Maternal & Child Health (MCH) Program

Utilizing innovative & integrated approaches to improve healthcare services in underserved communities in Pakistan

Subhash Chandir, MBBS, MPH, PhD
Director, Maternal & Child Health
subhash.chandir@ird.global
About IRD - Reimagining Global Health

IRD is committed to improving the lives of vulnerable communities by building a network that shares ideas and innovations to create global impact.
IRD Programs

Through effective health delivery programs, disease surveillance, clinical research & information technology innovations, IRD is making an impact in **15 countries**

- Maternal & Child Health
- Mental Health
- Neglected Tropical Diseases
- Infectious Diseases
- Youth Engagement
- Non Communicable Diseases
MCH Programs & Studies

Technological initiatives

- Zindagi Mehfooz
  Electronic Immunization Registry
- Predictive analytics
- AI based Chatbot for immunization
- GSM tracking for vaccinators
- THRIVE
  OpenSRP
- Decision Support System (DSS)
- Pregnant Women & Child Registry
- eIMCI
MCH Programs & Studies

Ongoing programs and studies

- Incentive schemes and reminders
  - Kiran Sitara

- Cold chain equipment monitoring

- Vaccine hesitancy

- Mobile Vans for Immunization

- Affordable transport for immunization

- Extended immunization clinics

- Bracelet reminders

- HPV vaccination in Pakistan

- ANC-TB

- Immunization monitoring assessment study

- Health facility assessment
Maternal & Child Health Global Footprint

Ongoing programs/projects

Areas of expansion

Pakistan
Bangladesh
Indonesia
Nigeria
South Africa
Maternal & Child Health-Footprint in Pakistan

4 Provinces

8 Cities

16+ Programs and research projects

Islamabad Capital Territory
- Zindagi Mehfooz
- Kiran Sitaras for immunization
- mCCTs for immunization
- Affordable transport for immunization

Bhong
- Decision Support System (DSS)

Gilgit Baltistan
- Zindagi Mehfooz
- Decision Support System (DSS)

Lahore
- Zindagi Mehfooz
- eIMCI
- Family planning
- Malaria

Muzaffargarh
- Zindagi Mehfooz
- eIMCI
- Family planning
- Malaria

Badin
- eIMCI
- Zindagi Mehfooz
- Family planning

Karachi
- Zindagi Mehfooz
- eIMCI
- Antenatal Care
- Thrive OpenSRP
- Immunization Monitoring Assessment Study
- Bracelet Study
- Kiran Sitaras for immunization
- mCCTs for immunization
- Chatbot for immunization

Shikarpur
- Kiran Sitaras for immunization
- mCCTs for immunization
- Affordable transport for immunization

Gilgit Baltistan
- Zindagi Mehfooz
- Decision Support System (DSS)

Lahore
- Zindagi Mehfooz
- eIMCI
- Family planning
- Malaria

Muzaffargarh
- Zindagi Mehfooz
- eIMCI
- Family planning
- Malaria

Badin
- eIMCI
- Zindagi Mehfooz
- Family planning

4 Provinces

8 Cities

16+ Programs and research projects
The Immunization Landscape in Pakistan

Vaccine Coverage by Region
Percentage of Children aged 12-13 months fully vaccinated (BCG, measles and 3 doses of DPT and polio each)

Globally

1 OUT OF 5
Children are not fully immunized

In Pakistan

2 OUT OF 5
Children are not fully immunized

Source: 2017-18 Pakistan Demographic and Health Survey
DTP3 Coverage in Surviving Infants in Urban cities

Source: WHO 2017
Preliminary Findings

Evaluating the impact of Small Conditional Cash Transfers of Different Sizes, Designs and Schedules on Improving Immunization Outcomes: A Randomized Controlled Trial

Maternal & Child Health
mch@ird.global
A Case for Conditional Cash Transfers (CCTs)

In Sindh Province of Pakistan:

**2007** Food Vouchers showed more than a **2-fold increase** in DTP3 coverage

**2014** Lottery based Transfers showed a **15% increase** in Fully Immunized Child (FIC) coverage

**2017** Designed a **7-arm trial** to ascertain optimal incentive design, schedule and size

**Key Study Objective:**
Determine the impact of small incentives, **4.80 - 15 USD per fully immunized child**, of different designs, schedules and sizes, on immunization outcomes of children <2 years of age

**Methodology**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Recommended age</th>
<th>Without Lottery</th>
<th>With Lottery</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>All birth</td>
<td>0.80</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>6 weeks</td>
<td>0.80</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>10 weeks</td>
<td>0.80</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>14 weeks</td>
<td>0.80</td>
<td>4.00</td>
</tr>
<tr>
<td>Measles-1</td>
<td>9 months</td>
<td>0.80</td>
<td>0.40</td>
</tr>
<tr>
<td>Measles-2</td>
<td>15 months</td>
<td>0.80</td>
<td>0.40</td>
</tr>
</tbody>
</table>

**Cost/Child to Complete Immunization Schedule**
- 4.80
- 4.80
- 5.00
- 5.00
- 14.4
- 14.4
- 15.0
- 15.0
- 14.4
- 14.4
- 0
- 0

*All amounts are in USD; Probability of winning lottery set at 0.2 (1 out of 5).*

**BCG**
- At birth

**Penta-1**
- 6 weeks
  - Enrolled from 12 EPI centers in Korangi Town
  - Followed up to 18 Months

**Penta-2**
- 10 weeks
  - 11,197 infants
  - Within 6 Months

Blood collection of sub-sample (15%) for Validation
**Up to date Immunization Coverage for children up to 18 months of age by study arm, incentive design, structure and amount (N=11,197)**

