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INVENTORY *of*

Disease Modeling, Health Planning, Budgeting, Costing & Resource Allocation Tools, and Health Information System Platforms

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INVENTORY OF DISEASE MODELING, HEALTH PLANNING, BUDGETING, COSTING & RESOURCE ALLOCATION TOOLS, AND HEALTH INFORMATION SYSTEM PLATFORMS

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WHY THIS INVENTORY?

This inventory was developed to:

- Help DDS team make an informed decision on whether to develop a new health planning tool to improve frontline systems and if so, the features of that tool

- Ensure compatibility with and usefulness for frontline service delivery re-design team and their planning processes

In aiding the development of a new tool, it is important to understand:

- Advantages and disadvantages of the existing data systems and health planning and resource allocation tools

- IT aspects and system architecture of existing and potential
future tools

- Commonly used software environment and what are missing

- Functionalities

- Data requirements

- Anticipated feasibility and challenges

CURRENT HEALTH PLANNING & DATA SYSTEMS TOOLS: LIMITATIONS

- Little attention to end-users in the design and rollout of the tools
- Data standards are lacking, hindering health information exchange between reporting systems and data types
- Limited interoperability between data systems
- Limited ability to link (in real time) epi data with program routine (MIS), human resources, logistics, & cost data
- Limited use of existing/ available data; lack a culture of data use for decision making, especially at the sub-national level
- Data quality issues
- Limited types of data available—operational and input data typically not available
- Planning tools are static, not updated regularly

THIS INVENTORY TARGETS FOUR MAIN TYPES OF TOOLS

1. **HIV EPIDEMIC MODELS**

2. **HEALTH PLANNING AND BUDGETING TOOLS (SIMPLE, EXCEL WORKBOOK)**

3. **HEALTH RESOURCE ALLOCATIONS AND PRIORITIZATIONS (COMPLEX SOFTWARE)**

4. **HEALTH INFORMATION SYSTEMS (HIS)**

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INVENTORY CRITERIA

- We include all modeling tools focusing on HIV program planning and allocative efficiency (AE) conducted by the **World Bank** in 2016

- We include major HIS tools from the **"Global Goods Guidebook"** published by Digital Square in 2019

- We include additional tools supported by major donors including **USAID, DFID**, the **Bill & Melinda Gates Foundation**, and **UN agencies** that are commonly used by international and local NGOs, and government implementers in LMICs or MICs and

- *Non-Open access, commercial tools are excluded*

LIST OF TOOLS

HIV EPIDEMIC MODELING	PLANING, COSTING AND DEVELOPMENT	RESOURCE ALLOCATION & PRIORITIZATION	HEALTH INFORMATION SYSTEMS (HIS)
UNAIDS Modes of Transmission	CorePlus	Spectrum Suite	OpenHIE
HIV synthesis model (STM)	Planning, Costing and Budgeting Framework (PCBF)	Resource Needs	OpenMRS
SSOPHIE (Stochastic Simulation of Outcomes of PLHIV in Europe)	MBB Toolkit	GOALS	OpenSRP
Menzies TB-HIV model	RH Costing Tool	HIPTool	OpenLMIS
Strategic Epi-ART in India Model	Optimized Treatment Costing	OneHealth Tool	iHRIS
PopART	PrEP-it	Optima Suite	CommCare
ICRC HIV Transmission Model	Gates funded SDP (Nigeria pilot)	WHO CHOICE	SOMAS
HIV-HEP	Umich's proof of concept for PHC service delivery	AIDS Epidemic Model	Reveal
Goodreau et al	PHC-CAP		DHIS-2
Gems			JembiHealth
Age-Structured Mathematical(ASM) model			

Section 1
HIV EPIDEMIC MODELS

KEY CHARACTERISTICS OF SECTION 1 TOOLS:

► Single disease: **HIV epidemic model**

► Most were developed for a narrow set of objectives or for specific studies

► Require intensive data and external assistance

► Have limited adaptability

► Have limited usage

► Not interoperable with other HIV modeling tools

► Do not provide resource allocation or optimization scenarios

UNAIDS MODES OF TRANSMISSION MODEL (MOT)

Description/ Purpose:	Identifying who is at risk of HIV infection.
Strengths:	Simple to use; simple outputs that can be used for advocacy.
Data need:	The model requires demographic, epidemiological and behavioral data.
Software:	Excel workbook
Available at:	http://www.unaids.org/en/dataanalysis/datatools/incidencebymodesoftransmission

Policy questions addressed by MOT:

- What is the predicted distribution of new HIV infections among different populations in the next year?

