Power and Passenger: Understanding Uterine Activity

Michelle Flowers RNC-OB
Emily Hamilton MDCM

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

Featuring Michelle Flowers, RNC-OB Program Manager

Michelle Flowers serves as a PeriGen Program Manager & Clinical Consultant. Her 20+ year career also includes experience as a Clinical Quality Coordinator, Educator for obstetric services, and L&D charge nurse.

Her more recent experience has focused on designing and executing OB documentation workflows and training programs. Her education credentials have included AWHONN Intermediate/Advanced Fetal Monitoring Instructor, ICEA Approved Trainer and Certified Childbirth Educator and AAP NRP Instructor.

PeriGen
Advanced
Perinatal Systems

Featuring Emily Hamilton, MDCM
Senior Vice President of Clinical Research

An experienced obstetrician, Dr. Hamilton is currently an Adjunct Professor of Obstetrics and Gynecology at McGill University, as well as leading PeriGen's clinical research team.

Dr. Hamilton is the inventor of the PeriCALM advanced fetal monitoring system, holding 32 US and international patents for her research work. She is an internationally-known clinical thought leader on the use of technology to improve obstetric outcomes. She presents her research regularly at obstetric conferences and in peer-reviewed journals.

PeriGen
Advanced
Perinatal Systems

Objectives

1. Review definitions related to uterine activity
2. Review etiology and physiology of uterine tachysystole
3. Analyze impact of UT on the fetal heart rate

PeriGen
Advanced
Perinatal Systems

Uterine Contractions

Quantified as the number of contractions in 10 minutes averaged over 30 minutes.

- Uterine activity terminology used to assess and describe contractions:
  - Frequency
    - Beginning of contraction to beginning of next one
  - Duration
    - Length of contraction from beginning to end
    - Measured in seconds
  - Intensity
    - Strength of contraction
    - Assessed via palpation or mmHg (Montevideo units)
  - Resting Tone
    - Intrauterine pressure when uterus is not contracting
    - Assessed via palpation or mmHg

PeriGen
Advanced
Perinatal Systems

Uterine Palpation

Palpation of uterine contractions is one of the key components of labor assessment.

Uterus	Feels Like	Contraction Intensity
Easily Indented	Tip of Nose	Mild
Slightly indented	Chin	Moderate
Cannot indent	Forehead	Strong

PeriGen
Advanced Perinatal Systems

Contractions

- Generate intrauterine pressure
- Cause retraction, effacement and dilation of the cervix
- Facilitate descent and birth of the fetus
- Affect maternal blood flow through the myometrium
- Normal contraction pattern
  - 5 Contractions or less in 10 minutes

PeriGen
Advanced
Perinatal Systems

Resting Tone

- Measured by palpation or IUPC
- Normal
  - Assists in maintaining adequate fetal oxygenation
- Hypertonus (elevated resting tone)
  - Palpation: uterus that doesn't return to soft
  - IUPC: >20-25 mmHg

PeriGen
Advanced
Perinatal Systems

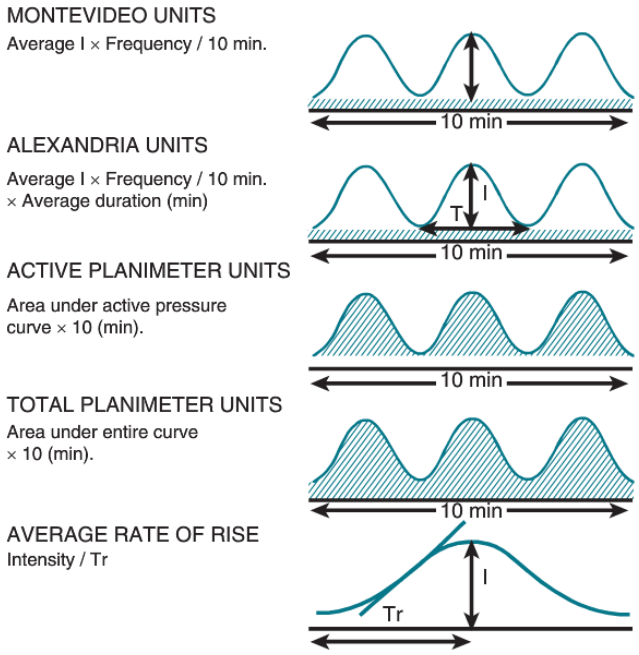
Montevideo Units

- Two methods of measurement

- Measured in 10 minute segments
  - Measure peak intensity, or amplitude, in mmHg for each contraction and add together
  - Subtract baseline uterine tone from peak contraction pressure for each contraction and add together

PeriGen
Advanced
Perinatal Systems

Other Contraction Measurements



PeriGen
Advanced
Perinatal Systems

Quantitation of uterine activity in 100 primiparous patients. Miller FC, Yeh SY, Schifrin BS, Paul RH, Hon EH. Am J Obstet Gynecol. 1976 Feb 15;124(4):398-405.

Physiology

Contractions

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

Contraction Physiology

- The uterine muscle is composed of upper and lower uterine segments
  - Upper segment: active and contains pacemaker sites
  - Lower segment: passive zone
- At the start of labor, changing levels of various hormones cause myometrial cells to be more excitable.
  - (corticotrophin–releasing hormone, progesterone, estrogen, prostaglandin and oxytocin)
- Myometrium advances from a quiet to an active state.
- Contractions result when there is **coordinated propagation** of myometrial contraction usually beginning in the fundus

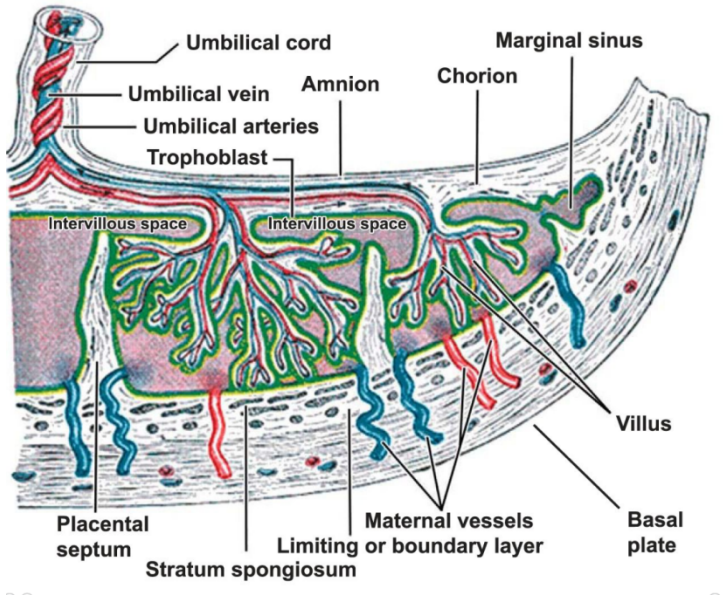
PeriGen
Advanced
Perinatal Systems

Contractions

Intramyometrial Pressure Effect on Blood Flow

Fleisher 1987 Brar 1988 Janbu 1987

- Maternal flow reduced
- Directly related to pressure
- Spiral arteries compressed when pressures >35-60 mmHg

