Effect of an Intensive Nurse Home Visiting Program on Adverse Birth Outcomes in a Medicaid-Eligible Population

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Roadmap

• Background on need for intervention and partnership in South Carolina
• Pragmatic study design
• Results
• Discussion
• Time for questions
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Motivation

• Need: scalable, effective interventions for reducing adverse birth outcomes and improving disparities

• Intensive nurse home visiting has been recommended
  • Significant federal investment through the Maternal, Infant and Early Childhood Home Visiting (MIECHV) program
What is nurse home visiting?

• Many varieties
  • Healthy Families America
  • Parents as Teachers
  • Family Connects
  • Nurse Family Partnership
  • ..., many others

• Nurse Family Partnership is a flagship program
What is the Nurse Family Partnership (NFP)?

Home visits with a registered nurse
• Pregnancy → first 2 years of child’s life
• Bi-weekly/monthly visits
• First-time low-income pregnant people

Model of “evidence-based policy”
• 3 small-scale RCTs (1977-1994)
• Positive impacts on pregnancy health, child education, and maternal employment
• Operates in 40 states
What do NFP nurses do?

- Health assessments
  - Prenatal health assessment at intake
  - Monitoring (e.g. maternal weight or blood pressure)
  - Screening for depression, anxiety, intimate partner violence
- Referrals to health care providers and community resources
- Educational content focused on clients’ priorities
- Psychosocial support
Maternal / Child Health Context in South Carolina

• 22% of children born into households below the federal poverty line (45th of 50 states)\(^1\)
• Over half of births in the state covered by Medicaid\(^2\)
• No Medicaid expansion
• Substantial disparities in maternal and neonatal health outcomes
  • Large racial disparities in outcomes – one example is 11.1% overall preterm birth rate; 14.1% for black mothers\(^2\)
  • Rate of maternal mortality in the first 6 weeks of life was 26 per 100,000 – more than 2x higher among black mothers\(^3\)
  • Significant access issues in rural areas, many closures of OB and NICU facilities\(^4\)

Research Context

• SC State Medicaid office saw potential for NFP to improve maternal and child health outcomes in Medicaid population
  • “Pay for Success” contract enabled state to promise funds for further expansion conditional on positive evidence of impact from randomized trial

• Evaluation question: What is the impact of NFP on health outcomes when delivered at scale?
What is Pay for Success?

Government identifies social problem → Service provider has solution → Investors provide upfront capital → Government repays investors from savings (if outcomes achieved)

Intermediary manages project → Independent evaluator measures success

Content: Policy Innovation Lab; Image credit: The Noun Project
Pay for Success framework

Funding mechanisms:
- Medicaid Waiver
- Pay for Success (PFS) contract
- Both contingent on randomized evaluation
Potential to expand

- The Nurse-Family Partnership (NFP), served less than 600 of 11,500 eligible mothers each year before the project.

- Medicaid waiver allowed Medicaid to cover home visiting services by NFP nurses
  - Waiver covers up to 40 visits during period covering pregnancy and first two years of child’s life
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Evaluation Design

• Randomized Controlled Trial
  • Simple randomization, enrolled 5670 mothers into the evaluation between 2016 and 2020, with 2/3 allocated to the intervention group
  • Randomization after consent, enrollment (all conducted by trained NFP nurses)

• Eligibility Criteria
  • First-time mothers aged 15 and older
  • Meet the income-eligibility criteria for Medicaid
  • No more than 28-weeks gestation at enrollment

• Data Collection
  • Baseline Survey
  • Outcomes observed entirely through Administrative Data
    • Mothers consent to follow their outcomes and their children’s outcomes for up to 30 years
    • Data sources for analysis of birth outcomes: vital records, Medicaid and hospital discharge claims
Study design

Eligible Pregnant People

2016-2020

Consent & Baseline Survey

Treatment

(N=3,806)

Control

(N=1,864)

- Medicaid claims
- All-payer hospital discharge
- Vital records
Data collection & analysis

