

Cesarean Delivery Model

Meeting the challenge to reduce rates of Cesarean delivery

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November 13, 2014



Agenda

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

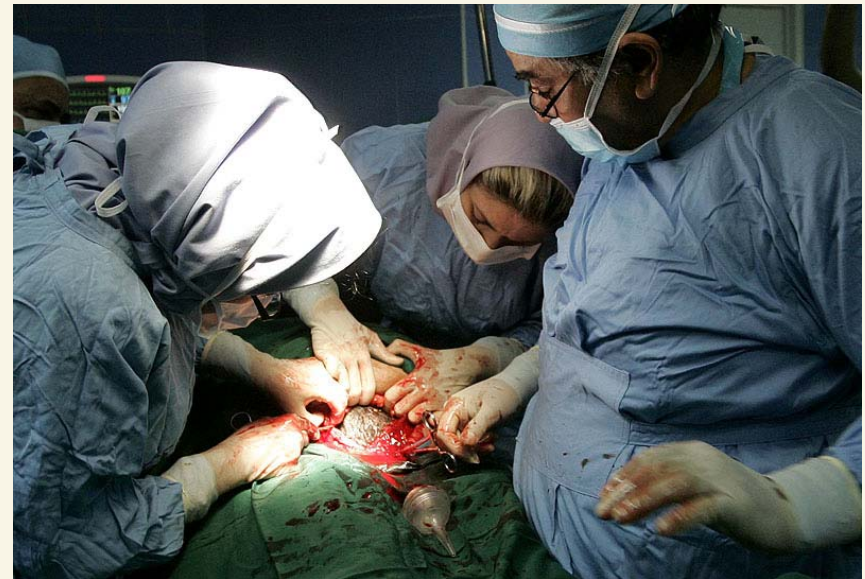
1. Background

Types of childbirth delivery

Vaginal delivery
natural childbirth



