96.8
- 80 min
 - Urination
 - Usg 1.013

Birth Resuscitation

- 93 min
 - Finished 4th bolus
- 101 min
 - Plasma as bolus
- 103 min
 - 112/75(90) 173
- 105 min - temp 97.9

Birth Resuscitation

- 109 min
- pH 7.257
- P_{CO_2} 39.1
- P_{O_2} 59.4
- SAT 85.7
- Lac 13
- BE -8.2
- HCO_3 17.6
- INO_2 8 lpm

Birth Resuscitation

- 12 hours
- pH 7.456
- P_{CO_2} 36.3
- P_{O_2} 243.8
- SAT 99.3
- Lac 1.9
- BE 2.6
- HCO_3 25.9
- INO_2 5 lpm



Birth Transition Special Case



Birth Resuscitation

Birth Transition

- At Birth - expected
 - Bradycardia
 - Apneic
 - Low ETCO_2
 - Not responsive
 - Good perfusion
- Transition
 - HR increases
 - Spontaneous respiration
 - ETCO_2 normalizes
 - Responsive
 - Improved perfusion

Birth Resuscitation

Failure of Birth Transition

- Heart rate
 - Inappropriate bradycardia
 - Ineffective tachycardia
 - Other arrhythmia
- Remains apneic
 - Once should be awake
 - Especially with high ETCO_2

Birth Resuscitation

Failure of Birth Transition

- ETCO_2
 - Low
 - Perfusion failure
 - Iatrogenic
 - Appropriate compensation for acidosis
 - High – respiratory failure
- Not responsive
 - Seizure as recover from anesthesia
- Poor perfusion
 - Poor vascular control
 - Poor cardiac output

Birth Resuscitation Monitoring

- Clinical signs perfusion
- Responsiveness
- Serial Apgar scoring
- Capnography
- ABG
 - Coupled with capnography
- Central venous gas

Birth Resuscitation Treatment

- Ventilation
 - Spontaneous – ensure effective
 - Assisted/ controlled
 - Initially room air
 - If not respond – enrich with oxygen
- Perfusion
 - Monitor rhythm
 - Expect arrhythmias
 - Treat non-perfusing rhythms
 - Monitor peripheral perfusion
 - BP – only part of picture
 - Arterial pulse, tone, fill
 - Leg temperature – best indicator

Birth Resuscitation Treatment

- Perfusion
 - Treat hypoperfusion
 - Fluid boluses
 - First line therapy
 - Only if adequate CO
 - Inotrope/pressors
 - Dobutamine
 - Vasopressin
- Other supportive measures
 - Glucose infusion
 - Dry patient – tactile stimulation, don't overdo
 - Warming
 - Avoid active warming
 - Passive OK
 - Hypothermia may be advantageous

Birth Resuscitation Cautions

- Don't over ventilate
 - Hyperventilation
 - Low ETCO_2
 - Poor CO?
 - Iatrogenic hyperventilation?
 - Decreased cerebral perfusion
 - Respiratory compensation for acidosis
 - Hyperinflation
 - Volutrauma
 - Increase pulmonary vascular resistance
 - Increase ADV
 - Reversion/ retention of fetal circulation
 - Fetal circulation
 - Reversion can occur at anytime



Clinical Course

- 12 hours
 - Perfusion
 - HR 120
 - Good arterial tone
 - Good arterial fill
 - Strong pulses
 - Warm legs
 - 112/65(86)118; 120
 - Temperature – 98.6 F
 - Respiratory rate – 60 bpm
 - Off dobutamine/ vasopressin