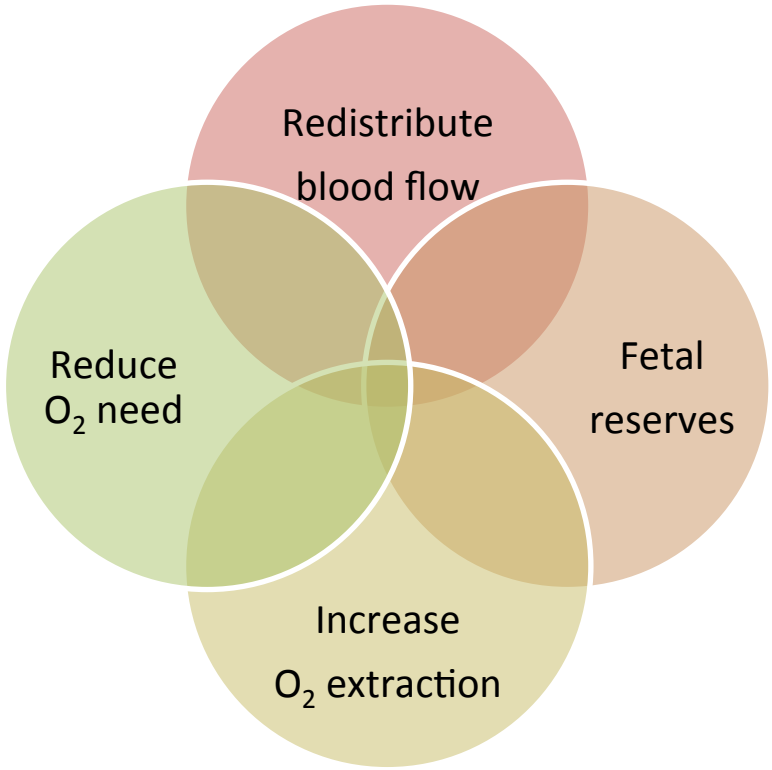


PeriGen
Advanced Perinatal Systems

Compensatory Mechanisms

Healthy fetus has twice the reserve required to navigate the birth process.

- Extrinsic factors impacting FHR Patterns:
  - Maternal Influences
  - Utero-placental perfusion
  - Umbilical circulation
  - Amniotic fluid characteristics
- Intrinsic factors impacting FHR Patterns:
  - Placental transfer capacity
  - Fetal adaptive compensatory mechanisms



PeriGen
Advanced Perinatal Systems

Uterine Tachysystole

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

Definition

Uterine Tachysystole

> 5 contractions per 10 minutes averaged over 30 minutes

Mathematical equivalent:
>15 contractions in 30 minutes

PeriGen
Advanced
Perinatal Systems

Causes of Tachysystole

- Known complication of induction/augmentation
- Spontaneous
  - Intrauterine infection
    - "Irritation" of the myometrium by bacterial toxins
  - Placental abruption
- Cocaine use
- Unknown etiology

PeriGen
Advanced
Perinatal Systems

Physiology

Uterine Tachysystole

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

Timing

Uterine Contraction Intervals and
Transcutaneous Levels of Fetal Oxygen Pressure

F. KLINK, MD, R. GROSSPIETZSCH, MD, L. V. KLITZING, MD,
AND F. OBERHEUSER, PhD

tc O_2

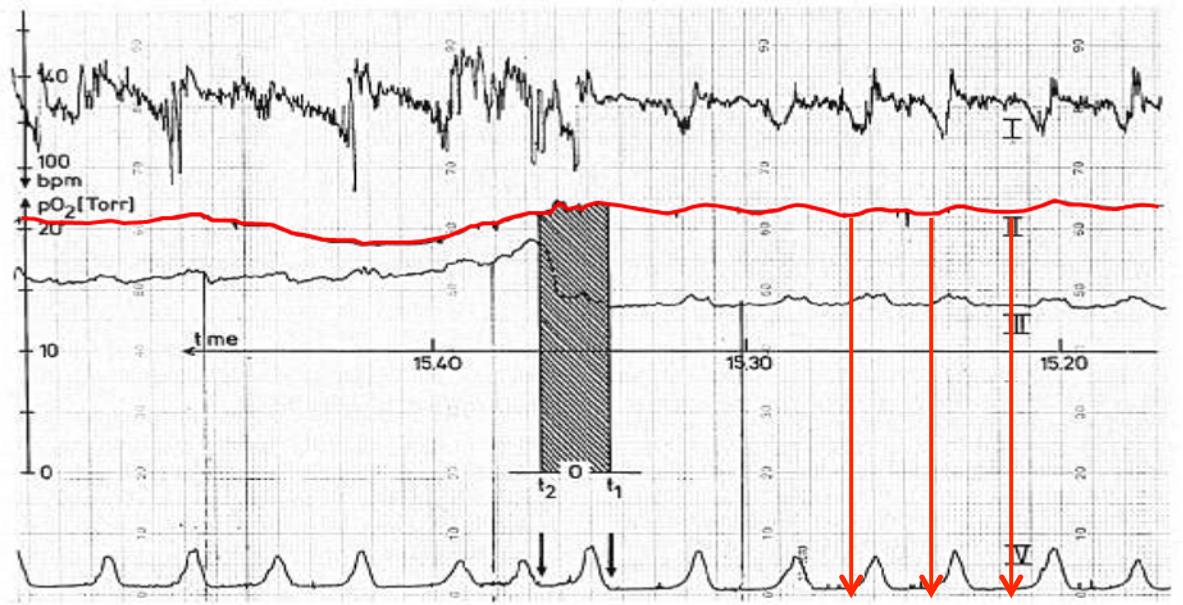


Figure 1. Fetal heart rate (I), fetal tcP_{O_2} (II), relative local perfusion (III), and intrauterine pressure in a patient in labor. Shaded area = tcP_{O_2} integral during a contraction period. Arrows = onset and end of corresponding contraction period. Recording paper moves from right to left.