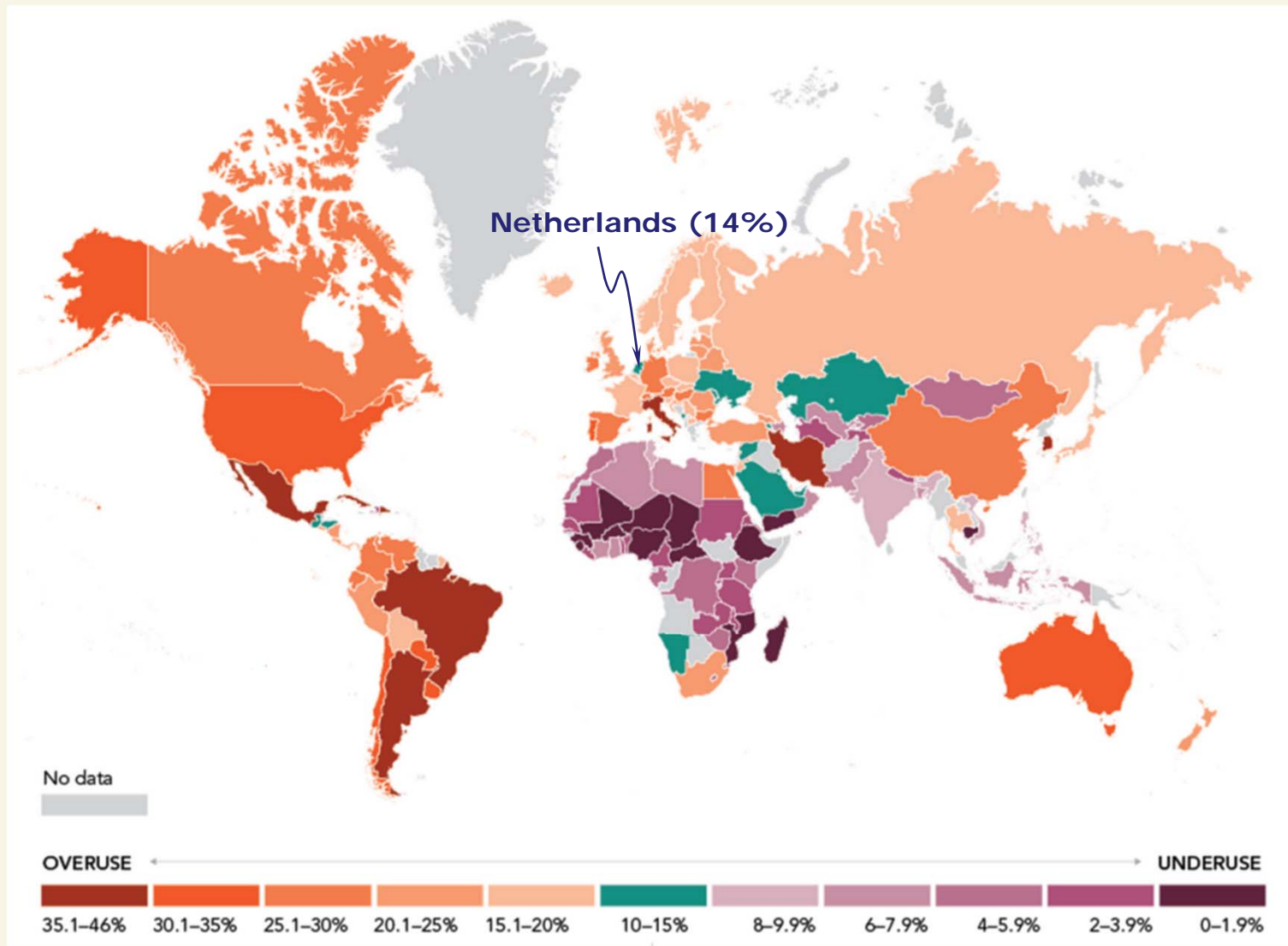
Cesarean delivery
surgical intervention



Cesarean delivery problems

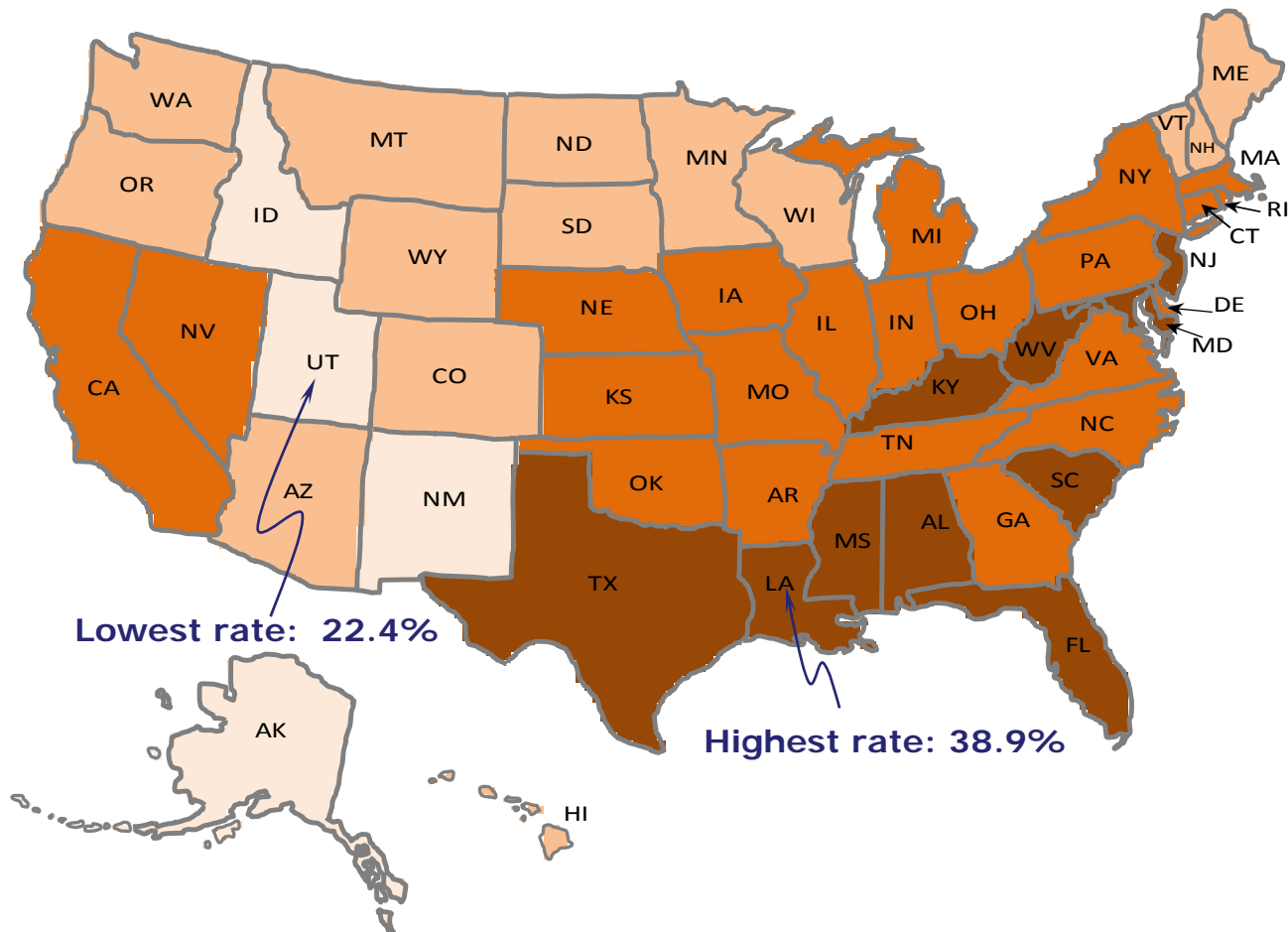
- Poor psychosocial outcomes
- Risks of major abdominal surgery
- Pulmonary disorders
- Compromised breast feeding
- Complications for later births
- Increased perinatal mortality
- Greater cost