- Which specific populations contribute most to HIV incidence during the coming year?

- What are the populations in need of prevention efforts and resources (in terms of overall incidence and incidence within a population) in order to reduce HIV transmission and acquisition?

- What are the effects of changes in service coverage or behavior changes on the distribution of new infections?

- Among which populations should HIV screening be scaled up?

- Where are the gaps in data availability?

HIV SYNTHESIS TRANSMISSION MODEL (STM)

Description/ Purpose:	• Modeling impact of different prevention, treatment, patient management and new diagnostic interventions and technologies • It is an epidemic model but also can conduct cost-effectiveness analysis with cost data
Strengths:	STM is a sophisticated simulation model that utilizes our understanding of HIV disease progression and the effect of ART.
Reach:	Used in Malawi, Lesotho, Zimbabwe, the UK.
Software:	SAS
Available at:	http://www.ncbi.nlm.nih.gov/pubmed/17944687
Contact:	Andrew Phillips at andrew.phillips@ucl.ac.uk

Policy questions:

• What is the epidemiological consequence of a population-based approach to ART with standardized regimens and clinical decision making based on CD4 count?

• What is the cost-effectiveness of second-line drugs for ART in settings without virologic monitoring?

• What is the potential long-term impact of transmitted drug resistance on mortality in people on ART in resource limited settings?

• What is the epidemiological impact of ART, HIV testing, and condom use on HIV epidemic among MSM?

• What is the potential impact of expanding diagnosis, retention, and eligibility criteria for antiretroviral therapy initiation on future drug resistance?

SSOPHIE (STOCHASTIC SIMULATION OF OUTCOMES OF PLHIV IN EUROPE)

Description/ Purpose:	Projecting the status of HIV-infected individuals in countries throughout Europe.
Data:	Population size, HIV prevalence, natural history of HIV infection, ARV use and failure.
Strengths:	SSOPHIE is specifically designed to be applied for PLHIV populations in Europe and can characterize the HIV epidemic of specific countries in Europe.
Software:	Individual-based, stochastic model
Availability:	• Limited; contact SSOPHIE team to work directly with the countries for application • http://cordis.europa.eu/result/report/rcn/56019_en.html
Contact:	Loveleen Bansi-Matharu (l.bansi-matharu@ucl.ac.uk) Fumiyo Nakagawa (f.nakagawa@ucl.ac.uk)

MENZIES TB-HIV MODEL

Description/Purpose:	• Modeling TB/HIV, and effects of control interventions directed at these diseases • Deterministic, state-transition, dynamic compartmental model
Strengths:	Impact model but can conduct CEA with cost data.
Data and TB requirements	• Demographic, TB and HIV burden, sensitivity and specificity of treatment, mortality rate • Requires the team to work directly with the countries for application
Reach:	Used in Botswana, Lesotho, Swaziland, Namibia and South Africa
Software:	Contact the model author for more information
Available at:	http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1001347
Contact:	Nick Menzies at nickmenzies@mail.harvard.edu

Policy questions:

• What is the impact (epidemiology, disease burden, and resource utilization) of control interventions directed at TB and HIV?

• What is the potential health impact and economic consequences of implementing Xpert, the test for rapid detection of TB?

STRATEGIC EPI-ART IN INDIA MODEL

Description/ Purpose:	• Modeling epidemiological impact of ARV treatment and ARV resistance among female sex workers in India • Deterministic, population, compartmental model
Data:	Epi, behavioral population size
Software:	—
Available at:	http://journals.lww.com/aidsonline/Fulltext/2014/01001/Exploring_the_population_level_impact_of.7.aspx
Contact:	Sharmistha Mishra at sharmistha.mishra@utoronto.ca

Policy questions:

- What is the potential population-level impact of expanding ART in HIV epidemics concentrated among FSWs and clients in India?
- What is the epidemiological impact of ARV treatment and ARV resistance in India?