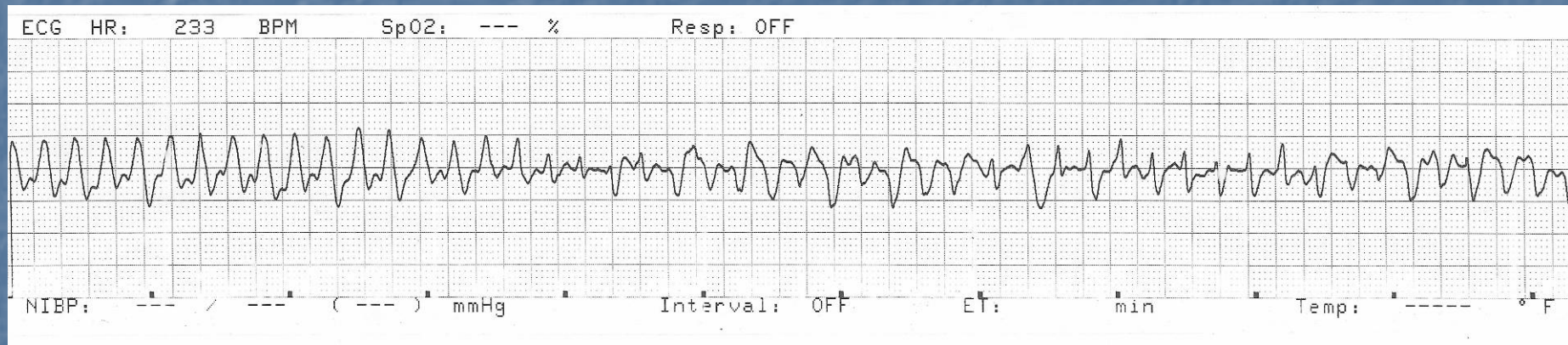
Cardiopulmonary Arrest

- While BP taken
 - Auscult HR 120 to 0 in 60 seconds
 - Apnea
- 0 min – arrest recognized
 - Moved off mattress
 - Began cardiac compression
 - Intubated with some difficulty
 - Began ventilation

Cardiopulmonary Arrest

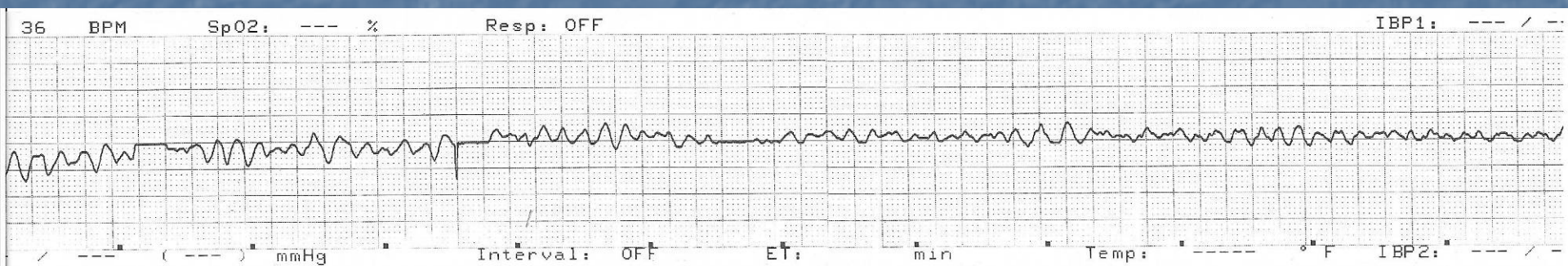
- 4 min
 - Epinephrine IV
 - Capnograph & ECG
- 6 min
 - ETCO₂ 13
 - ECG HR 62
 - Epinephrine
- 8 min
 - Epinephrine + vaso
 - Ventricular tachycardia/ fibrillation

Cardiopulmonary Arrest



Cardiopulmonary Arrest

- Clipping chest for defibrillation
- 9 min
 - ETCO₂ 5
- 11 min
 - Auscult heart - No organized activity
- 12 min
 - Epinephrine
 - Shock 100j



