Artificial Intelligence for Social Good: Our Approach at Wadhwani AI

P. Anandan
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Wadhwani AI
AI FOR SOCIAL GOOD
AI, Decision and Delivery Science In Health: an Overview and World Bank Perspective

Marelize Görgens, World Bank
Key Messages

• This meeting is at the nexus of 3 things that the World Bank believes is essential to reduce extreme poverty and boost shared prosperity
  1. Disruptive Technology and Artificial Intelligence for Development
  2. Human Capital Development
  3. Universal Health Coverage

• For countries to reach towards universal health coverage, they need to focus both on WHAT to finance in health (priority setting) and HOW to implement it well (service delivery and quality)

• During the past 5 years, progress has been made with developing and using decision science tools – including some big data analytics – to improve priority setting and delivery of health and nutrition services
1. Disruptive Technology and Artificial Intelligence: The World Bank's focus

https://youtu.be/KtTuA-PLrAg
HUMAN CAPITAL ACCOUNTS FOR AN ESTIMATED 70 PERCENT OF WEALTH IN RICH COUNTRIES, BUT ONLY 41 PERCENT IN POORER COUNTRIES.
https://www.youtube.com/watch?v=wbHUYxTLWRM
3. Importance of Universal Health Coverage

- Health is a foundational investment in human capital and in economic growth—without good health, children are unable to go to school and adults are unable to go to work.

- UHC is also key to achieving the World Bank’s twin goals of ending extreme poverty and increasing equity and shared prosperity.

- Essential part of the Sustainable Development Goals:
  - **SDG 3** includes a target to “achieve universal health coverage, including financial risk protection, access to quality essential health care services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all.”
To achieve UHC, some priority setting is needed.

Core characteristics of health priority setting processes:

- How budget and program funding decisions are made.
- Whether and how prioritization is done and the extent to which evidence, data and quantitative methods are used.
- Governance for priority setting, who leads and who is involved in the process.
- Essential Medicines Lists - existence, processes and evidence used in development.
- Standard Treatment Guidelines /Program Guidelines - existence, processes and evidence used in development.
- Beyond prioritization – focus on implementation and quality of provision.
<table>
<thead>
<tr>
<th>Stage 0</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget and program funding decisions</td>
<td>History</td>
<td>History</td>
<td>Investment cases</td>
<td>Prioritisation – CEA/ECEA and mathematical models</td>
</tr>
<tr>
<td>Whether and how prioritization is done</td>
<td>No</td>
<td>No</td>
<td>Partial</td>
<td>Partial</td>
</tr>
<tr>
<td>Governance for priority setting</td>
<td>None</td>
<td>Ad hoc</td>
<td>Committee</td>
<td>Technical working Group</td>
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<tr>
<td>Essential Medicines Lists</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Standard Tx Guidelines</td>
<td>No</td>
<td>No</td>
<td>Partial</td>
<td>Yes</td>
</tr>
<tr>
<td>Beyond prioritization</td>
<td>None</td>
<td>None</td>
<td>Some</td>
<td>Partial focus on implementation and quality</td>
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</tbody>
</table>
Key Messages

This meeting is at the nexus of **3 things that the World Bank believes is essential** to reduce extreme poverty and boost shared prosperity

1. Disruptive Technology and Artificial Intelligence for Development
2. Human Capital Development
3. Universal Health Coverage

For countries to reach towards universal health coverage, they need to focus both on **WHAT to finance** in health (priority setting) and **HOW to implement it well** (service delivery and quality)

- During the past 5 years, progress has been made with **developing and using decision science tools** – including some big data analytics – to improve priority setting and delivery of health and nutrition services
  - These examples have shown that **it is possible to do more with existing resources**, and use existing data in smarter ways to improve health and nutrition
<table>
<thead>
<tr>
<th>Health Service Priority Setting</th>
<th>Improvements in Implementation and Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve TB Program Allocative Efficiency using Optima TB</td>
<td>YES</td>
</tr>
<tr>
<td>Improve HIV Program Allocative Efficiency using Optima HIV</td>
<td>YES</td>
</tr>
<tr>
<td>Improve Nutrition Program Allocative Efficiency using Optima Nutrition</td>
<td>YES</td>
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<tr>
<td>Health Services Prioritisation Tool for UHC Benefits</td>
<td>YES</td>
</tr>
<tr>
<td>Cascade Diagnostics and Optimization</td>
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</tr>
<tr>
<td>Big Data Analytics</td>
<td>YES</td>
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</tbody>
</table>
Optima HIV and Optima TB
Improving allocative efficiency using mathematical modelling

Optima is helping countries to identify the optimal mix of interventions to maximize the impact of investments ... Ensuring we deploy the right interventions in the right mixes for the right people in the right places can transform the impact of health investments and bring the goal of a science of delivery closer.”