World cesarean delivery rates – 2008



Source: World Health Organization

U.S. cesarean delivery rates – 2013



Lowest rate: 22.4%

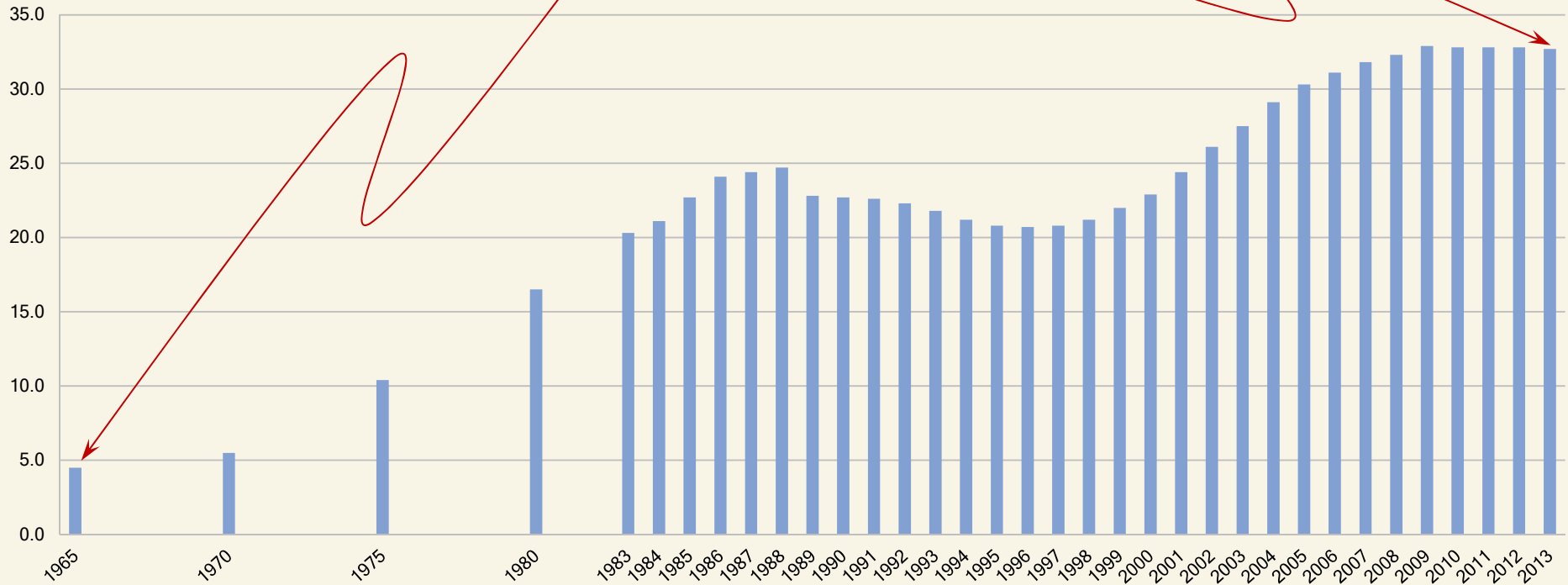
Highest rate: 38.9%



Source:

U.S. cesarean delivery rates

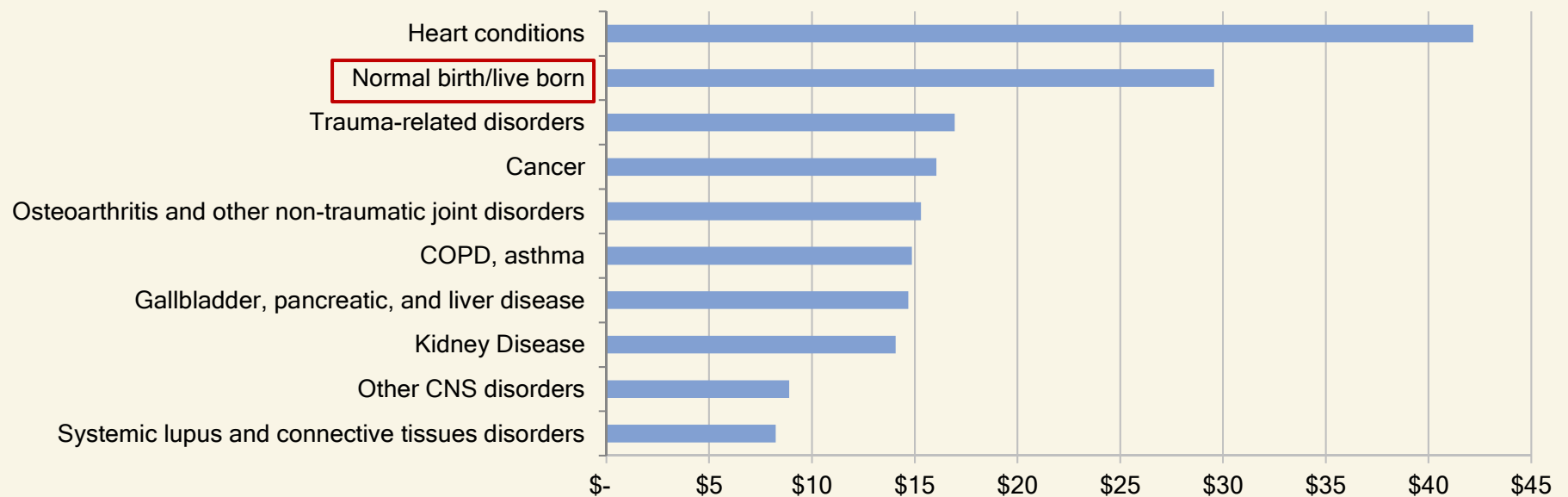
1965: 4.5% 2013: 32.7%



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

Key behaviors

Women

- 1 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

- 2 Choose Hospital
Decide delivery method
Submit claim

CNMs

- 2 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
3 Choose backup Obstetrician
Refer delivery attendance
Attend vaginal birth
Submit claim