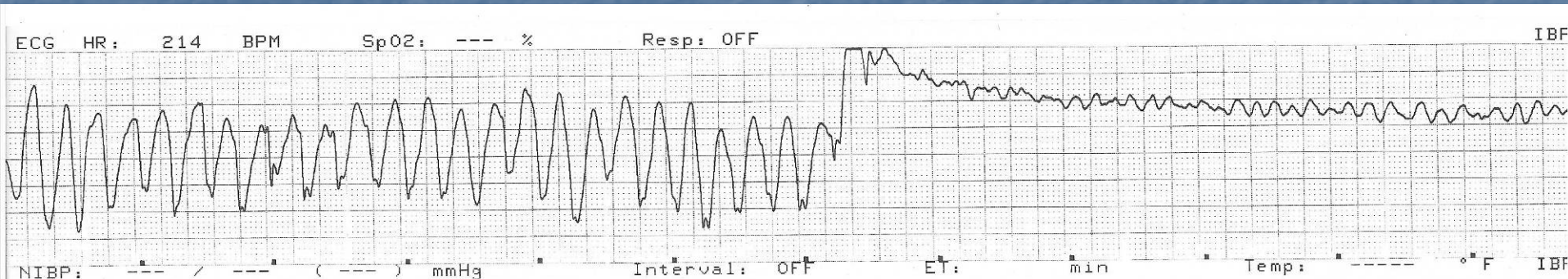
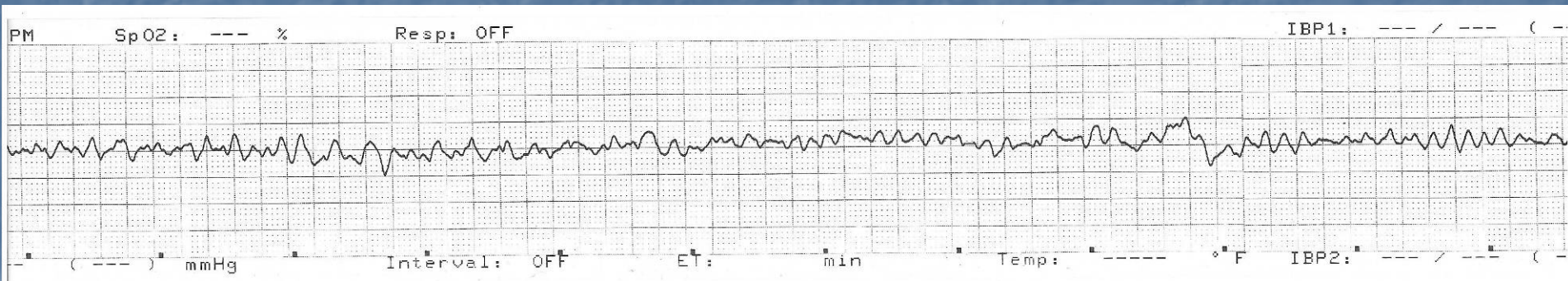
Cardiopulmonary Arrest

