Can We Use Models to Predict Vaginal Birth After Cesarean Delivery?

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Disclosure Statements

- I have no relevant financial relationships to disclose or conflicts of interest to resolve

Learning Objectives

- Describe trends in VBAC versus elective repeat cesarean
- Counsel women regarding risks and benefits of VBAC
- Utilize VBAC models to predict success
- Incorporate prediction models into VBAC counseling

Background

- TOLAC offered to women with history of cesarean delivery
- Decision-making regarding mode of delivery dependent on several factors
  - Availability of TOLAC
  - Weighing risks and benefits
  - Obstetrical history
  - Patient preference

www.cgtrader.com

Trends in VBAC Over Time

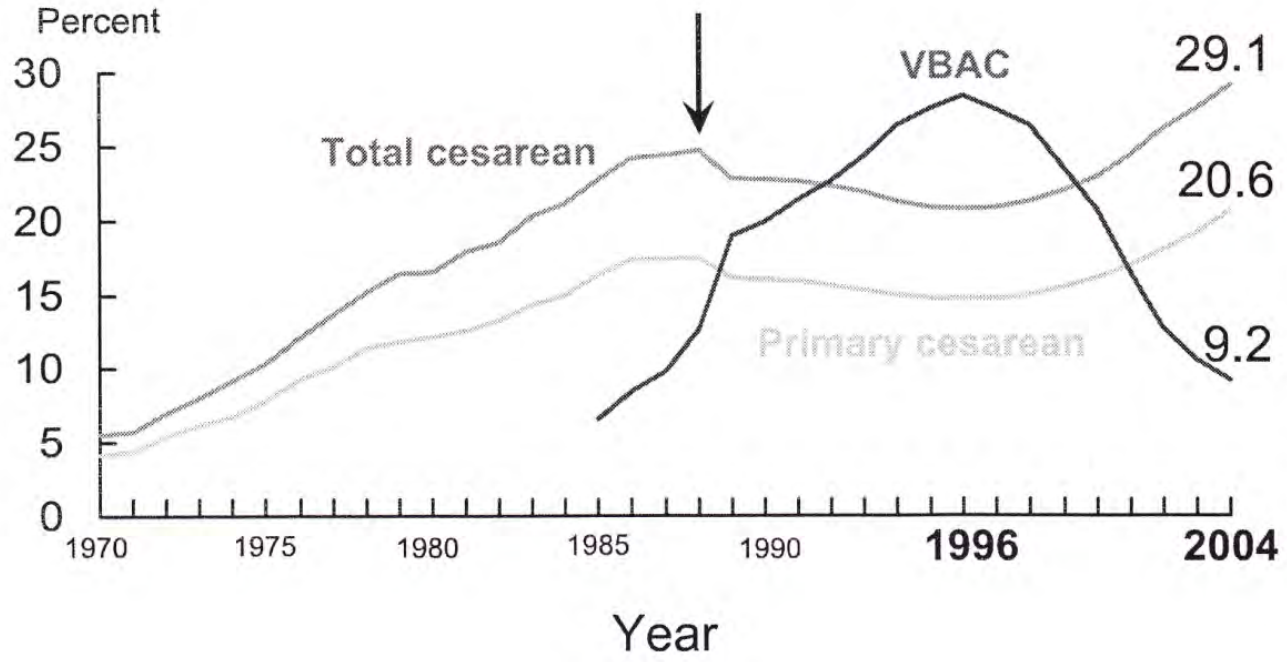


Figure 1 Total and primary cesarean rate, 1970 to 2004, and VBAC, 1985 to 2004. (Source: Data for 1970–1988 are from the National Hospital Discharge Survey [NHDS]. Data for 1989-2004 are from the National Vital Statistics System. For 1989 the estimate of the total cesarean rate from the NHDS was 23.8 percent; the estimate from vital records was 22.8 percent. Data for 2004 are preliminary.)

Trends in VBAC Over Time

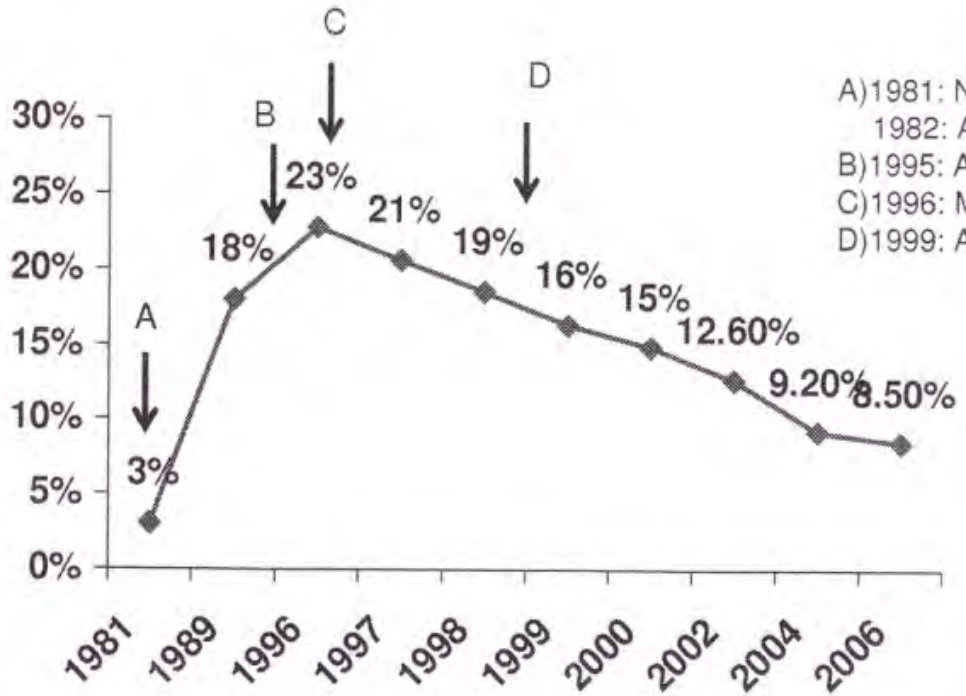


Figure 1 Trends in VBAC rates since 1981 NIH Consensus Conference on cesarean childbirth with timeline of external events impacting VBAC rates. (Reprinted with permission.[24,25]) (Color version of figure is available online.)

Contributors to Decreased TOLAC

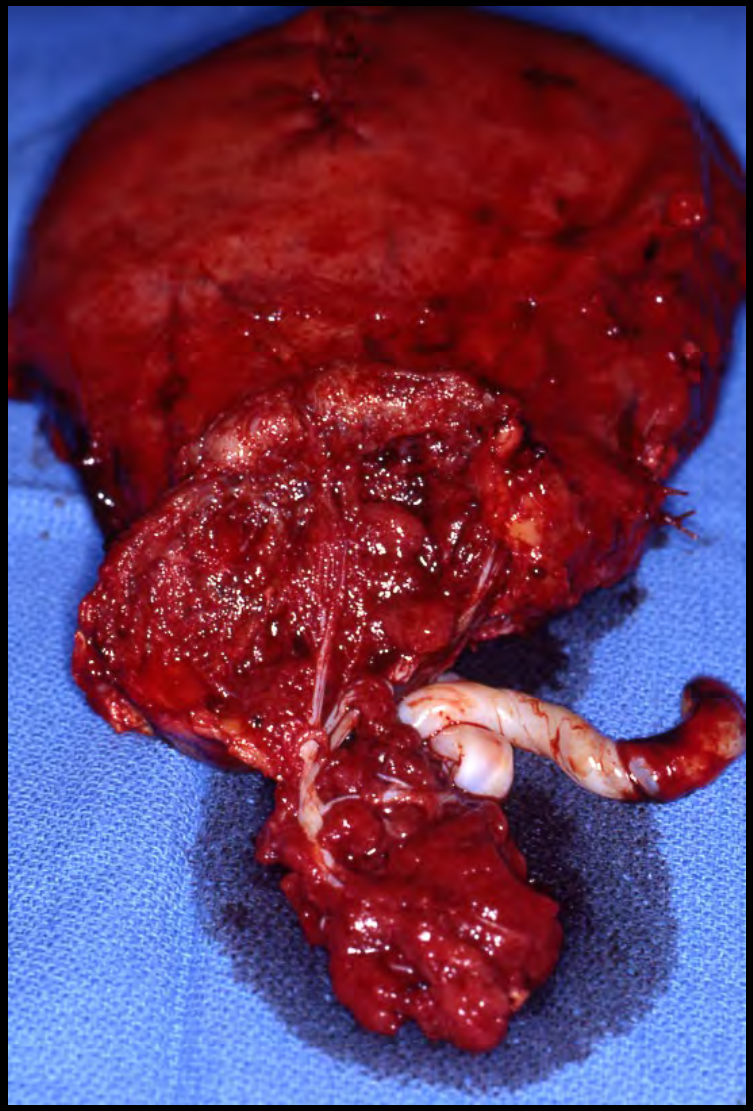
- Reports of uterine rupture
- Medico-legal concerns
- Difficulty in providing/understanding ACOG's "immediate availability"
- No TOLAC
  - 1/3 of hospitals
  - 1/2 of obstetricians

How do we weigh the risks and benefits of TOLAC?

