Leveraging Telemedicine to Eliminate Outcome Disparities for Rural-born Newborns

March 16, 2023
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• Recordings will be posted to our YouTube Channel:
  https://www.youtube.com/c/nctrc
Leveraging Telemedicine to Eliminate Outcome Disparities for Rural-born Newborns

Alexa Craig, MD, MS, MSc
Assistant Professor of Pediatrics
Tufts University of School of Medicine
Disclosures

• Grant funding: Northern New England Clinical and Translational Research Network (NNE-CTR) (NIH U54GM115516)

• Grant funding: Center of Biomedical Research Excellence in Acute Care Research and Rural Disparities (NIH 1P20GM139745-01)

• This research would not be possible without the families, who have been generous with their time and insights
Objectives

• Identify barriers to optimal care for neonatal encephalopathy in rural areas

• Learn about strategies being implemented such as telemedicine to evaluate neonatal encephalopathy and improve the parent experience

• Learn about ways in which we are expanding telemedicine application to other types of care in newborns and in children
Did you know that the human brain is the only organ that studies itself?
The Brain is an Energy Hog

- Brain Size: 2%
- Brain's Energy Needs: 20%
Hypoxic Ischemic Encephalopathy (HIE)
Hypoxic Ischemic Encephalopathy (HIE)

• Estimated incidence rate of 1-3 per 1,000 live births (in developed countries)

• Maine has an annual birth rate of ~12,000
  - Potentially 36 (or more) incidences of Hypoxic Ischemic Encephalopathy per year in Maine

• HIE is associated with cerebral palsy, hearing and vision loss and seizure disorders among other sequelae
  - The lifetime costs of children with functional or intellectual disabilities such as cerebral palsy, hearing and vision loss in the United States is estimated at $16.1 billion (Honeycutt, Grosse, Dunlap 2003)
• Term birth
• Umbilical cord prolapse -> stat C-section with general anesthesia
• Chest compressions
• Intubated after 4 attempts
• Arterial cord gas 6.8/-15
• TREATMENT: Therapeutic hypothermia

*Signed consent from Aaron’s parents to share photos for the purpose of education
Therapeutic Hypothermia

*Signed consent from David's parents to share photos for the purpose of education*
Aaron had no seizures on EEG for 72 hrs of cooling and 12 hours rewarming

MRI of the brain was normal at completion of hypothermia

Discharged home on day of life 11 on full oral feeds
A case: part 3

*Signed consent from parents of Aaron to share photos for the purpose of education*
What was the role of chance in this good outcome??
His pediatrician got to the bedside in 10 minutes.

She was ultimately successful at securing his airway after 4 attempts.

She new about therapeutic hypothermia and called us at the tertiary care center quickly.

---

The Swiss Cheese Model of Organizational Accidents:
https://www.researchgate.net/figure/Swiss-Cheese-model-of-organizational-accidents_fig1_265177684
Maine is a very rural state

- 2/3rd of babies born in Maine are delivered in small community hospitals (<1 baby born per day)
Transport Team-Cooled Aaron in the Rig
Where we started with cooling…

Number of Infants Treated with Hypothermia at MMC by year

- 2008: 1
- 2009: 8
- 2010: 6
- 2011: 7
- 2012: 11
- 2013: 16
- 2014: 16
Even though there were few differences in the mothers and babies, there are obvious differences in outcomes.
Small Volume Hospital Associated with Increased Risk

<table>
<thead>
<tr>
<th>Model</th>
<th>Odds Ratio</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted model for death/severe brain injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Medium volume vs Large volume</td>
<td>2.5</td>
<td>0.8, 9.4</td>
</tr>
<tr>
<td>• Small volume vs Large volume</td>
<td>5.9</td>
<td>2.0, 21.8</td>
</tr>
<tr>
<td>Adjusted for maternal age and gestational age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Medium volume vs Large volume</td>
<td>2.7</td>
<td>0.8, 11.3</td>
</tr>
<tr>
<td>• Small volume vs Large volume</td>
<td>7.5</td>
<td>2.3, 30.0</td>
</tr>
</tbody>
</table>