<table>
<thead>
<tr>
<th>% Difference in Immunization Coverage</th>
<th>Cost/Child for FIC (USD)</th>
<th>Penta-3</th>
<th>Measles-1</th>
<th>Measles-2</th>
<th>FC at 12 months of age*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Arm**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Flat</td>
<td>4.0</td>
<td>5.2</td>
<td>4.2</td>
<td>8.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Low Sharp</td>
<td>4.0</td>
<td>7.7</td>
<td>6.1</td>
<td>8.3</td>
<td>6.9</td>
</tr>
<tr>
<td>High Flat</td>
<td>12.0</td>
<td>7.5</td>
<td>9.3</td>
<td>11.4</td>
<td><strong>8.9</strong></td>
</tr>
<tr>
<td>High Sharp</td>
<td>12.0</td>
<td>8.1</td>
<td>7.8</td>
<td>11.3</td>
<td>8.4</td>
</tr>
<tr>
<td>Easy Paisa</td>
<td>12.0</td>
<td>5.5</td>
<td>5.9</td>
<td>5.8</td>
<td>5.6</td>
</tr>
<tr>
<td>SMS</td>
<td>0.0</td>
<td>3.8</td>
<td>2.7</td>
<td>3.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Control</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Incentive Design**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lottery</td>
<td>-2.2</td>
<td>-4.4</td>
<td>-7.4</td>
<td>-4.3</td>
<td></td>
</tr>
<tr>
<td>No-Lottery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Incentive Schedule**

<table>
<thead>
<tr>
<th></th>
<th>-1.6</th>
<th>0.2</th>
<th>0.2</th>
<th>-0.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Incentive Size**

<table>
<thead>
<tr>
<th></th>
<th>1.4</th>
<th>3.4</th>
<th>3.0</th>
<th>2.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Increase in FIC in High Flat arm vs the control (p<0.001)**

- **4.3%** increase in FIC in the Non-Lottery vs the Lottery arm (p<0.001)

Seropositivity Rate (SPR) Trends for measles and tetanus antibodies were consistent with coverage estimates. Absolute differences between SPR and coverage were 9-15% for Tetanus and 0-6% for Measles.

*Children receiving BCG, 3 doses of Penta and 1 dose of measles by 12 months of age

**Compared to control
Predictors of full immunization coverage (FIC) at 12 months of age in study participants (n=10,602)

**All incentive arms** made children 7-16% more likely to achieve FIC by 12 months of age.

The highest impact was in the **High Flat Arm**

Receiving a total of 12 USD made children 16% more likely to be fully immunized

(IRR: 1.16, CI: 1.09-1.22, P-value <0.001)

**What Else?**

- **Having lesser siblings**
  (IRR 0.97, CI: 0.96-0.98, P-value: <0.001)
- **Higher maternal education**
  (IRR 1.02, CI: 1.01-1.02, P-Value: <0.001)
- **Having a personal vehicle**
  (IRR 1.05, CI: 1.01-1.09), P-value: 0.008

**Conclusion**

Even **CCTs of 5 USD** for each child can significantly improve immunization coverage >5%. The greatest impact can be seen when sure payments of 2.4 USD are provided on each visit

*All CIs are at 95% confidence*
Pregnant Women and Birth Registry in Super High-Risk Union Councils (SHRUCs) in Karachi

Integrated with Government’s ZM Electronic Immunization Registry (ZM EIR)
Background

Pakistan has one of the highest burdens of maternal, fetal, and child mortality worldwide.

31% pregnant women are not vaccinated against tetanus
61% of U2 children are not registered
39% children do not receive BCG by 28 days of age
48% children do not receive OPV-0 by 28 days of age

Objectives for Implementation

Provide all pregnant women and newborns from SHRUCs in Sindh province visiting the 15 birthing facilities with an EPI digital identity and link to vaccinators
Achieve Universal Immunization Coverage for birth dose of polio vaccination & other routine immunizations in SHRUCs
Improve health outcomes for pregnant women and newborns, ensuring health equity in SHRUCs

Objectives for Research Component

To investigate the impact of sociodemographic characteristics and antenatal care practices on health and immunization outcomes

Sources: Pakistan National Institute of Population Studies; UNICEF; DHS 2017-18; ZM EIR
Pregnant Women & Birth Registry Project: Overview of the Implementation & Research Component

**Implementation**

- Shadowing of activities at 15 birthing facilities
- End-user field testing of Registry at 1 pilot site
- Phase-wise deployment across all 15 birthing facilities
- Transition of Registry to hospital staff

**Research**

- At enrollment:
  - Socio-demographic data
  - Medical data
  - ANC attendance
- Throughout pregnancy:
  - Women’s triage data
  - Pregnancy-related conditions
  - Obstetric scan outcomes
- Within 48 hrs post-delivery:
  - Pregnancy outcomes
  - Newborn health & vaccination
  - Postnatal healthcare use
Number of Women Enrolled/Followed up and Newborns Enrolled and Vaccinated (BCG/OPV0) at 13 Birthing Facilities

Women Enrolled/Followed up

- **11,473** Enrollments
- **20,998** Follow ups

Newborns vaccination status

- **3,306** Enrollments
- **2,866** Vaccinated
- **440** Not vaccinated

Number of newborns enrolled

- **Nov 2020**: Enrolled 100, Followed up 200
- **Dec 2020**: Enrolled 300, Followed up 400
- **Jan 2021**: Enrolled 500, Followed up 600
- **Feb 2021**: Enrolled 700, Followed up 800
- **Mar 2021**: Enrolled 900, Followed up 1000
- **Apr 2021**: Enrolled 1100, Followed up 1200

Vaccinated BCG/OPV0
- **Nov 2020**: 10
- **Dec 2020**: 20
- **Jan 2021**: 30
- **Feb 2021**: 40
- **Mar 2021**: 50
- **Apr 2021**: 60

