Improving the Efficiency of Newborn Screening from Collection to Test Results

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Improving the Efficiency of Newborn Screening from Collection to Test Results (#72453)

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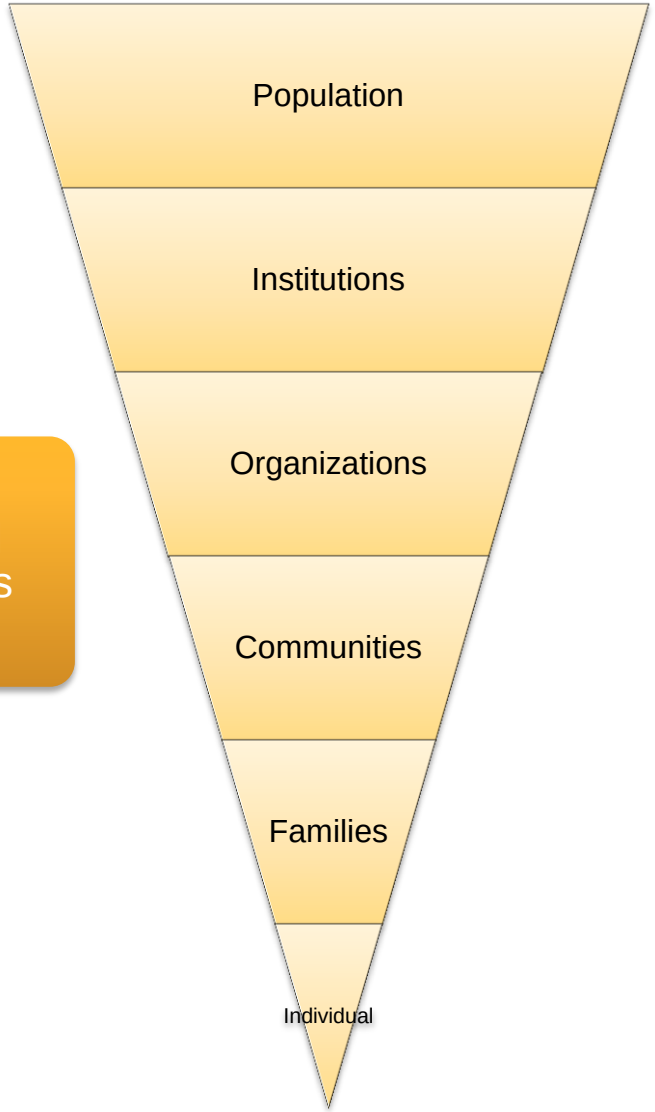
Goals Today

- Present project design and goals
- Review preliminary results
- Discuss next steps for project