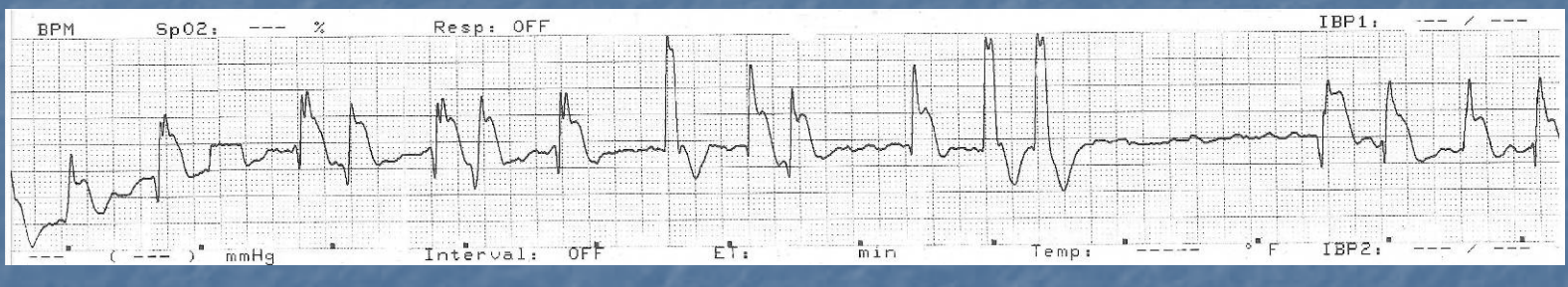
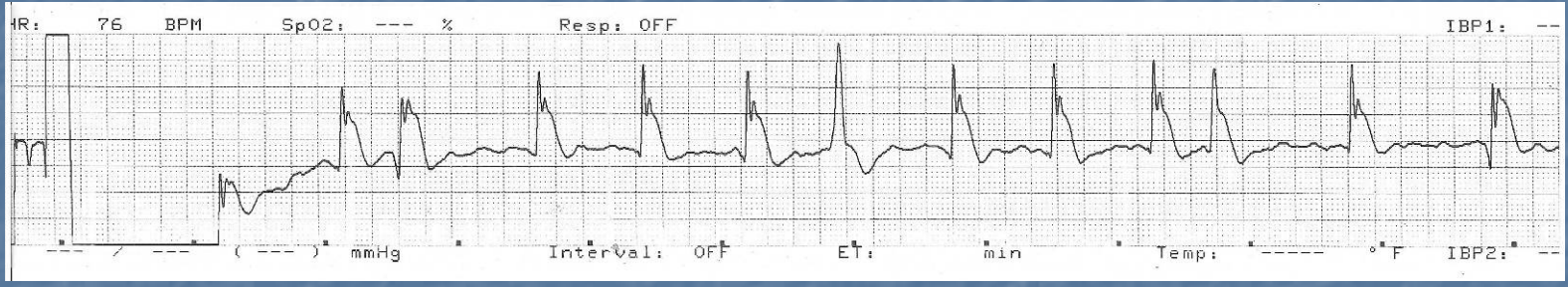
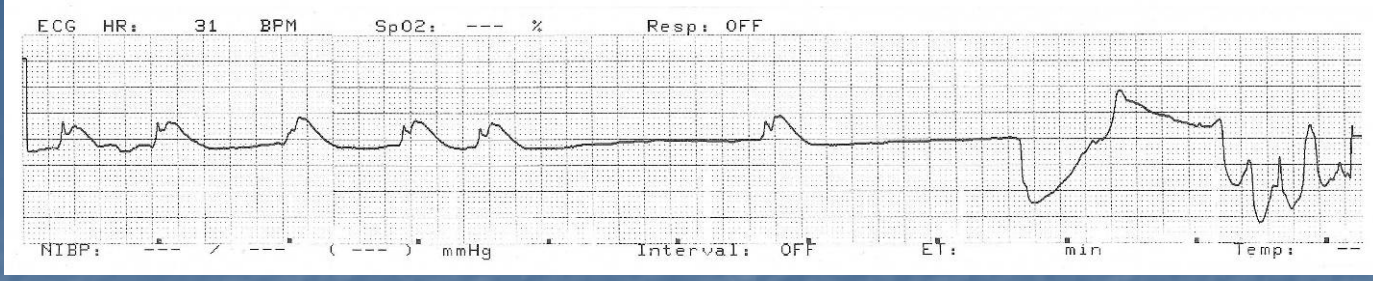
- 14 min
 - Shock 200 j
- 15 min
 - Continued chest compressions
 - 3 cc lidocaine iv
- 16 min
 - Shock 200 j
 - Chest compressions
 - Conversion - nonperfusing bradycardia

Cardiopulmonary Arrest

- 18 min
 - Chest compressions
- 19 min
 - 1 ml epinephrine
 - Back in ventricular tachycardia/fibrillation
- 21 min
 - Shock 200 j - conversion

