Transforming Lives with Pediatric Remote Monitoring

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Conflict of Interest

Dr. Jeffrey Vergales, Pediatric Cardiologist, UVA Children’s, and Amy Dirks Stevens, EVP and Practice Lead, AVIA Health Innovation have no real or apparent conflicts of interest to report.
Agenda

- Welcome
- Introduction + Industry Insights
  - Amy Stevens, AVIA
- Building HOPE: Changing Lives through Pediatric Remote Monitoring at UVA Children’s
  - Dr. Jeffrey Vergales, UVA Children’s
- Driving New Use Cases: COVID and Telehealth
- Where Pediatric Hospitals are Acting
- Widening the Range of Pediatric Remote Monitoring Use Cases
- Deeper Dive on Devices
- Q&A and Gratitude!
Learning Objectives

- **Identify** the appropriate use cases for pediatric remote monitoring
- **Explain** some of the potential challenges to be considered when implementing a pediatric remote monitoring program
- **Describe** macro level KPI’s impacted by Pediatric Remote Monitoring Programs
Introduction + Industry Insights

Amy Stevens, AVIA

• The world of pediatric remote monitoring has transformed our ability to care for fragile newborns.

• The opportunity to seamlessly transition care to a parent’s arms from a NICU has proven results in pediatric outcomes including bonding, weight gain, feeding and recovery from cardiac surgery.

• While pediatric cardiac surgery outcomes are improving, transplant survival remains at 70% at 36 months of life. We have learned that by paying more attention to these patients in the first 6 months, the mortality rate improved from 10% to 5%.
Remote Monitoring: Growing Momentum

**Consumer Awareness**
- Pre COVID: 1 in 4 adult Americans have a wearable to monitor their health
- Post COVID: Solution companies see 50%+ increase in Remote Monitoring clients

**Cost and Outcomes Impact**
- Health system results show positive impacts to cost of care, clinical outcomes and patient experience

**Technology**
- Faster/better/cheaper
- Smaller/smarter
- Convenient/connected
- Multi-purpose devices
- More use cases

**Pandemics**
- Remote care reducing infection risk and improving continuity of care
- Hospital @ Home Waivers

**Regulatory Tailwinds**
- CMS released new FFS billing codes in 2019, 2020, and 2021
- Medicaid is following Medicare in a growing number of states

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Remote Monitoring: Beyond Device Enablement

Remote Monitoring is enabling the transition of rich PRO, survey, and care-path based approaches for care at home to continuously monitored leverage for providers to serve larger populations for even greater impact.
Remote Monitoring Technology: Beyond Device Enablement

Bluetooth enabled biometrics are becoming adjuncts to care and decision support across the continuum of care.

**Care Path Support**
- Smart Phone/App based
- Text, Talk, Video
- Education / Adherence
- Some consumer biometrics

**Diagnostic**
- Cardiology
- Pregnancy
- Glucose
- Sleep & behavioral

**PostAcute**
- Postsurgical
- Neonatal
- Rehabilitation
- Nutrition
- Physical Therapy

**Condition Specific**
- Disease management
- Chronic conditions
- Congenital conditions
- Longterm conditions
- Behavioral Health
- Phobias/Pain Management

**Disease Agnostic**
- General biometric monitoring
- Hospital at home
- Other acute & subacute facilities
- Virtual Visits

**Care Team**
- Nutrition
- Physical Therapy

**Remote Monitoring Technology: Beyond Device Enablement**

Remote Patient Monitoring at UVA-Children’s

Dr. Jeffrey Vergales
World of the Single Ventricle

- While anatomically different, each of these lesions represents a patient with significant morbidity and mortality, especially in the home environment
While operative mortality has significantly reduced for surgical palliation (10%), transplant-free survival continues to be around 70% at 36 months of life.

Although we have done a great job of managing hospital care, a large disease burden continues to exist when these patients are discharged.

Temporal Trends in Overall Mortality

- We see this even in the first 6 months, where a large proportion of major centers reported mortality rates as high as 26% after hospital discharge.

- Furthermore, in 2010, the at-home mortality rate in the first 6 months nearly surpassed the operative mortality rate.