NBS: The System

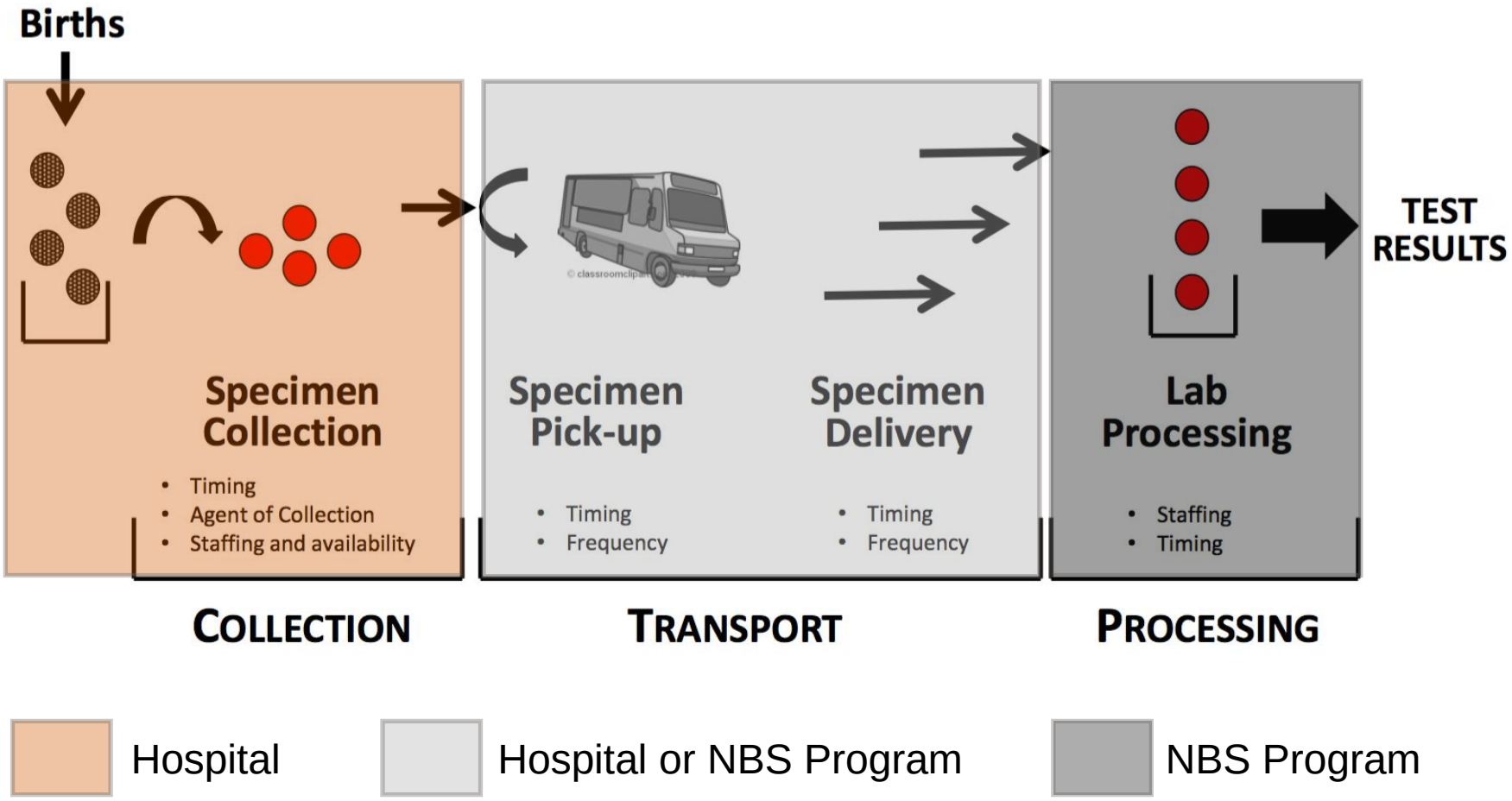
- **Complex process**
  - NBS requires coordinated and timely collaboration between multiple stakeholders
    - within and between clinical medicine and public health
- **Different ways to organize and delivery NBS**
  - Each state program designs its own process
  - NOTE: Different designs can be equally effective