LMs

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

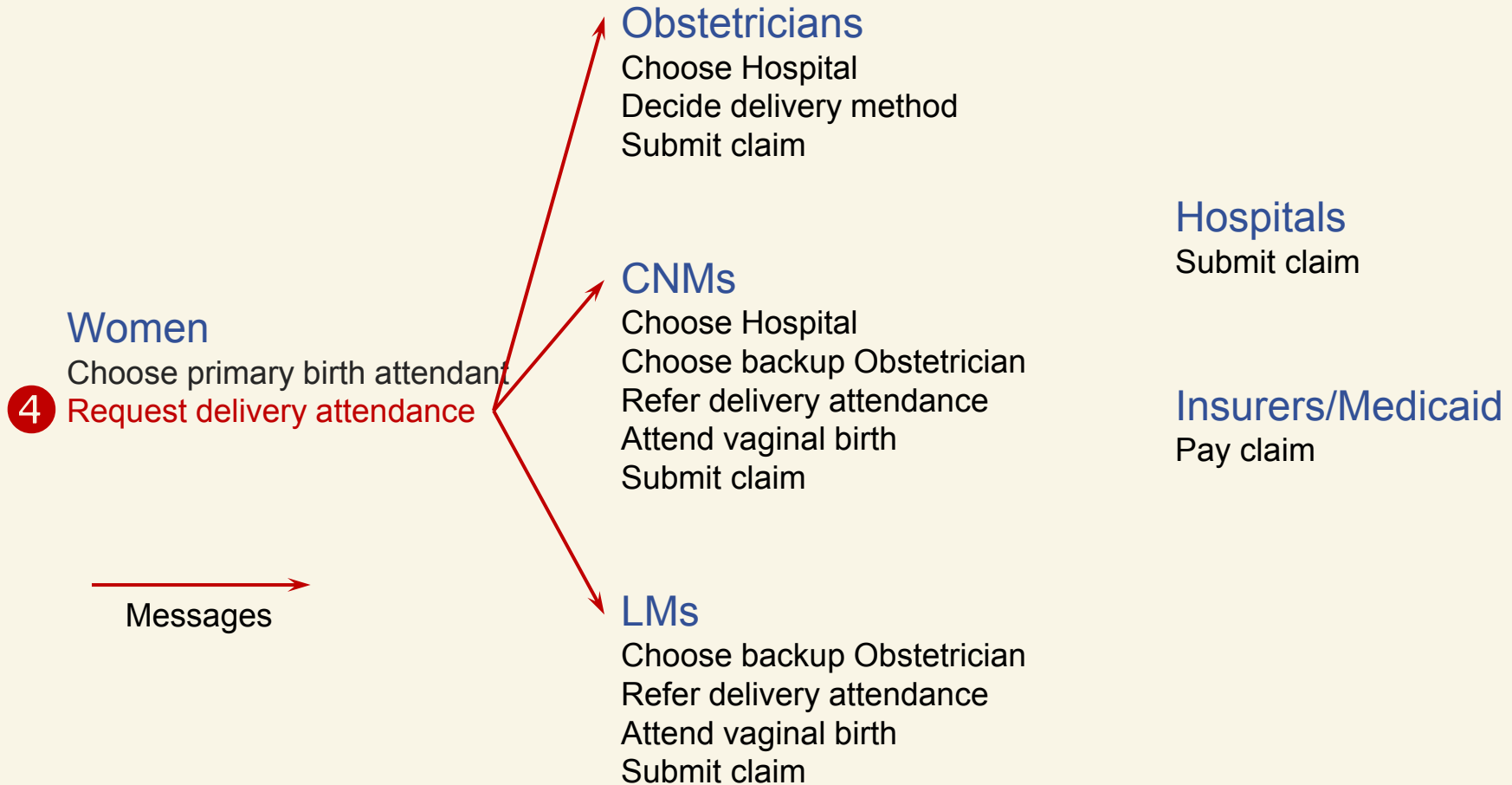
Hospitals

Submit claim

Insurers/Medicaid

Pay claim

Key behaviors



Key behaviors

Women

Choose primary birth attendant
Request delivery attendance

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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