Accreta, Uterine Rupture and Failed TOLAC, oh my…

Deadline.com

Placenta Accreta



Placenta Accreta: Morbidity

- Blood transfusion ≥ 80%
  - ≥ 4 units in 40%
- Large volume blood loss
- Cystotomy (bladder injury)
- Ureteral injury
- ICU admission: 25 – 50%
- Re-operations
- Vesico-vaginal fistulas

Placenta Accreta

Incidence

- 1960s: 1 in 30,000 deliveries
- 1985 – 1994: 1 in 2,510 deliveries
- 1982 – 2002: 1 in 533 deliveries

- Correlation with rising cesarean rate
- Most common indication for cesarean hysterectomy in developed countries

Miller et al., AJOG 1997;177:210
Wu et al., AJOG 2005;192:1458

Accreta

CS#	N	Accreta
1	6,195	15 (0.2%)
2	15,805	49 (0.3%)
3	6,326	36 (0.6%)
4	1,457	31 (2.1%)
5	260	6 (2.3%)
≥ 6	89	6 (6.7%)

Silver et al., Obstet Gynecol 2006;107:1226

Previa and Accreta

CS#	Previa	Accreta
1	397	13 (3.3%)
2	212	23 (11%)
3	72	29 (40%)
4	33	20 (61%)
5	6	4 (67%)
≥ 6	3	2 (67%)

Silver et al., Obstet Gynecol 2006;107:1226

Utah Data with Multidisciplinary Care Team

- Estimated blood loss 2 liters
- Admission to ICU 43%
- Coagulopathy 29%
- Blood transfusion of ≥ 1 unit 82%
- Blood transfusion of ≥ 4 units 43%
- Ureteral injury 6%
- Median length of stay 5 days

Eller et al., Obstet Gynecol 2011;117:331

Why not offer everyone a TOLAC ?

Trial of Labor vs. Repeat CS

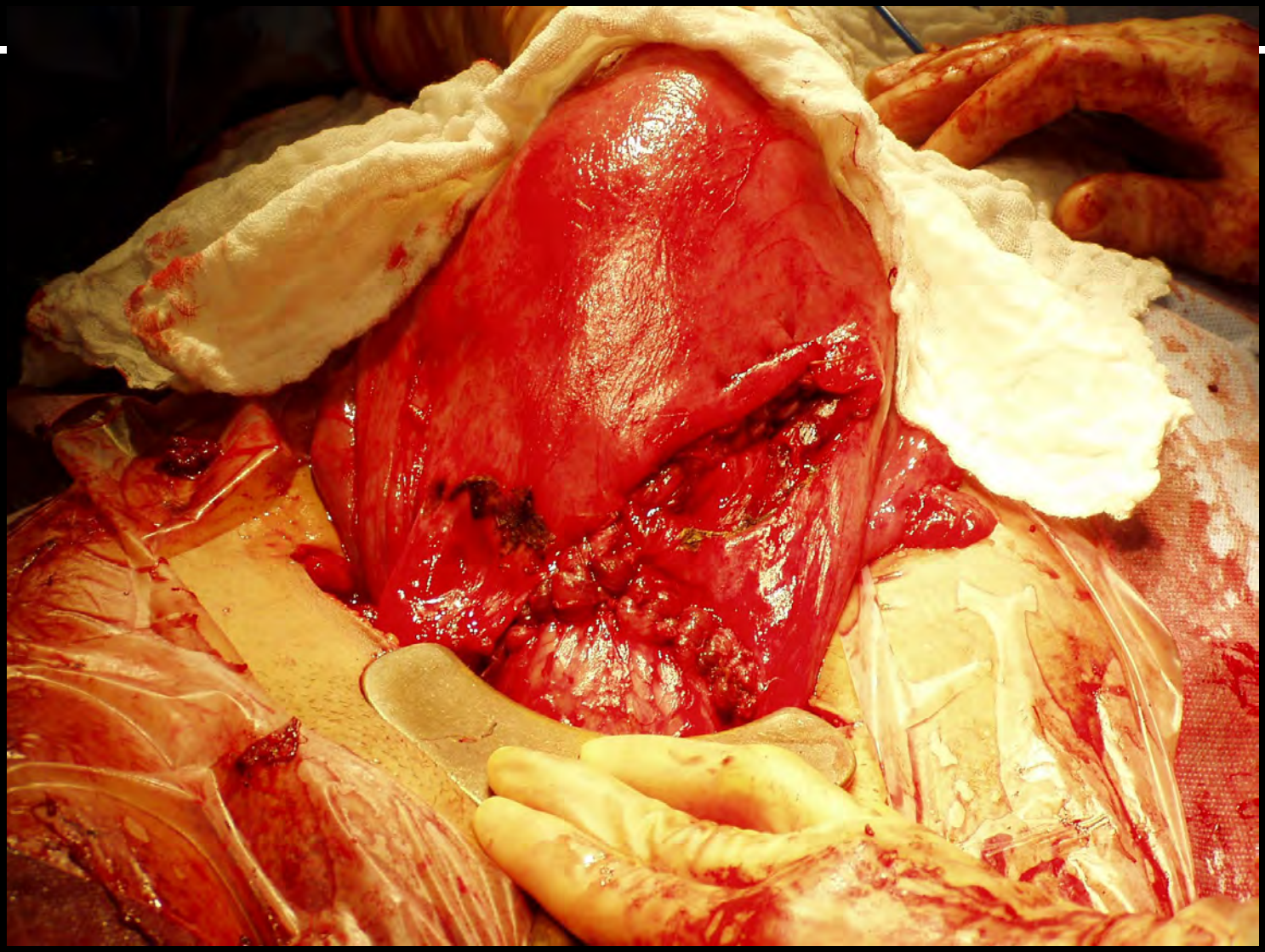
3,249 TOL versus 2,889 ERC

- Minor complications (6.3 vs 7.6%)
  - Puerperal fever, transfusion, infection
  - No significant differences
- Major complications (1.6 vs 0.8%)
  - Hysterectomy, uterine rupture, operative injury
  - Twice as likely in TOL group

McMahon et al; N Engl J Med 1996;335:689

Guardian.co.uk

Uterine Rupture



MFMU TOLAC Study

- 4-year prospective observational trial
  - MFMU Network (19 centers)
  - 1 prior LTCS, singleton pregnancy
  - TOLAC (17,898) vs. RCS (15,801)
- Neonatal data
  - NICU admission
  - Morbidity at discharge and up to 120 days of life

Landon, et al, NEJM 2004; 351:2581-9

Demographics

	TOL (17,898)	ERC (15,801)	*P Value*
Maternal age	28.7±6	29.9±6	<0.001
Married	9,854	10,437	<0.001
BMI	31.9±7	33.5±7	<0.001
Prior VD	50%	16%	<0.001
Prior VBAC	34%	16%	<0.001
Maternal disease	18%	22%	<0.001

Landon, et al, NEJM 2004; 351:2581-9

Maternal Outcomes

	TOL (17,898)	ERC (15,801)	*P* value
Uterine rupture	124 (0.7%)	0	<0.001
Hysterectomy	41 (0.2%)	47 (0.3%)	0.22
Thrombosis	7 (0.04%)	10 (0.1%)	0.32
Transfusion	304 (2%)	158 (1%)	<0.001
Endometritis	517 (3%)	285 (2%)	<0.001