Vaccinated OPV0
- **Nov 2020**: 5
- **Dec 2020**: 10
- **Jan 2021**: 15
- **Feb 2021**: 20
- **Mar 2021**: 25
- **Apr 2021**: 30

Not Vaccinated
- **Nov 2020**: 5
- **Dec 2020**: 10
- **Jan 2021**: 15
- **Feb 2021**: 20
- **Mar 2021**: 25
- **Apr 2021**: 30
Number of women enrolled/followed up at 13 birthing facilities in Research survey

Launch date  
Feb, 2021  
Mar, 2021  
Apr, 2021

Enrolments  
Follow ups

Number of women enrolled/followed up at 13 birthing facilities in Research survey
Key Takeaways

Successfully enrolling all pregnant women and newborns, benefitting both SHRUCs & overall Karachi metropolitan

- Increased ANC visits through SMS reminders
- Increased TT vaccine coverage among pregnant women
- Registration of newborns into Health System & National database
- Improved timeliness of BCG vaccination
- Higher coverage & timeliness of OPV-0 vaccination
Predictive Analytics

Preventing missed opportunities and achieving higher immunization coverage and timeliness by identifying children who are at high risk of defaulting on their immunization schedule

Maternal & Child Health
mch@ird.global
A Global Problem

Despite initiating vaccination, millions of children **default on the immunization schedule** each year.

- **34.6%**
  - Children drop out between BCG and Measles 2 in low-income countries

- **6 million**
  - Children drop out between first and third dose of DTP every year

Vaccinators unable to identify high-risk children upon encounter

Governments lack resources to target all children

Source: WHO
Predictive Analytics to Prevent Drop-Outs & Delays

Child receives immunization

Vaccinator enters child’s data into Electronic Immunization Registry (EIR); Predictive Analytics (PA) algorithm executes

PA categorizes child as high risk. Vaccinator is alerted & risk status is stored in the system

PA categorizes child as low risk. Standard of care is adopted

Evidence-based interventions are targeted at caregivers of high-risk child
A Cutting-Edge Solution

Machine learning

Mathematical and computational statistical modeling

Multidimensional data mining

Artificial Intelligence enables the system to iteratively improve over time, and to adapt to dynamic contexts

- Improve Routine Immunization Timeliness
- Lower BCG to Measles Dropout Rate
- Improve Immunization Equity
- Identify Variables Correlating with High Dropout Risk
Model Development and Testing

**STUDY POPULATION**

49,439 records in registry
May 2012 to April 2016

21 Immunization centers
(Karachi and Muzzaffargarh)

2 CITIES

**FLOW DIAGRAM**

Zindagi Mehfooz Digital Immunization Registry Database
N=49,439
Excluded (n=329)

Analysis Cohort
N=47,554

Bootstrap sample training set
n=47,554

Validation set
n=11,889

**PREDICTORS**

Gender
Language spoken at home
Place of residence
Enrollment vaccine timelines
Enrollment staff
Enrolling staff
Age group

Random Sampling

Enrolling vaccine timelines
DoB

M36
Performance Parameters for Prediction Models

Recursive Partitioning
- c-statistic: 0.787

Support Vector Machine
- c-statistic: 0.799

Random Forests
- c-statistic: 0.739

C-Forest
- c-statistic: 0.816
Feasibility Testing Results

<table>
<thead>
<tr>
<th>Model</th>
<th>Number of correct cases predicted</th>
<th>AUC-c statistic</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recursive partitioning</td>
<td>6974</td>
<td>0.787</td>
<td>0.792 UCL</td>
</tr>
<tr>
<td>Support vector machines</td>
<td>7108</td>
<td>0.799</td>
<td>0.807</td>
</tr>
<tr>
<td>Random forests</td>
<td>6487</td>
<td>0.739</td>
<td>0.738</td>
</tr>
<tr>
<td>C-forest</td>
<td>7254</td>
<td>0.816</td>
<td>0.823</td>
</tr>
</tbody>
</table>
Game-changing Aspects

- Instantaneous & accurate risk categorization
- Self-learning algorithm
- Elimination of time lags

Interoperable with EIRs
Applicable to low resource settings
Reduced burden on vaccinator
GSM Tracking

For Vaccinators

GSM based GIS tracking to improve workforce monitoring for improved geographic coverage of immunization services

Maternal & Child Health
mch@ird.global
GSM Tracking for Vaccinators

Pacesetters in utilizing low cost GSM based GIS tracking to **improve real time monitoring and accountability** of vaccinators during polio supplementary immunization activities (SIAs)

- **Real-time tracking**
- **Active surveillance system to ensure complete coverage**
- **Route view to monitor attendance and mobility of field staff**
- **Live web dashboard for supervision**
- **Team view for simultaneous supervision of multiple teams**
- **Touch points to enable follow-up teams to locate refusal households**
- **Online mapping**
- **Geo-fencing for effective coverage of remote areas**
GSM Tracking Benefits

- Highly cost efficient
- Great potential for scale-up
- Effective monitoring of high-risk security areas
- Generates real-time actionable data
- Improved geographic coverage of SIAs
- Improved accountability of vaccinators
GSM Tracking for Vaccinators

Team tracking

Route tracking
Vaccinator Monitoring Mechanism Used before VTS (n=18)

22% respondents said there was no proper system in place before VTS
Preference of VTS over other Monitoring Mechanisms (n=18)

89% Respondent said they prefer VTS to the old system they used
Advantages of VTS compared to other Monitoring Mechanisms (n=18)

94% of respondents said they found VTS to be better for monitoring of field workers
Usage of Vaccinator Tracking System at District level (n=18)

78% said they use the system to monitor staff, on average, once a day while 11% said they used it 2-3 times a day and 11% said their usage was a few times a week.
Kiran Sitaras for Immunization
Mobilizing Adolescent Girls to Improve Immunization Coverage and Timeliness
**Background and Objectives**

**Background**

*Source: WHO/UNICEF Estimates of National Immunization Coverage, 2019*

Demand and supply-side factors can explain endemic pockets of low immunization coverage: **Inaccessibility** of outsiders to closely knit societies, **Caregivers lack knowledge, information and motivation**, **Weak linkages** between community and health system.

