Remote Temperature Monitoring

Protecting Vaccines & Driving Data for Improved Immunization Systems & Outcomes

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Vaccines save lives…

...yet an unknown number of kids every year get damaged, ineffective vaccines.

Vaccine doses must be stored between 2°C and 8°C, but vaccine fridges in rural clinics often fail.

Unreliable equipment, frequent power outages, poor fridge management, and a lack of maintenance all lead to temperature excursions.

Temperature excursions damage vaccines. And damaged vaccines do not protect kids.
Causes of Temperature Excursions in Fridges

- Refrigerator
- ~20%
- ?
A nurse sees that a vaccine fridge is running hot. She logs the dangerous temperature by hand during the day. She has no idea if the vaccines are in danger overnight.

The health systems manager can’t advocate for a new fridge without evidence. She does not replace the fridge until next year. She stops sending vaccines to the remote clinic with no functioning fridge.

The nurse tells the regional technician about the fridge. Without any real data and with limited resources, the technician has no way to diagnose the problem or repair it remotely.

A child who received a damaged vaccine from the clinic with a failing fridge contracts measles, leaving many children vulnerable to the disease.
Protecting Vaccines: The ColdTrace System

The ColdTrace System has 3 Core Components:

<table>
<thead>
<tr>
<th>ColdTrace Sensor Device</th>
<th>Data Analytics Dashboard</th>
<th>Standard Operating Procedures (SOPs)</th>
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</thead>
</table>
| • The ColdTrace sensor device sends **alerts via SMS (text message) and email** when fridge temperatures get **too hot** or **too cold** | • Secure, cloud-based dashboard that allows remote access to **real-time temperature data**  
• **Integrates into** existing LMIS systems (VIMs)  
• Provides **customizable analytics** and **report-generating tools** to track equipment performance | • SOPs for nurses, maintenance technicians, regional supervisors, and ministries of health for **effective cold chain system management** |

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Critical Use-Case: SMS Alerts for Nurses

**SMS ALERT**: Temp is -2ºC! Vaccines kept too COLD for 7 hours, in danger of freezing.

Refrigerator Calls for Help
Randomized Control Trial:
Reduced Freezing and Improved Uptime with SMS Alerts

ColdTrace alerts reduced total freezing time by 74%
Remote Diagnosis: Temperature Data Signatures

Clear patterns in temperature data viewable on the RTM dashboard can be used to remotely diagnose these types of fridge failures:

Figure E: Screenshot of ColdTrace dashboard showing 24 hours of temperature data from a fridge that needs thermostat adjustment. The temperature is consistently out of range.

Figure F: Screenshot of ColdTrace dashboard showing 48 hours of temperature data from a solar fridge with flat battery. At opening and closing time, when facility personnel check the temperature of the fridge, the temperature appears between 2-8°C. However, temperature excursions occur overnight.
Fridges needing thermostat adjustments can be diagnosed & fixed remotely

Figure A: Screenshot of ColdTrace dashboard showing temperature data from a fridge experiencing cold and freezing excursions before the thermostat adjustment, then performing in range after the adjustment.

Figure B: Screenshot of ColdTrace dashboard weekly summary showing performance of 8 fridges before and after thermostat adjustment.
Turning Data into Actionable Information: What Countries Need

- Which of our fridges are failing the most? Which clinics need new fridges urgently?
- Which clinics in our country have unreliable power and need solar fridges?
- How much should we budget for spare parts and maintenance from year to year?
- Which fridges should we buy, based on actual performance in tough field conditions?
- How can we save money and protect expensive vaccines?
- How can we expand our vaccine system to reach even more children?
Supporting Ministries of Health: Data-Driven Budgeting & Procurement

Region A: Facilities with Alarms

<table>
<thead>
<tr>
<th>Month</th>
<th># of Facilities with Alarms</th>
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<tbody>
<tr>
<td>Jan 2015</td>
<td>10</td>
</tr>
<tr>
<td>Apr 2015</td>
<td>15</td>
</tr>
<tr>
<td>Jul 2015</td>
<td>18</td>
</tr>
<tr>
<td>Oct 2015</td>
<td>21</td>
</tr>
</tbody>
</table>
The Larger Impact: Data Visibility System-wide

1. The nurse receives a text alert: VACCINES IN DANGER. She moves the vaccines.

2. The technician can tell what’s wrong with a broken fridge remotely. He brings the right tools with him to the clinic and makes efficient repairs.

3. The health systems manager has a data-informed budget. She can afford spare parts and new fridges when they’re needed. She keeps sending vaccines to the clinic.

4. Vaccines are protected. A baby gets a potent, life-saving vaccine.
Strengthening Cold Chain Management

- **FACILITY STAFF**
  - Temperature Alarms and Preventive Care

- **TECHNICIAN**
  - Remote Fridge Repairs and Informed Facility Visits

- **DISTRICT/PROVINCE MOH**
  - Maintenance Planning and Information Flow

- **NATIONAL MOH**
  - National Procurement and Maintenance Strategy

- **FACILITY STAFF**
  - Temperature Alarms and Preventive Care
Lessons Learned / Best Practices

Data alone does not lead to impact

So how do we implement this technology to ensure data is used by nurses and managers to improve vaccine cold chain?
Technology Uptake: Training Nurses

Training nurses and creating SOPs to improve responses to alerts

A ColdTrace device continuously sends real-time data from the clinic.
Sense of Ownership: Ministry of Health should be involved in the training, installation and implementation of the technology.
Training technicians and supervisors to access and use the data

Link the use-cases of data to every day tasks and decision making

Do not overwhelm users with unnecessary data - only provide data that **answers their questions**

Conduct refresher trainings - video trainings in cases of staff transition
Challenges in the Field

- Connectivity
- Staff transition
- Monthly recharge of the SIMs
- Ministry independently sustaining the long-term cost of RTM
- Demonstrating the return of investment
When Designing Innovative Technology Solutions...

• Technology has to be made around the needs of the users/target population.
• Has to be tested many times in the field!
• Co-design and iterate on the reports and visualizations with users’ feedback.
• Interoperability: Integrating with existing data management systems in the country.
• Allow customization - language translation
• Learn best practices from other partners who have succeeded in implementation of similar projects
• When designing it think about sustainability and replicability of the project by countries (without your help!)
• Never stop monitoring and measuring impact of the technology (it can always be better!)
Thank You 😊

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