Temporal Trends in Overall Mortality

- Simply by paying more attention to these patients in the first 6 months, the mortality rate improved from 10% to 5%

**Effectiveness of Digital RPM in Pediatric Cardiology**

**Table 2. Descriptive Outcomes of Standard HMP Compared to Digitally Integrated HMP.**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Standard HMP (n = 38)</th>
<th>Digitally integrated HMP (n = 31)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative day of first enteral feed</td>
<td>4.6 ± 3.3</td>
<td>5.3 ± 3.3</td>
<td>.69</td>
</tr>
<tr>
<td>Postoperative day of first oral feed</td>
<td>12.3 ± 8.0</td>
<td>13.2 ± 9.1</td>
<td>.67</td>
</tr>
<tr>
<td>Gastrostomy tube placed prior to S1P discharge</td>
<td>8 (21%)</td>
<td>3 (10%)</td>
<td>.32</td>
</tr>
<tr>
<td>Discharged with home NG feeds</td>
<td>1 (3%)</td>
<td>8 (26%)</td>
<td>.03</td>
</tr>
<tr>
<td><strong>Postoperative length of stay (days)</strong></td>
<td>33.0 ± 10.2</td>
<td>30.0 ± 12.5</td>
<td>.04</td>
</tr>
<tr>
<td>Age at S1P discharge (days)</td>
<td>41.2 ± 26</td>
<td>37.6 ± 16.5</td>
<td>.53</td>
</tr>
<tr>
<td>Weight at S1P discharge (kg)</td>
<td>3.18 ± 1.05</td>
<td>3.46 ± 0.71</td>
<td>.22</td>
</tr>
<tr>
<td>WAZ at S1P discharge</td>
<td>−1.48 ± 0.9</td>
<td>−1.67 ± 1.0</td>
<td>.48</td>
</tr>
<tr>
<td>Age at S2P (months)</td>
<td>5.4 ± 1.1</td>
<td>4.6 ± 0.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Total home monitoring time (days)</td>
<td>122 ± 39.9</td>
<td>101 ± 25.1</td>
<td>.01</td>
</tr>
<tr>
<td>Weight gain during interstage (e/d)</td>
<td>20.0 ± 6.9</td>
<td>23.1 ± 4.8</td>
<td>.10</td>
</tr>
<tr>
<td><strong>Change in WAZ at S2P admission</strong></td>
<td>0.33 ± 0.9</td>
<td>0.71 ± 0.9</td>
<td>.02</td>
</tr>
<tr>
<td>Growth failure during interstage</td>
<td>8 (21%)</td>
<td>5 (16%)</td>
<td>.34</td>
</tr>
<tr>
<td><strong>Successful transition to all oral feeds at 1 year</strong></td>
<td>26 (68%)</td>
<td>28 (90%)</td>
<td>.03</td>
</tr>
</tbody>
</table>

Abbreviations: HMP, home monitoring program; NG, nasogastric; S1P, stage 1 palliation; S2P, stage 2 palliation; WAZ, weight-for-age z score.

*Values are reported as mean ± SD and frequency (%) where appropriate. Growth failure during interstage defined as negative change in weight-for-age z score.

Effectiveness of Digital RPM in Pediatric Cardiology

Neonatal Transition Programs

- Attempting to “shift the bar” as to when it is safe to send children home, we began transitioning neonates home sooner than previous.
- These are mainly former preterm infants still requiring NG tube feeds as well as issues with growth.
- All were sent home on average 8-10 days early compared to counterparts before the program.
- We successfully wean the majority to total oral feeding on average of 7 days at a faster rate than counterparts in the hospital with no readmissions.

Pediatric Remote Monitoring: Making it Happen
Basics of Remote Patient Monitoring

• We start with an infant who had major heart surgery at 4 days of life, spent the last month in the hospital recovering, monitored by the most advanced computer systems, watched continuously by highly-trained medical professionals and still has a 10% mortality rate...
Difficulties Established in Home Monitoring

- Difficult to get parents to record daily information and then only learn about it 3 days later during scheduled phone calls
- Parents have to somewhat interpret the data they are gathering, which can be challenging for some
- Providers at our institution cannot see the information parents are gathering
- In 2021, information needs to be secured, backed up, and HIPAA compliant
- We want to increase parent engagement, making it easier/simpler for them to care for their high-risk children
Difficulties Established in Home Monitoring
Building HOPE: Changing Lives through Pediatric Remote Monitoring
The Launch of Building HOPE

• After 9 months of development and tireless work by:
  • Nurses
  • Physicians
  • Parents
  • Software developers
  • The EHR team

• We launched Building HOPE, starting in the Children’s Heart Center
Expectations of Parents and Healthcare Teams

**Parent Expectations**
- Obtain infant’s weight daily
- Obtain infant’s oxygen saturation daily
- Keep detailed feeding log for infant
- Maintain at least twice weekly phone contact
- Maintain weekly physician appointments

**Healthcare Team Expectations**
- Provide equipment for the families to gather the data
- Member of the home monitoring team available by phone 24/7
- Ability to see patient in person at any time by a small, familiar group of providers
- Help family identify and obtain resources for them to be successful in at-home care of their infant
- Maintain clear and consistent communication with family and other health care members involved in infant’s care, regardless of the infant’s location
Importance of Parental Involvement