**Objectives**

1. **1.4 million** children in Pakistan are zero-dose** and under-immunized

   Develop, pilot & conduct the **Adolescent Health & Leadership Program**

   Evaluate the feasibility of KS community mobilization in identifying **zero-dose and under-immunized children** under 2-years of age

   Validate KS’s ability to accurately identify **zero-dose** and **under-immunized children** through follow-up verification surveys

*Source: WHO/UNICEF Estimates of National Immunization Coverage, 2019*

**Never-immunized**
Program Overview of Kiran Sitaras (KSs) for Immunization

1. Program team trains teachers

2. Teachers train KSs on leadership skills & health directives

3. KSs conduct community mobilization and screen < 2 years children

4. Program team enters data collected by KSs

5. Field staff conducts follow-up surveys to verify the immunization statuses identified by KSs

6. Program team analyzes the accuracy of the collected data

7. 2nd wave of community mobilization to invite children to receive vaccination

8. Program team organizes mobile immunization camps in the targeted communities
Skills Developed by Kiran Sitaras (KSs) for Immunization

- Communication Skills
- Leadership
- Community Mobilization
- Self Awareness
- Empowerment

Health (Immunizations, Tuberculosis, Menstrual Hygiene, Human papillomavirus)
Evaluation of Immunization Statuses identified by Kiran Sitaras through follow-up verification surveys (n=1,628*) (May 3, 2020-Dec 21, 2020)

591 KSs screened 10,330 households and identified 3,295** children

KSs identified 7% zero-dose children and 27% under-immunized children

<table>
<thead>
<tr>
<th></th>
<th>Zero-dose</th>
<th>Under-Immunized</th>
<th>Up-to-date Immunized</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>0%</td>
<td>36.7%</td>
<td>90.9%</td>
</tr>
<tr>
<td>PPV</td>
<td>28.9%</td>
<td>53.8%</td>
<td>79.0%</td>
</tr>
<tr>
<td>Specificity</td>
<td></td>
<td>80.0%</td>
<td>98.0%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>21.7%</td>
<td>35.4%</td>
<td>85.8%</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td>49.6%</td>
<td>90.4%</td>
</tr>
</tbody>
</table>

*Excludes cases where at least one of the vaccination dates was missing
**Missing immunization status for 26 children
Preliminary comparison of antigen-wise coverage at 12 months among 12-23 months old children in the 5 UCs where Kiran Sitaras surveyed households in Karachi, Pakistan

<table>
<thead>
<tr>
<th>Antigen</th>
<th>All Children Living in the 5 UCs*</th>
<th>Children screened by KSs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Due</td>
<td>Given</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>BCG</td>
<td>42,420</td>
<td>41,760</td>
</tr>
<tr>
<td>OPV-0</td>
<td>25,331</td>
<td>25,321</td>
</tr>
<tr>
<td>Penta-1</td>
<td>51,205</td>
<td>45,029</td>
</tr>
<tr>
<td>OPV-1</td>
<td>51,224</td>
<td>45,126</td>
</tr>
<tr>
<td>Rota-1</td>
<td>47,164</td>
<td>37,863</td>
</tr>
<tr>
<td>PCV-1</td>
<td>48,223</td>
<td>42,045</td>
</tr>
<tr>
<td>Penta-2</td>
<td>45,765</td>
<td>37,182</td>
</tr>
<tr>
<td>OPV-2</td>
<td>45,847</td>
<td>37,210</td>
</tr>
<tr>
<td>Rota-2</td>
<td>39,907</td>
<td>31,467</td>
</tr>
<tr>
<td>PCV-2</td>
<td>44,445</td>
<td>35,866</td>
</tr>
<tr>
<td>Penta-3</td>
<td>38,387</td>
<td>32,035</td>
</tr>
<tr>
<td>OPV-3</td>
<td>38,727</td>
<td>32,084</td>
</tr>
<tr>
<td>PCV-3</td>
<td>38,654</td>
<td>31,896</td>
</tr>
<tr>
<td>IPV</td>
<td>52,413</td>
<td>35,765</td>
</tr>
<tr>
<td>Measles-1</td>
<td>60,891</td>
<td>38,709</td>
</tr>
<tr>
<td>Measles-2</td>
<td>39,206</td>
<td>22,731</td>
</tr>
<tr>
<td>FIC_M1</td>
<td>20,491</td>
<td>19,171</td>
</tr>
<tr>
<td>FIC_M2</td>
<td>31,244</td>
<td>20,496</td>
</tr>
</tbody>
</table>

*Data Nagar-11, Ghaziabad-6, Gujro-04, Hanifabad-3, Saeedabad-5

14.5% increase in coverage for penta-3

>20% increase in rota-2, IPV, measles-1 & 2 coverage rates
The Adolescent Health and Leadership Program (AHLP) is a feasible and acceptable intervention for identifying and linking zero-dose and under-immunized children to immunization services in under-served communities.

A community-based youth engagement immunization initiative can cause and improve caregivers' knowledge on immunization and an increase in the uptake of immunization services thus leading to the eventual reduction in prevalence of vaccine preventable diseases.