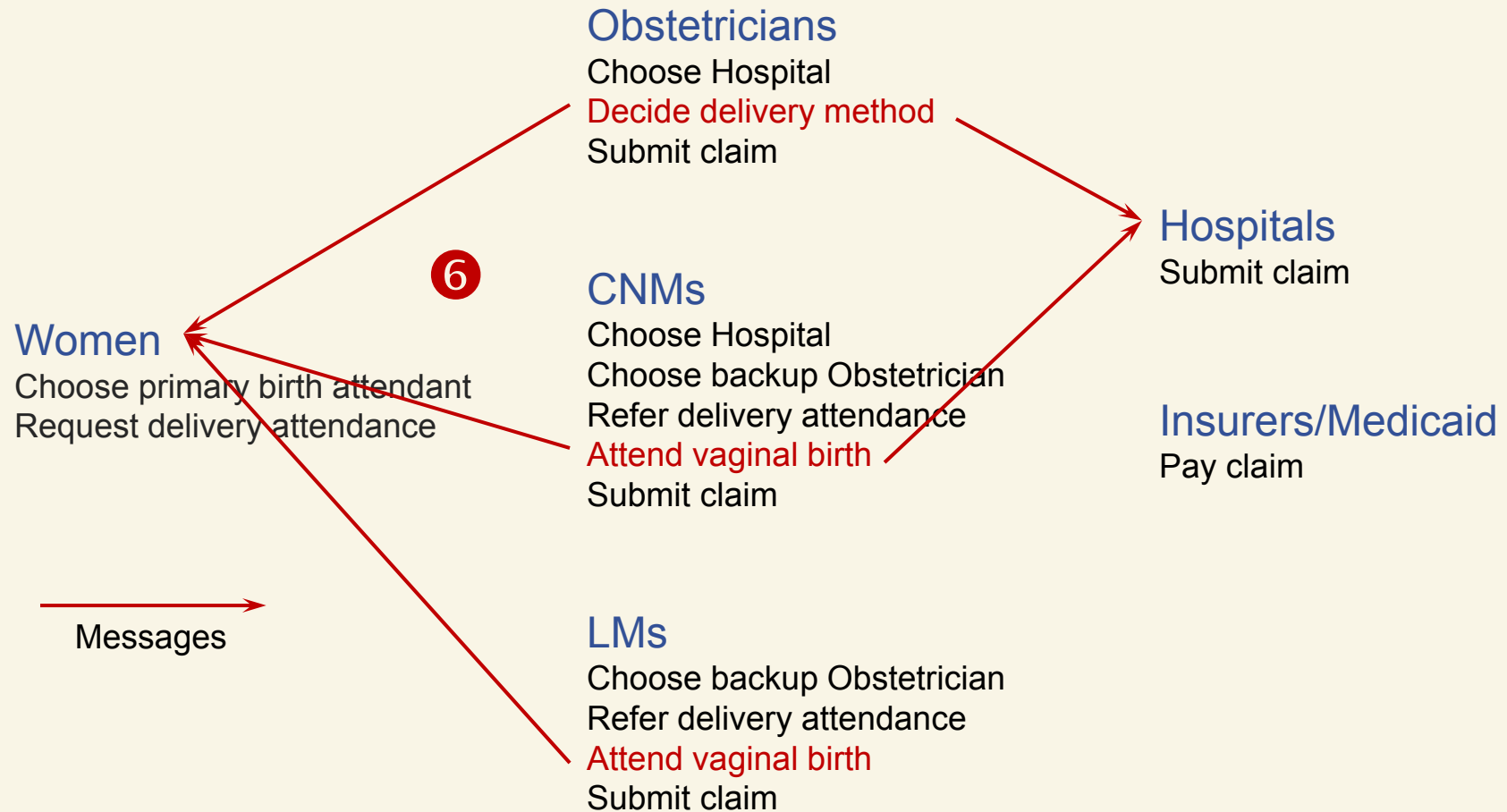
Submit claim

Insurers/Medicaid

Pay claim

Messages

Key behaviors



Key behaviors

Women

Choose primary birth attendant
Request delivery attendance



Messages

Obstetricians

Choose Hospital
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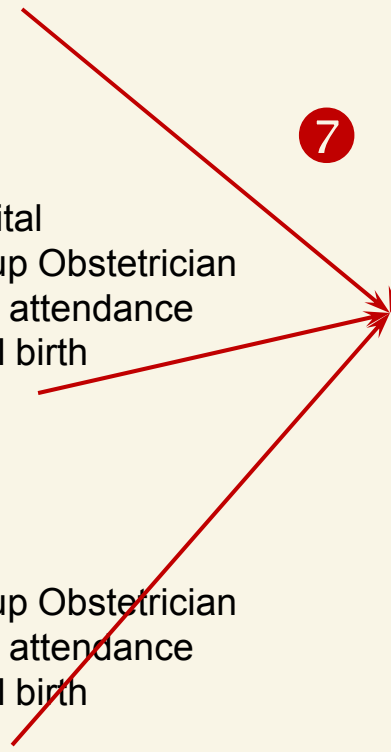
Hospitals

Submit claim

Insurers/Medicaid

Pay claim

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Key behaviors

Women

Choose primary birth attendant
Request delivery attendance

→
Messages

Obstetricians

Choose Hospital
Decide delivery method
Submit claim

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Choose Hospital
Choose backup Obstetrician
Refer delivery attendance
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Submit claim

LMs

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Refer delivery attendance
Attend vaginal birth
Submit claim

Hospitals

Submit claim

Insurers/Medicaid

Pay claim

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```
graph TD; Women[Women] -- Messages --> Obstetricians[Obstetricians]; Women -- Messages --> CNMs[CNMs]; Women -- Messages --> LMs[LMs]; Obstetricians --> Hospitals[Hospitals]; Obstetricians --> Insurers[Insurers/Medicaid]; CNMs --> Hospitals; CNMs --> Insurers; LMs --> Insurers; Hospitals --> Insurers;
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General behavior model