Cardiopulmonary Arrest





Cardiopulmonary Arrest

- 23 min
 - ROSC
- 25 min
 - ETCO₂ 87
 - ETCO₂ 91
 - ETCO₂ 99
- 26 min
 - ETCO₂ 66-68

Cardiopulmonary Arrest

- 27 min
 - Temperature 99.9
- 29 min
 - Back on all fluids
- 30 min
 - Ambu assisted respiration rate 30
 - HR 92
 - ETCO₂ 56
- 34 min
 - Spontaneous respiration
 - ETCO₂ 40

Cardiopulmonary Arrest Initiating Event

- Asphyxial
 - Respiratory arrest → bradycardia → arrest
- Ischemic
 - Septic shock → bradycardia → arrest
- Arrhythmogenic
 - Intrinsic myocardial event

Cardiopulmonary Arrest

- Establishing ventilation
 - Asphyxial/ischemic – priority
 - Can negatively effect outcome
 - Rapid infrequent breaths
- Chest compressions
 - Cardiogenic arrest – priority
 - Nonperfusing rhythm
 - Initiated immediately
 - Maximum interruption of 10 sec
 - > 2 min between interruptions

Cardiopulmonary Arrest

- Administering drugs
- Determining the cardiac arrhythmia
- Treat
 - Drugs
 - Defibrillation

Cardiopulmonary Arrest

- Vascular access
 - Jugular catheter
 - Intratracheal route
 - Intraosseous route
- Drugs
 - Epinephrine
 - Vasopressin
 - Contraindicated
 - Fluid boluses
 - Glucose infusions

Cardiopulmonary Arrest Mantra

- *Push hard*
- *Push fast*
- *Minimize interruptions*
- *Don't over ventilate*

Clinical Uses of Capnography

CPR

- Cardiac arrest
 - No blood flow to lungs
 - $\text{ETCO}_2 = 0$
- Cardiac compressions
 - Low cardiac output
 - ETCO_2 6-12
 - Very large ADV



Clinical Uses of Capnography CPR

- ROSC
 - Cardiac output increasing
 - $\text{ETCO}_2 > 18$ and rising
 - ADV large but decreasing
- ETCO_2 function of CO for any given ventilation
 - Noninvasive monitor of pulmonary blood flow
 - Determine the most effective technique of cardiac compression
 - ETCO_2 monitoring prognostic
 - If low > 10 minutes, cardiopulmonary resuscitation is futile