PopART

Description/ Purpose:	• Modeling the generalized HIV epidemics in South Africa and Zambia, the two countries where the trial HPTN 071 (PopART) took place • Dynamic deterministic, compartmental model of heterosexual transmission of HIV
Strengths:	Sophisticated model.
Data needed:	Population size, proportion of adults in the population, birth rates, HIV prevalence, ART coverage, proportion of men circumcised, rates of HIV testing, treatment and circumcision, sexual contact patterns, relative susceptibility and relative infectivity of different compartments.
Software:	The model is coded in C++ and stored on Sourceforge
Available at:	http://www.plosone.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pone.0084511&representation=PDF
Contact:	Christophe Fraser (c.fraser@imperial.ac.uk)

Policy questions:

• What are the drivers of the generalized HIV epidemics in South Africa and Zambia, the two countries where the HPTN 071/PopART trial is taking place?

• Can a combination prevention package including universal testing and treatment, as delivered in the HPTN 071/PopART trial, reduce HIV incidence?

ICRC HIV TRANSMISSION MODEL

Description/ Purpose:	• Estimating the impact of ARV-based interventions on HIV transmission • Deterministic, population, compartmental model
Strengths:	Can perform cost-effectiveness assessment.
Data needed:	Population size and distribution, HIV prevalence and incidence, ART coverage.
Reach:	Uganda, Kenya, South Africa.
Software:	Matlab
Available at:	http://www.jiasociety.org/index.php/jias/article/view/20013
Contact:	Ruanne Barnabas (rbarnaba@uw.edu) Roger Ying (rying1@uw.edu) Allen Roberts (dallenr@uw.edu)

HIV-HEP

Description/ Purpose:	• Modeling impact of ART on HIV/HCV or HIV/HBV progression and vertical or sexual transmission • HIV-HEP model was used by groups from the Social and Mathematical Epidemiology Group, LSHTM and University of Bristol to address questions about whether individuals co-infected with HIV and HCV or HBV should be prioritized for early ART • Deterministic, compartmental model
Data needed:	Behavioral data; Injection behaviors of IDU; HIV and HCV biological model parameters such as transmissibility and cofactor increase in HIV transmission probability.
Software:	—
Available at:	http://www.ncbi.nlm.nih.gov/pubmed/24468945
Contact:	Peter Vickerman (peter.vickerman@bristol.ac.uk) Natasha Martin (natasha.martin@bristol.ac.uk)

Policy questions:

• What is the impact of early antiretroviral therapy for adults co-infected with HIV and hepatitis B or C in South Africa?

• Is it cost-effective to implement interventions aimed at promoting and offering hepatitis C testing and treatment to injecting drug users?

GOODREAU et al.

Description/ Purpose:	• To evaluate HIV interventions among the HIV transmission network for MSM • It is a dynamic, stochastic, network-based model, based in exponential random graph models (ERGMs) • No costing component, but CEA can be conducted
Data needed:	Demographic and epidemiological and behavioral data; disease progress rate.
Software:	R (Package 'ergm' in the R package suite statnet)
Available at:	http://www.plosone.org/article/metrics/info%3Adoi%2F10.1371%2Fjournal.pone.0050522;jsessionid=0CEEE33BBCA6681CB0E09F10B3702EEC
Contact:	Steven M. Goodreau (goodreau@uw.edu)

Policy questions:

• What are the HIV transmission characteristics for men who have sex with men (MSM) in the U.S. and Peru by sexual behaviors?

• What are the roles of acute infection and concurrent partnerships in HIV transmission dynamics among young adults?