As a low-cost intervention, the AHLP empowers young adolescent girls to not only promote immunization equity and coverage in their communities today but also champion this cause in their capacity as tomorrow’s mothers.
Piloting sentinel surveillance with the government, EPI and local partners to establish a sustainable monitoring system for CCE performance in Pakistan & Bangladesh
Problem Statement and Objective

Lack of a systematic Post Market Monitoring (PMM) mechanism for Cold Chain Equipment (CCE) causes poor design or performance to go unnoticed and unaddressed, threatening vaccine potency.

- Develop a centralized, systematic sentinel surveillance system to address deficiencies in cold chain equipment monitoring.

- Equip the national Expanded Programme on Immunization (EPI) with a comprehensive cold chain equipment monitoring framework that enables rapid identification and diagnosis of equipment failure.

- Protect vaccine potency by ensuring a properly functioning cold chain system.
Methodology

• IRD Implemented a centralized, systematic sentinel surveillance system to address deficiencies in CCE monitoring

• Selected 93 sentinel sites in Pakistan and 20 in Bangladesh on the basis of accessibility, weather, and power-availability

• Collected temperature data of 153 Ice-lined Refrigerators (ILRs) in Pakistan and 53 in Bangladesh using Fridge-Tag

• Reported an ILR non-functional if Fridge-Tag produced $\geq 5$ heat alarms (continuous temperature excursion above $+8^\circ$C for $\geq 10$ hours) or $\geq 1$ freeze alarm (continuous temperature excursion below $-0.5^\circ$C for $\geq 1$ hour) in a month

• Conducted root-cause-of-failure-analysis (RCFA) of non-functional ILRs and categorized cause of failure as poor equipment-performance, human error, or external factors
### Cumulative Temperature Alarms and Functionality Status of Operational ILRs & SDDs by Manufacturer (N = 153) – Pakistan
(Feb 26, 2020 – Mar 31, 2021)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>ILRs/SDDs with fridge tag data collected</th>
<th>Heat alarms</th>
<th>At least 1 Freeze alarm</th>
<th>Non-functional ILRs/SDDs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At least Five (10hrs)</td>
<td>At least One (48hrs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N* %</td>
<td>n %</td>
<td>n %</td>
<td>N %</td>
</tr>
<tr>
<td>B Medical System</td>
<td>32 21</td>
<td>3 9</td>
<td>6 19</td>
<td>3 9</td>
</tr>
<tr>
<td>Haier</td>
<td>44 29</td>
<td>13 30</td>
<td>10 23</td>
<td>2 5</td>
</tr>
<tr>
<td>Vestfrost</td>
<td>73 48</td>
<td>7 10</td>
<td>11 15</td>
<td>10 14</td>
</tr>
<tr>
<td>Dulas</td>
<td>4 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electrolux</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>153 100</td>
<td>23 15</td>
<td>27 18</td>
<td>14 10</td>
</tr>
</tbody>
</table>

*N shows unique ILRs/SDDs surveilled with Fridge Tag data collected since the beginning of the study.
Cumulative temperature alarms and functionality status of operational ILRs by manufacturer (N = 53) - Bangladesh (April 1 – Feb 28, 2021)

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>ILRs with fridge tag data collected</th>
<th>Heat alarms</th>
<th>At least One (48hrs)</th>
<th>At least Five (10hrs)</th>
<th>Non-functional ILRs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N*</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Vestfrost</td>
<td>4</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B Medical System</td>
<td>7</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electrolux</td>
<td>5</td>
<td>9</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Domestic</td>
<td>37</td>
<td>70</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
</tbody>
</table>

*N shows unique ILRs/SDDs surveilled with Fridge Tag data collected since the beginning of the study
Key Takeaways

• Our results demonstrate presence of sub-optimal equipment performance both in Bangladesh and Pakistan

• Specific CCE components, including the thermostat and sensor, need design improvement. Furthermore, there is a need for proactive preventive action, including provision of alternate sources of power and regular cleaning

• Overall, a systematic CCE monitoring mechanism that enables rapid identification and diagnosis of equipment failure can help maintain an effective cold chain
Mobile Immunization Vans

Expanding provision of vaccine services in under-served and inaccessible areas to improve immunization coverage
Problem Statement and Objective

Distantly located immunization centers coupled with unavailability of affordable and reliable means of transport is one of the major barrier preventing access to immunization in Pakistan, including Karachi.

- Expand provision of vaccine services in slums and under-served areas in Karachi including the **Super High Risk Union Councils**
- Vaccinate **under-immunized children** who have not received all the age-appropriate vaccines and are likely to default on their schedule
- **Enroll zero-dose** children in the government’s Electronic Immunization Registry
Methodology

Vaccines are administered by the vaccinators and data is entered in Government-EIR. Coverage is supported by LHW's and CHW's to mobilize the community.

Announcements are made by field workers via loudspeaker to mobilize children.

Day-to-day activities of the Mobile Immunization Vans:
- Vans get deployed daily at 8am.
- Vans reach EPI center to pick up vaccines and vaccinators.
- Vans arrive at sites as per micro plans developed in coordination with EPI.

Coverage is supported by LHW's and CHW's to mobilize community.
Monthly Trend Of Total Immunization Visits Through Mobile Vans (Apr 08, 2019 – Apr 30, 2021)

- **COVID-19 lockdown period** (Mar 17 – May 16, 2020)
- **Post COVID-19 lockdown period** (May 18 – Jun 20, 2020) (Aug 10 – To date)
- **Smart lockdown period** (Jun 22 – Aug 08, 2020)

- **Enrollment**: 27,526
  - **Follow-up**: 56%
  - **Enrollments**: 44%

- *Follow-up children can be repeated in more than one month*

**Consistency in micro-plans and improved implementation**
**Increased CBV support and strict implementation**
**Reduced activity time in Ramadan**
Antigens Administered by Doses through Mobile Vans in Karachi (n=78,933) From Apr 8, 2019 – Apr 30, 2021
Key Takeaways

1. Provision of vaccine services in the under-served areas through mobile vans encourage caregivers to get their children vaccinated who otherwise may not get access to immunization services.