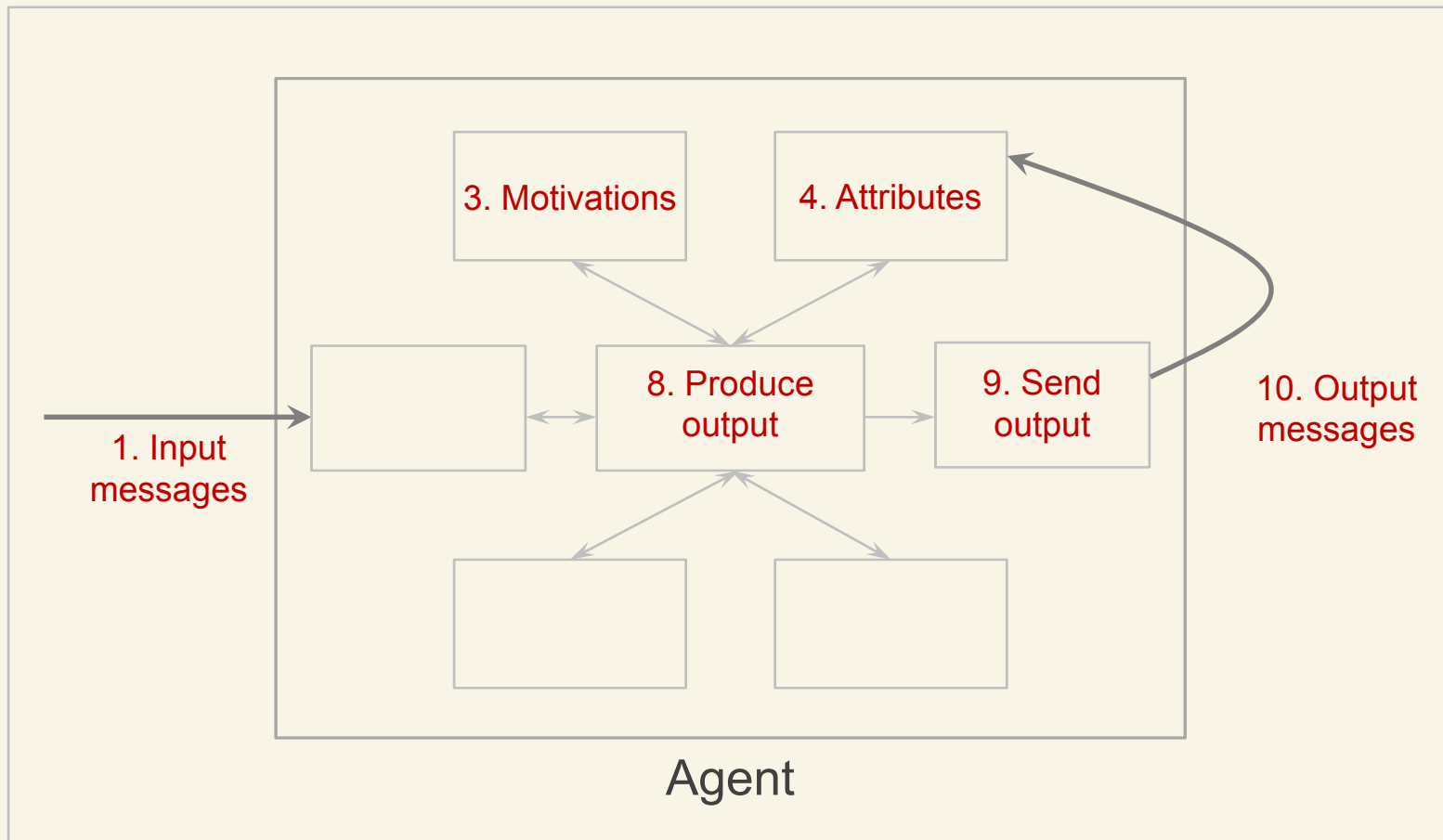
Example behavior:

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



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

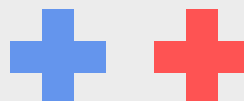
Environment (GIS)