GEMS

Description/ Purpose:	• Simulating cohorts of patients and estimate the impact of different interventions on disease outcomes.
	• Stochastic, individual-based cohort model. The model allows for simulating multistate models with general hazard functions. It also calculates transition probabilities and cumulative incidences.
Strengths:	Gems can incorporate complex and detailed transition rules between health states.
Data needed:	Demographic and epidemiological data; population size, time to immunological and biological failure and death, HIV-related mortality.
Reach:	Malawi, Zambia, South Africa, Switzerland.
Software:	R (Package 'gems')
Available at:	http://cran.r-project.org/web/packages/gems/gems.pdf
Contact:	Olivia Keiser (olivia.keiser@ispm.unibe.ch)
	Nello Blaser (nello.blaser@ispm.unibe.ch)

Policy questions:

- What is the impact of monitoring HIV patients prior to treatment in resource-poor settings?
- What is the impact of viral load monitoring of ART, on cohort viral load and HIV transmission in Southern Africa?
- When should HIV/Hepatitis C co-infected patients start therapy against hepatitis C?

AGE-STRUCTURED MATHEMATICAL (ASM) MODEL

Description/ Purpose:	• Assessing impact of VMMC through epidemiological, health economics, program efficiency, and policy measures, and determine how sub-population prioritization can increase program efficiency and impact of the VMMC programs in sub-Saharan Africa • Is a disease impact model with simple costing component • Deterministic compartmental mathematical model
Strengths:	The model describes the heterosexual transmission of HIV in a given population by stratifying the population into compartments.
Data needed:	Demographic, behavioral, epidemiological data; population size.
Reach:	Zambia, Zimbabwe.
Software:	MATLAB®
Available at:	http://www.ncbi.nlm.nih.gov/pubmed/24468945
Contact:	Laith J. Abu-Raddad (lja2002@qatar-med.cornell.edu)

Policy questions:

- What is the impact of VMMC as an HIV intervention at the population level?
- Which VMMC policy scenario will optimize impact on HIV epidemic whilst minimizing costs?
- How will VMMC intervention epidemiologically interact with existing HIV interventions?

SUMMARY OF TOOLS

1. HIV EPIDEMIC MODELS

Tool	Purpose	Data need	Outputs	Global reach	Developer
UNAIDS Modes of Transmission	Identifying who is at risk of HIV infection	The model requires demographic, epidemiological and behavioral data	New infections by population groups in a single year	Widely used globally before 2015	UNAIDS http://www.unaids.org/en/dataanalysis/ datatools/incidencebymodesoftransmission/
HIV synthesis model (STM)	Modeling impact of different prevention, treatment, patient management and new diagnostic interventions and technologies	Intensive; model is not easy to adapt	Estimate of disease burden, drug failure	Limited: Malawi, Lesotho, Zimbabwe, the UK	UCL http://www.ncbi.nlm.nih.gov/pubmed/17944687 Contact Andrew Phillips at andrew.phillips@ucl.ac.uk
SSOPHIE (Stochastic Simulation of Outcomes of PLHIV in Europe)	Projecting the status of HIV-infected individuals in countries throughout Europe	Population size, HIV prevalence, natural history of HIV infection, ARV use and failure	Diagnosis, treatment usage, resistance, pregnancy, and rates of AIDS and death.	EU	UCL http://cordis.europa.eu/result/report/rcn/56019_en.htm Loveleen Bansi-Matharu (l.bansi-matharu@ucl.ac.uk)/ Fumiyo Nakagawa (f.nakagawa@ucl.ac.uk) l
Menzies TB-HIV model	Modeling TB/HIV, and effects of control interventions directed at these diseases.	Demographic, TB and HIV burden, sensitivity and specificity of treatment, mortality rate	TB and HIV cascade figures	Botswana, Lesotho, Swaziland, Namibia, South Africa	Harvard University http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2F journal.pmed.1001347 Contact: Nick Menzies at nickmenzies@mail.harvard.edu
Strategic Epi-ART in India Model	Modeling epidemiological impact of ARV treatment and ARV resistance among female sex workers in India	Epi, behavioral population size	HIV infections and deaths corresponding to ART coverage	Limited; India	Imperial College London http://journals.lww.com/aidsonline/Fulltext/2014/01001/Explorin g_the_population_level_impact_of.7.aspx Contact: Sharmistha Mishra at sharmistha.mishra@utoronto.ca
PopART	Modeling the generalized HIV epidemics in South Africa and Zambia	Demographic, epi, behavioral, HIV testing and treatment	HIV burden, new infections and deaths following different interventions; drivers of the epidemic	Limited; developed for PopART study in South Africa and Zambia	Imperial College London http://www.plosone.org/article/fetchObject.action?uri=info%3Ad oi%2F10.1371%2Fjournal.pone.0084511&representation=PDF Contact: Christophe Fraser (c.fraser@imperial.ac.uk)
ICRC HIV Transmission Model	Estimating the impact of ARV-based interventions on HIV transmission	Population size and distribution, HIV prevalence and incidence, ART coverage	New HIV infections following an intervention (s)	Uganda, Kenya, South Africa	University of Washington International Clinical Research Center http://www.jiasociety.org/index.php/jias/article/view/20013 Contact: Ruanne Barnabas (rbarnaba@uw.edu)
HIV-HEP	Modeling impact of ART on HIV/HCV or HIV/HBV progression and vertical or sexual transmission	Behavioral data; HIV and HCV epi data; transmissibility	HIV, HCV infections and progression	Limited, not easy to use	LSHTM and University of Bristol http://www.ncbi.nlm.nih.gov/pubmed/24468945 Contact: Peter Vickerman (peter.vickerman@bristol.ac.uk)