- Parental involvement is key in successful remote patient monitoring
- This includes careful assessment of how parents/families will interface with whatever programs and technology one uses
- Still, understanding how these programs can be both anxiety relieving AND anxiety provoking is essential in developing a remote monitoring program\(^1\)
- Stress and challenges in the family dynamics can and frequently do occur with more intensive outpatient monitoring\(^2\)

Integrated Platform

- Every family in our monitoring program is sent home with an iPad
- The platform, configured for the individual infant, allows parents to enter data about their child and send it in real time directly to the EMR at UVA
- Consequently, we have created a direct link between the patient and the care providers at UVA regardless of where they are
Parent View

Today, May 11
0/7

Measure

0/2 SpO2

Record

0/1 Baby Weight

Record

0/1 Heart Rate

Record

0/1 Intake

Record

0/1 Output

Record

Optional

Only record the following if they occur.

0 Emesis

Record
**Parent View**

Enter your child's oxygen saturation.

- **64%**
- **11:34 am**
- **Note**: Optional

Please obtain and record your baby's oxygen saturation (O2) once/day.

To obtain the most accurate O2 reading:
- Your baby’s foot should be warm.
- The pulse ox probe can be sensitive to light; therefore, cover the probe with a sock or blanket to get the most accurate reading.
- Leave the pulse ox probe on for a few minutes.
- Consider placing the probe on your baby prior to a feeding. When the baby is comfortable and quiet while feeding, turn on the pulse ox machine.
- The pulse ox probes are reusable. The O2 sat will vary slightly, which is normal. If the pulse ox machine is not working, please call the company. The phone number is on the pulse ox machine.

Record & Save

The value entered is out of the suggested range.

Please call 888.555.5555

If you think you may have incorrectly entered this value hit 'Cancel' to try again.
**Parent View**

Today's Tasks

Measure

Upload a picture of your child's incision.

Upload an Image Optional

Remove

Notes Optional

Helpful Tips & Information

A provider's note for current measurement and importance as it relates to the patient population, tips for taking proper measurements, etc.

If you have any questions or concerns please call 1-888-555-5555

Record & Save

FAQ

Insights

Contact

Previous 30 Days

SpO2

70

90

Apr 04

May 03

SpO2 (%)

Baby Weight

Dashboard

Insights

Profile

100
Clinician View - Patient Level

Baby Weight (kg)

Oxygen Saturation (%)

Intake (mL)

Intake - PO Percentage of Total Volume

Intake (oz/day)

Wednesday, Jun 8, 04:10
Intake Daily Total: 19.5 oz (576.68385 mL) Baby Weight: 6.15 kg (13 lbs 5.0 oz) Calculation: 85.50 kcal/kg, 93.75 mL/kg

2016-06-04 04:10: 4.0 oz, 27.0 kcal/oz. 2016-06-04 09:30: 3.0 oz, 27.0 kcal/oz. 2016-06-04 14:30: 6.0 oz, 27.0 kcal/oz. 2016-06-04 21:30: 0.0 oz, 27.0 kcal/oz. 3 hrs interval ABP with 1.5 oz formula
Clinician Application
Driving New Use Cases: COVID and Telehealth
RPM as a Component of Telehealth

- We have seen as modalities of RPM become more and more complex, we become synergistic with existing telehealth strategies.
- In many ways, it has bridged the gap in many pediatric subspecialties from instances of care to true continuation of care.

Foster, et al. Integrated Multimodality Telemedicine to Enhance In-Home Care of Infants During the Interstage Period. Pediatric Cardiology. 2021;42:349-360
RPM During the COVID-19 Pandemic

• Nationally, as telehealth has expanded during the current pandemic, it is not surprising we have seen an increase in RPM services at the same time.

• Uses have varied from better management of patients with chronic conditions to directly managing patients with COVID at home.

Remote Patient Monitoring Program for Hospital Discharged COVID-19 Patients

William J. Gordon1,2,3, Daniel Henderson3,4, Avital DeSharone4, Herrick N. Fisher1,3, Jessica Judge1, David M. Levine1,3, Laura Maclean5, Diane Sousa5, Mack Y. Su3, Robert Boxer1,3

Telehealth for Pediatric Cardiology Practitioners in the Time of COVID-19

Devyani Chowdhury6, Kyle D. Hope7, Lindsay C. Arthur7, Sharon M. Weinberger4, Christina Ronal8, Jonathan N. Johnson9, Christopher S. Snyder7

COVID-19: Technology-Supported Remote Assessment of Pediatric Asthma at Home

Mattienne R. van der Kamp1,2, Monique Tabak2,3, Sophia E. J. A. de Rooij4, Pieter P. E. van Lierop1,6, and Boony J. Thio1
RPM During the COVID-19 Pandemic

- Various Pilot studies have been performed in select populations looking at what types of data can be routinely gathered in patients who are considered high risk if they get COVID, or those who have COVID who are at high risk of exacerbation.