Hyperventilation Hyperthermia

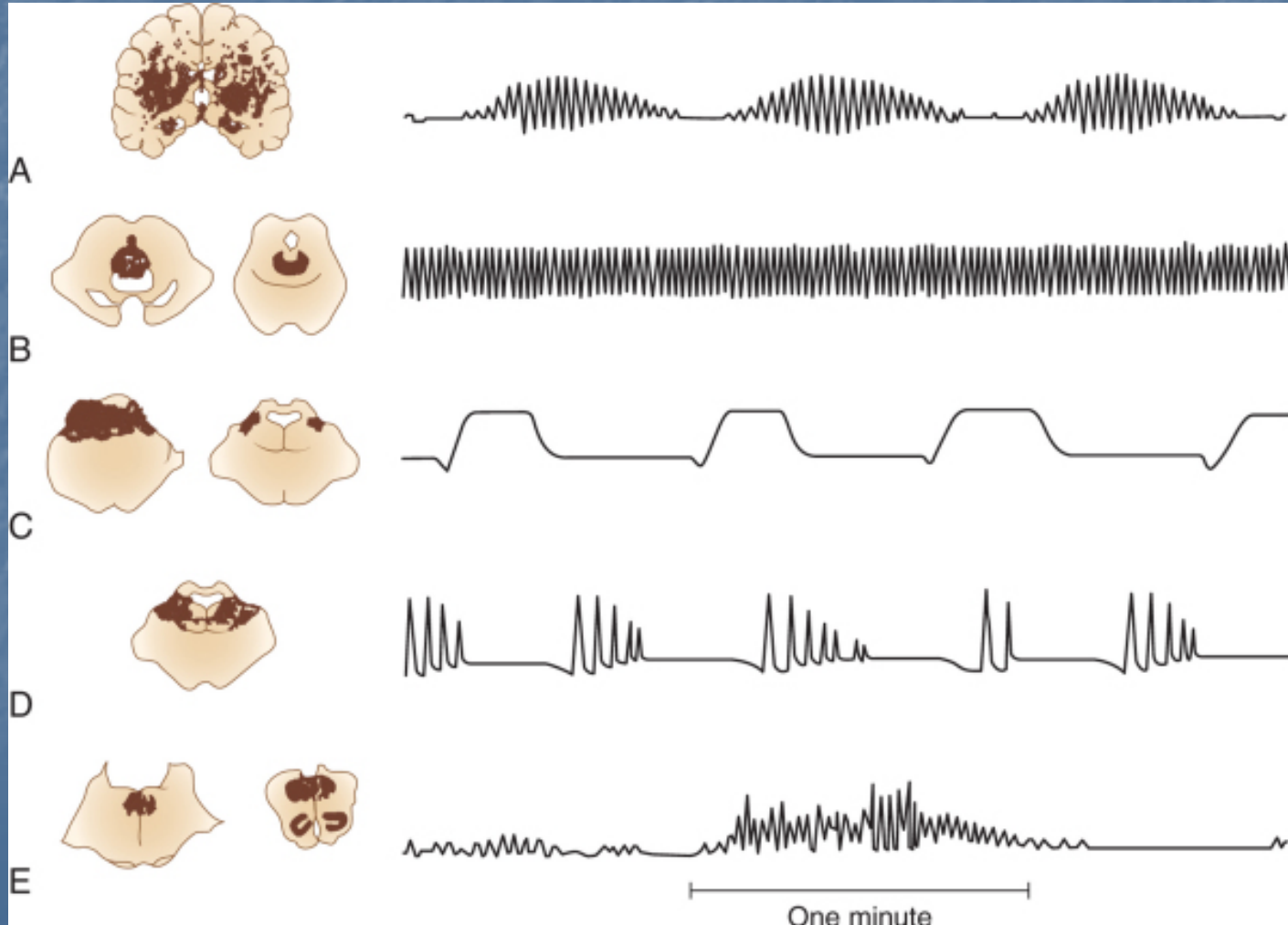
- 19 hrs
 - Temp 104.4
 - HR 120
 - RR 100

pH	7.481
Pco ₂	27.6
Po ₂	199.9
SAT	97
HCO ₃	20.8
BE	-1.2

	19 hr	24 hr	48 hr	72 hr
Temp	104.4	104.5	104.2	104.0
pH	7.481	7.547	7.521	7.500
Pco ₂	27.6	28.6	31.1	34.9
Po ₂	199.9	180.4	103.5	90.5
SAT	99	99	96	96
HCO ₃	20.8	25.2	25.7	27.5
BE	1.2	3.8	3.8	4.9

Central Respiratory Patterns

Cheyne-Stokes



Central
Hyperventilation

Apneusis

Cluster breathing

Ataxic breathing

Hyperventilation

- Etiology
 - Hypoxemia
 - Pulmonary Disorders
 - Cardiovascular Disorders
 - Metabolic Disorders – acidosis
 - Anemia
 - Drug-induced
 - Fever
 - Sepsis
 - Pain
 - Central