SUMMARY OF TOOLS

1. HIV EPIDEMIC MODELS

Tool	Purpose	Data need	Outputs	Global reach	Developer
Goodreau et al	To evaluate HIV interventions among the HIV transmission network for MSM	Demographic and epidemiological and behavioral data; disease progress rate	HIV infections and transmission characteristics among MSM (network based)	Limited; not easy to use	University of Washington http://www.plosone.org/article/metrics/info%3Adoi%2F10.1371%2Fjournal.pone.0050522;jsessionid=0CEEE33BBCA6681CB0E09F10B3702EEC Contact: Steven M. Goodreau (goodreau@uw.edu
Gems	Simulating cohorts of patients and estimate the impact of different interventions on disease outcomes	Demographic and epidemiological data; population size, time to immunological and biological failure and death, HIV-related mortality	HIV outcomes by interventions	Malawi, Zambia, SA, Switzerland	University of Bern, Switzerland http://cran.r-project.org/web/packages/gems/gems.pdf
Age-Structured Mathematical (ASM) model	Assessing impact of VMMC programs in sub-Saharan Africa	Demographic, behavioral, epidemiological data; population size	HIV infections under different intervention scenarios	Zambia, Zimbabwe	Cornell University For more information, contact: Laith J. Abu-Raddad (lja2002@qatar-med.cornell.edu)

Section 2
PLANNING, COSTING AND BUDGETING TOOLS

KEY CHARACTERISTICS OF SECTION 2 TOOLS:

► Simple, open access tools—largely Excel workbook

► Not interoperable

► Most can aid in the health planning & budgeting for a single health intervention

► A few can aid in the health planning & budgeting for multiple health interventions (e.g., the Nigeria SDP)

► Can aid in the health decision making process based on scenario comparisons

► Require manual data collection and data entry

► Require manual data update

► Simple built-in analytics (no AI, no advance technologies)

► Do not project health impacts based on disease progression

► Do not provide resource optimization

MARGINAL BUDGETING FOR BOTTLENECKS TOOLKIT (MBB)

Description/ Purpose:	• Identify bottlenecks and model impact of reducing them to increase coverage of interventions • Child and adult immunizations; child health interventions; family planning; HIV/AIDS; Malaria prevention and treatment; maternal health; TB prevention and treatment • Can facilitate a process of budgeting for government health expenditures to provide a basis for equity focused policy dialogue and planning
Strengths:	Excel workbook; simple to use
Data requirements:	Population, epi, program coverage and cost
Reach:	26 countries
Available at:	http://www.aidstar-one.com/focus_areas/ treatment/ART_costing_cross_walk/marginal_budge ting_bottlenecks_mbb_toolkit

Policy questions:

• Which high impact interventions can be integrated into existing providers/service delivery arrangements to accelerate progress towards the health goal?