PeriGen
Advanced
Perinatal Systems

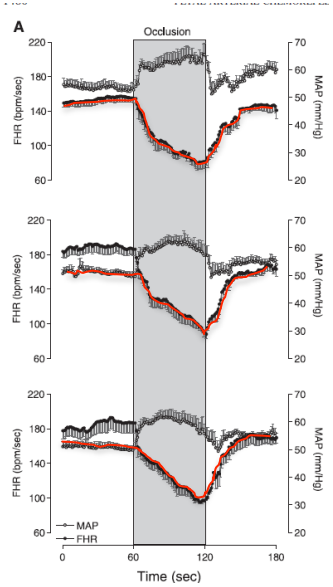
Repeated 1 min Cord Occlusion

5 mins

First 30 min

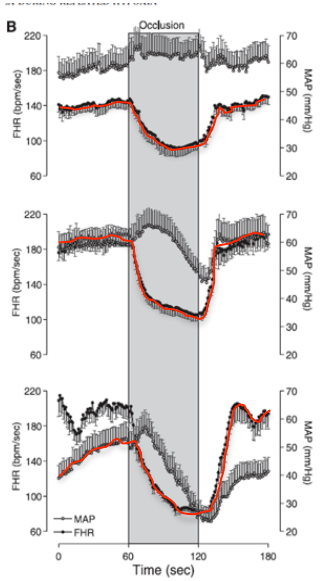
Mid 30 min

Last 30 min



pH 7.34 stable…
BD 1.3 stable …

2.5 min



pH 7.25 7.14 **6.92**
BD 3.3 13.6 **19.2**

PeriGen
Advanced
Perinatal Systems

Fetal Experience

1. Amount of oxygen available correlated with contraction *strength*, *duration* and intercontraction *interval*.

2. Reperfusion time important to restore oxygen levels in the intervillous space before next contraction begins

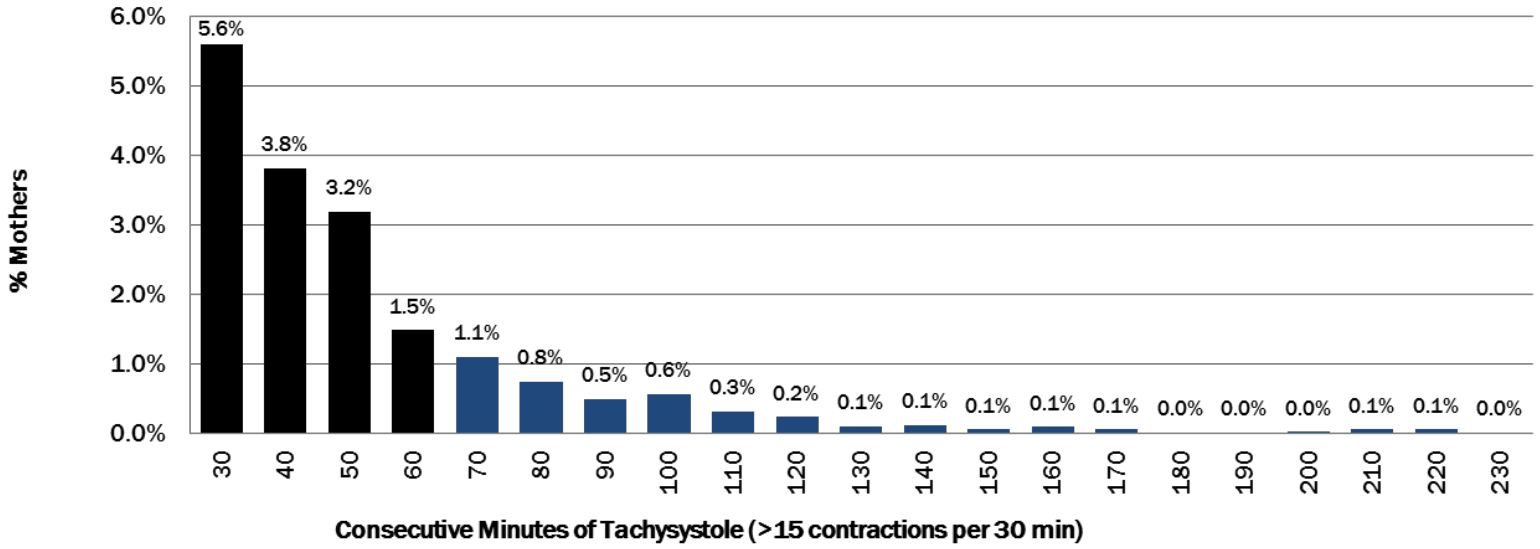
PeriGen
Advanced
Perinatal Systems

Incidence of UT

Bakker et 2007
Rice Simpson et al 2008
Hamilton et al 2012
Kunz et al 2013
Smith et al 2013
Ahmed et al 2016

PeriGen
Advanced
Perinatal Systems

UT lasting >1hr 4.2%



PeriGen
Advanced
Perinatal Systems

Clinical associations with uterine tachysystole. Smith S, Zacharias J, Lucas V, Warrick PA, Hamilton EF. J Matern Fetal Neonatal Med. 2014 May;27(7):709-13

% DEP low even with UT >60min

DEP = Neonatal Depression
Umbilical artery BD ≥ 10 mmol/L or 5 minute Apgar ≤ 6

	No uterine tachsystole #	Any uterine tachysystole ##	Uterine tachysystole 30-60 minutes *	Uterine tachysystole Over 60 minutes **
Number	5095	1139	879	260
n (%)Neonatal Depression	66 (**1.3%**)	11 (**1.0%**)	6 (**0.7%**)	5(**1.9%**)
	# vs. ## P=0.45	# vs. **P*= 0.17	# vs. ***P*=0.56	* vs. ** *P*=0.14

PeriGen
Advanced Perinatal Systems

% UT: Higher with Oxytocin

	Induction *		Augmentation **		Neither #		*P* * vs. #	*P* ** vs. #	*P* * vs. **
	2567		1004		2663				
	n	%	n	%	n	%			
Uterine Tachysystole	480	**18.7%**	232	**23.1%**	427	**16.0%**	0.012	<0.0001	0.0035
Neonatal Depression	34	1.3%	17	1.7%	26	1.0%	0.498	0.104	0.50
DEP in UT n (%)	5/480	1.0%	4/232	1.7%	2/427	0.5%	0.457	0.195	0.48

PeriGen
Advanced
Perinatal Systems

% DEP: low and similar

	Induction *		Augmentation **		Neither #		*P* * vs. #	*P* ** vs. #	*P* * vs. **
	2567		1004		2663				
	n	%	n	%	n	%			
Uterine Tachysystole	480	18.7%	232	23.1%	427	16.0%	0.012	<0.0001	0.0035
Neonatal Depression	34	**1.3%**	17	**1.7%**	26	**1.0%**	0.498	0.104	0.50
DEP in UT n (%)	5/480	1.0%	4/232	1.7%	2/427	0.5%	0.457	0.195	0.48

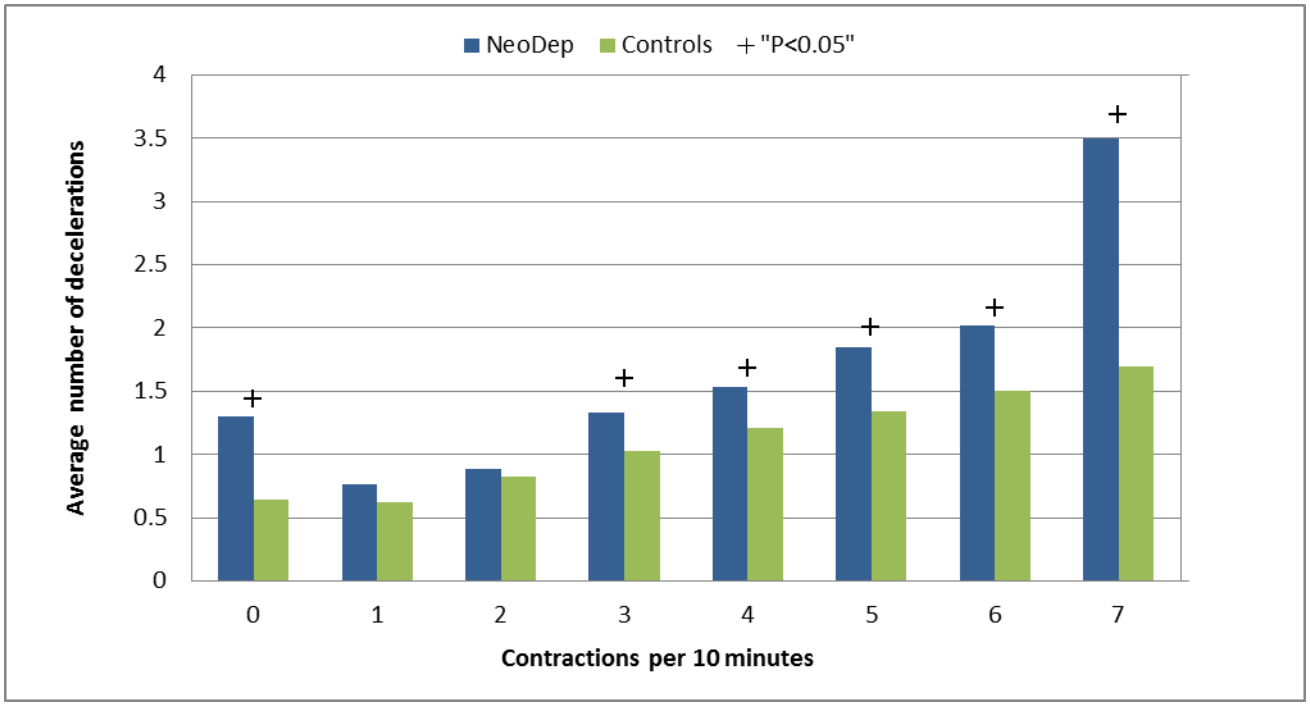
PeriGen
Advanced
Perinatal Systems

% DEP in UT: low and similar

	Induction *		Augmentation **		Neither #		*P* * vs. #	*P* ** vs. #	*P* * vs. **
	2567		1004		2663				
	n	%	n	%	n	%			
Uterine Tachysystole	480	18.7%	232	23.1%	427	16.0%	0.012	<0.0001	0.0035
Neonatal Depression	34	1.3%	17	1.7%	26	1.0%	0.498	0.104	0.50
DEP in UT n (%)	5/480	**1.0%**	4/232	**1.7%**	2/427	**0.5%**	0.457	0.195	0.48