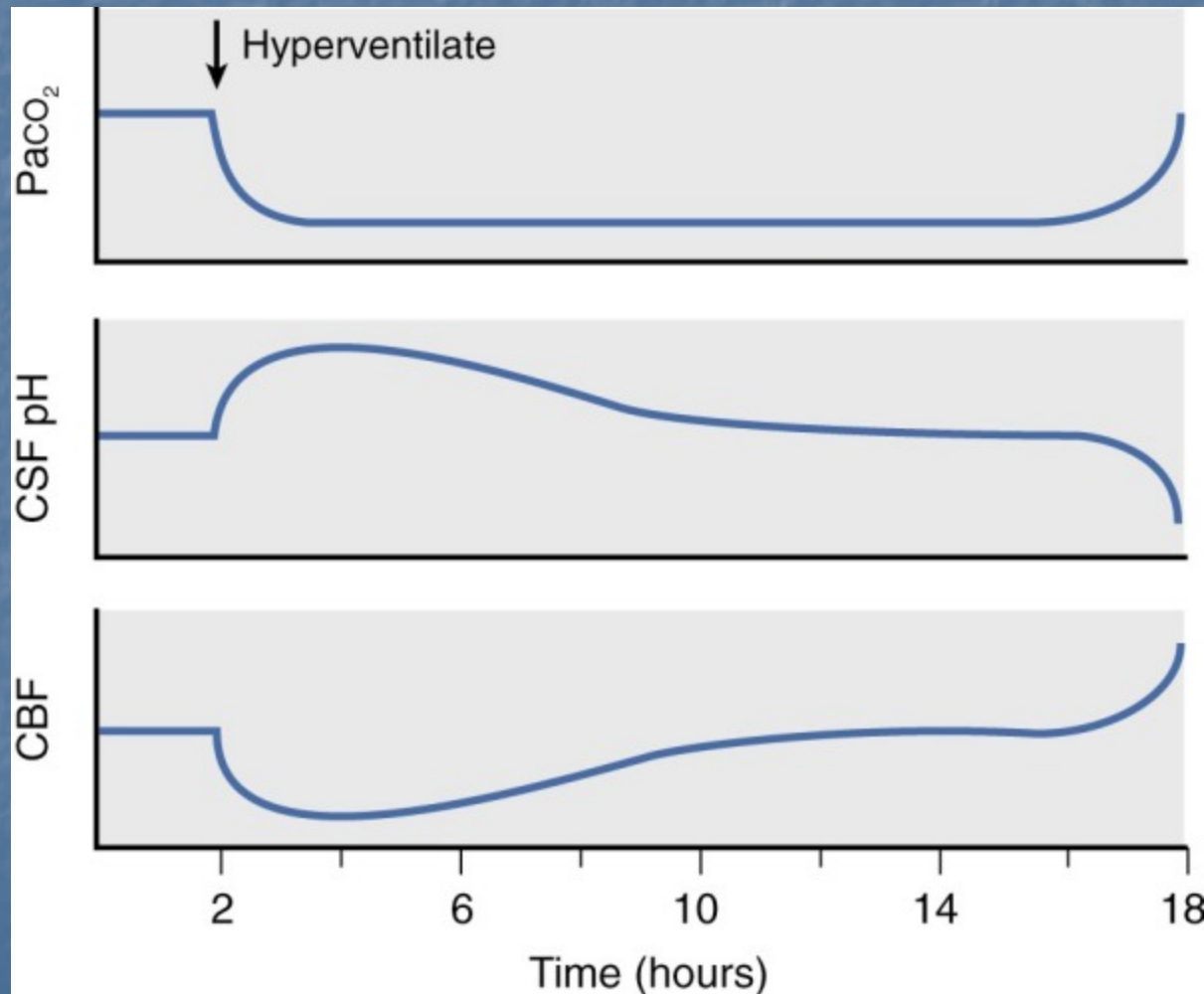
Hyperventilation

- Consequences
 - Cerebral vasoconstriction
 - Oxyhemoglobin dissociation curve
 - Reduces peripheral O₂ release
 - Decreases Ca⁺⁺
 - Increased albumin binding
- Cerebral ischemia
 - Pco₂ < 20-25
 - Marginal systemic perfusion
 - Increased metabolic demand

Hyperventilation

- Self limiting
 - If severe
 - Local lactate production will counterbalance pH
 - 6 – 18 hours
 - Change in carbonic anhydrase activity
 - Return cellular pH to normal
- If prolonged
 - Rapid return in P_{CO_2} levels
 - Mimic physiologic effect of respiratory acidosis

Hyperventilation



From: Miller: Miller's Anesthesia, 7th ed.