• What are the major hurdles or "bottlenecks" hampering the delivery of health services, and what is the potential for their improvement?

• How much money is needed for the expected health results?

• How much can be achieved in health outcomes such as reduction in incidence by removing the bottlenecks?

CORE Plus

Description/ Purpose:	• Estimate the cost of individual services within integrated service facilities as well as the total cost of the facilities, and can model the financial impact of changing numbers of services, resources, and fee levels.
	• Integrated primary health care services; Includes TB, malaria, MNCH and NCDs where provided.
Strengths:	• Very easy to model different scenarios, several of which are built-in
	• Easily adapted
Data requirements:	Population distribution, catchment population served by facility, intervention data, service needs, staff and program
Reach:	South Africa, Rwanda, Zimbabwe.
Software:	Excel
Available at:	http://erc.msh.org/toolkit/Tool.cfm?lang=1&TID=113&CID=3/

Policy questions:

• What is the cost of different service delivery models for HIV interventions, such as community-based or facility-based?

PLANNING, COSTING AND BUDGETING FRAMEWORK (PCBF)

Description/ Purpose:
- Originally developed for HIV/AIDS planning but can be used for any health interventions
- Generic template for setting out time-bound measurable goals and objectives
- Structured and logical process of developing a plan, costing and budget
- Assumes user has pre-formulated strategic plan with chosen target coverage, timeframe and/or health outcome

Strengths:
- Clear links; shows elements of a plan and costs as well as budget on one spreadsheet
- Simple to understand

Software: Excel

Available at: http://www.msh.org/resources/planning-costing-and-budgeting-framework

Policy questions:

- What are the activities and resources required for attaining the health goals and objectives?
- What are the related quantities and costs of activities linked to the goals and objectives?
- How much funding is required for the plan and what is the funding gap?

OPTIMIZED TREATMENT COSTING (OTC)

Description/ Purpose:	• Calculate total and unit costs of different optimized treatment scenarios for antiretroviral therapy (ART). When national level data are entered • Can help policymakers undertaking overall national strategic planning • It is an excel based, user-friendly tool where cost data from ongoing studies and/or expenditure data can be used to build, compare and conduct analyses
Strengths:	User-friendly; where cost data from ongoing studies and/or expenditure data can be used to build, compare and conduct analyses
Data requirements:	Limited
Software:	Excel
Reach:	26 countries
Available at:	https://avenirhealth.org/download/software/National%20Optimized%20Treatment%20Costing%20Tool%20user's%20guide%207.17.17.pdf

Policy questions:

• Where will cost savings occur when treatment scenarios are changed?

• Which optimized treatment scenario provides the greatest cost savings?

• What is the total projected cost for different treatment scenarios annually for the next five years, by patient type (with sub-totals for key components)?

• What is the overall unit cost by patient type for different treatment scenarios?

PrEP IMPLEMENTATION PLANNING, MONITORING AND EVALUATION TOOL (PrEP-it)

Description/ Purpose:

- Assesses sites' service delivery capacity and identifies site-level bottlenecks for oral PrEP delivery
- Monitors program by tracking monthly PrEP initiation and continuation rates
- Helps with national or subnational target-setting, allowing users to generate and analyze numerical targets based on population-based coverage or service delivery capacity
- Forecasts drug supply needs based on targets or program implementation
- Estimates program costs based on targets or program implementation
- Examines a program's projected impact (number of HIV infections averted) based on targets or past delivery

Software: Excel

Available at: www.prepwatch.org/resource/prep-it

OTHER COSTING TOOLS DEVELOPED BY MSH

COMMUNITY HEALTH PLANNING AND COSTING TOOL

Description/ Purpose: Developed with UNICEF to cost packages of community health services and produce results to help evaluate performance, plan future services, and prepare investment cases