Poster presented at PAS 2021: Prathusha Yerramilli¹, Nabeel Hashmi¹, Jay Kerecman MD², Misty Melendi³ MD, Alexa Craig³ MD; Tufts University School of Medicine¹, Northern Light Eastern Maine Medical Center², Maine Medical Center³
**Educational Outreach Intervention**

**TIME IS BRAIN**

Any infant **RESUSCITATED** at birth may be a candidate for TREATMENT WITH THERAPEUTIC HYPOTHERMIA

Please call Maine Medical Center Neonatology for assistance and guidance (207) 662-2246

<table>
<thead>
<tr>
<th>HIGH RISK</th>
<th>MODERATE RISK</th>
<th>LOW RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cord pH ≤ 7.0</em> or <em>5 min Apgar ≤ 5</em> or <em>Need for resuscitation including respiratory support or chest compressions</em> or <em>Abnormal exam which may include flexed tone, poor suck, poor response to stimulation</em> or <em>Seizures at less than 6 hours of life</em></td>
<td><em>Cord pH ≤ 7.2</em> or <em>5 min Apgar ≤ 7</em> or <em>No resuscitation required</em> or <em>Infant with strong cry, flexed position and frequent movements of all extremeties, strong and coordinated suck reflex</em></td>
<td><em>Cord pH &gt; 7.25</em> or <em>5 min Apgar ≥ 7</em> or <em>No resuscitation required</em> or <em>Infant with strong cry, flexed position and frequent movements of all extremeties, strong and coordinated suck reflex</em></td>
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**EMERGENT CONSULT FOR PROBABLE TRANSFER** |

- The earlier hypothermia is initiated, the better the neurological outcome.
- Hypothermia **MUST** be initiated before 6 hours of life.
- Maintain infants temperature 36.0–36.5°C pending neonatology consultation.

**URGENT CONSULT FOR POSSIBLE TRANSFER** |

- Infant blood gas in the first hour of life is especially beneficial when cord gas is not available.
- Echocardiography can present as LETHARGY or a HYPERTHERMIA state. Serial examinations and consultation with a neonatologist are recommended.

**ROUTINE NEWBORN CARE** |

- The earlier hypothermia is initiated, the better the neurological outcome.
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Please call the Eastern Maine Medical Center NICU for assistance and guidance (207) 973-8781

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After Education Outreach Numbers Triple

Number of Infants Treated with Hypothermia at MMC by year

- 2008: 1
- 2009: 8
- 2010: 6
- 2011: 7
- 2012: 11
- 2013: 16
- 2014: 16
- 2015: 43
- 2016: 39
• Family medicine doctor or pediatrician stabilizes the baby
• Phone call to MMC NICU for advice—provide verbal description of infant’s exam
Knowledge of Neonatal Encephalopathy
Telemedicine 2017-2018-1st Platform
Telemedicine consults to assess neonatal encephalopathy are feasible in the neonatal intensive care unit

Alexa K. Craig¹ · Lauren M. McAllister² · Scott Evans³ · Misty E. Melendi¹³

Received: 18 June 2020 / Revised: 14 August 2020 / Accepted: 10 September 2020
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Lauren McAllister, MD
Misty Melendi, MD
Scott Evans, RN-NIC
**Disparity identified for Outborn babies:**

1. **Time to consult**
   - 2.1 vs 4.7 hrs
2. **Treated with TH**
   - 27% vs 36%

