Cesarean Delivery Model
Meeting the challenge to reduce rates of Cesarean delivery

Alan Mills FSA MAAA ND
November 13, 2014
Agenda

1. Background
2. The U.S. Cesarean delivery challenge
3. Cesarean Delivery Model design
4. Results
1. Background
Types of childbirth delivery

Vaginal delivery
natural childbirth

Cesarean delivery
surgical intervention
Cesarean delivery problems

- Poor psychosocial outcomes
- Risks of major abdominal surgery
- Pulmonary disorders
- Compromised breast feeding
- Complications for later births
- Increased perinatal mortality
- Greater cost
World cesarean delivery rates – 2008

Source: World Health Organization
U.S. cesarean delivery rates – 2013

Lowest rate: 22.4%

Highest rate: 38.9%

Source:
U.S. cesarean delivery rates

1965: 4.5%
2013: 32.7%

Source:
U.S. hospital inpatient expenditures – 2011
(ages 0 – 65, $ billions)

Source:
2. The U.S. Cesarean delivery challenge
How can we reduce the U.S Cesarean delivery rate to a reasonable level (10% - 15%)?
My approach

1. Focus on individual States

2. Bring together the State’s major stakeholders:
   - Legislators
   - Health agencies
   - Health insurers
   - Medicaid
   - Clinicians (Obstetricians, Certified Nurse Midwives, Licensed Midwives)
   - Women

3. Use AnyLogic simulations as the focus
Reasons for using AnyLogic

One cogent framework accessible to all stakeholders:
- GIS visualization
- Sophisticated agent-based modeling
- Scalable for many agents
- State charts and flow diagrams for agent behavior
- Interface with Excel
- Robust experiment types
- Message passing
Why agent based modeling?

- Many heterogeneous agents interacting over time
- Independent agent behavior
- Importance of space
- Network effects
- Feedback
3. Cesarean Delivery Model design
Agents

- Women
- Obstetricians
- Certified nurse midwives (CNMs)
- Licensed midwives (LMs)
- Hospitals
- Health insurers
- Medicaid
Data

Data from the State:

Synthetic data
- Women
- Obstetricians, CNMs, LMs

Actual data
- Hospitals
- Insurers
Women
Choose primary birth attendant
Request delivery attendance

Obstetricians
Choose Hospital
Decide delivery method
Submit claim

CNMs
Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

LMs
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals
Submit claim

Insurers/Medicaid
Pay claim
Key behaviors

Women
Choose primary birth attendant
Request delivery attendance

Obstetricians
Choose Hospital
Decide delivery method
Submit claim

CNMs
Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals
Submit claim

Insurers/Medicaid
Pay claim

LMs
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim
Key behaviors

Women
Choose primary birth attendant
Request delivery attendance

Obstetricians
Choose Hospital
Decide delivery method
Submit claim

CNMs
Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals
Submit claim

Insurers/Medicaid
Pay claim

LMs
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim
Key behaviors

Women
- Choose primary birth attendant
- Request delivery attendance

Obstetricians
- Choose Hospital
- Decide delivery method
- Submit claim

CNMs
- Choose Hospital
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

LMs
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

Hospitals
- Submit claim

Insurers/Medicaid
- Pay claim
Key behaviors

**Women**
- Choose primary birth attendant
- Request delivery attendance

**Messages**

**Obstetricians**
- Choose Hospital
- Decide delivery method
- Submit claim

**CNMs**
- Choose Hospital
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

**LMs**
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

**Hospitals**
- Submit claim

**Insurers/Medicaid**
- Pay claim
Key behaviors

Women
- Choose primary birth attendant
- Request delivery attendance

Messages

Obstetricians
- Choose Hospital
- Decide delivery method
- Submit claim

CNMs
- Choose Hospital
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

LMs
- Choose backup Obstetrician
- Refer delivery attendance
- Attend vaginal birth
- Submit claim

Hospitals
- Submit claim

Insurers/Medicaid
- Pay claim
Key behaviors

Women
Choose primary birth attendant
Request delivery attendance

Messages

Obstetricians
Choose Hospital
Decide delivery method
Submit claim

CNMs
Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

LMs
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals
Submit claim

Insurers/Medicaid
Pay claim
Key behaviors

Women
Choose primary birth attendant
Request delivery attendance

Obstetricians
Choose Hospital
Decide delivery method
Submit claim

CNMs
Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals
Submit claim

Insurers/Medicaid
Pay claim

LMs
Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim
General behavior model

1. Input messages
2. Get input
3. Motivations
4. Attributes
5. Experience
6. Rules
7. Context
8. Produce output
9. Send output
10. Output messages
Example behavior:
Choose primary birth attendant

Agent: Woman
1. Input messages: Childbirth month (data item)
2. Get input: NA
3. Motivations: Desired birth attendant type (data item)
4. Attributes: Residence latitude and longitude (data item)
5. Experience: NA
6. Rules: NA
7. Context: NA
8. Produce output: Get Identifier of nearest desired birth attendant type
9. Send output: Send output to Woman attributes
10. Output messages: Clinician Identifier
Example behavior: Choose primary birth attendant

Agent

3. Motivations
4. Attributes
8. Produce output
9. Send output
10. Output messages
1. Input messages
Message passing

“Message” Class parameters:
- Message type
- Sending agent type
- Sending agent identifier
- Woman identifier
- Delivery method
- Amount

Messages are passed using “send(Object, Agent)” through AnyLogic’s standard “connections” link.
Visualization: Washington State
Model demonstration: Visualization
User interface

Cesarean Delivery Model (WA)

Description
The Cesarean Delivery Model (WA) simulates how new payment methods, organizational structures, and other health reform measures for Washington State hospitals and clinicians can affect:
- the rate of unnecessary cesarean deliveries
- expenditures for vaginal and cesarean deliveries paid by State commercial health insurance companies and Medicaid
- financial results for State hospitals and clinicians

The model addresses the following questions:
1. What combination of organization structure reform, reform of the payment method for State hospitals and clinicians, and clinician manpower reforms will produce the greatest long-term reduction in the number of unnecessary cesarean deliveries in Washington State?
2. What is the long-term impact of the health system reforms on:
   - the income of hospitals and clinicians
   - the expenditures of individual State commercial health insurance companies and Medicaid
   - total State health expenditures

The model includes health incorporates Medicaid, commercial health insurers, hospitals, and the following clinicians:
- Obstetricians
- Certified Nurse Midwives (CNMs), who practice in hospitals
- Licensed Midwives (LMs), who practice in free-standing birth centers and at home births

Prepared by
Alan Mills PISA MAAA ND
(alan.mills@earthlink.net)

Model parameters
Several parameters control how the model runs. These parameters are organized in groups corresponding to the buttons below. To view or enter a parameter for a particular group, click on its button. To return to this page, click the 'Return' button on the parameter page. Of course, for any parameter you can leave its default value as it is.

To save or retrieve a parameter set for a particular simulation scenario, click "Save/retrieve scenario".

After you are satisfied with the model's parameters, go to 'Run the model' below.

Run the model
To run the model, click the 'Run' button below.
Model demonstration: User interface
4. Results
Significance of the Cesarean Delivery Model

- First holistic model of the Cesarean delivery challenge
- Stakeholder focus for Cesarean delivery reform
- First step toward a complete health system model
- First step toward reusable agents and behaviors
Model demonstration: Results
Key results

- Payment reform by itself won’t work as intended
- A multi-faceted approach is required
- Retooling the workforce will take time
Questions or comments?
Review

1. Background
2. The U.S. Cesarean delivery challenge
3. Cesarean Delivery Model design
4. Results
Thank you