Central Hyperthermia

- Fever vs Central hyperthermia
 - Fever
 - Infection/inflammation
 - Hematology
 - Fibrinogen
 - Blood cultures
 - Diurnal variation
 - Central hyperthermia
 - Remarkably consistent temperature
 - Refractory to NSAIDs
- Consequences
 - Brain higher temperature
 - Increased metabolic rate
 - Neuroexcitability
 - Increased oxygen demand

Central Hyperventilation

Central Hyperthermia

- One-Two Punch
- Aggressive intervention
 - Central hyperthermia
 - Active cooling
 - Alcohol baths
 - Cold water or ice packs
 - But ... Cooling the skin
 - Vasoconstriction
 - Retain heat
 - Core cooling
 - Cold water enemas
 - Gastric lavage
 - Central hyperventilation
 - Phenobarbital



Renal challenge

- First 24 hours
 - Cr
 - Birth 5.90 mg/dl
 - 24 hr 4.10 mg/dl
 - Na
 - Birth 133 mEq/l
 - 24 hr 124 mEq/l

Renal challenge

■ Fluid balance

- Wt increase 8.2 kg (by 48 hrs 10 kg)
- 9.6 liters fluids given
- 60 kg foal – increased 7 kg (12%) wt (48 hr 17%)
- Estimated insensible loss 1.2 l
- No urine
- (0.2 kg not accounted for)

Renal challenge

- 50 hr
 - No urination yet
 - Bladder moderately distended
- Catheterized bladder
 - Total urine 1360 ml
 - 0.45 ml/kg/hr
 - Usg = 1.035
 - Clcr 0.23 ml/kg/min
 - Exna = 0.29 mEq/kg/day
- Edema significant
- Urine sediment
 - WBC 0-2/hpf
 - RBC 0-2/hpf
 - No epithelial cells
 - No casts

Neonatal Vasomotor Nephropathy

- Balance afferent/efferent tone
 - Vasoconstrictors
 - Angiotensin II
 - Receptor distribution
 - Receptor responsiveness
 - Receptor function
 - Adrenergics
 - Circulating – epi/norepi
 - Renal derived
 - Renal sympathetic tone
 - Vasodilators
 - PG
 - NO

Neonatal Vasomotor Nephropathy

- Risk
 - Hypovolemia/hypoperfusion
 - Stress
 - Hypertension
 - Autonomic dysfunction
 - Pressor therapy
 - NSAID therapy
 - Failure birth transition
- Signs
 - Oliguria
 - Concentrated urine
 - Normal/high/low Fxna
 - Slow Cr decrease or increase

Neonatal Vasomotor Nephropathy

- Therapy
 - Volume trial
 - Inotrope/pressor trial
 - Dopamine?
 - Furosemide trial
 - Increase PG – vasodilate
 - 1-4 mg/kg trial doses
 - Time
- Consequences
 - Usually no parenchymal damage
 - Fluid/water overload
 - Na overload
 - Impaired acid/base correction?

Renal Challenge Therapy

- Renal
 - Clinical indications of excellent perfusion
 - Dobutamine
 - Had been receiving
 - Weaned
 - Fluid challenge - contraindicated
 - Furosemide trial
 - Urine decreased to 0.125 ml/kg/hr (4 hours)
- Fluid restriction
 - 1/2 maintenance + PPN
 - Insensible losses + PPN
 - 52 ml/hr plasma

Renal Challenge Therapy

- Na balance
 - Ex_{Na} 0.29 mEq/kg/day
 - Plasma high in Na
 - May confound the edema
- 64 hr
 - Began diuresis
 - 2.4 ml/kg/hr
- Diuresis maintained
 - Pulled urinary catheter
 - Usg dropping 1.008 to 1.002