Women


Obstetricians

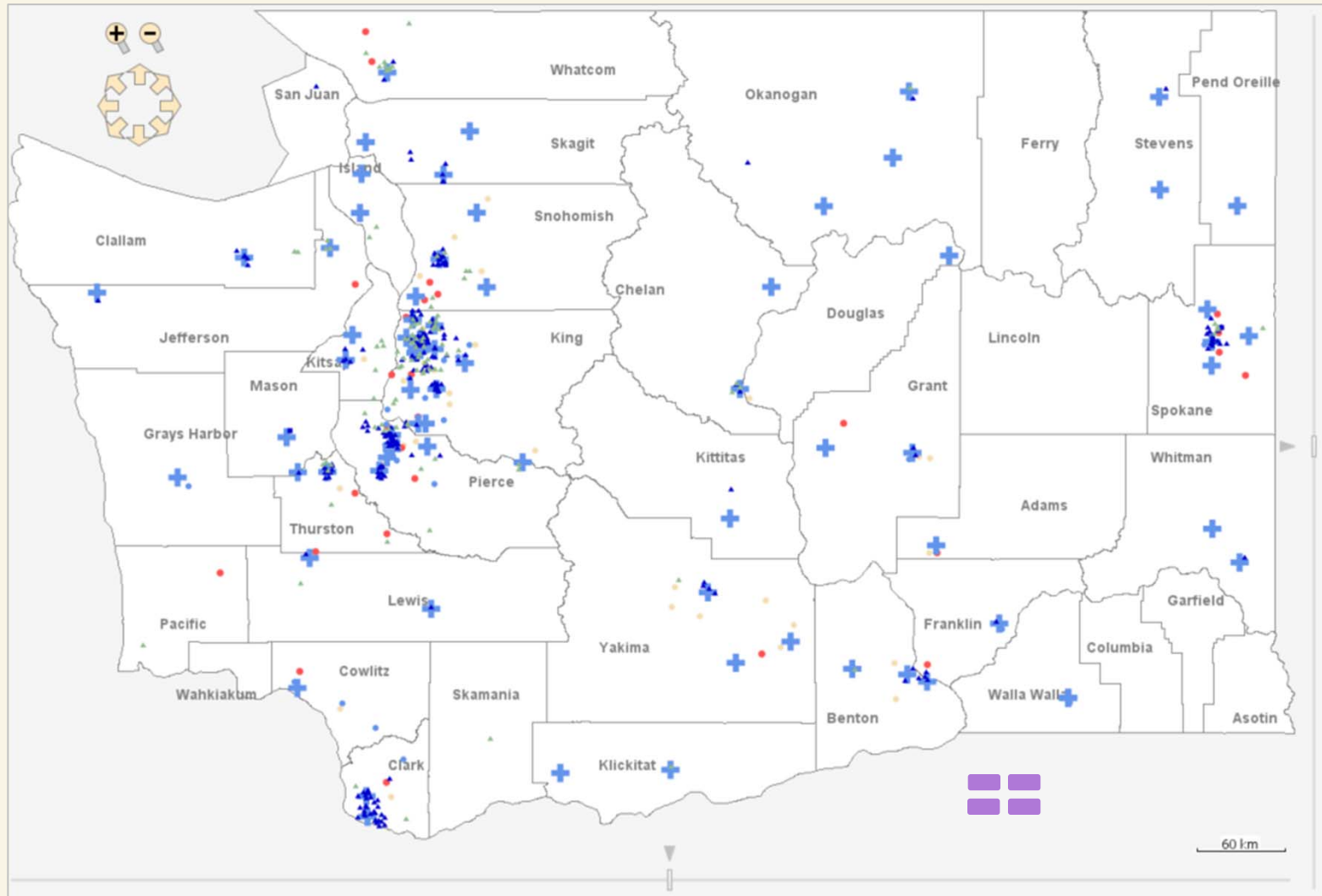

Certified Nurse Midwives
(CNMs)


Licensed Midwives
(LMs)


Hospitals


Insurers

Visualization: Washington State



Model demonstration: Visualization

User interface

Cesarean Delivery Model (WA)
Version 1

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

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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.

Simulation **Birth**

Data input **Women**

Reform scenario **Clinicians**

Save/retrieve scenario **Birth facilities**

Insurers

Run the model
To run the model, click the 'Run' button below.

Run

Run: 0 Idle Time: - Date: - Memory: 55M of 14,222M 0.0 sec

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

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Thank you