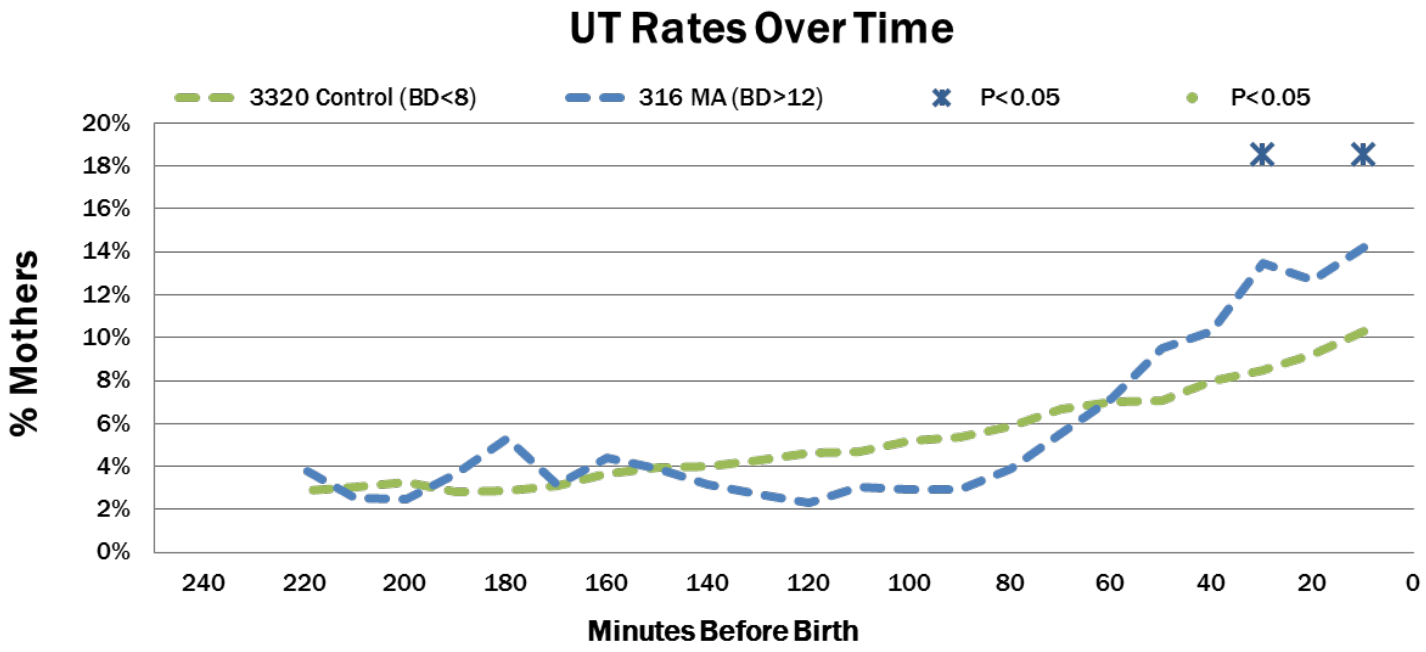
PeriGen
Advanced Perinatal Systems

More Decelerations



PeriGen
Advanced
Perinatal Systems

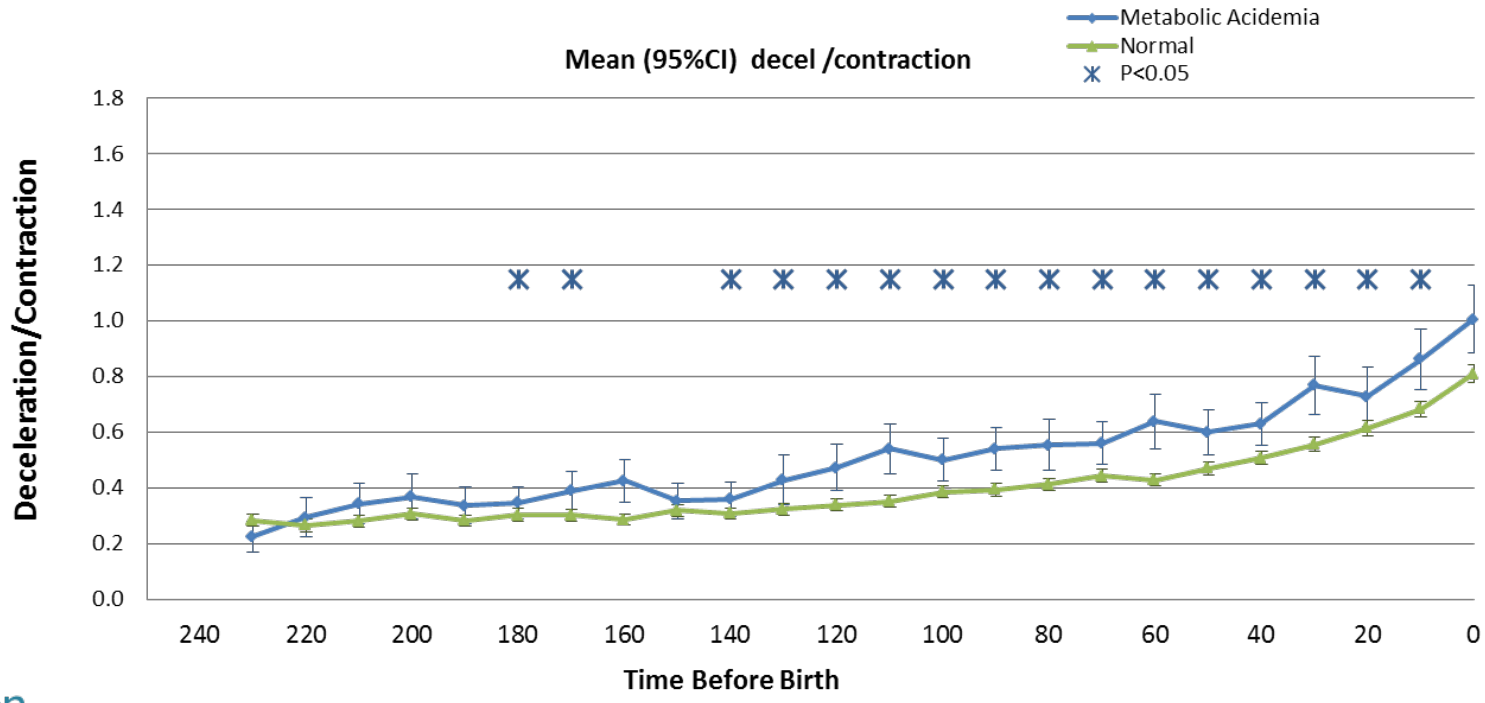
Greater Exposure to UT



PeriGen
Advanced Perinatal Systems

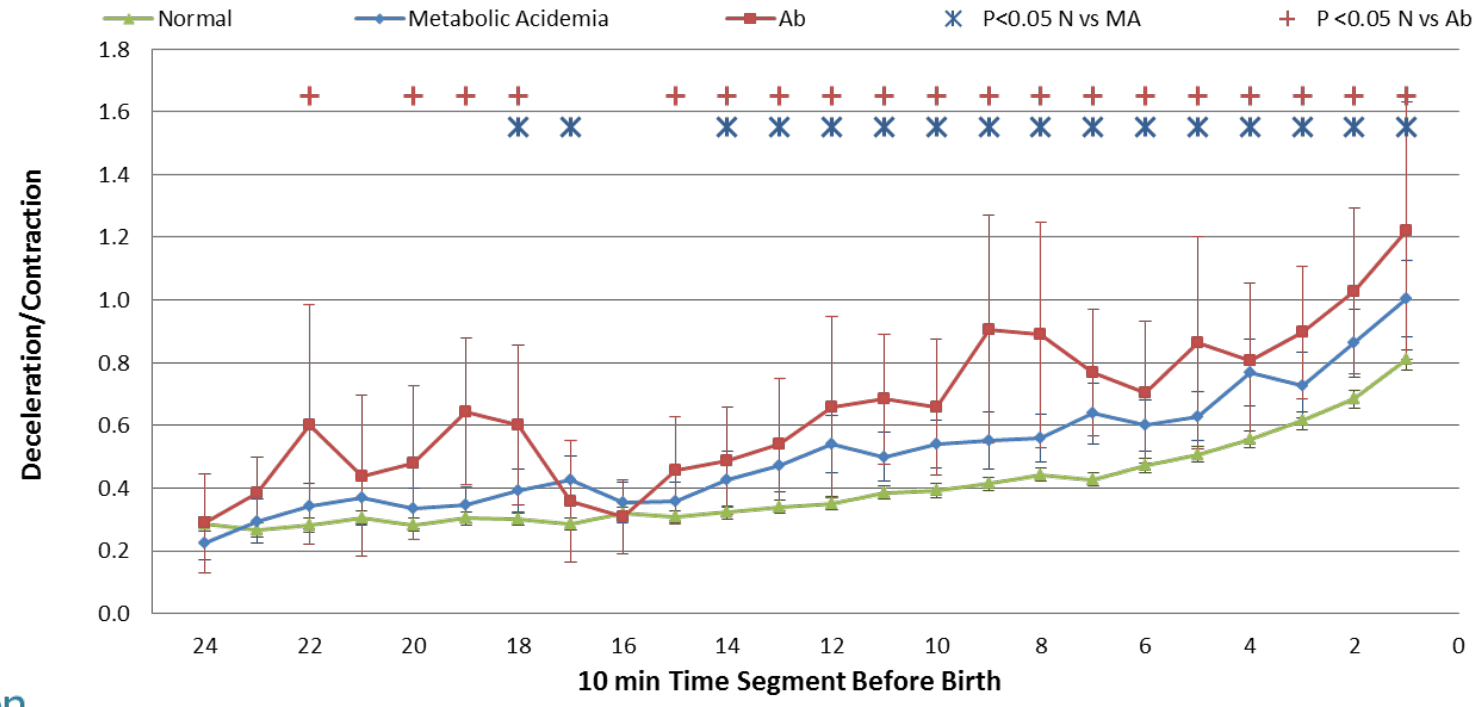
High uterine contraction rates in births with normal and abnormal umbilical artery gases. Hamilton E, Warrick P, Knox E, O'Keeffe D, Garite T. J Matern Fetal Neonatal Med. 2012 Nov;25(11):2302-7.

Higher rate of #deceleration/#contractions



PeriGen
Advanced
Perinatal Systems

HIE babies
highest ratio



PeriGen
Advanced
Perinatal Systems

Clinical Summary

1. UT is common (usual range ~11-26%)
2. How a baby responds to UT depends upon the balance between contraction-related decreases in perfusion and compensatory capacity of baby
3. Compensatory capacity is finite
4. Red flag: Deceleration response to any level of contractions
5. Red flag: What is causing the UT?