Health Services Research



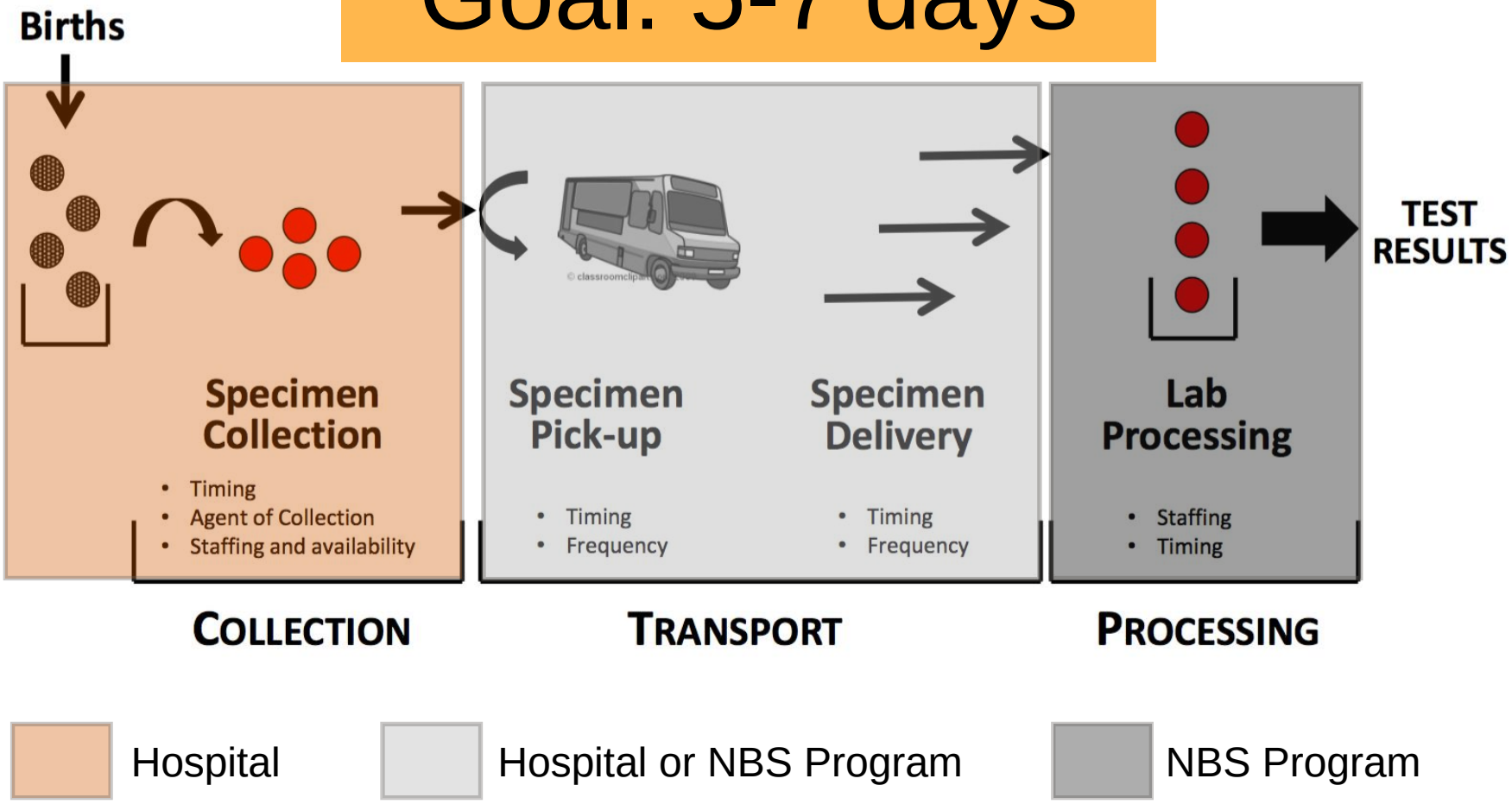
(Academy for Health Services Research and Health Policy, 2000)