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tertiary Care Center (n=15)</th>
<th>Community Hospital (n=11)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational age (weeks)</td>
<td>38.5 (1.5)</td>
<td>39.6 (1.4)</td>
<td>0.054</td>
</tr>
<tr>
<td>Birth via C-section (n, %)</td>
<td>7 (47%)</td>
<td>5 (46%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Delivery complications:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuchal or body cord</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Fetal bradycardia or decelerations</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Meconium stained amniotic fluid</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Shoulder dystocia</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Placental abruption</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Intrauterine growth restriction</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Home birth</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Footling breech delivery</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Maternal general anesthetic</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Twin gestation</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hypermagnesemia</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Birthweight (kg)</td>
<td>3.3 (0.7)</td>
<td>3.1 (0.7)</td>
<td>0.61</td>
</tr>
<tr>
<td>Apgar 1 min (median, IQR)</td>
<td>2.0 (2.0, 3.5)</td>
<td>2.0 (1.5, 2.0)</td>
<td>0.28</td>
</tr>
<tr>
<td>Apgar 5 min (median, IQR)</td>
<td>7.0 (5.0, 7.5)</td>
<td>6.0 (4.0, 6.5)</td>
<td>0.24</td>
</tr>
<tr>
<td>Apgar 10 min (median, IQR)</td>
<td>8.0 (8.0, 9.0)</td>
<td>6.0 (6.0, 8.0)</td>
<td>0.004</td>
</tr>
<tr>
<td>Arterial cord pH</td>
<td>7.12e (0.13)</td>
<td>7.08e (0.10)</td>
<td>0.56</td>
</tr>
<tr>
<td>Arterial cord base deficit</td>
<td>10.4e (5.6)</td>
<td>11.1e (5.0)</td>
<td>0.77</td>
</tr>
<tr>
<td>Venous Cord pH</td>
<td>7.18 (0.10)</td>
<td>7.13e (0.16)</td>
<td>0.36</td>
</tr>
<tr>
<td>Venous cord base deficit</td>
<td>9.7 (4.4)</td>
<td>9.8e (5.0)</td>
<td>0.96</td>
</tr>
<tr>
<td>Required positive pressure ventilation in the delivery room</td>
<td>9 (60%)</td>
<td>6 (55%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Intubated in the delivery room</td>
<td>3 (20%)</td>
<td>0 (0%)</td>
<td>0.34</td>
</tr>
<tr>
<td>Duration of first NE encephalopathy</td>
<td>25.5 (18.5)</td>
<td>36 (24.7)</td>
<td>0.90</td>
</tr>
<tr>
<td>Treated with therapeutic hypothermia</td>
<td>4 (27%)</td>
<td>4 (36%)</td>
<td>0.92</td>
</tr>
<tr>
<td>Hour of life of first teleconsult</td>
<td>2.1 (1.4)</td>
<td>4.7 (2.2)</td>
<td>0.009</td>
</tr>
<tr>
<td>Hour of life of second teleconsult</td>
<td>3.1 (1.1)</td>
<td>5.1 (0.63)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

*kg kilograms, NE neonatal encephalopathy.

* n=13, ²n=10 ³n=8 ⁴n=7 ⁵n=6 ⁶n=5.
Fewer babies treated with hypothermia

Number of Infants Treated with Hypothermia at MMC by year

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Infants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1</td>
</tr>
<tr>
<td>2009</td>
<td>8</td>
</tr>
<tr>
<td>2010</td>
<td>6</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
</tr>
<tr>
<td>2012</td>
<td>11</td>
</tr>
<tr>
<td>2013</td>
<td>16</td>
</tr>
<tr>
<td>2014</td>
<td>16</td>
</tr>
<tr>
<td>2015</td>
<td>43</td>
</tr>
<tr>
<td>2016</td>
<td>39</td>
</tr>
<tr>
<td>2017</td>
<td>42</td>
</tr>
<tr>
<td>2018</td>
<td>36</td>
</tr>
</tbody>
</table>
Telemedicine 2018-2020-2nd Platform
Time to Consult: 2018-2020

Table 2: Encephalopathy scores and timing of scores

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Tertiary Care Center, N = 19</th>
<th>Community Hospitals, N = 34</th>
<th>p-value(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Encephalopathy Score</strong></td>
<td></td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>4 (2, 6)</td>
<td>6 (1, 9)</td>
<td></td>
</tr>
<tr>
<td><strong>Time from birth to first consult (min)</strong></td>
<td>66 (43, 91)</td>
<td>98 (76, 127)</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>Second Encephalopathy Score</strong></td>
<td></td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>N</td>
<td>14</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>2 (0, 4)</td>
<td>4 (0, 8)</td>
<td></td>
</tr>
<tr>
<td><strong>Time from first to second consult (min)</strong></td>
<td>106 (94, 132)</td>
<td>151 (103, 194)</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Third Encephalopathy Score</strong></td>
<td></td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>N</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>0 (0, 2)</td>
<td>9 (8, 10)</td>
<td></td>
</tr>
<tr>
<td><strong>Time from second to third consult (min)</strong></td>
<td>130 (116, 146)</td>
<td>108 (99, 116)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

\(^1\)Wilcoxon rank sum test

Inborn: 7 (37%) treated
Outborn: 17 (50%) treated; 9 (26%) not transferred; 8 were transferred and not treated
New question—are we missing anyone?