INTEGRATED COMMUNITY CASE MANAGEMENT (ICCM) COSTING AND FINANCING TOOL

Description/ Purpose: Estimates the cost of introducing or scaling up community case management services for childhood malaria, diarrhea, and pneumonia. Results are used to inform decisions on the implementation and scale-up of iCCM activitie

TB SERVICES COSTING TOOL | THE MDR-TB COST-EFFECTIVENESS ANALYSIS TOOL | TB ECONOMIC BURDEN ANALYSIS TOOL

Description/ Purpose: Assist governments and NGOs develop service delivery and financing strategies and advocate for funding

PRIMARY HEALTH CARE COSTING, ANALYSIS, AND PLANNING (PHC-CAP) TOOL

Description/ Purpose: *Under development* and funded by the Gates Foundation. This open-source tool will be available as a public good and will allow users to estimate the cost of current and required resources for primary health care services and systems at the community, facility, and district levels.

Available at: https://msh.org/our-expertise/strengthening-health-systems/financing-health-services/costing-of-health-services

REPRODUCTIVE HEALTH (RH) COSTING TOOL

Description/ Purpose:	• Estimate cost to scale up a package of reproductive health services from current to universal levels. Can also be used to cost required health system improvements • HIV/AIDS prevention and treatment, family planning, newborn health interventions. Condom promotion for commercial sex workers, MSM, and other vulnerable populations. First and second line ARVs, PMTCT, VCT, PEP • Calculates total cost and number of cases to obtain cost per case • Key features of the tool is the incorporation of population dynamics (e.g., impact family planning on demand for maternal and child health services) • Does not incorporate budget & financing, effectiveness, health outcome, health production function, or unit cost
Strengths:	Simple to use
Data requirements:	Four Excel workbooks, three of which require data entry; cost data from ongoing studies and/or expenditure data can be used to build, compare and conduct analyses
Software:	Excel
Reach:	14 countries
Available at:	http://www.who.int/pmnch/topics/economics/ costing_tools/en/index15.html

PHC SERVICE DELIVERY PLANS (SDP)
MODEL OPTIONS FOR KADUNA STATE, NIGERIA

Description/ Purpose:	• Cost an entire primary SDP plan or plans • To develop a plan to improve primary health care service delivery • To develop a roadmap and implementation plan that considers the sequencing, prioritization, and tradeoffs of developing an affordable PHC delivery model for the short and medium term • Provides an engine for costing the entire primary healthcare system *(of Kaduna State in example)* • Provides a bottom up costing of human resources (personnel cost), facility, operation, supply chain, drugs & commodities, governance, outreach, and referrals • Depending on different service delivery plans (SDP), a corresponding cost will be produced—used to inform decision making process • Can be adapted from district to district; state to state • Does not predict health impact; is not a resource allocation tool
Strengths:	User-friendly; where cost data from ongoing studies and/or expenditure data can be used to build, compare and conduct analyses.
Data requirements:	Compresence costing data collection.
Software:	Excel
Reach:	26 countries.
Available at:	https://avenirhealth.org/download/software/National%20Optimized%20Treatment%20Costing%20Tool%20user's%20guide%207.17.17.pdf

The current primary health care system comprises of ~1000 operational facilities, staffed with ~5400 health workers

Driver	Description of status quo across drivers
Facilities	• 1,074 total facilities of which only 996 are operational[1] (248 Centres (23%) , 641 Clinics (60%), and 107 Posts (10%) • Facility type is based on SPHCDA categorisation, highly variable • 255 Centres prioritized but well below MSP standards, e.g., for HRH ~96% of centers have fewer nurses/midwives than the required 4/Centre under MSP
HRH	• 5,398 personnel with 3,852 (71%) technical[2] staff and 1,546 (29%) non-technical staff • 0 medical officers (MO) in the entire PHC system; aspiration to have 1 MO/LGA • 41% of 3,852 technical staff are CHEWs and ~12% are nurses
Services	• Kaduna lags behind in 5 out of 13 national coverage indicators • Service availability varies widely among facility types • Limited provision of more specialized care (i.e., emergency obstetric service) • Poor quality: 34% diagnostic accuracy and 26% adherence to clinical guidelines • Limited availability of life saving commodities
Delivery channel	**Outreach** • HRH aspire to conduct at least 1 outreach visit per month; in addition to 1 routine immunization (RI) outreach/week • Limited funding for facilities to carry out outreach programmes in the State • Little to no monitoring of outreach visits being carried out **Community** • Vertical programs by partners with minimal State oversight or Partner alignment • Disparities in stipends and engagement of community volunteers • Limited engagement, monitoring and supervision of village development committees and ward development committees • CORPS have been trained and provided with kits, work has commenced in select LGAs