PeriGen
Advanced
Perinatal Systems

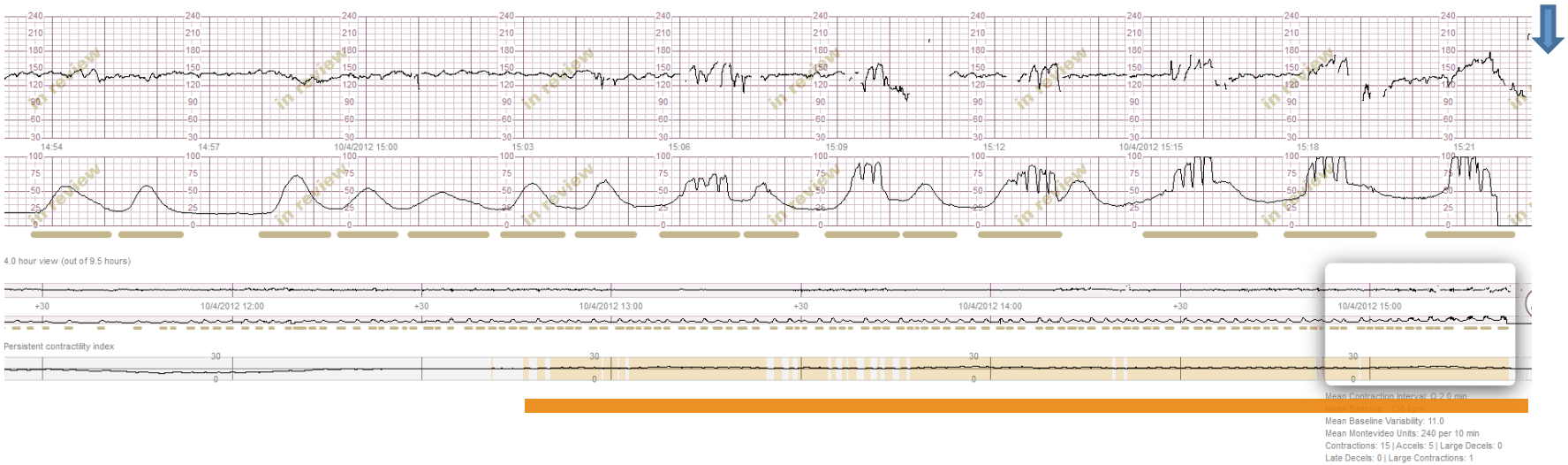
Impact of UT on the Fetal Heart Rate

Case Presentations

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

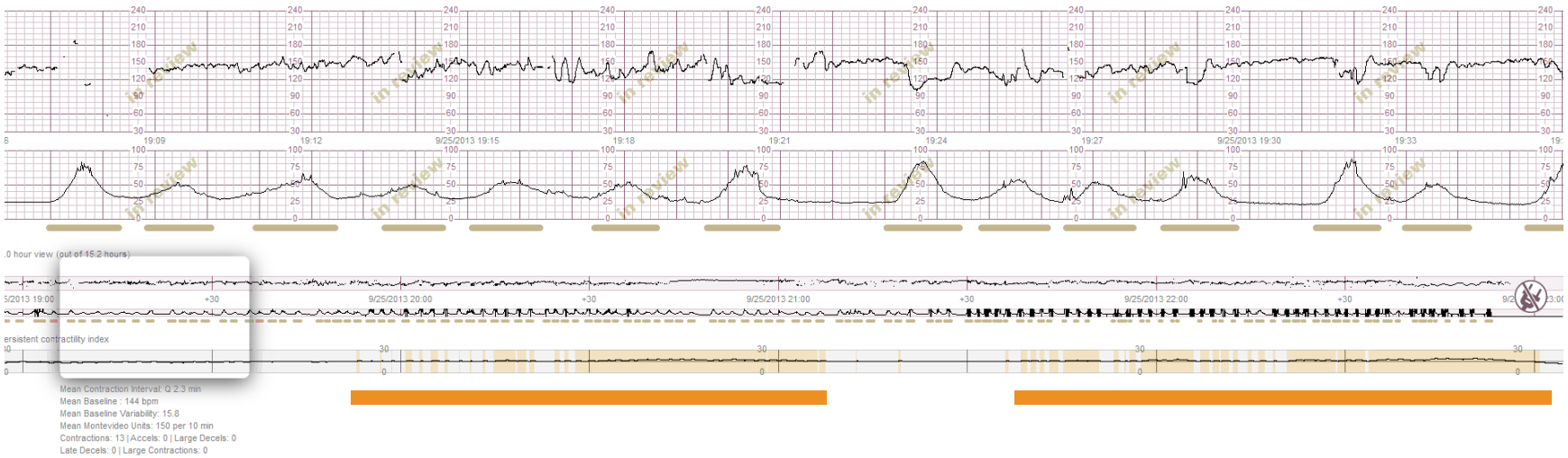
G3P1 39 5/7 wks
NVD pH 7.35 BD 0.6 Apgar 8/9 3800g 4663