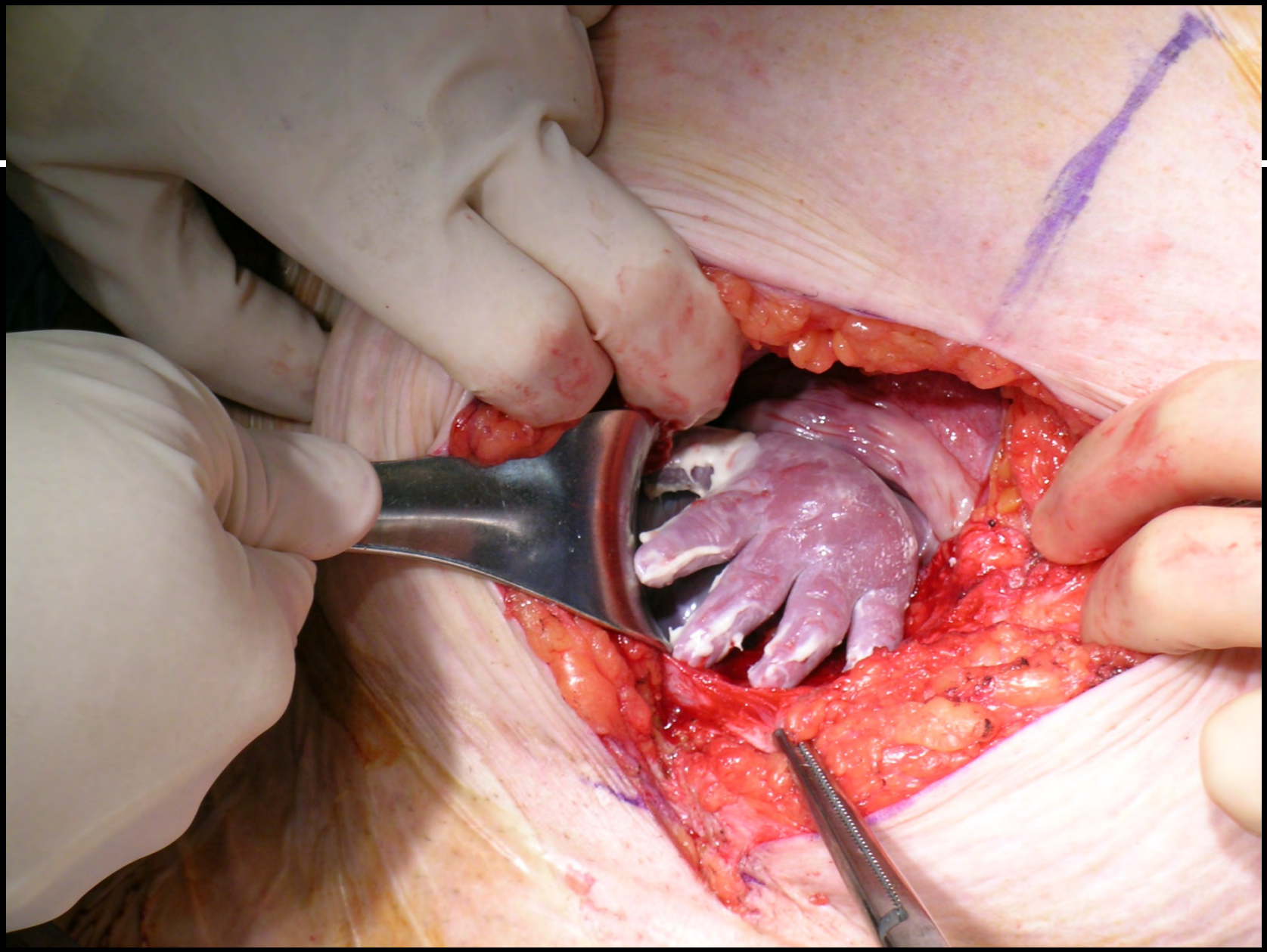
Adjusted OR: Maternal Complication 2.0 (1.7, 2.2)

Landon, et al, NEJM 2004; 351:2581-9

Perinatal Outcomes and Uterine Rupture

Uterine rupture	N=114	
Intrapartum stillbirth	0	0%
HIE	7	6%
Neonatal death	2	2%

Landon, et al, NEJM 2004; 351:2581-9



TOLAC vs ERCD

- RCTs are lacking and not feasible
- Propensity analysis
  - Rates of endometritis, operative injury, RDS, newborn infection lower with ERCD
  - Rates of hysterectomy and wound complication higher with ERCD
  - 62 (95% CI 40-138) women would need to undergo ERCD to prevent one adverse maternal outcome
  - 43 (95% CI 29-78) women would need to undergo PRCD to prevent one adverse neonatal outcome

Gilbert et al AJOG 2012

Failed Versus Successful TOL

	Fail (1287)	Success (1962)	OR
Minor	9.3%	4.3%	1.5*
Fever	3.8%	0.2%	5.1*
Major	3.8%	0.2%	5.1*
Uterine rupture	0.6%	0.1%	3.7*
Operative Injury	3.0%	0.1%	5.1*
All complications	13.1%	4.5%	5.1*

McMahon et al; N Engl J Med 1996;335:689

Failed Versus Successful TOLAC

	Fail (4759)	Success (13139)	OR
Uterine rupture	2.3%	0.1%	22 (13,39)
Hysterectomy	0.5%	0.1%	3 (1.7,5.9)
Thromboembolism	0.1%	0.02%	NS
Endometritis	7.7%	1.2%	7.1 (5.9,8.6)
One or more comp	14.1%	2.4%	6.8 (5.9,7.8)

Landon, et al, NEJM 2004; 351:2581-9

Successful VBAC

Is better than

Scheduled Elective Repeat CS

Is better than

Failed TOLAC with Emergency CS

How do we choose good candidates for TOLAC?

General Counseling TOLAC

- Success rates 60–80%
- Individual variation
- Strong predictors of success
  - Prior vaginal birth
  - Spontaneous labor

General Counseling TOLAC

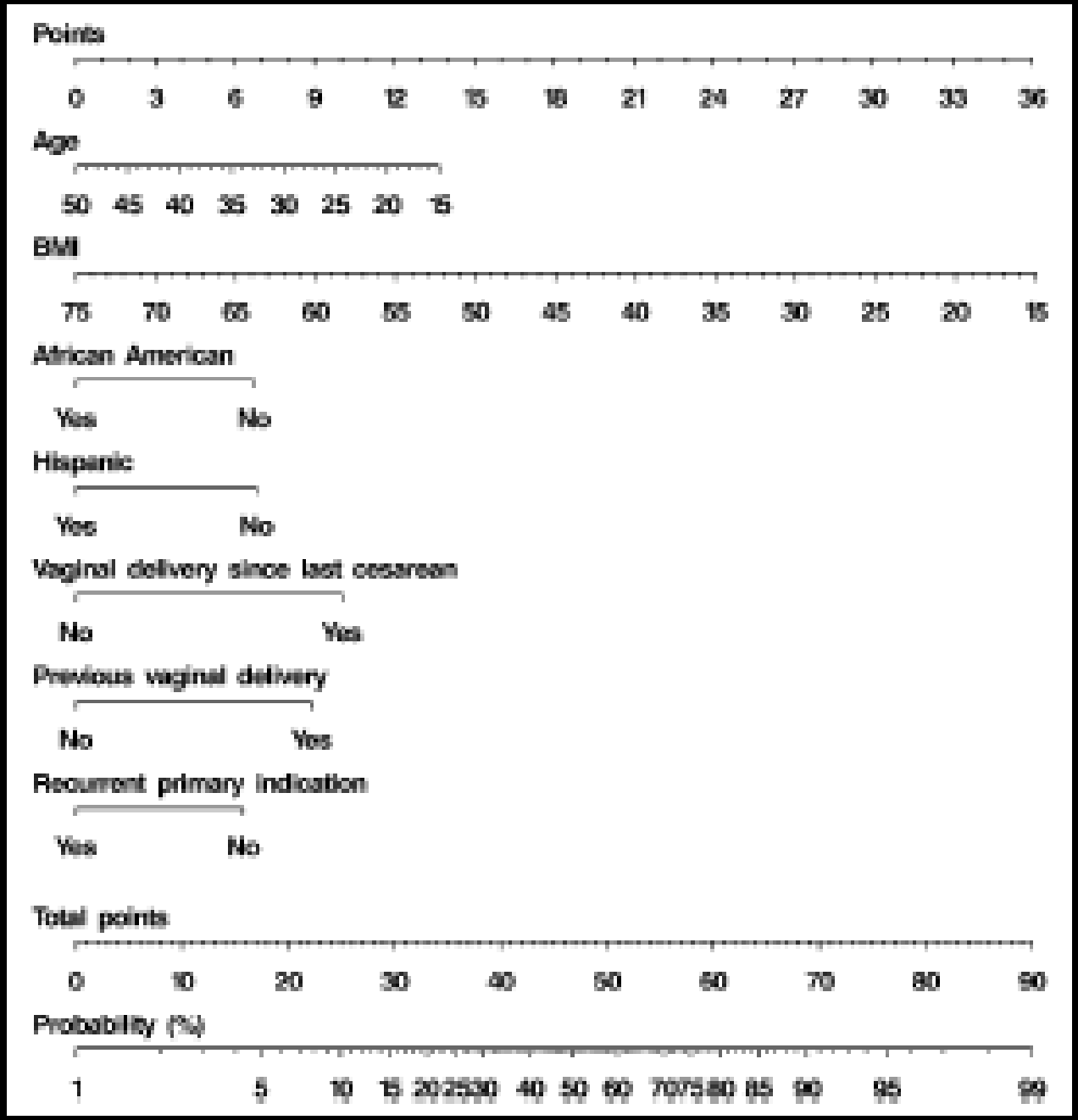
- Predictors of decreased success
  - Recurrent indication for CS (dystocia)
  - Increased maternal age
  - Non-white ethnicity
  - ≥ 40 weeks gestation
  - Maternal obesity
  - Preeclampsia
  - Short inter-pregnancy interval
  - Increased neonatal birth weight