Baseline Survey

Administrative Data

Data collected by NFP

Data collected by SC
Baseline survey

• Administered by Nurse Home Visitors
• Collects identifiers to link to administrative data
• Collects information to allow for sub-group analysis
Study enabled by South Carolina’s administrative data hub
Analyses related to birth outcomes

• **Primary outcome:**
  • Composite of at least one of: small for gestational age, or low birth weight, or preterm birth or perinatal mortality

• **Secondary outcomes**
  • *Neonatal outcomes:* large for gestation age, NICU admission, neonatal morbidity
  • *Maternal outcomes:* Cesarean delivery, maternal morbidity and mortality, substance abuse, experience of violence or homicide, utilization of routine postpartum care, utilization and quality of prenatal care, mental health care utilization
  • Today we will primarily show outcomes related to birth
Analyses related to 2-year outcomes

• **Primary outcomes:**
  • Composite of at least one of: Health care encounter or mortality from major injury, or concern for abuse or neglect
  • Birth interval of less than 21 months

• **Secondary outcomes**
  • Emergency department utilization, all-cause mortality
  • *Preventative child health care utilization:* proportion of recommended well-child visits, lead screening, developmental screening, dental care utilization
  • *Family planning utilization:* counseling for family planning, utilization of moderately or highly effective contraception, intrauterine device insertion
  • Not yet analyzed
Longer-term outcomes observed following moms and babies for up to 30 years

- Health care utilization
- Timing of subsequent pregnancies
- Use of social services
- Criminal justice involvement
- Educational outcomes
- Economic opportunity
Home Visiting & Birth outcomes: prior evidence

- Evidence from previous NFP trials
  - RCT of NFP in Elmira, NY:
    - adolescent mothers who received NFP had babies with higher birth weights\(^1\)
    - among mothers who reported smoking during pregnancy, mothers in the treatment group experienced a reduced likelihood of preterm birth\(^1\)
  - RCT of NFP in Memphis, TN:
    - mothers receiving NFP less likely to experience hypertensive disorders of pregnancy\(^2\)
    - no change in preterm birth or low birth weight\(^2\)
- Large-scale RCT evaluating the impact of the MIECHV program and an evaluation of a home visiting program in UK found no evidence of impacts on birth outcomes\(^3\)

Pre-specified sub-group at elevated risk

We pre-specified a sub-group of moms as having elevated risks for adverse outcomes based on previous trials of NFP and targeting of home visiting programs:

- Less than HS
- < 19 years old
- PQH 2 score indicating depression (≥ 3), or reported having mental health help or treatment in past year
- Consistent with how many programs define elevated risk: i.e focus on adolescents, socio-economic disadvantage and risk of depression
- Approximately 46% of sample meet this criteria

Because of substantial racial disparities, we pre-specified a plan to look at differences between Black moms and other moms in the sample
Sample and Analysis

• Results shown today are intent-to-treat
  • All models control for a pre-specified vector of baseline characteristics
  • Binary outcomes estimated with linear probability models
  • Continuous outcomes estimated with OLS

• We also estimate
  • LATE models
  • Adjustment for multiple hypothesis testing
COVID

• Study enrollment ended prematurely on March 17, 2020
  • South Carolina’s stay at home order went into effect on March 23rd, 2020