General Steps of NBS Process: Collection, Transport, Lab



General Steps of NBS Process: Collection, Transport, Lab

Goal: 5-7 days



Project Rationale

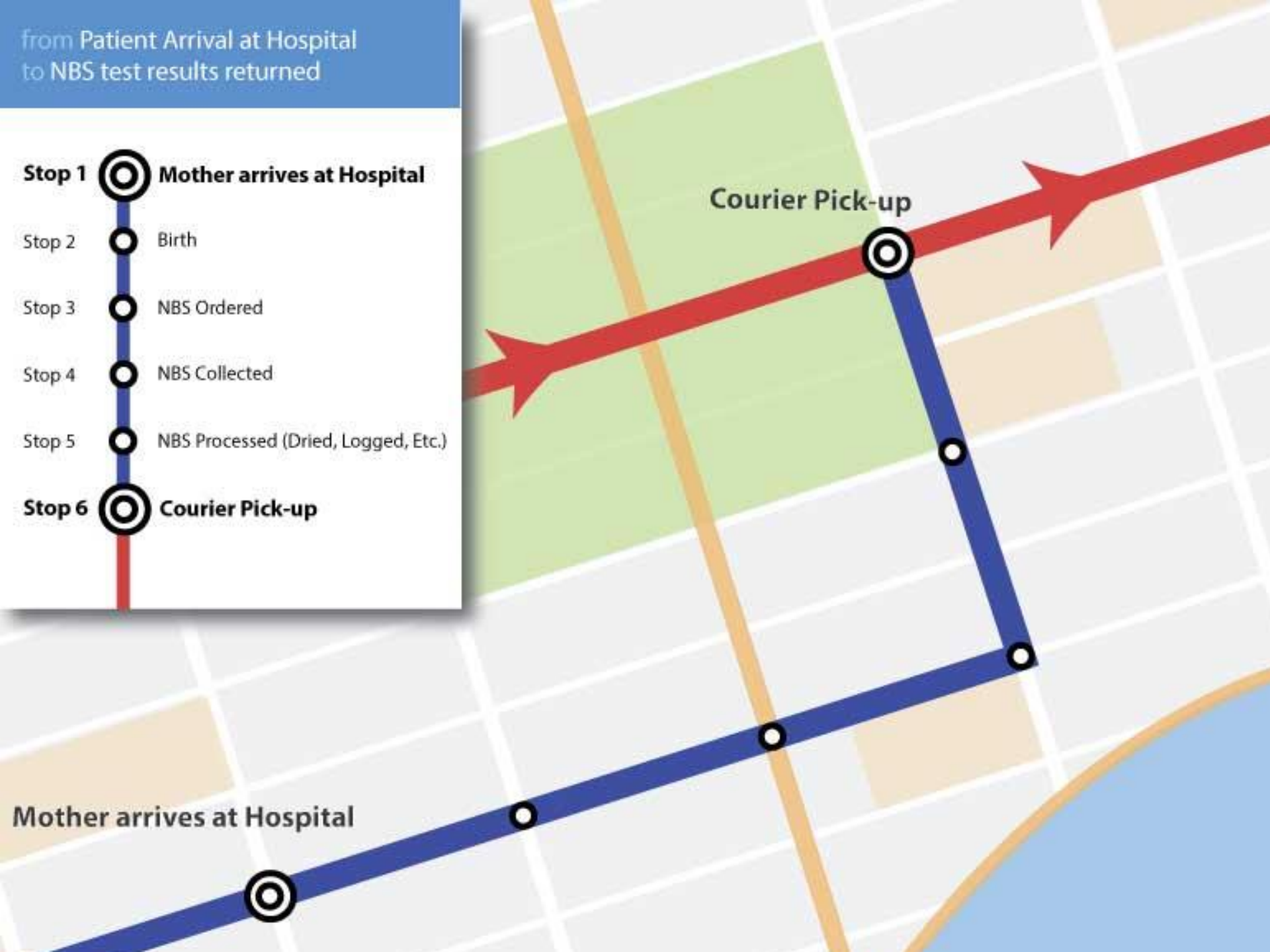
By taking a **broader perspective** of the process

and performing a **systematic analysis**,

we can **identify leverage points**

where we can **potentially intervene** and

improve process efficiency


from Patient Arrival at Hospital
to NBS test results returned
Stop 1
Mother arrives at Hospital
Stop 2
Birth
Stop 3
NBS Ordered
Stop 4
NBS Collected
Stop 5
NBS Processed (Dried, Logged, Etc.)
Stop 6
Courier Pick-up
Courier Pick-up
Mother arrives at Hospital

Project Goals

- Use innovative dynamic simulation modeling techniques to systematically identify potential process improvement strategies for reducing time from collection to test results
- Assess the trade-off between timeliness and cost for the strategies identified

Simulation Modeling

- **What is it?**
  - Statistical method for identifying steps in a state's NBS process that can be modified to improve timeliness
- **What are implications?**
  - Systematic and efficient method for assessing timeliness of a state's NBS process
  - Can identify steps in process linked to significant change in timeliness (i.e., leverage points)
  - Can be tailored to state's specific process (i.e., state specific procedures and data)

Early Challenges and Barriers to the Project

- NBS Process complexity
- Variability in organization and implementation
  - At program and hospital level
- Availability of necessary NBS program and hospital data
- What is the health outcome gain of <5 days?