Number of Infants Treated with Hypothermia at MMC by year

- 2008: 1
- 2009: 8
- 2010: 6
- 2011: 7
- 2012: 11
- 2013: 16
- 2014: 16
- 2015: 43
- 2016: 39
- 2017: 42
- 2018: 36
- 2019: 29
- 2020: 25
- 2021: 21
Stakeholder Engagement: Providers

MaineNET Stakeholder Engagement
Clairette Kirezi

Traumatic Birth
Concern for Neonatal Encephalopathy

MaineNET Consult

Outcomes

Reduced Trauma | Access to Education | Generates Care Team Collaboration | Improved Resource Utilization | Streamlined Communication

SCAN ME
Parent Interview Themes

- Unmet parental expectations
  - 4 subthemes: MORPHINE USE, PARENTS AS DECISION MAKERS, IMMEDIATE SURVIVAL, LONG TERM UNCERTAINTY

- Communication in the Neonatal Intensive Care Unit
  - 3 subthemes: TRANSPARENCY, CONSISTENCY, DELIVERY STYLE

- Traumatic and healing experiences
  - 7 subthemes: TRAUMA, LOSS OF NORMALCY, SEPARATION, INCORPORATING PARENTS INTO NICU CARE, RECLAIMING PARENTHOOD, CONNECTING WITH OTHER FAMILIES
• **Improve access:** by addressing gaps in care, workforce shortages, better workflows and/or improving the quality of health care services

• **Expand capacity and services:** by creating effective systems through the development of knowledge, skills, structures, and leadership models

• **Enhance outcomes:** by improving patient and/or network development outcomes through expanding or strengthening the network’s services, activities or interventions

• **Sustainability:** by positioning the network to prepare for sustainable health programs through value-based care and population health management.
• **Improve access**: by addressing gaps in care, workforce shortages, better workflows and/or improving the quality of health care services

• **Expand capacity and services**: by creating effective systems through the development of knowledge, skills, structures, and leadership models

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• **Sustainability**: by positioning the network to prepare for sustainable health programs through value-based care and population health management.

• **Improve access**: Expand Maine NET coverage from 7 to 10 southern ME rural hospitals

• **Expand capacity and services**: Expand Maine NET coverage to 9 northern rural hospitals AND add new service of telemedicine consults for non-neurological issues to all

• **Enhance outcomes**: by avoiding unnecessary transfers and developing a statewide algorithm to improve location of care for families (choosing the tertiary care closest)

• **Sustainability**: perform cost-analysis to demonstrate financial savings associated with decreased transfers and improved referral patterns

---

Applied 11/22/22 : 300k/year x 4 years
Whole System Connected

- Maine Medical Center
  - Hub for south
- Northern Light Eastern Maine Medical Center
  - Hub for North
- Borderlands
  - Both can consult
Ongoing Research Using Telemedicine; Mild Encephalopathy
Stages of Neonatal Encephalopathy

NORMAL

MILD

MODERATE

SEVERE
**Telemedicine 2020-present-3rd Platform**

**AT RISK NEWBORN:**
- MMC (n=11)
- NLEMMC (n=0)
- UVM (n=0)
Other Uses of Telehealth: Simulation Training for Neonatal Resuscitation
Road Trip: On-site Simulation Training
Resuscitation work: On-site simulation training

Allison Zanno MD, Misty Melendi MD, Micheline Chipman, RN, MSN, CHSE, Jeffrey Holmes MD, Alexa Craig MD, on behalf of the MOOSE Research Team; Maine Ongoing Outreach Simulation Education (MOOSE)
Assessing Performance - Scoring NRP
On-Site Simulation Training: Confidence