Jim Kim, World Bank
Introduction to Mathematical Optimization:

What’s **New** and **Different**?
How does Optima work?

1. Burden of ‘disease’
   - Data synthesis
   - Epidemic modelling

2. Programmatic responses
   - Identify interventions & delivery modes

3. Objectives and constraints
   - Strategic goals
   - Ethical, logistic & economic

4. Optimization algorithm
Mathematical optimization is tricky: consider just two programs (most programs have many more than 2).

Objective function: e.g. DALYs

Apply an optimization algorithm to calculate best resource allocation.
Non-financial constraints: logistic, political, ethical

Objective function: e.g. DALYs

Funding to Program A

Funding to Program B
Which **OPTIMIZATION ALGORITHM**?

Traditional algorithms (e.g., simulated annealing) require many function evaluations—**slow**

**Optima’s algorithm:**

“**Adaptive stochastic descent**”

- **Adaptive**: learns probabilities and step sizes
- **Stochastic**: chooses next parameter to vary at random
- **Descent**: only accepts downhill steps
Comparison of algorithms: The ASD ALGORITHM PERFORMS VERY EFFICIENTLY for this class of problems.

The choice of algorithm is essential for the computing power needed: the fewer iterations until one obtains a global minimum value, the more efficient (computationally).
Countries where OPTIMA HAS BEEN APPLIED
The case of SUDAN
Sudan example, a fragile country with political and OPPOSITION TO HIV PROGRAMS for Key Populations.
How did budgets actually change?
Reallocation of HIV resources in 2015–17 budget for the HIV response

More for programs, despite lower total budgets

ART increased from 12% to 18%
Prevention for KPs increased from 7% to 29%

2015–17 budgets (annual average)
Implementation Cascade Diagnosis and Optimisation
THE SERVICE DELIVERY CASCADE

1. First, am I diagnosed if I have a health condition?
2. Second, am I linked to proper care?
3. Third, do I adhere to the needed care?
4. Fourth, do I achieve disease control?

Failure at each stage precludes a successful outcome at the next, so the cascade tumbles rapidly.
The estimated total burden of hypertension in adults aged 18 years and above in Bangladesh divisions:

- **Rangpur**: 1.8M
- **Rajshahi**: 1.7M
- **Mymensingh**: 1.2M
- **Sylhet**: 0.8M
- **Khulna**: 1.9M
- **Chittagong**: 2.5M
- **Barisal**: 0.8M
- **Dhaka**: 3.8M

About 14% of adults in Bangladesh are hypertensive, with a significant higher prevalence of hypertension in females and in urban settings.
HYPERTENSION CASCADE IN BANGLADESH (ADULTS 35+ YRS)

- Approx. 14.4 million hypertensive (of 56 million adults 35+) – 26%
- Another 15.4 million pre-hypertensive
- Hypertension burden highest in rural women
- Only 18% (2.8 million) of all hypertensives have BP control

Pre-hypertensive = 120-139 SBP or 80-89 DSP; Hypertensive 140+ SBP or 90+ DBP
Sources: BDHS 2011 and 2016 UN population estimates
HSP Tool for Improved UHC
How to prioritize health services given the limited fiscal space?
We are much better positioned to answer this question now: can complement cost effectiveness analysis approaches

A unique policy window

A complex evidence base

Benefits of optimisation analyses understood

Health Service Prioritization
Health Services Prioritization tool: From evidence base to user-friendly outputs in order to better guide resource allocation

A complex evidence base
Optima Nutrition
More Money for Nutrition and More Nutrition for the Money: Using Data to support Nutrition the efficiency of nutrition investments

Jakub Kakietek, Health Economist, World Bank
The Problem

151 MILLION* CHILDREN UNDER 5 ARE STUNTED WORLDWIDE
*As of 2017

85% live in 37 high-burden countries

*WORLD BANK GROUP*
Investments in Nutrition Build Human Capital and Boost Shared Prosperity

<table>
<thead>
<tr>
<th>SCHOOLING</th>
<th>EARNINGS</th>
<th>POVERTY</th>
<th>ECONOMY</th>
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</thead>
<tbody>
<tr>
<td>Early nutrition programs can increase school completion by one year</td>
<td>Early nutrition programs can raise adult wages by 5-50%</td>
<td>Children who escape stunting are 33% more likely to escape poverty as adults</td>
<td>Reductions in stunting can increase GDP by 4-11% in Asia &amp; Africa</td>
</tr>
</tbody>
</table>