VBAC Calculators

MFMU Prenatal VBAC Calculator

- 11,856 (73%) prospective cohort delivered vaginally
- Multivariable logistic regression to identify factors associated with successful VBAC
- Factors weighted and nomogram created
- AUC 0.75 (95% 0.74-0.77)

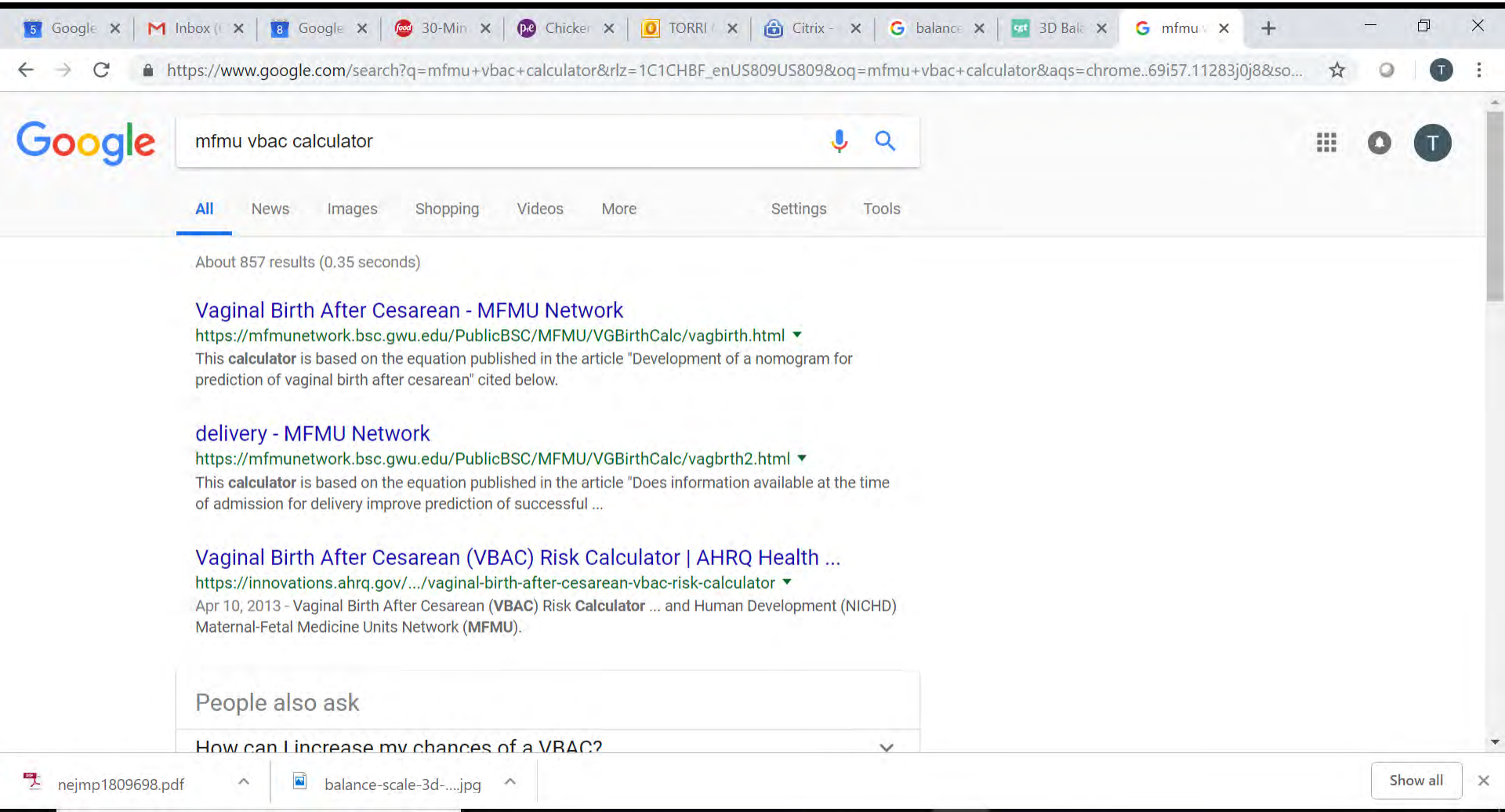
Grobman et al Obstet Gynecol 2007



Grobman et al. Obstet Gynecol 2007; 109:806

Case Examples

MFMU VBAC Calculator



MFMU VBAC Calculator

https://mfmunetwork.bsc.gwu.edu/PublicBSC/MFMU/VGBirthCalc/vagbirth.html

VAGINAL BIRTH AFTER CESAREAN

Height & weight optional; enter them to automatically calculate BMI

Maternal age	18 ▼ years
Height (range 54-80 in.)	in
Weight (range 80-310 lb.)	lb
Body mass index (BMI, range 15-75)	25 ▼ kg/m^2
African-American?	no ▼
Hispanic?	no ▼
Any previous vaginal delivery?	no ▼
Any vaginal delivery since last cesarean?	no ▼
Indication for prior cesarean of arrest of dilation or descent?	no ▼

Calculate

CLICK HERE for calculator based on information available at admission.

This calculator is based on the equation published in the article "Development of a nomogram for prediction of vaginal birth after cesarean" cited below. It is designed for educational use and is based on a population of women who received care at the hospitals within the MFMU Network. Responsibility for its correct application is accepted by the end user.