• 87% of enrollees delivered their babies prior to March 17, 2020
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### Sample Characteristics & Balance (1)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nurse Home Visiting Group</th>
<th>Usual Care Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(N = 3794)</em></td>
<td><em>(N = 1861)</em></td>
<td></td>
</tr>
<tr>
<td>Median gestational age in weeks at enrollment (IQR)</td>
<td>13.0 (9.0-20.0)</td>
<td>13.0 (9.0-19.0)</td>
</tr>
<tr>
<td>Received at least one antenatal care visit before enrollment</td>
<td>3139/3750 (83.7%)</td>
<td>1511/1837 (82.3%)</td>
</tr>
<tr>
<td>Age in years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-18</td>
<td>679 (17.9%)</td>
<td>324 (17.4%)</td>
</tr>
<tr>
<td>19-24</td>
<td>2067 (54.5%)</td>
<td>1011 (54.3%)</td>
</tr>
<tr>
<td>25-34</td>
<td>932 (24.6%)</td>
<td>485 (26.1%)</td>
</tr>
<tr>
<td>35+</td>
<td>116 (3.1%)</td>
<td>41 (2.2%)</td>
</tr>
<tr>
<td>Race and ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian, Indigenous, Native Hawaiian and Pacific Islander, non-Hispanic</td>
<td>51/3548 (1.4%)</td>
<td>15/1730 (0.9%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>217/3548 (6.1%)</td>
<td>108/1730 (6.2%)</td>
</tr>
<tr>
<td>More than one race reported, non-Hispanic</td>
<td>105/3548 (3.0%)</td>
<td>56/1730 (3.2%)</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>1936/3548 (54.6%)</td>
<td>957/1730 (55.3%)</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>1239/3548 (34.9%)</td>
<td>594/1730 (34.3%)</td>
</tr>
<tr>
<td>Highest education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school diploma</td>
<td>851/3780 (22.5%)</td>
<td>409/1855 (22.0%)</td>
</tr>
<tr>
<td>High school diploma or equivalent</td>
<td>1375/3780 (36.4%)</td>
<td>639/1855 (34.4%)</td>
</tr>
<tr>
<td>Some college, less than bachelor's degree</td>
<td>1270/3780 (33.6%)</td>
<td>665/1855 (35.8%)</td>
</tr>
<tr>
<td>Bachelor's degree or higher</td>
<td>283/3780 (7.5%)</td>
<td>142/1855 (7.7%)</td>
</tr>
<tr>
<td>Economic conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Received one or more social service program</td>
<td>2416/3712 (65.1%)</td>
<td>1205/1820 (66.2%)</td>
</tr>
<tr>
<td>Worked for pay at time</td>
<td>1979/3791 (52.2%)</td>
<td>953/1859 (51.3%)</td>
</tr>
<tr>
<td>Lived with parents</td>
<td>1599/3789 (42.2%)</td>
<td>800/1858 (43.1%)</td>
</tr>
<tr>
<td>Experienced housing insecurity</td>
<td>663/3788 (17.5%)</td>
<td>334/1857 (18.0%)</td>
</tr>
<tr>
<td>Sample Characteristics &amp; Balance (2)</td>
<td>Nurse Home Visiting Group (N = 3794)</td>
<td>Usual Care Group (N = 1861)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td><strong>Mental health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High stress, (Perceived Stress Scale-4 ≥ 4)</td>
<td>2458/3741 (65.7%)</td>
<td>1215/1836 (66.2%)</td>
</tr>
<tr>
<td>Depressive symptoms, (PHQ-2 ≥ 3)</td>
<td>730/3766 (19.4%)</td>
<td>352/1853 (19.0%)</td>
</tr>
<tr>
<td>Received mental health treatment in last year</td>
<td>508/3788 (13.4%)</td>
<td>249/1856 (13.4%)</td>
</tr>
<tr>
<td><strong>Body Mass Index</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 18.5</td>
<td>205/3672 (5.6%)</td>
<td>92/1784 (5.2%)</td>
</tr>
<tr>
<td>18.5 - 24.9</td>
<td>1361/3672 (37.1%)</td>
<td>702/1784 (39.3%)</td>
</tr>
<tr>
<td>25 - 29.9</td>
<td>832/3672 (22.7%)</td>
<td>388/1784 (21.7%)</td>
</tr>
<tr>
<td>30.0 and above</td>
<td>1274/3672 (34.7%)</td>
<td>602/1784 (33.7%)</td>
</tr>
<tr>
<td><strong>Health behaviors and care seeking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reported using emergency department in six months before enrollment</td>
<td>1945/3793 (51.3%)</td>
<td>978/1858 (52.6%)</td>
</tr>
<tr>
<td>Reported drinking alcohol in the three months before pregnancy</td>
<td>1902/3771 (50.4%)</td>
<td>927/1849 (50.1%)</td>
</tr>
<tr>
<td>Reported smoking cigarettes in the three months before pregnancy</td>
<td>939/3736 (25.1%)</td>
<td>495/1838 (26.9%)</td>
</tr>
<tr>
<td>Reported health as fair/poor</td>
<td>483/3774 (12.8%)</td>
<td>206/1854 (11.1%)</td>
</tr>
<tr>
<td><strong>Family Planning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reported a desire for more children in the future</td>
<td>2575/3793 (67.9%)</td>
<td>1274/1860 (68.5%)</td>
</tr>
<tr>
<td>Reported previously obtaining family planning or birth control</td>
<td>2100/3785 (55.5%)</td>
<td>1010/1856 (54.4%)</td>
</tr>
<tr>
<td>Reported interacting with the father of the child daily</td>
<td>3028/3778 (80.1%)</td>
<td>1484/1852 (80.1%)</td>
</tr>
</tbody>
</table>
Study Design: Visits Throughout Pregnancy