Preliminary Model Results

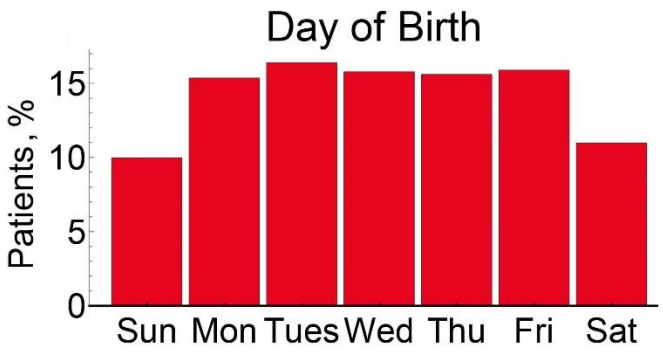
NBS Process:

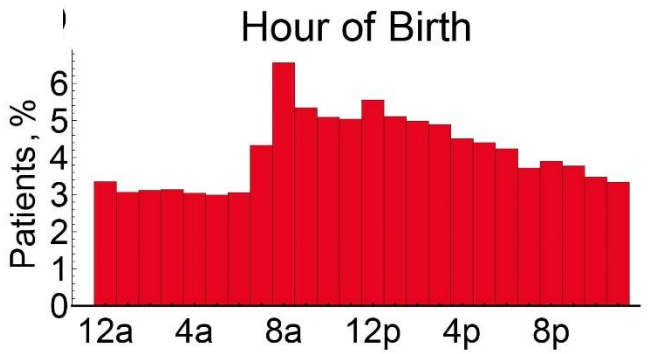
Birth To Lab Arrival

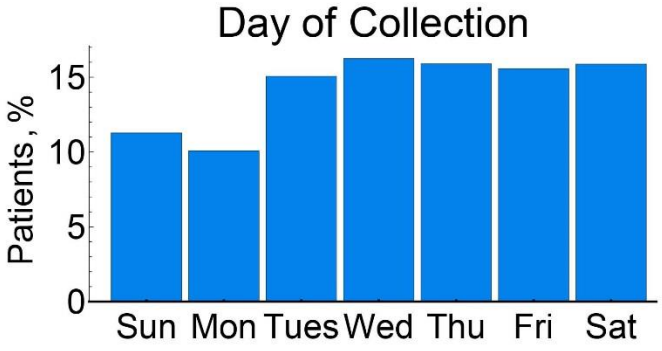
Data Source: Michigan Newborn Screening Program

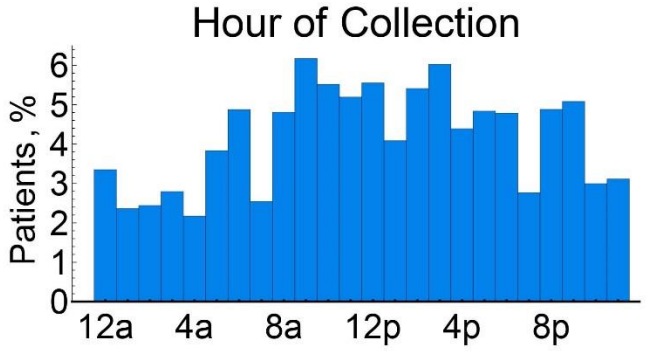
- 94,770 NBS specimens
- 83 Michigan birthing hospitals
- April 2014 to March 2015
- Newborns from neonatal intensive care unit (NICU) or a special care unit were not included
- Hospital ID; time and date of birth, collection, and receipt of lab arrival; mileage from hospital to lab; and pickup schedules by hospital