PeriGen
Advanced
Perinatal Systems

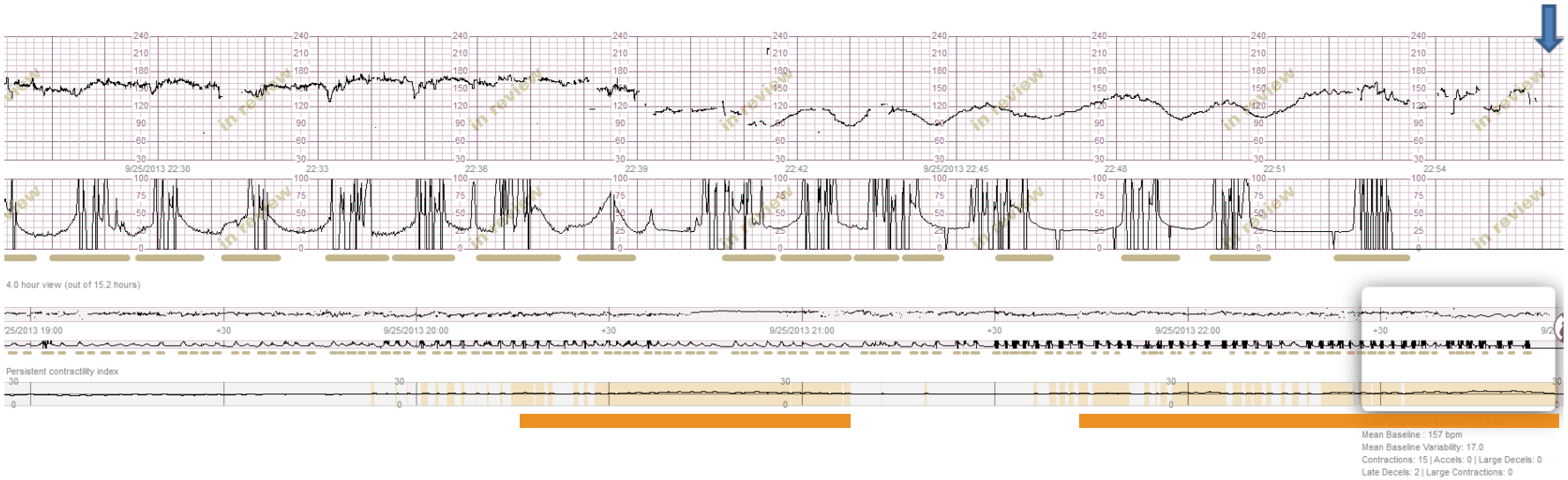
Compensation capacity Is Finite

4 hrs before birth 9363



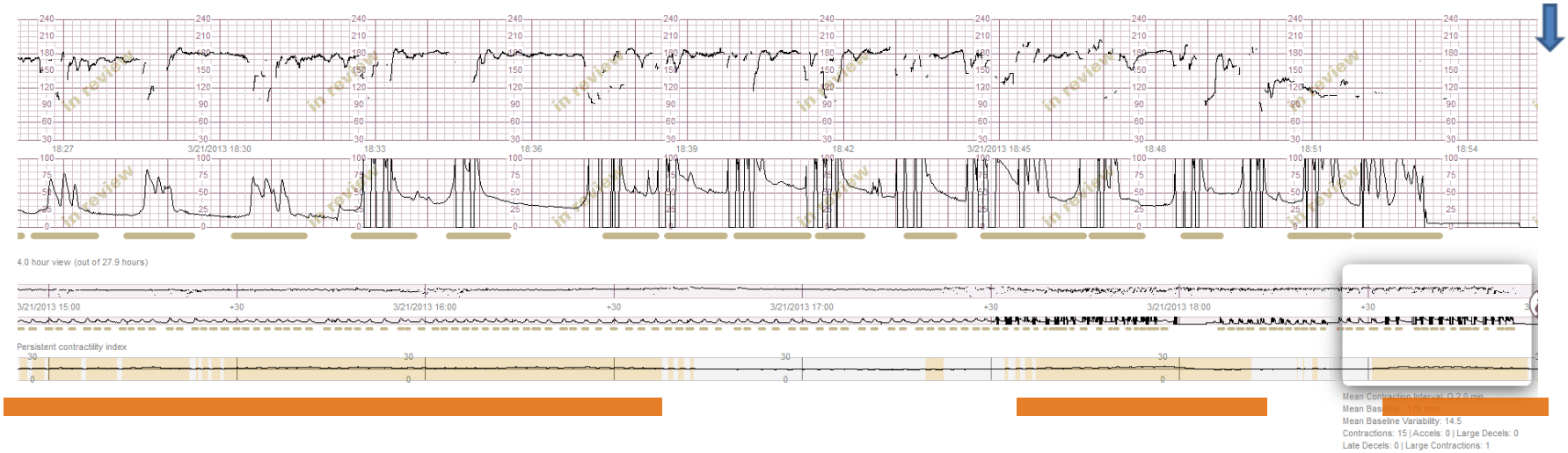
PeriGen
Advanced
Perinatal Systems

G3P0 40 3/7 wks
NVD pH 7.04 BD 13.3 Apgar 8/9 4100g 9363



PeriGen
Advanced
Perinatal Systems

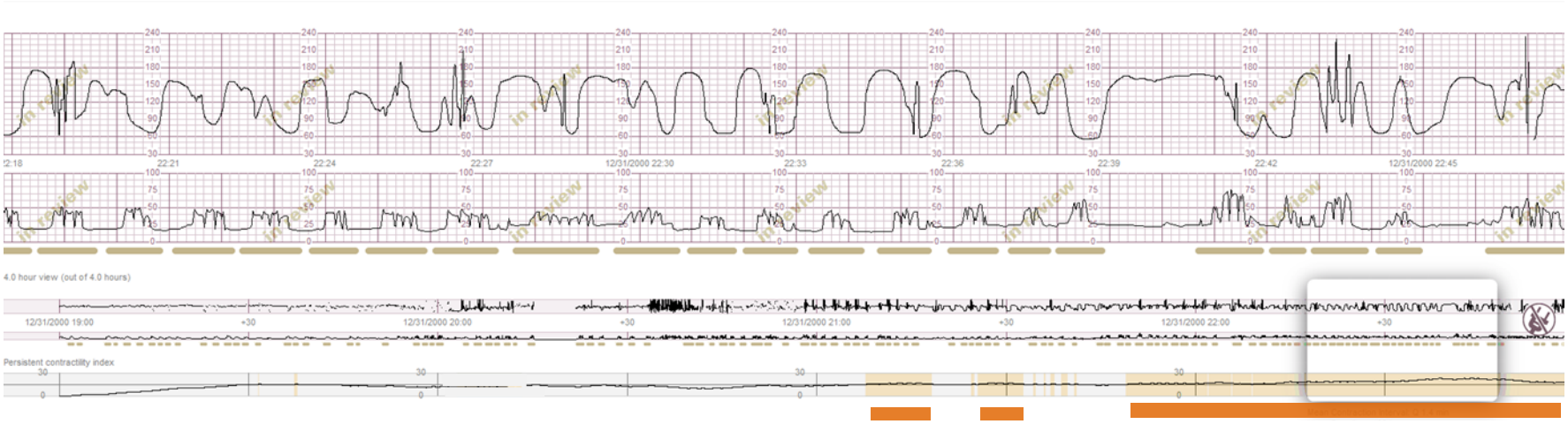
G3P1 39 3/7 wks
NVD ph 7.05 BD 16.2 Apgar 8/9 3500g 6236



PeriGen
Advanced
Perinatal Systems

G1P0 39 0/7 wks

NVD pH 6.6 BD 27 Apgar 0/0 3300g 101018



PeriGen
Advanced
Perinatal Systems

Medicolegal Perspective

PeriGen
Advanced
Perinatal Systems

© 2017 PeriGen, Inc.

Uterotonics and Adverse Outcomes

45% of brain injuries - Excessive use of contraction stimulating drugs

Clark SL, et al Obstet Gynecol. 2008 Dec;112(6):1279-1283.

71% of births with severe asphyxia seeking legal action - incautious use of oxytocin