Grobman WA, Lai Y, Landon MB, Spong CY, Leveno KJ, Rouse DJ, Varner MW, Moawad AH, Caritis SN, Harper M, Wapner RJ, Sorokin Y, Miodovnik M, Carpenter M, O'Sullivan MJ, Sibai BM, Langer O, Thorp JM, Ramin SM, Mercer BM; National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units Network (MFMU), "Development of a nomogram for prediction of vaginal birth after cesarean delivery," Obstetrics and Gynecology, volume 109,

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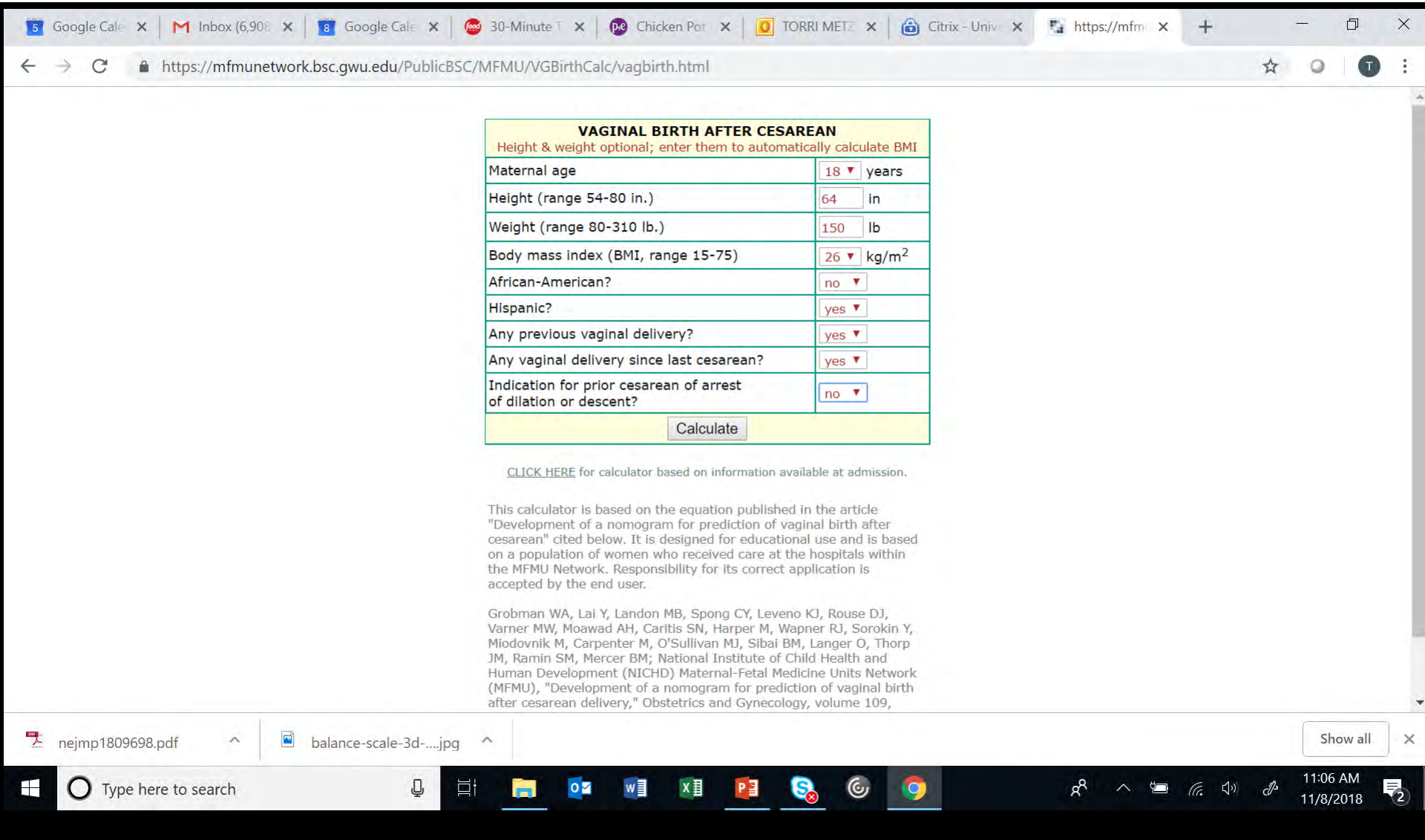

https://mfmunetwork.bsc.gwu.edu/PublicBSC/MFMU/VGBirthCalc/vagbirth.html

VAGINAL BIRTH AFTER CESAREAN

Height & weight optional; enter them to automatically calculate BMI

Maternal age	18 years
Height (range 54-80 in.)	64 in
Weight (range 80-310 lb.)	150 lb
Body mass index (BMI, range 15-75)	26 kg/m^2
African-American?	no
Hispanic?	yes
Any previous vaginal delivery?	yes
Any vaginal delivery since last cesarean?	yes
Indication for prior cesarean of arrest of dilation or descent?	no

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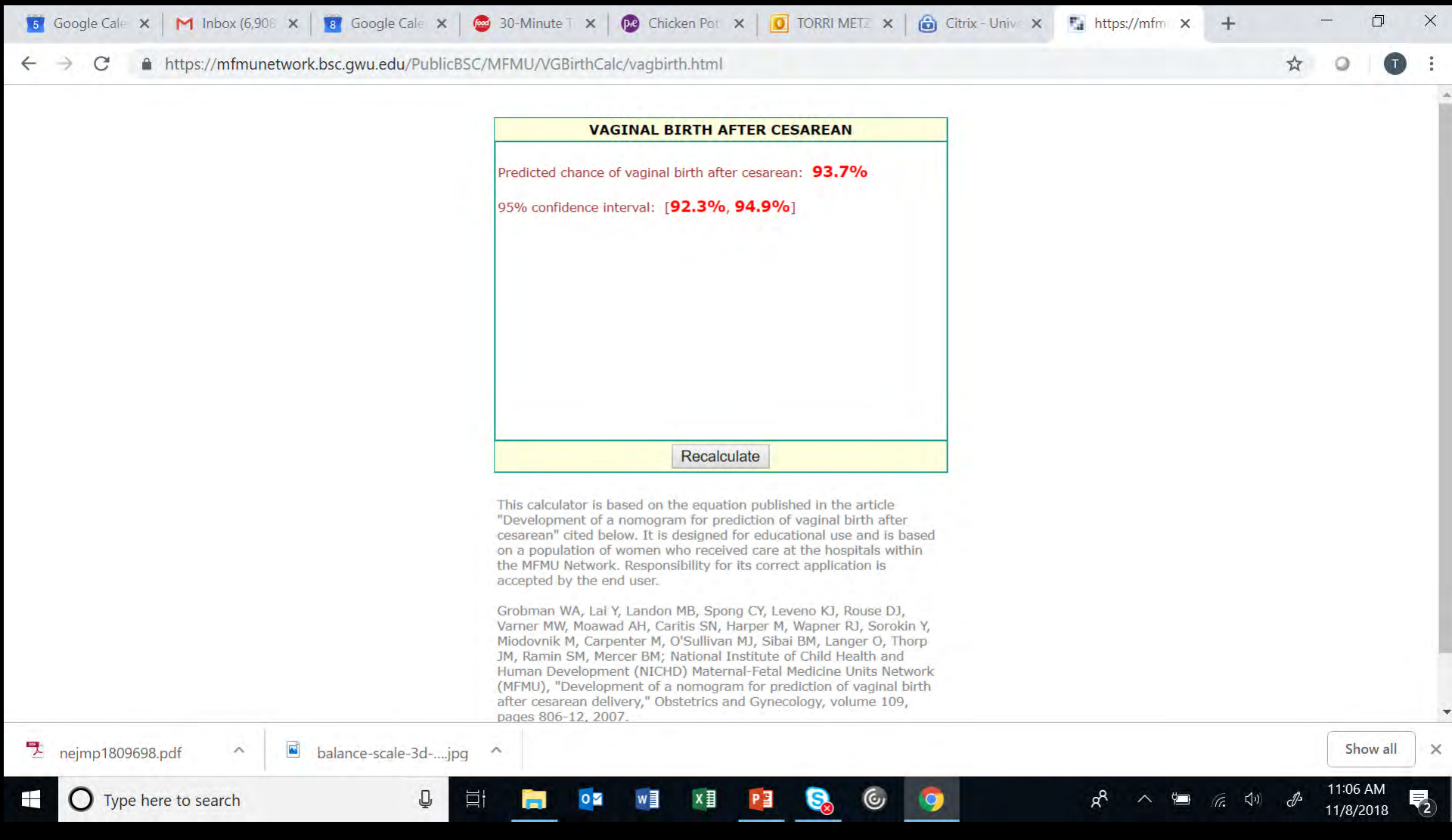

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VAGINAL BIRTH AFTER CESAREAN

Height & weight optional; enter them to automatically calculate BMI

Maternal age	18 ▼ years
Height (range 54-80 in.)	61 in
Weight (range 80-310 lb.)	190 lb
Body mass index (BMI, range 15-75)	36 ▼ kg/m^2
African-American?	yes ▼
Hispanic?	no ▼
Any previous vaginal delivery?	no ▼
Any vaginal delivery since last cesarean?	no ▼
Indication for prior cesarean of arrest of dilation or descent?	yes ▼

