Global update on temperature monitoring
Why bother about temperature monitoring

Objectives of the immunization supply chain

- **Availability of vaccines at the right place in the right time**
- **Vaccines are potent and have not been impacted by temperature excursions**
- **Resources are used efficiently**

Impacts of temperature excursions...

<table>
<thead>
<tr>
<th>If undetected</th>
<th>If detected</th>
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</thead>
<tbody>
<tr>
<td>Potential stockouts</td>
<td>Potential damaged</td>
</tr>
<tr>
<td>May not achieve sero-conversion</td>
<td>Wastage</td>
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</table>

Temperature monitoring: detects excursions and can help avoid future excursions
Temperature sensitivity of vaccines

Heat sensitivity

Most sensitive

Least sensitive

Freeze sensitivity

Not sensitive

Least sensitive

Most sensitive

Vaccines to the left of the line are not damaged by freezing.

Vaccine formulation

- Freeze dried
- Liquid, no adjuvant
- Liquid, with alum adjuvant

*The diluent for MenA PS-PCV contains alum adjuvant and is freeze sensitive.
Two stories of what happened to a vaccine at country level

Heat alarm: >8°C for 10 hours

Freeze Alarm: ≤ 0.5°C for 1 hour

Source: UNICEF data
Currently heat excursions are easier to detect than freezing if VVM is applied

**Too hot**

“Easier to detect”

Health worker in Niger shows bottles with vaccine vial monitors. Source: WHO

**Too cold**

“Harder to detect”

Continuous temperature monitoring

**What do we know from the EVM Data Analysis**

Over 90% of storekeepers and health workers know how to read VVMs.

“What about excursions during weekends?”

Example of Freeze indicators

Only 11% of facilities pack freeze indicators with deliveries of freeze-sensitive vaccines

Shake test. Source WHO
Recent evidence in literature and from country studies suggests that freezing remains a major concern, especially during transit.

Systematic literature review in 2007 covering 35 studies: 14-35% of refrigerators or transport exposed vaccines to freezing temperatures\(^1\)

**Recent literature (courtesy of PATH)**

**Thailand 2006\(^2\):** 6.3% (peripheral health facilities) and 6.4% (transit) of time
Min: \(-12^\circ\text{C}\)

**China 2009\(^3\):** 23.3% of time in county stores Min: \(-5.5^\circ\text{C}\)

**Malaysia 2010\(^4\):** 20.2% of refrigerators

**India 2012\(^5\):** 10.5% (peripheral health facilities) and 18.1% (transit) of the time
Min: \(-21.3\) and \(-15.0^\circ\text{C}\)

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... and more evidence...

**Link to Potency**

**HepB study**\(^6\): Damage to the vaccine increased with duration of freezing, lower temperature, and the number of freezing episodes.

**China 2009 study**\(^3\): 6.3% of vials tested from 7 health facilities showed decreased potency.

**Link to Infection**

**Mongolia HepB study**\(^7\): Association between winter vaccination and total infection was evident for rural areas. The study tied this with the vaccine temperature study showing exposure to freezing temperatures during rural transport.

**Additional evidence welcome**

**But evidence shows that temperature monitoring works**

**Vietnam 2010**\(^8\): EPI work to prevent freezing using approaches such as continuous temperature monitoring. Minimum between 0-2\(^\circ\)C, but no sub-zero temp.

**Tunisia 2014**\(^9\): Using continuous temperature monitoring and PCM transport packs. Freeze alarms at health facility level reduced by 40%. Freezing during transit: reduced from 13.8% to 1.7%.

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\(^{7}\)Davaalkham D, et. al.. Administration of hepatitis B vaccine in winter as a significant predictor of the poor effectiveness of vaccination in rural Mongolia. J Epidemiol Community Health. 2007 Jul;61(7):578-84.


WHO recommendations for temperature monitoring for storing vaccines

**Recommended best practices**

**Walk in cold rooms**
- Central temperature monitoring system

**Refrigerators**
- 30 day electronic temperature logger
- Stem thermometer (as backup)
- Integrated digital thermometer or gas/vapour pressure-dial thermometer
- VVMs

**Freezers**
- Stem thermometer
- Integrated digital thermometer or gas/vapour pressure-dial thermometer
- VVMs

**EVM data**

- % of facilities in which all cold and freezer rooms have continuous temperature recorders
  - ~ 40%

- % of facilities in which all vaccine refrigerators have continuous temperature recorders or freeze indicators
  - ~ 40%

**Can new technology make systems more “reactive”?**
Partners developed cost-benefit tool to assist countries to make evidence based decision about temperature monitoring system

How to think about the costs and benefits of different temperature monitoring systems?
- 30 DTRs
- 30 DTRs + sms model (e.g. Laos)
- Remote Temperature Monitoring Devices (e.g. Mozambique)

<table>
<thead>
<tr>
<th>Cost-benefit ratio of the monitoring system</th>
<th>Costs</th>
<th>Ongoing and recurring costs</th>
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<td>Upfront costs (e.g. device procurement, training, deployment / installation, data management systems)</td>
<td>(e.g. SMS costs, server costs, maint. &amp; repair)</td>
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| Benefits | Benefits through cost savings from preventing freezing |
Can we actually put a value on the Risk of Freezing?

72% of the vaccine value is for freeze sensitive vaccines!

National store
EPI target population of 1 million children; stores 4 months of vaccine stock:
$7,000,000

Regional store
Serves 125,000 children; stores 3 months of vaccine stock:
$653,000

Health center
Serves 300 children; stores 1 month of vaccine stock:
$520

Assumptions: Vaccine schedule includes BCG, OPV, pentavalent, measles, rotavirus, and PCV vaccines all at 85% coverage rate, and tetanus toxiod at 70% coverage rate. Uses Gavi vaccine prices.
Next steps… and welcome to TECHNET

New guidance materials are being developed:
- Vaccine Management handbook on temperature monitoring
- UNICEF practical guide for 30 DTR (& remote temp. devices) implementation
- Cost/benefit analysis tool
- Protocols review and new tools developed for temperature monitoring studies and temp. mapping

Get inspired – play with devices & talk to experts

- Take a look at of what is possible
- Provide feedback to the suppliers – express your needs!

Learn from some failures and successes

Country presentations
- Laos, Mozambique, Turkey

Posters
- E-health Africa & UNICEF Nigeria
- Village Reach, Nexleaf Analytics, EPI Mozambique and PATH
- CHAI
- U. of Wash. & PATH

Think “beyond” devices

Right device +
Right process +
Right system +
= SUCCESS

!!! DON’T FORGET THE USER!!!

!!! DON’T FORGET THE OVERAL HEALTH SYSTEM !!!