Confidence Improves

Acumen did NOT Improve
Telesimulation: Need more frequent training

Allison Zanno MD, Misty Melendi MD, Micheline Chipman, RN, MSN, CHSE, Jeffrey Holmes MD, Alexa Craig MD, on behalf of the MOOSE Research Team; Maine Ongoing Outreach Simulation Education (MOOSE)
Resuscitation work: Telesimulation

Allison Zanno MD, Misty Melendi MD, Micheline Chipman, RN, MSN, CHSE, Jeffrey Holmes MD, Alexa Craig MD, on behalf of the MOOSE Research Team; Maine Ongoing Outreach Simulation Education (MOOSE)
Resuscitation work: Performance Improves

A Telesimulation program leads to improved skill efficiency & adherence to NRP® guidelines in one rural hospital.
## Resuscitation work: Specific Skills

<table>
<thead>
<tr>
<th>Skill</th>
<th>Average Baseline Time from Birth</th>
<th>Average Time from Birth after Telesim Sessions</th>
<th>Fold Faster</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG Lead Placement</td>
<td>4:19</td>
<td>0:49</td>
<td>5.3x</td>
</tr>
<tr>
<td>Definitive Airway</td>
<td>11:47</td>
<td>4:31</td>
<td>2.6x</td>
</tr>
<tr>
<td>1st Epinephrine dose</td>
<td>14:08</td>
<td>9:30</td>
<td>1.5x</td>
</tr>
</tbody>
</table>
## Department of Health and Human Services

### Part 1. Overview Information

<table>
<thead>
<tr>
<th>Participating Organization(s)</th>
<th>National Institutes of Health (NIH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components of Participating Organizations</td>
<td>National Institute of Biomedical Imaging and Bioengineering (NIBIB) National Institute on Minority Health and Health Disparities (NIMHD)</td>
</tr>
</tbody>
</table>

**Funding Opportunity Title**

Technology Development to Reduce Health Disparities (R01 Clinical Trial Optional)

**Activity Code**

R01 Research Project Grant

**Announcement Type**

New

**Related Notices**

- NOT-EB-22-016 - Notice of Change in Application Due Date for RFA-EB-21-001
- NOT-OD-23-012 Reminder: FORMS-H Grant Application Forms and Instructions Must be Used for Due Dates On or After January 25, 2023 - New Grant Application Instructions Now Available
- NOT-OD-22-190 - Adjustments to NIH and AHRQ Grant Application Due Dates Between September 22 and September 30, 2022
- NOT-OD-22-018 - Reminder: FORMS-G Grant Application Forms & Instructions Must be Used for Due Dates On or After January 25, 2022 - New Grant Application Instructions Now Available
- NOT-OD-21-181 - Updates to the Non-Discrimination Legal Requirements for NIH Recipients
- NOT-OD-21-169 - New NIH "FORMS-G" Grant Application Forms and Instructions Coming for Due Dates on or after January 25, 2022
- NOT-OD-21-170 - Update: Notification of Upcoming Change in Federal-wide Unique Entity Identifier Requirements
- NOT-OD-21-106 - Expanding Requirement for eRA Commons IDs to All Senior/Key Personnel

**Funding Opportunity Announcement (FOA) Number**

RFA-EB-21-001
Meet Holobaby™

Three dimensional HoloBaby™ in top-down and side view. Hologram representation of monitor with vitals.

https://media.giphy.com/media/9xKwUeB9JNwBWHrT/i.gif
High Fidelity vs Holobaby™

• Randomized non-inferiority cluster trial
  - 8 hospitals: 4 -> High Fidelity
    4-> Holobaby™
  - Measure NRP Adherence as the primary outcome
  - Measure teamwork and communication as secondary outcome

• Aim 2 uses implementation science to insure consistency between sites and to develop tool box for broader future applications
Maine Medical Center

NICU
I CAN'T KEEP UP WITH ALL THIS NEW TECHNOLOGY

LYNCH
Thank you and questions??
Our Next Webinar

The NCTRC Webinar Series

Occurs 3rd Thursday of every month.

Telehealth Topic: Social Determinants of Health and Value-Based Pay
Hosting TRC: California Telehealth Resource Center (CTRC)
Date: April 20, 2023
Times: 11 AM – 12 PM (PT)

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