Berglund S, et al . BJOG. 2008 Feb;115(3):316-323

47% of babies born with metabolic acidosis have oxytocin misuse

Jonsson M, et al BJOG. 2009 Oct;116(11):1453-60.

>70% of closed legal claims with oxytocin use showed a failure to appreciate and act on severity of EFM abnormalities. **75%** resulted in a settlement.

CMPA Perspective, March 2014

PeriGen
Advanced
Perinatal Systems

UT in perspective

28,486 >34 wks, vaginal births 1994-2004
routine with umbilical artery gases

161 Severe metabolic acidosis UA pH <7.05 and BD ≥12 mmol/L

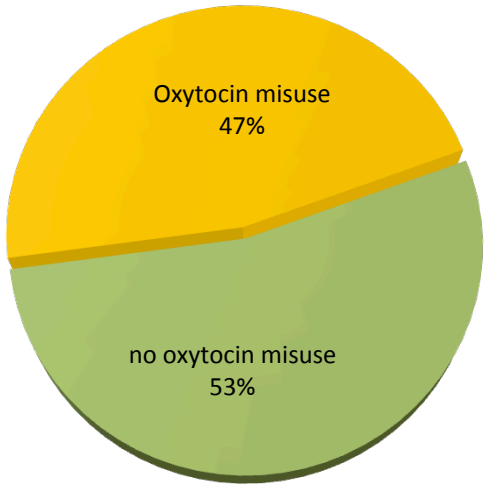
Excluded
Elective CS
Catastrophic OB events (abruption, cord prolapse, ecalmpsia)

UT => 6/10 x 20 minutes

PeriGen
Advanced
Perinatal Systems

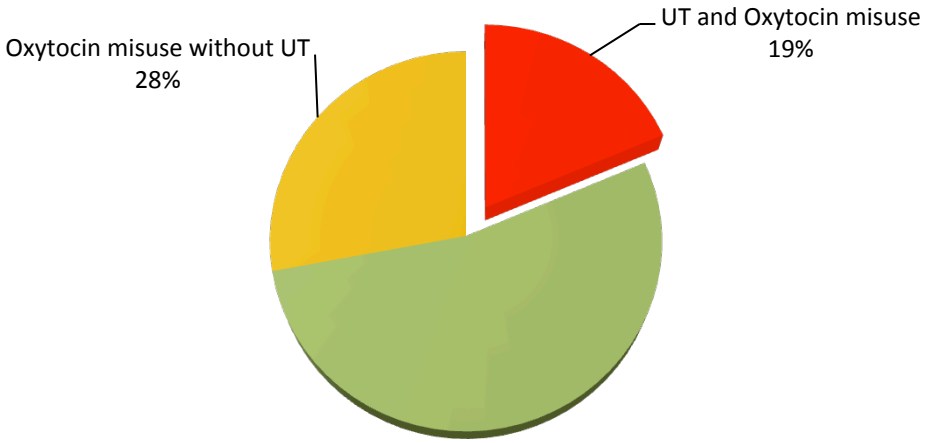
Jonsson M, et al BJOG. 2009 Oct;116(11):1453-60.