2. Expanding convenient access to vaccine administration is a cornerstone for achieving universal immunization coverage and equity, particularly in areas where outbreaks of vaccine-preventable diseases are still common.

3. Engagement of mobile vans for the purpose of immunization is an affordable and reliable approach to target zero-dose children residing in remote and inaccessible areas.
**Immunization Reminder & Tracker Bracelets**

Improving immunization coverage and timeliness by using simple silicon bracelets designed especially for children under 2 years of age.
Background

**Problems**

- 20 million children are deprived of routine vaccines, globally.
- 50% of children in Pakistan do not receive timely vaccinations.
- Innovative methods for parental reminders are required to improve immunization coverage.

**Objectives**

**Overall Aim:**
Improve routine immunization coverage and timeliness in Pakistan.

**Objective 1:**
Adapt Alma Sana bracelets for use in Pakistan.

**Objective 2:**
Evaluate impact of reminder bracelets on coverage and timeliness of Penta 3 and Measles 1 vaccine.
Methods

Study Sites
4 EPI Centers in Landhi, Town Karachi

Participants
1,446 infants enrolled in 3 different intervention Arms

Randomization

Intervention Arm A
482
Alma Sana Bracelet

Intervention Arm B
482
Simple Silicon Bracelet

Intervention Arm C
Only EPI Card

Outcome
Impact of bracelet for vaccine reminder & Timeliness

Child who has received:

- One dose of BCG
- 3 doses of each OPV, Pentavalent & PCV immunizations
- 1 dose of Measles vaccine
## Results

**Up to date coverage by antigen and allocation group for study participants due* for each vaccine**

<table>
<thead>
<tr>
<th></th>
<th>Alma Sana Bracelet n=482</th>
<th>Simple Silicon Bracelet n=482</th>
<th>Control n=481</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enrollments at:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At BCG</td>
<td>217 (45.0)</td>
<td>200 (41.5)</td>
<td>216 (44.9)</td>
</tr>
<tr>
<td>At Penta 1</td>
<td>265 (55.0)</td>
<td>282 (58.5)</td>
<td>265 (55.1)</td>
</tr>
<tr>
<td>Penta 1**</td>
<td>208 (95.8)</td>
<td>183 (91.5)</td>
<td>202 (93.5)</td>
</tr>
<tr>
<td>Penta 2</td>
<td>446 (92.5)</td>
<td>435 (90.2)</td>
<td>432 (89.8)</td>
</tr>
<tr>
<td>Penta 3</td>
<td>412 (85.4)</td>
<td>412 (85.4)</td>
<td>403 (83.7)</td>
</tr>
<tr>
<td>Measles 1***</td>
<td>348 (72.5)</td>
<td>340 (70.5)</td>
<td>332 (69.1)</td>
</tr>
</tbody>
</table>

*Number of children due for a particular vaccine is calculated by determining the number of children who have reached the minimum recommended age in days for receiving the vaccine. The minimum recommended age is as follows: Penta1 (42 days), Penta2 (70 days), Penta3 (98 days), Measles 1 (274 days).

**For infants enrolled at BCG**

*** Denominator of children due for measles 1 till date – A-480, B-482, C-480, after excluding 3 children who passed away
Key Takeaways

1. Tracker bracelets could be used as low-cost reminders for childhood vaccines
2. Tracker bracelets provides optimum benefits to caregivers who could not read or interpret written messages
Adolescent girls’ perspectives on Human Papilloma Virus Vaccination
Background

Globally, cervical cancer is 4th most common cancer in females and the 7th most common cancer overall.

In Pakistan, cervical cancer is the 3rd most common cancer among females.

No formal program for adolescents vaccinations including HPV, in Pakistan.

Objectives

1. Assess knowledge and attitude of adolescence girls towards cervical cancer, HPV infection, and HPV vaccination.

2. Investigate adolescent girls’ perceived informational needs with regards to cervical cancer prevention and HPV vaccination.

3. Identify factors that influence HPV vaccine-related decision-making amongst adolescent girls.
Methodology

Study Design
Qualitative Exploratory

Study Site
District West, Karachi, Pakistan

Study Participants
Adolescence girls

Inclusion criteria
1. Unmarried
2. Age between 16-19 years

Study Methods
4 Focus Group Discussions (12 participants each)

Analysis
Thematic Analysis
Results

Desirable goals

Outreach

- Selection of eligible girls through household visits

Accessibility

- People don’t trust [GP clinics] for vaccine.

Safe environment

- Presence of doctors, adult family member

Ma’am it’s just a matter of trust. If [girls] trust, they will come [back].