- Zero control group enrollees received home visits
- 98% of treatment group enrollees received at least one home visit

<table>
<thead>
<tr>
<th>Estimate within Treatment Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Received visits to birth</td>
<td>78.3%</td>
</tr>
<tr>
<td>Number of visits in the prenatal period (median)</td>
<td>9.0</td>
</tr>
<tr>
<td>Duration of in-person visit (minutes)</td>
<td>65.5</td>
</tr>
<tr>
<td>Received at least one telehealth visit (phone or video)</td>
<td>28.0%</td>
</tr>
<tr>
<td>Average share of total visits conducted via telehealth</td>
<td>5.0%</td>
</tr>
</tbody>
</table>
Study Design: Visits Throughout Pregnancy

Visit Time Spent on Each Program Area

- personal health
- maternal role
- life course, environmental health
- family & friends

Index month of program period with respect to delivery date
Results: program participation

• Length of home visit meets minimum program expectations
  • Median home visit length was 65 minutes
    • Program expectation is that visits last at least 60 minutes
  • Most common referrals
    • General services (housing, transport, CPS) (25% referred)
    • Health care services (23% referred)

• Number of visits during pregnancy mirrors other implementation settings
  • Median number of visits 9 visits
    • Similar to other evidence from multistate evaluations that included NFP
    • Program expects up to 12 visits during pregnancy
No impact on birth outcomes

### Table 3. Effects of Intervention on Primary and Secondary Outcomes Related to Maternal and Newborn Health

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>No./total (%)^a</th>
<th>Between-group difference, percentage point (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nurse home visiting group</td>
<td>Usual care group</td>
</tr>
<tr>
<td><strong>Primary outcome^d</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite adverse birth outcome^e</td>
<td>892/3319 (26.9)</td>
<td>430/1647 (26.1)</td>
</tr>
<tr>
<td><strong>Secondary infant outcomes (components of primary outcome)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small for gestational age^f</td>
<td>553/3295 (16.8)</td>
<td>265/1637 (16.2)</td>
</tr>
<tr>
<td>Low birth weight (&lt;2500 g)</td>
<td>436/3295 (13.2)</td>
<td>219/1637 (13.4)</td>
</tr>
<tr>
<td>Preterm (&lt;37 wk gestation)</td>
<td>379/3295 (11.5)</td>
<td>190/1637 (11.6)</td>
</tr>
<tr>
<td>Neonatal morbidity^g</td>
<td>328/3295 (10.0)</td>
<td>144/1637 (8.8)</td>
</tr>
<tr>
<td>Very low birth weight (&lt;1500 g)</td>
<td>78/3295 (2.4)</td>
<td>48/1637 (2.9)</td>
</tr>
<tr>
<td>Extremely preterm (&lt;28 wk gestation)</td>
<td>32/3295 (1.0)</td>
<td>16/1637 (1.0)</td>
</tr>
<tr>
<td>Perinatal mortality^h</td>
<td>27/3319 (0.8)</td>
<td>10/1647 (0.6)</td>
</tr>
<tr>
<td><strong>Secondary infant outcomes (not in primary outcome)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overnight NICU stay^i</td>
<td>241/3046 (7.9)</td>
<td>128/1497 (8.6)</td>
</tr>
<tr>
<td>Large for gestational age^c</td>
<td>166/3295 (5.0)</td>
<td>95/1637 (5.8)</td>
</tr>
<tr>
<td>Birth weight, g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>3295</td>
<td>1637</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>3085.2 (609.6)</td>
<td>3095.7 (622.0)</td>
</tr>
<tr>
<td>Gestational age, wk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>3295</td>
<td>1637</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>38.2 (2.3)</td>
<td>38.1 (2.3)</td>
</tr>
<tr>
<td><strong>Secondary maternal level outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>1015/3295 (30.8)</td>
<td>530/1637 (32.4)</td>
</tr>
<tr>
<td>Severe maternal morbidity^j</td>
<td>56/3464 (1.6)</td>
<td>23/1694 (1.4)</td>
</tr>
</tbody>
</table>
No impact on birth outcomes