Metabolic Acidosis



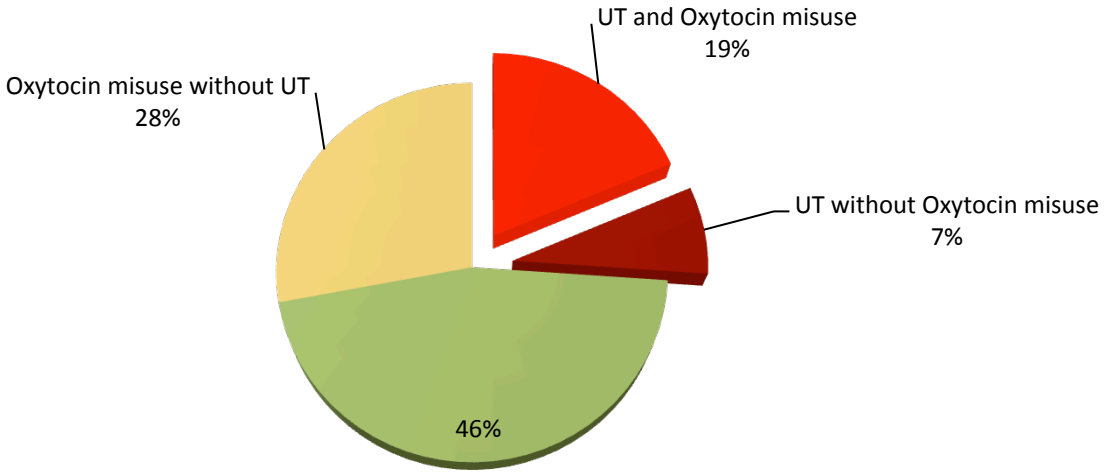
PeriGen
Advanced
Perinatal Systems

Metabolic Acidosis



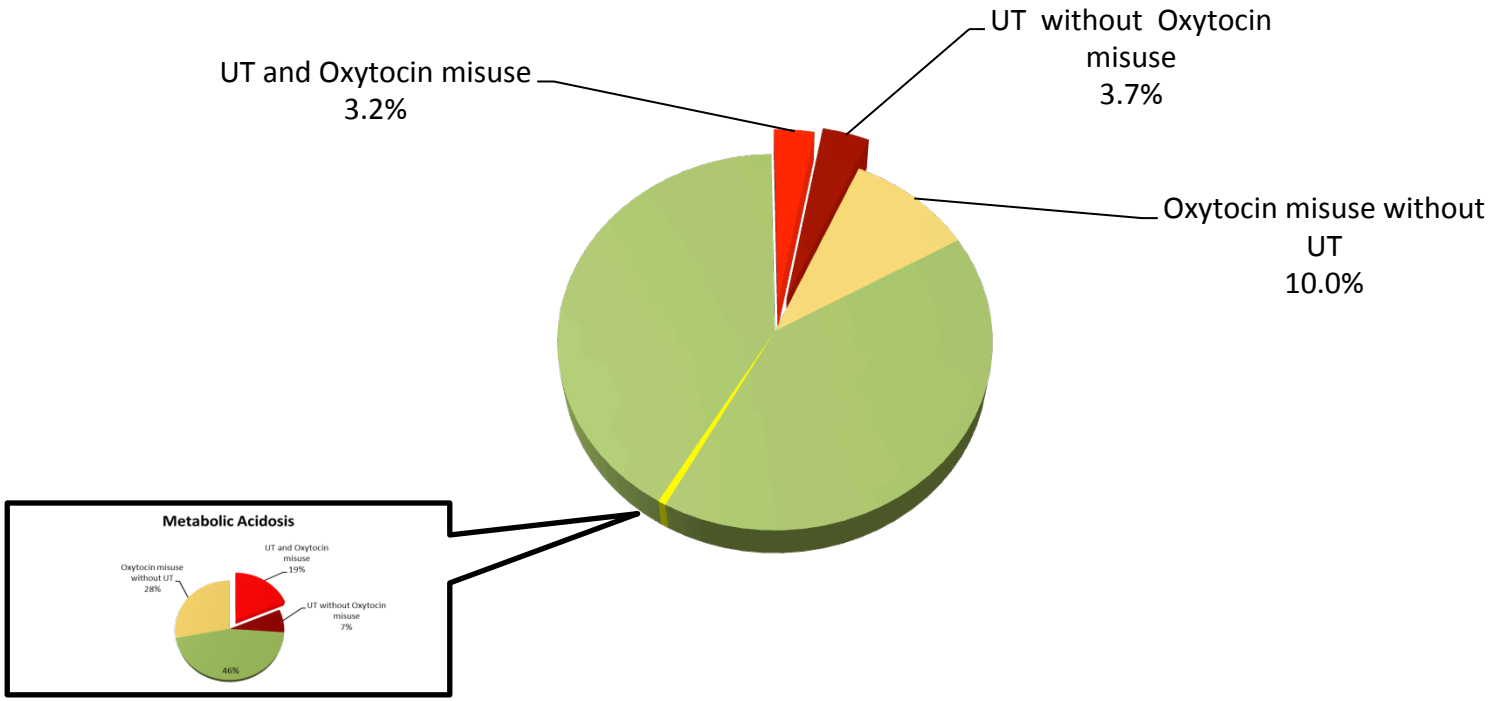
PeriGen
Advanced
Perinatal Systems

UT without Oxytocin Misuse



PeriGen
Advanced
Perinatal Systems

UT Normal



PeriGen
Advanced Perinatal Systems

Conclusions: Uterine Tachysystole

1. Fetal tolerance demonstrated by changes in FHR

2. Uterine tachysystole and/or failure to intervene for abnormal FHR is very common in OB litigation

3. Avoid it, Fix it, Can't defend it!

PeriGen
Advanced
Perinatal Systems

References

Ahmed AI, Zhu L, Aldhaheri S, Sakr S, Minkoff H, Haberman S.Uterine tachysystole in spontaneous labor at term. J Matern Fetal Neonatal Med. 2016 Oct;29(20):3335-9

Aldrich CJ, D'Antona D, Spencer JA, Delpy DT, Reynolds EO, Wyatt JS. Fetal heart rate changes and cerebral oxygenation measured by near-infrared spectroscopy during the first stage of labour. Eur J Obstet Gynecol Reprod Biol. 1996 Feb;64(2):189-95.

Bakker PC, Kurver PH, Kuik DJ, Van Geijn HP. Elevated uterine activity increases the risk of fetal acidosis at birth. Am J Obstet Gynecol. 2007 Apr;196(4):313.e1-6.

Bennet L, Westgate JA, Liu YC, Wassink G, Gunn AJ. Fetal acidosis and hypotension during repeated umbilical cord occlusions are associated with enhanced chemoreflex responses in near-term fetal sheep. J Appl Physiol (1985). 2005 Oct;99(4):1477-82.

Berglund S, Grunewald C, Pettersson H, Cnattingius S. Severe asphyxia due to delivery-related malpractice in Sweden 1990-2005. BJOG. 2008 Feb;115(3):316-23.

Brar HS, Platt LD, DeVore GR, Horenstein J, Medearis AL. Qualitative assessment of maternal uterine and fetal umbilical artery blood flow and resistance in laboring patients by Doppler velocimetry. Am J Obstet Gynecol. 1988 Apr;158(4):952-6.

Clark SL, Belfort MA, Dildy GA, Meyers JA. Reducing obstetric litigation through alterations in practice patterns. Obstet Gynecol. 2008 Dec;112(6):1279-83.

Managing the Risks of Labour Induction. CMPA Perspective March 2014

PeriGen
Advanced
Perinatal Systems

References

Miller FC, Yeh SY, Schifrin BS, Paul RH, Hon EH. Quantitation of uterine activity in 100 primiparous patients. Am J Obstet Gynecol. 1976 Feb 15;124(4):398-405.

Fleischer A, Anyaegbunam AA, Schulman H, Farmakides G, Randolph G. Uterine and umbilical artery velocimetry during normal labor. Am J Obstet Gynecol. 1987 Jul;157(1):40-3.

Hamilton E, Warrick P, Knox E, O'Keeffe D, Garite T. High uterine contraction rates in births with normal and abnormal umbilical artery gases. J Matern Fetal Neonatal Med. 2012 Nov;25(11):2302-7.

Janbu T, Nesheim BI. Uterine artery blood velocities during contractions in pregnancy and labour related to intrauterine pressure. Br J Obstet Gynaecol. 1987 Dec; 94(12):1150-5.

Jonsson M, Nordén-Lindeberg S, Ostlund I, Hanson U. Metabolic acidosis at birth and suboptimal care--illustration of the gap between knowledge and clinical practice. BJOG. 2009 Oct;116(11):1453-60.

Klink F, Grosspietzsch R, Klitzing LV, Oberheuser F. Uterine contraction intervals and transcutaneous levels of fetal oxygen pressure. Obstet Gynecol. 1981 Apr; 57(4):437-40.

Kunz MK, Loftus RJ, Nichols AA. Incidence of uterine tachysystole in women induced with oxytocin.J Obstet Gynecol Neonatal Nurs. 2013 Jan-Feb;42(1):12-8.

Simpson KR, James DC. Effects of oxytocin-induced uterine hyperstimulation during labor on fetal oxygen status and fetal heart rate patterns. Am J Obstet Gynecol. 2008 Jul;199(1):34.e1-5.

Smith S, Zacharias J, Lucas V, Warrick PA, Hamilton EF. Clinical associations with uterine tachysystole. J Matern Fetal Neonatal Med. 2014 May;27(7):709-13.

PeriGen
Advanced
Perinatal Systems