Suggested strategies

- Vaccination at community-based camp

1. Side effects mitigation
2. Issuance of vaccine cards
3. Phone reminders

Key requisite

Trust

- We will visit their homes and tell them about [the HPV] vaccine. We will take parents in confidence and take their permission to vaccinate their children.
Key Takeaways

1. Adolescent girls are key stakeholders in designing HPV vaccination programs

2. Inclusion of adolescent girls in community-based HPV vaccination programs could improve vaccine uptake and reduce vaccine hesitancy
Sehat Savaris (Health-Cars) for Immunizations

Introducing immunization carpool services to facilitate immunization of children under 2 years

Maternal & Child Health
mch@ird.global
Background

- Low immunization rates (66%)
- >60% rural population
- Distantly located center
- Limited or no transport facilities
- Socio-cultural barriers for women to travel alone

Objectives

- To evaluate feasibility of establishing an immunization carpool model
- To assess uptake and performance of immunization cars by gauging end-user utilization and feedback
- To estimate the difference in immunization coverage after the Intervention
**Methodology**

**Feasibility Trial**

**Design**

**Shikarpur**

- **Site**
  - 4 Sub-districts
  - 4 Low coverage Immunization Clinics
  - 98 Catchment Sites

**<2 years**

**Participants**

**Interventions**

- Free transport service for mother-child pairs of children aged under 2 years
- Educational sessions for the community
Results

2,520 Round Trips
4,691 Immunization Visits
2,391 Children Transported
1,100 Educational Sessions
3,521 Session Participants

Difference in Immunization Coverage among Children Enrolled at Same Clinics

Different in Immunization Timeliness among Children Enrolled at Same Clinics
1. Immunization carpool model can be established conveniently in rural settings using local transport options.

2. The model is well accepted and utilized by female caregivers in the community.

3. Transport model can successfully improve immunization coverage and timeliness by women empowerment & reducing accessibility barriers.
Immunization Decision Support System (iDSS)

Development and Validation of DSS-Application Programing Interface (API) for automatic forecasting of age-appropriate vaccine schedule for <2 years children

Maternal & Child Health
mch@ird.global
Low Middle Income Countries (LMICs) disproportionately suffer from low immunization coverage.

- **50%** Children in Pakistan & Bangladesh do not receive timely vaccination
- **32%** Prevalence of missed opportunities for vaccination among children in LMICs

**Missed Opportunities for Immunization (MOI) created by:**

1. Lack of refresher trainings for vaccinators (Salihi et al, 2019)
2. Complex EPI schedules (Butt et al, 2020)
4. Over-burdened vaccinators (Salihi et al, 2019)

**Objectives**

1. To develop a robust iDSS for calculating age-appropriate vaccine schedule as per WHO recommended immunization schedule for <2 years children
2. To implement and validate the diagnostic accuracy of the iDSS in scheduling catch-up immunization schedules for <2 years children
3. To generate rigorous end-user feedback on the feasibility, utility and functionality of iDSS
Pakistan and Bangladesh
6 immunization Facilities
July 2019 to April 2020

Total 6,241 immunization visits recorded
Pakistan – 4,557 visits
Bangladesh – 1,684 visits

Using date of birth and past immunization history, iDSS formulates individualized schedules displayed on a color coded Interface

Comparison of iDSS outputs with gold standard (immunization expert)
Results: Comparison of Vaccine Schedule Constructed by iDDS & Vaccinator with the Gold Standard

Pakistan (n=4,557)

Bangladesh (n=1,684)

MOI that could potentially be prevented through iDDS:

- Penta1: 3%
- IPV: 34%
- Measles1: 5%
- Penta1: 1%
- IPV-2: 12%
- Measles1: 5%
- Measles2: 2%

iDDS scheduled individual immunization doses with a sensitivity of 99-100% and specificity of 98-100%
Key Takeaways

- Algorithm based on child’s vaccination history, date of birth, and timing and spacing of doses
- Color coded scheme to support low literacy vaccinators
- Search functionality to retrieve child record
- Interoperable

Embedded logic & process algorithms as per WHO schedule

Offline mode
User-friendly
Easily modifiable
Fast
eVVM 2D Barcode Scanning To Track Vaccine Vials

Piloting eVVM 2D barcodes on vaccine vials to link vials to immunized child: A digital solution for accurate management of vaccine stocks

Online Meeting with Temptime: Apr 23, 2021
Background

In Pakistan, the current vaccine stock and supply management system has severe limitations. Data reported is untimely and inaccurate, stock and storage capacity indicators are unreliable, mainly due to the reliance on vaccinator self-reporting for consumption data.

Develop: Deploy: Validate: Disseminate:

1. Develop:
   - Develop an integrated ZM EIR tool for 2D barcode vaccine vials
   - Develop and test survey tool

2. Deploy:
   - District level (1 management)
   - 12 vaccinators/ fixed site and outreach
   - Live tracking of process and bug fixes

3. Validate:
   - Quantitative and qualitative data collection
   - Data analysis

4. Disseminate:
   - Dissemination event with all key stakeholders
   - Publications in journals
Study Aim

To evaluate the feasibility and acceptance of using 2D barcodes to track vaccine vials from the district cold room/storeroom to the immunized child in selected government EPI centres in Pakistan
Primary Objectives

Evaluating the feasibility and acceptance of scanning vaccine vials with 2D barcodes in a field setting at selected Government’s EPI centres (fixed and outreach) in Sindh, Pakistan

Evaluating the hardware performance of existing android camera phones and Temptime provided add-on handheld scanners for successfully capturing bar codes on vials
Secondary Objectives

Expand the capacity of Zindagi Mehfooz Electronic Immunization Registry (ZM-EIR) to capture 2D barcode information (product identity, batch, lot, serial number and expiry date) from vaccine vials, to the immunized child to establish “vial to child” linkages.