Figure 2. Effect Heterogeneity

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>No./total (%)</th>
<th>Between-group difference, percentage point (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nurse home visiting</td>
<td>Usual care</td>
</tr>
<tr>
<td>Composite adverse birth outcome</td>
<td>Whole sample</td>
<td>892/3319 (26.9)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>423/1567 (27.0)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>547/1713 (31.9)</td>
</tr>
<tr>
<td>Large for gestational age</td>
<td>Whole sample</td>
<td>166/3295 (5.0)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>67/1554 (4.3)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>68/1705 (4.0)</td>
</tr>
<tr>
<td>Overnight NICU stay</td>
<td>Whole sample</td>
<td>241/3046 (7.9)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>118/1441 (8.2)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>133/1572 (8.5)</td>
</tr>
<tr>
<td>Neonatal morbidity</td>
<td>Whole sample</td>
<td>328/3295 (10.0)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>160/1554 (10.3)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>168/1705 (9.9)</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>Whole sample</td>
<td>1015/3295 (30.8)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>427/1554 (27.5)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>553/1705 (32.4)</td>
</tr>
<tr>
<td>Severe maternal morbidity</td>
<td>Whole sample</td>
<td>56/3464 (1.6)</td>
</tr>
<tr>
<td></td>
<td>Vulnerable subgroup</td>
<td>26/1625 (1.6)</td>
</tr>
<tr>
<td></td>
<td>Non-Hispanic Black</td>
<td>28/1789 (1.6)</td>
</tr>
</tbody>
</table>

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Results: impact on birth outcomes

- Substantial adverse outcomes (26% for full sample control group)
  - large racial disparities (31% for Black study participants control group)

- No impact on primary or secondary outcomes

- No improvement in outcomes for any subgroup

- Consistent with findings from recent evaluations looking at birth outcomes (MIHOPE, FNP in UK)
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Limitations

• Results are incomplete pending the analysis of other primary outcomes related to child well-being and maternal life-course.

• The use of administrative data doesn’t allow us to capture participant’s subjective well-being or subjective experience in the program.
Discussion – why no impact on birth outcomes

• Major changes since original trials (expansion of Medicaid coverage during pregnancy, lower rates of adolescent pregnancy, smoking)
  • Nonetheless we still see high and inequitable rates of adverse birth outcomes
• Most striking pattern of adverse outcomes is driven by racial inequities
  • Outcomes may be driven by pre-pregnancy health or structural factors (racism, poverty) program not designed to address
• Trial population already well connected to clinical services (~85% had already received prenatal care prior to enrollment)
  • In-home nurse visiting may be appealing to those already receiving services
  • Future analyses will compare study population to likely eligible population
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Acknowledgments

• **Team:** Sam Ayers, Farah Allouch, Nicolas Perreault, Slawa Rokicki, Maria Steenland, Michelle Woodford Martin, Annetta Zhou, Mary Ann Bates, Katherine Baicker, Chloe Zera, Alyna Chien, Michele Hacker, research assistance from Anna Nachbor

• Study participants and staff of the Nurse Family Partnership

• DHHS South Carolina

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  • Children’s Trust of South Carolina, Arnold Ventures, The Duke Endowment, The BlueCross BlueShield Foundation of South Carolina, J-PAL North America Health Care Delivery Initiative

• Questions?
THANK YOU