Calculate

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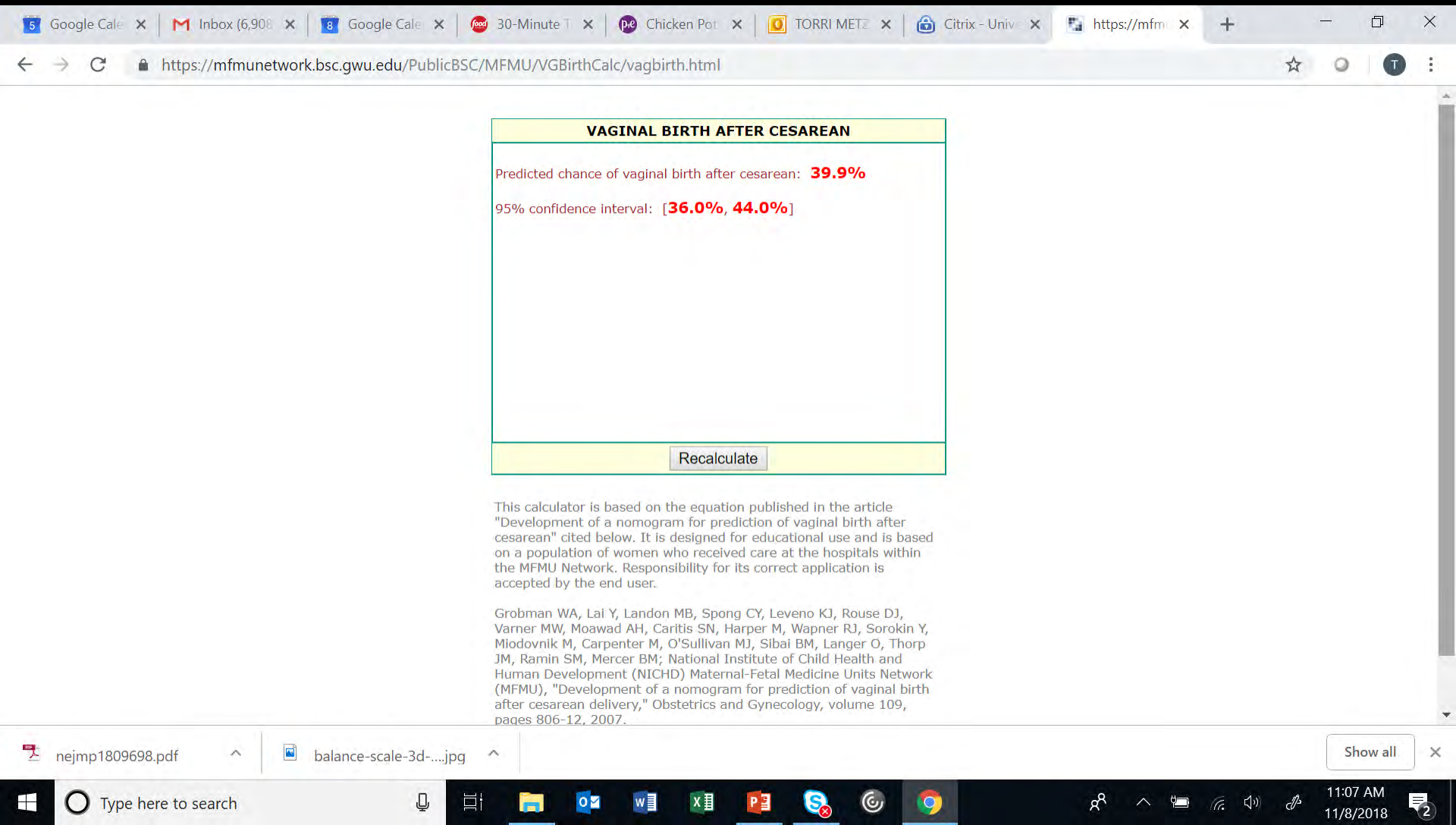

MFMU Time of Admission Calc

- Utilizes same MFMU retrospective cohort
- Replaces prepregnancy BMI with time of admission BMI
- Other factors only available at time of delivery
  - Gestational age
  - Cervical exam
  - Comorbidities (preeclampsia, gestational HTN)
  - Induction of labor
- AUC 0.77 (95% CI 0.76-.78) *Grobman et al Am J Perinatol 2009*

MFMU VBAC Calculator

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VAGINAL BIRTH AFTER CESAREAN

Height & weight optional; enter them to automatically calculate BMI

Maternal age	18 years
Height (range 54-80 in.)	in
Weight (range 80-310 lb.)	lb
Body mass index (BMI, range 15-75)	25 kg/m^2
African-American?	no
Hispanic?	no
Any previous vaginal delivery?	no
Any vaginal delivery since last cesarean?	no
Indication for prior cesarean of arrest of dilation or descent?	no

Calculate

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https://mfmunetwork.bsc.gwu.edu/PublicBSC/MFMU/VGBirthCalc/vagbrth2.html

VAGINAL BIRTH AFTER CESAREAN Height & weight optional; enter them to automatically calculate BMI	
Maternal age	30 ▼ years
Height (range 54-80 in.)	in
Weight (range 80-310 lb.)	lb
Body mass index (BMI, range 15-75)	40 ▼ kg/m^2
African-American?	no ▼
Hispanic?	no ▼
Any previous vaginal delivery?	no ▼
Any vaginal delivery since last cesarean?	no ▼
Indication for prior cesarean of arrest of dilation or descent?	no ▼
Estimated gestational age at delivery	40 ▼ weeks
Hypertensive disease of preganancy	no ▼
Effacement	25 ▼ %
Dilation	1 ▼ cm
Station (0:Floating/Ballotable, 1:-5, 2:-4, 3:-3, 4:-2, 5:-1, 6:0, 7:+1, 8:+2, 9:+3)	3 ▼
Labor induction	yes ▼
Calculate	

This calculator is based on the equation published in the article "Does information available at the time of admission for delivery improve prediction of successful birth after cesarean?" cited below. It is designed for educational use and is based on a population of women who received care at the hospitals within the MFMU Network.