Assess the efficiency of reading VVM data embedded within the 2D barcode on vaccine vials.
Stock Supply and Cold Chain Generating Accurate Vaccine Consumption Data And Vial-to-Child Linkage

Innovative 2D bar codes with eVVM

Automated Instant interpretation for vaccinator + EIR record linking vial-to-child
Vial to Child Link in ZM EIR

Leveraging existing digital technologies to merge supply-side barcoded vaccine vials with service-delivery-side barcoded immunization cards

Vaccine with 2D serialized barcode + eVVM

Real-time Child immunization in ZM EIR

Vial to child
Gamified Training for Vaccinators

Low-cost, High impact, Readily scalable solution for educational, interactive and engaging trainings to improve vaccinator performance and motivation
The Challenge & Objectives

- Only 2808 vaccinators providing services for an annual birth cohort of 1.7 million children in Sindh
- Lack of standardized yet personalized delivery of training and refreshers on the job
- Logistical and individual barriers to enhanced skills development
- The project aims to leverage the availability of mobile technology among vaccinators to provide an engaging, flexible and up-to-date training experience in order to boost productivity, improve performance and ultimately enhance immunization outcomes for 3.2 million children under 2 years of age
Interactive, Game-based Trainings to Boost Vaccinator Performance

Through the ZM app, 4000 vaccinators across Sindh can access digital, game based learning modules to receive on-job training, access refresher courses and learn new information.

- Story-based videos
- Multiple choice questions for each chapter
- Friendly Competition/Leaderboard
- Peer to peer communication
Methodology

1. **Formative Research**
   Conduct formative research with a sample group to test the engagement and motivation strategies of different kinds of game-based apps to inform the way forward.

2. **Content Development**
   Develop game structure, narratives, video content and assessments for training modules.

3. **Application Design**
   Design the game application with appropriately selected gamified elements.

4. **Launch & Training**
   Launch the training modules with successive groups of vaccinators across Sindh.

5. **M&E**
   Evaluate outcomes by comparing pre and post test scores and checking in-game performance.
Progress to Date

Trainings in 5/7 districts of Karachi have been completed

<table>
<thead>
<tr>
<th>S #</th>
<th>District</th>
<th>Total Target</th>
<th>Vaccinators Trained</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>1</td>
<td>Central</td>
<td>149</td>
<td>131</td>
</tr>
<tr>
<td>2</td>
<td>Korangi</td>
<td>111</td>
<td>83</td>
</tr>
<tr>
<td>3</td>
<td>East</td>
<td>133</td>
<td>111</td>
</tr>
<tr>
<td>4</td>
<td>West</td>
<td>87</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>Kemari</td>
<td>90</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>570</strong></td>
<td><strong>475</strong></td>
</tr>
</tbody>
</table>

Further data analysis is in progress
Key Takeaways

• First gamified app in Pakistan to conduct virtual trainings for vaccinators

• Can be used in the future in place of refresher trainings
Leveraging The Humanities in Healthcare Training

A Mixed Methods study for development and testing of an integrative Humanities curriculum for Lady Health Workers in Karachi, Pakistan
Background and Objectives

**BACKGROUND**

62/1,000 live births

Pakistan Under-5 Mortality (Pakistan Demographic & Health Survey, 2018)

186/100,000 live births


**PROBLEM**

Lady Health Workers (LHWs)

Inadequate training coupled with external stressors lower well-being and limit ability to provide humanistic care to ethno-religiously diverse communities

**SPECIFIC OBJECTIVES**

- Develop and refine a tailored Humanities curriculum consisting of local art and literature to enhance key character strengths among LHWs in Karachi, Pakistan
- Develop and validate a contextually-appropriate scale to measure character strengths among LHWs in Karachi, Pakistan
- Evaluate impact of curriculum intervention on character strengths among LHWs recruited from selected towns of Karachi, Pakistan, using mixed methods
Methodology

Multi-phase mixed methods design underpinned by lifecycle approach to measure increase in enthocrultral empathy, empathy towards religious minorities, purpose, compassion, and joy & self-worth.

- Limited deployment of the curriculum intervention with 48 participants from Korangi & Bin-Qasim Towns, Karachi.
- Ongoing process and formative evaluation throughout deployment.
- Administration of Character Strength scale pre- and post-intervention, and at 3 months follow-up.
- In-depth interviews with participants and their direct supervisors post-intervention.
Electronic Integrated Management of Childhood Illnesses (eIMCI)

A mixed methods evaluation of the feasibility and efficacy of implementing integrated management of childhood illnesses (IMCI) through use of mobile technology in a developing country setting
Integrated Management of Childhood Illnesses (IMCI)

Developed by WHO and its partners in 1990s to reduce childhood morbidity and mortality in lower- and middle-income countries (93/1000):

- improving case management practices of health workers (particularly in outpatient settings)
- strengthening health systems
- promoting community and family health practices
- Officially implementation began in Pakistan in 1998, but remains limited to 30% of health centres
- Pakistan child mortality 69.3/1000
The Electronic Integrated Management of Childhood (eIMCI)

Electronic version of the 2014 IMCI guidelines

- Interactive algorithms
- Automatic classification
- SMS reminders
- Electronic referrals
- Real time data monitoring and supervision
- Offline mode

Time: 8 Weeks
Location: Muzaffargarh
Quantitative: Distribution of illness among diagnosed children

<table>
<thead>
<tr>
<th>Illness</th>
<th>Baseline (n=57)</th>
<th>Endline (n=42)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>48</td>
<td>(84.2)</td>
<td>29</td>
</tr>
<tr>
<td>Measles</td>
<td>4</td>
<td>(7.0)</td>
<td>8</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>3</td>
<td>(5.3)</td>
<td>0</td>
</tr>
<tr>
<td>Malaria</td>
<td>2</td>
<td>(3.5)</td>
<td>5</td>
</tr>
</tbody>
</table>
Qualitative Results

- Caregiver perceived field Health workers (FHWs) to be more knowledgeable and proactive

- FHWs felt they had improved screening, diagnosis, and treatment skills

- FHWs expressed preference for eIMCI over paper-based tools

- Medical officers observed increased synergies between outreach and facility-based health teams
Thank you

Maternal & Child Health Program
mch@ird.global

Picture: Outreach Vaccine through Mobile Immunization Van in Sindh, Pakistan.