Characteristics: Births, Collection, Specimen Pickup

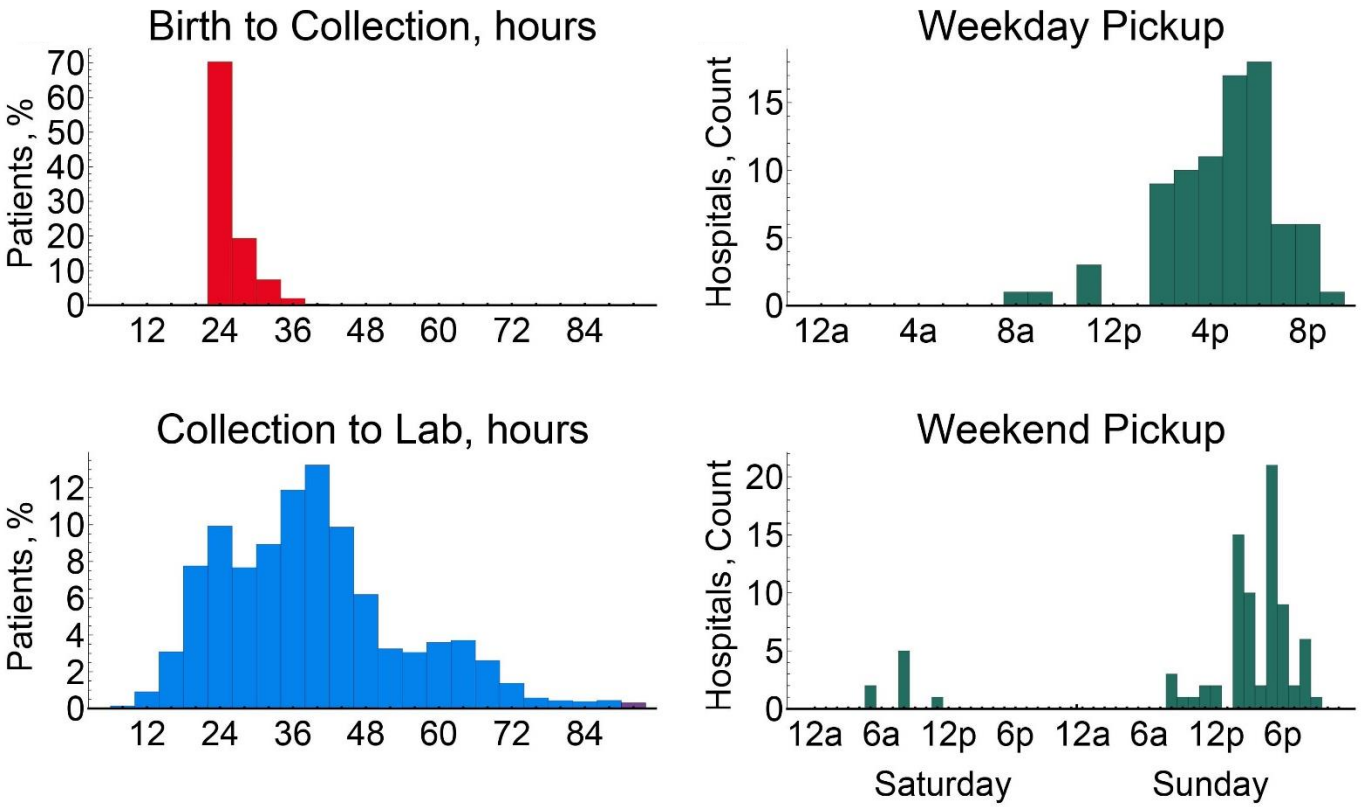








Characteristics: Births, Collection, Pickup



- Over 99% of specimens are collected within 36 hours of birth
- Most NBS specimens in Michigan are transported by state-funded couriers (UPS, Quest) from the hospital and arrive at the state lab on the following day

Regression [a]: Collection to lab arrival (hours)