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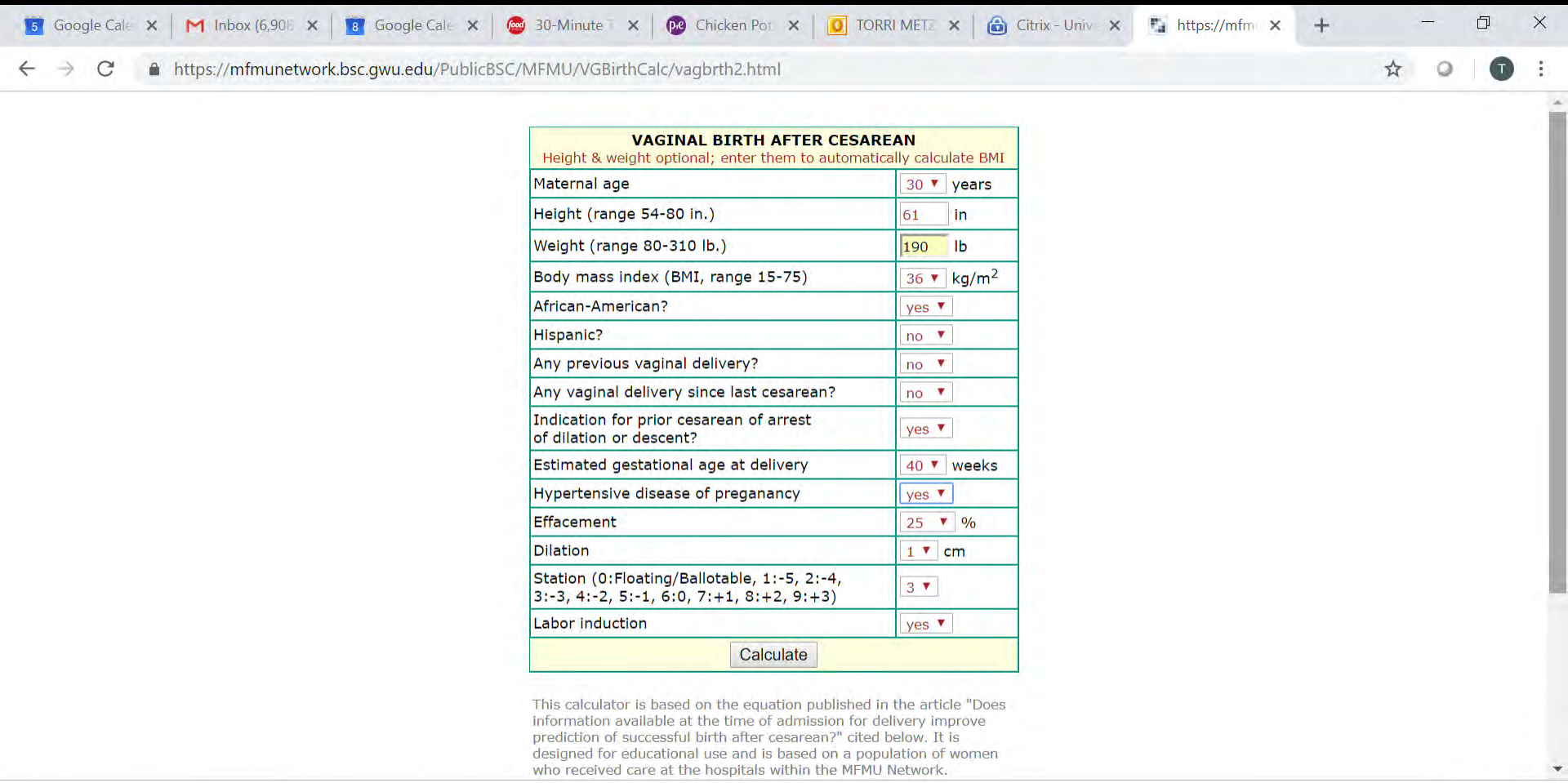
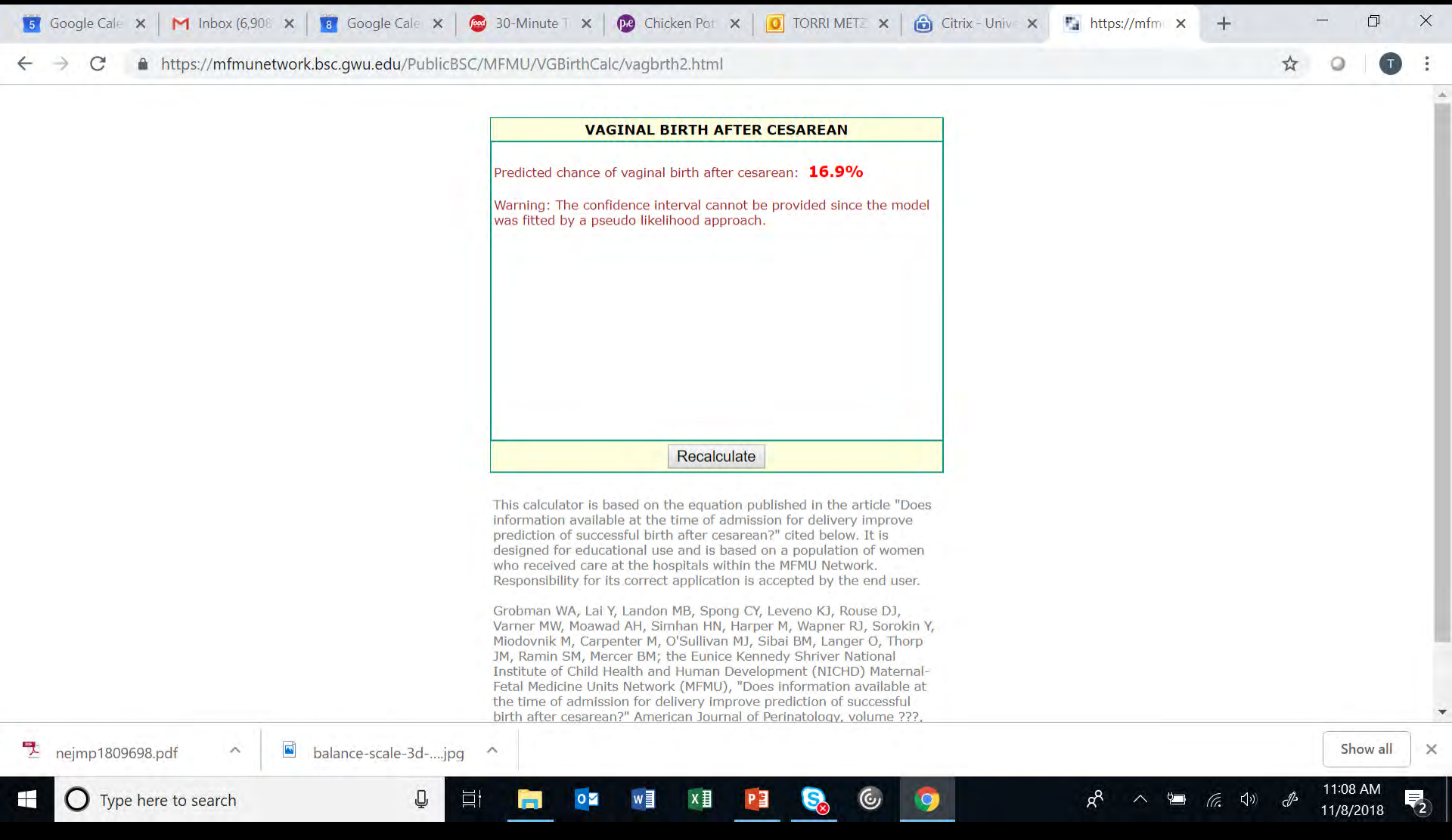


MFMU VBAC Calculator



Time of Admission VBAC Score

- 5,445 women at 8 hospitals
- 1,170 (21.5%) underwent TOLAC
  - 938 (80%) had a successful VBAC
- Multivariable logistic regression model
- Weighted variables remaining in model
- VBAC score
  - Bishop score at admission
  - Add points for: history of vaginal birth, age <35 yrs, absence of recurrent indication, BMI <30

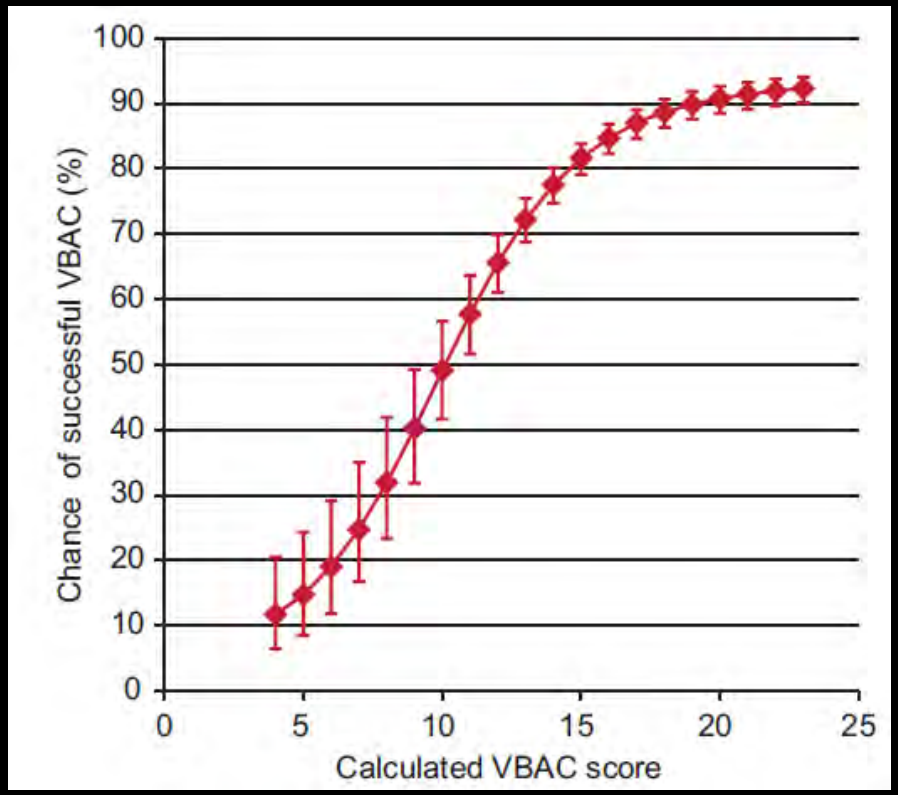
Metz et al Obstet Gynecol 2013

VBAC Score

Box 1. Calculation of Integer Vaginal Birth After Cesarean Score

Calculate the Bishop score using the cervical examination at the time of admission
Add 4 points for history of vaginal delivery
Add 2 points if prepregnancy body mass index is less than 30
Add 3 points if primary cesarean delivery was not because of a recurring indication
Add 2 points if maternal age at the time of delivery is younger than 35 years
Sum total score

AUC 0.80 (95% CI 0.76-.84)



Metz et al Obstet Gynecol 2013

What about women with 2 prior cesareans?