- Adherence and compliance during these acute monitoring phases remains quite high.

Where Pediatric Hospitals are Acting
Neonatal Transition Programs

- Hans Christian Andersen Children’s Hospital in Denmark explored sending patients home with tablets – done completely without home visits
- Used the tablets for secure video conferencing and data transfers
- Found lower than normal readmission rates compared with historical cohorts
- Found 50% increased in breastfeeding at 3 months secondary to involving lactation in the video conferencing
Parents experienced NTH as a personalized method for linking to specialist staff in the NICU. NTH promoted the parent’s role as the primary care provider, further strengthening the parent-infant relationship.
Widening the Range of Pediatric Remote Monitoring Use Cases
Use in Cystic Fibrosis

- We have been able to demonstrate improvement using RPM in infants with Cystic Fibrosis
- Medication changes and feed volumes were changed which led to improvement in weight-for-age measurements over the study period

Type of Change Recommended

- Change in formula/EBM concentration: 30%
- Change in feed volume: 11%
- Change in enzyme dose: 5%
- Addition/adjustment of acid suppression: 4%
- Constipation management: 5%

Improvement of Weight-for-Age Percentile Over Duration of Monitoring

- >50th percentile
- 26-50th percentile
- 10-25th percentile
- <10th percentile

Month of Use

- M1 (n=11)
- M2 (n=14)
- M3 (n=14)
- M4 (n=14)
- M5 (n=14)
- M6 (n=11)
- M7 (n=10)
- M8 (n=9)
- M9 (n=7)
- M10 (n=6)
- M11 (n=5)
- M12 (n=5)
Asthma Management

- Using a commercially available BCG accelerometer-based passive bed sensor, proof-of-concept studies have been performed correlating physiologic changes in respiratory rate and heart rate to predict asthma status.

- These devices and incorporation into remote patient monitoring interfaces are attempting to predict asthma exacerbations before they require higher level care.

- They can also provide continuous data previously unavailable to clinicians in management individuals as outpatients.

Deeper Dive on Devices
Electronic Medication Monitors

- Ingestible medication sensors have also been developed and utilized in pediatric patients where medication adherence is tantamount (such as pediatric organ transplant)

Amlodipine 5 mg Pattern

Electronic Medication Monitors

- Smart pill boxes and other medication delivery systems have begun to emerge to assist in chronic remote patient monitoring.
- They provide both patient-level use data as well as background trends to target improvements in adherence.
- Argues that deployment of these devices may depend on risk stratification of the individual being monitored.

Asthma Management

- Combining devices within remote-monitoring could be promising for improvement in chronic care models.
- Previous work has utilized at-home asthma devices including:
  - Spirometers
  - Smart Inhalers
  - ECG Monitors
  - Activity and respiratory monitors
- Episodes of uncontrolled asthma were able to be predicted with high levels of sensitivity.
- Clearly long-term adherence to these types of regimens remain the largest challenge.

Wearables in RPM

• Wearables in RPM have been shown to be feasible and tolerable in proof-of-concept studies

• Yet, lack of FDA approval as medical devices in pediatric patients, issues surrounding accuracy, and how to interpret continuously-derived data remain major hurdles to widespread adoption

Direct-to-Consumer Monitors

- Commercially-available monitors, approved under FDA Consumer Wellness Device, have become more and more popular to generate data at home.
- Here, a study demonstrated ability to pick up episodes of undetected tachycardia in an infant.
Direct-to-Consumer Monitors
Direct-to-Consumer Monitors

• Overall, these monitors are NOT considered medical devices
• Thus, they are marked mainly as “peace of mind” interventions
• Not surprisingly reviews of these items in consumer marketplaces remain very mixed

“...what I quickly learned was that constant information does not equal comfort. In fact, for me, it inspired the opposite.”

“Temporary pauses in breathing and periods of low blood oxygen occur occasionally in healthy infants, but if this normal variation triggers an alarm of a home monitor, it could lead to a cascade of unnecessary actions and parental anxiety…”
Direct-to-Consumer Monitors

• Compared the two most common infant physiologic monitors to hospital-grade devices in admitted kids

• While one performed well in assessing heart rate, the others were inconsistent compared to the reported “gold standard”

• Authors concluded that home physiologic monitors just may not currently perform as one would hope, or give clinically meaningful data that leads to appropriate action
Questions?

• Q&A
Thank you all for your engagement. Do you have further questions or areas of interest? Please find contact info for speakers below:

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