Model Term	Estimate	Std. Error	Statistic	Sig.
Intercept	43.6	1.2	35.7	<0.001
Hospital Volume	0.0	0.0	0.4	0.690
Sunday Collection	-9.1	0.2	-47.8	<0.001
Monday Collection	-11.4	0.2	-58.0	<0.001
Tuesday Collection	-11.9	0.2	-67.8	<0.001
Wednesday Collection	-10.8	0.2	-62.9	<0.001
Thursday Collection	-10.0	0.2	-57.8	<0.001
Friday Collection	2.7	0.2	15.6	<0.001
Saturday Collection	0[b]	.	.	.
Early Morning Collection	-3.4	0.2	-21.3	<0.001
Morning Collection	-3.1	0.1	-22.5	<0.001
Afternoon Collection	0.9	0.1	6.6	<0.001
Evening Collection	0[b]	.	.	.
Mileage to Laboratory	0.035	0.005	6.6	<0.001
Residual Variance	225.2	1.0	217.6	<0.001
Between-Hospital Variance	25.8	4.2	6.2	<0.001

[a] Linear mixed effects regression model; [b] Term is redundant.

Simulation: Birth to lab arrival

Could collection timing be important to NBS timeliness through its relation to lab hours and courier schedules?

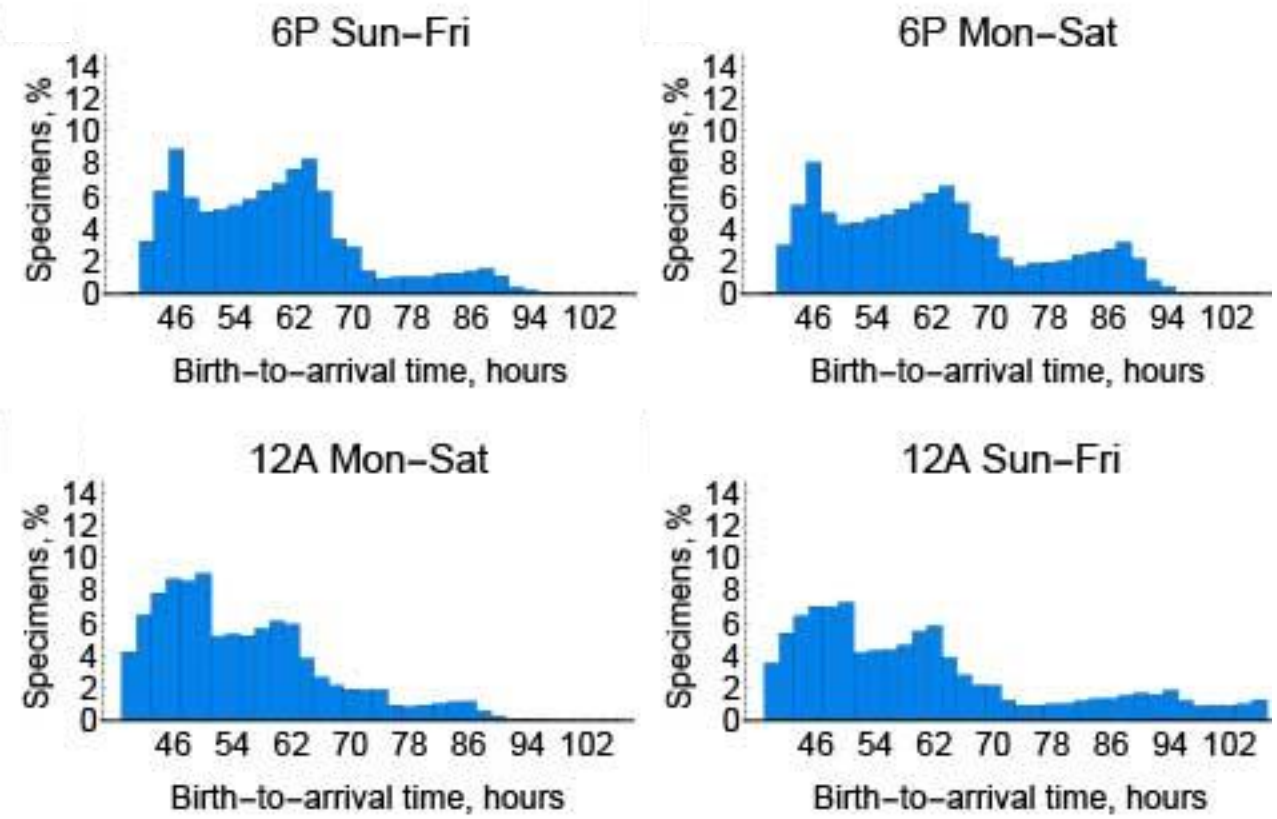
Simulated:

- Patterns of birth (including uncertainty)
- Birth to collection (including uncertainty) with tests ordered after 24 hours of birth
- Collection to pickup, allowing at least 4 hours of drying
- A fixed transit time of 10 hours †
- Processing starts immediately during laboratory hours ‡
- Varied laboratory hours and varied pickup schedules

† In Michigan, a typical pickup time is 6P and specimens arrive around 3-4A. Hospitals with their own courier have shorter transit times.

‡ Michigan lab hours: Mon–Fri 7A–5P, Sat 6:30A–4P

Simulation: Birth to lab arrival



Simulation: Birth to lab arrival

Rank	Pickup times	Mean (h)	SD (h)	T>48 h (%)	T>60 h (%)
#1	12A Mon-Sat	55.2	11.4	68.0	30.2
#2	9P Sun-Fri	55.4	11.6	65.7	32.0
#3	12A Wed-Mon	57.2	12.4	71.4	38.6
#4	12A Tue-Sun	57.6	12.7	71.7	39.4
#5	9P Tue-Sun	58.0	13.2	69.5	40.6
#18	6P Sun-Fri	59.1	11.8	78.2	44.6
	Minimum	55.2	11.2	65.7	30.2

- T is simulated time between birth and receipt of lab arrival
- 35 pickup schedules (six days at 12A, 6A, 12P, 6P, or 9P)
- Schedules are ranked on metrics
- Laboratory hours fixed (Mon–Fri 7A–5P, Sat 6:30A–4P).

Simulation: Birth to lab arrival

Laboratory hours	Mean (h)	SD (h)	T>48 h (%)	T>60 h (%)
7A-5P Mon-Fri, 6:30A-4P Sat	55.4	11.5	66.0	32.1
7A-5P Mon-Fri, 6:30A-4P Sat-Sun	51.7	7.7	59.0	19.2
7A-5P Mon-Fri	63.0	19.6	72.3	44.9
7A-5P Tue-Sat, 6:30A-4P Sun	54.6	11.4	63.0	28.9
7A-5P Mon-Fri, 6:30A-4P Sun	55.5	11.8	65.6	31.7
5A-3P Mon-Fri, 5A-2:30P Sat	55.9	11.7	69.5	33.5
9A-7P Mon-Fri, 9A-6:30P Sat	55.3	11.5	67.2	30.7

- For each laboratory schedule, assumed courier picked up specimens 10 hours prior to when the laboratory opens each day.

Conclusions: Data analysis

- Time from collection to receipt of lab arrival is an important bottleneck in the NBS process
- Pickup schedules and lab hours may be adjusted to improve NBS timeliness, by accounting for
  - Patterns of births (more on weekdays, in the morning)
  - When laboratory is open
- Simulation can estimate *a priori* impact on timeliness:
  - E.g., switching pickup schedules from 6P Sun-Fri to 9P Sun-Fri is estimated to have 12.6% fewer specimens received by the state laboratory 60 hours after birth
- Considerations: cost of changing courier or lab schedules, contacting primary care provider, lab processing

Next Steps

- Refine model with additional data from surveys from other hospitals and state NBS programs
- Collect data on costs

Thank you.

Questions?

Michigan Live Births by County - 2014