Maternal Outcomes, 2 Prior CS

	1 CS (12,535)	2 CS (1,082)	Adj RR
Uterine rupture	0.9%	1.8%	2.3
Bladder injury	0.43%	0.55%	NS
Transfusion	0.68%	0.92%	NS
Fever	9.5%	8.9%	NS
Operative injury	0.99%	1.02%	NS
Composite morbidity	2.12%	3.23%	1.61

Macones, et al, AJOG 2005; 192:1223

TOLAC with Two Prior CS

- 975 women with ≥ 2 CS and TOLAC—66% success rate
  - Rupture 0.9% (2 prior CS)
    - No increase in rupture (p=0.37)
  - 0.6% risk of hysterectomy (0.2%)
  - 3.2% risk of transfusion (1.6%)
  - Composite maternal morbidity
    - 1.41 (1.02 – 1.93) – low absolute risk

Landon, et al, Obstet Gynecol 2006; 108:12

TOLAC with Two Prior CS

- Systematic review and meta-analysis
- No RCTs – 20 studies
- Success rates – 71.1%
- Rupture rates – 1.36%
- Maternal morbidity of VBAC after 2 prior CS similar to RCS with 2 prior CS

Tahseen, et al, BJOG 2010; 117:5

TOLAC with Two Prior CS

- Systematic review and meta-analysis
- 5 observational cohort studies of uterine rupture
- Women with one prior CS were at lower risk of rupture than two prior CS
  - 0.72% versus 1.59% (OR 0.42, 95% CI 0.29-0.60)

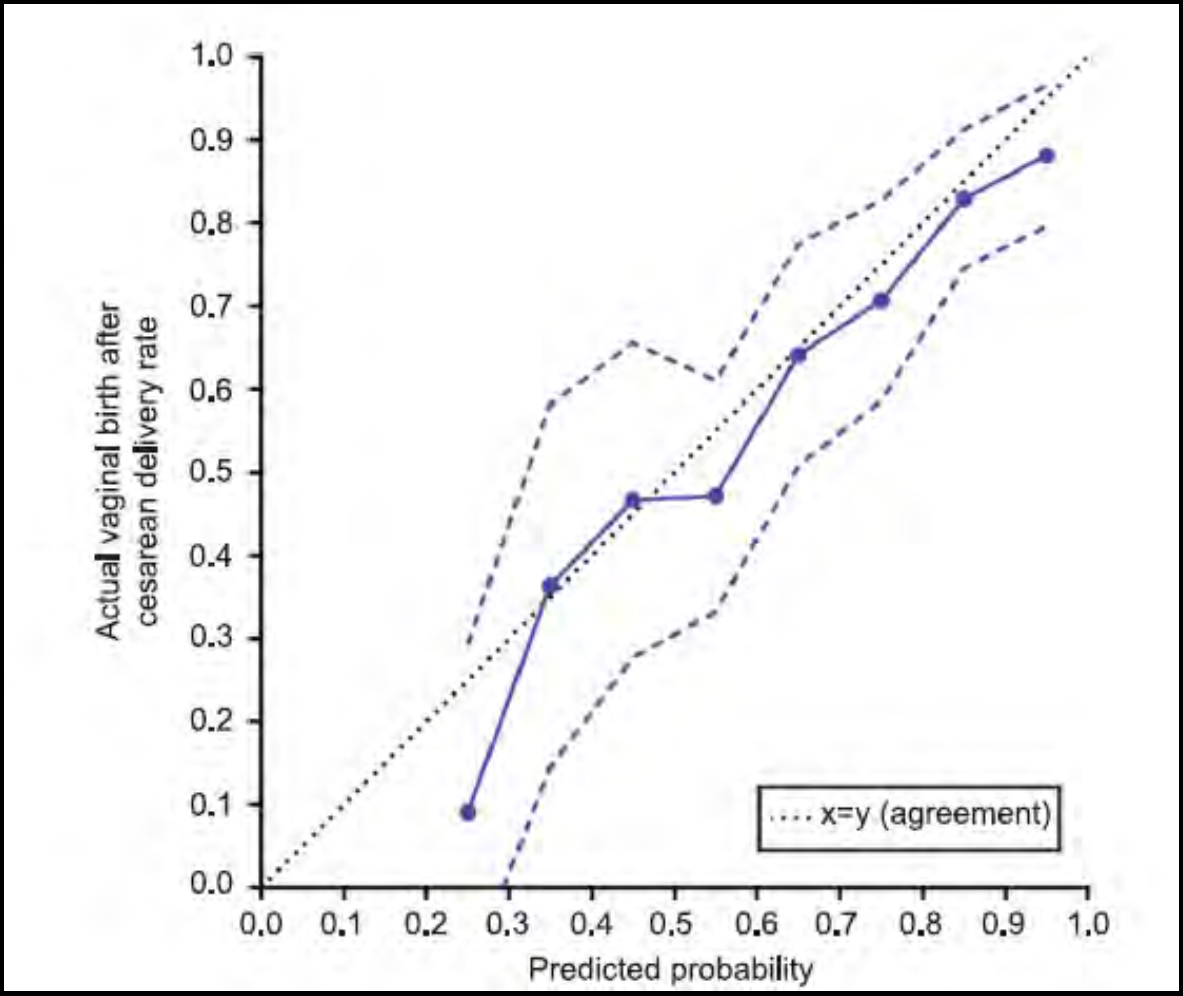
Cahill et al AJOG 2010

MFMU Model with Two Prior CS

- 369 women with two prior CS in MFMU Cesarean Registry
- Actual VBAC rate 66% (95% CI 61-71)
- Utilized MFMU prenatal care model
- Women with an arrest diagnosis as indication for either CS were considered 'yes' in model
- AUC 0.74 (95% CI 0.69-0.80)

Metz et al Obstet Gynecol 2015

MFMU Model with Two Prior CS



Metz et al Obstet Gynecol 2015

Preterm VBAC Model

- 1295 women undergoing TOLAC
- Gestational age 26wod to 36w6d
- VBAC rate 76.6%
- Multivariable prediction model
  - Factors increasing success: diabetes, greater cervical dilation, history of vaginal birth/VBAC
  - Factors decreasing success: induction, recurring indication for cesarean, hypertensive disease
- AUC 0.80 (95% CI 0.77-0.83)

Mardy et al AJOG 2016

Predicting Morbidity with Models

- Prospective cohort 13,500 candidates for TOLAC
- Stratified by likelihood VBAC MFMU Calculator
- Women with >70% likelihood of success had similar morbidity to those undergoing ERCD (RR 0.80, 95% CI 0.5-1.2)
- Women with <70% likelihood of success had increased risk maternal morbidity (RR 2.2, 95% CI 1.5-3.1)

Grobman et al AJOG 2009

Predicting Morbidity with Models

- Retrospective cohort 8,505 candidates for TOLAC
- Maternal morbidity similar between TOLAC and ERCD groups when predicted probability of success ≥ 60% (RR 0.8, 95% CI 0.6-1.1)
- Maternal morbidity higher when predicted probability <60% (RR 2.3, 95% CI 1.4-4.0)
- Neonatal morbidity similar when predicted probability ≥ 70%

Chaillet et al J Obstet Gynaecol Can 2012

Good Candidates

- Best chance of success
- Least risk of rupture
- Most women with 1 (or two) CD
- Not classical CD, previa, etc.
- Poor candidate may be OK if advanced labor

Shared Decision-Making

- Pilot study 25 women
- Tool incorporating education about risks and benefits of TOLAC plus calculator with likelihood of success
- Small proportion of women identified a predicted likelihood of success below which they would not attempt VBAC

Schoorel et al BJOG 2014

Shared Decision-Making!

- Availability of TOLAC
- Probability of successful VBAC
  - Incorporate VBAC models
- Significance and estimated frequency of complications with TOLAC and ERCD
- Patient's personal values, preferences, future pregnancy plans

Thank you!