Using Economic Analysis to Support Nutrition Programs in Client Countries:

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Analysis completed</th>
<th>Discussion Paper</th>
<th>Policy Brief</th>
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<tr>
<td>Togo</td>
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<tr>
<td>Mali</td>
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<tr>
<td>DRC</td>
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<td>✓</td>
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<td>Uganda</td>
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<td>Tanzania*</td>
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<td>Bangladesh</td>
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<td></td>
<td>✓</td>
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<tr>
<td>Afghanistan</td>
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<td>Global Investment Framework</td>
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</table>

**Analytic program in partnership with BMGF:**
- Analyses in 14 countries
- 10 stand-alone HNP discussion papers
- Multiple policy briefs and other dissemination materials
- 1 regional report for Sub-Saharan Africa
- Global Nutrition Investment Framework
Global Analytics: Global Investment Framework

Global Targets (WHA/SDGs)

- How much it will cost?
- What will we buy with this investment?
  - Nutrition
  - Health/lives saved
  - Economy
- How can it be financed?
- How can these analytics generate national political commitment? And how can we maximize the “bang for the buck”?

Benefits of Achieving Nutrition Targets in 2025

**STUNTING**
- 65 million cases of stunting prevented
- 2.8 million child deaths averted

**ANEMIA**
- 265 million cases of anemia in women prevented
- 800,000 child deaths averted

**BREASTFEEDING**
- 105 million additional babies exclusively breastfed
- 520,000 child deaths averted

**WASTING**
- 91 million children treated for severe wasting
- More than 860,000 child deaths averted

**BENEFITS OF ACHIEVING ALL FOUR TARGETS**
- 65 million cases of stunting prevented
- At least 3.7 million child deaths prevented
Investments to Meet the Global Nutrition Targets Have Enormous Economic Returns

<table>
<thead>
<tr>
<th>Condition</th>
<th>Total Economic Benefits (Billions)*</th>
<th>$1 Invested Yields</th>
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</thead>
<tbody>
<tr>
<td>Stunting</td>
<td>$417</td>
<td>$11</td>
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<tr>
<td>Breastfeeding</td>
<td>$298</td>
<td>$35</td>
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<tr>
<td>Anemia</td>
<td>$110</td>
<td>$12</td>
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<tr>
<td>Wasting</td>
<td>$25</td>
<td>$4</td>
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</table>
Using Data Analytics To Mobilize Resources for Nutrition and Improve Efficiency

Types of analyses conducted

- Estimating the costs
- Cost effectiveness analysis
- Benefit-cost analysis

Types of engagement with governments

- Development of key policy documents
- Prioritization of nutrition investments
- Advocacy for increased resources – “investment cases”

Types of resources mobilized

- IDA
- Innovative financing (GFF, PoN)
- Country budgets (DRM)
Political Commitment for Nutrition is Rising…

Spotlight on Nutrition,
Spring Meetings April 2017

“… we're focusing on nutrition; and there's really no excuses...we can make a difference for something around $10.00 per child, per year, in all of those numbers. So, the failure to act is unconscionable.” - Dr. Jim Yong Kim, World Bank President

“Stunting would be one very important issue, but you're making an investment in the future of your country.” – Sir Ratan N. Tata, Tata Trusts
THE HUMAN CAPITAL PROJECT

TRANSFORMING HUMAN CAPITAL

MORE AND BETTER INVESTMENT IN PEOPLE GLOBALLY

1. Human Capital Index: A entry point to raise the profile of the investment case for human capital

2. Measurement: A focus on evidence-based investments in human capital formation

3. Country engagement: A commitment to support Early Adopters, and ultimately all countries, to prepare national strategies to accelerate progress on human capital
The Human Capital Index indicators are linked closely to the SDGs.

**SURVIVAL**
- Under-5 mortality links to SDG target 3.2

**SCHOOL**
- Quality adjusted school years links to SDG target 4.1

**HEALTH**
- Improving adult survival rate by reducing causes of premature mortality links to SDG target 3.4
- Stunting links to SDG target 2.2
More Nutrition for the Money: Optima Nutrition

For different funding levels, how should resources be allocated across a mix of nutrition interventions and what impact is achievable?

Overall public health budget available for nutrition

Which investment combination leads to optimal outcomes?

Balanced energy protein supplementation
Iron and folic acid supplementation
Infant and young child feeding education
Vitamin A supplements
Prophylactic Zinc supplements
Treatment of severe acute malnutrition
Public food provision