1 Operational facilities have clinical staff (e.g., nurses/midwives, CHOs, CHEWS, JCHEWS).

2 Technical HRH includes: medical officers, nurses/midwives, CHOs, CHEWS, JCHEWS, EHOs, pharmacy tech, laboratory staff.

Kaduna State

The cost of the baseline system is estimated at ~₦6bn ($19.6m) per annum, or ~₦760 per capita ($2.40)

Kaduna State annual PHC system costs-baseline, ₦ mn

Category	Value
Total PHC	**6,282**
HRH	**5,162**
Operations incl. outreach	388
Governance	411
Drugs and commodities	251
Supply chain	70

Assumptions

- **5,398 HRH staff** employed in the system, applies basic salaries of each cadre, e.g., ₦1mn average annual salary of CHEWs & Nurses

- Cost of running **996 operational facilities** (out of ~1,074 facilities)-
- Estimated monthly cost of maintenance, utilities & equipment at **₦50,000/Centre, ₦25,000/Clinic**, and **₦5,000/Post**
- Facility mix of **248 Centres**, **641 Clinics**, **107 posts** based on State categorization

- **~75% attributed to SPHCDA** (including staff and overhead)
- **Performance management costs** (e.g., ISS, DQA[1], community meetings)

- **Cost of drugs and commodities** purchased for PHC facilities by SPHCDA, DMSMA, and KADSACA (including FP, FMCH, Malaria, HIV)
- Assumes 70% of drugs bought are for PHC facilities[2]

- **Cost of storage and transport** for supply chain
- Assumes cost of labour for is within HRH and staff governance costs

1   Integrated supportive supervision (ISS) and data quality assurance (DQA)
2   Based on 2015 UNICEF Costing Model estimating total cost of ~₦11.0 (at exchange rate of ₦320:$1)

Outreach will be conducted four times each month from all facilities in order to fulfill the RI MOU requirement

	SDP 1 PIN staffing	SDP 2 MSP Centres, 50% MSP staffing in Clinics	SDP 3 MSP staffing in Centres and Clinics
Outreach visits/month	4	4	4
HRH[1]	• JCHEW • CHEWs • CHOs • Nurses/midwives	• JCHEW • CHEWs • CHOs • Nurses/midwives	• JCHEW • CHEWs • CHOs • Nurses/midwives
Services	• Standard MSP outreach services	• Standard MSP outreach services	• Standard MSP outreach services
Annual cost[2] (₦mn)	31.1 / 27.6 — 58.8	31.1 / 41.5 — 72.6	31.1 / 41.5 — 72.6
Service access (%)	69%	76%	76%

Clinics ▮ Centres

- Includes **cost of transportation for staff,** excludes cost of drugs and commodities
- **4 outreaches/month from all facilities**
  - **SDP 1 Centres – 2 integrated** outreach visits/month with **3 HRH[1]** and **2 RI- only** sessions/month with **1 HRH[1]**
  - **SDP 2 and SDP 3 Centres**—4 integrated outreach visits/month with **3 HRH[1]**
  - **Clinics—4 RI-only** sessions/month with **1 HRH[1]** across all model options

1 HRH for integrated outreach include 2 clinical staff (Nurse, CHO, CHEW, JCHEW) and one records officer; for RI-only sessions one staff member administers immunization and records data

2 Cost of transportation for 3 clinical staff providing outreach visits from Centres only; ₦1000 provided to each staff for every outreach visit

Source: Kaduna State SPCDA Workshop, Mar 2017, Kaduna State MOU RI Workplan

The State will need to make clear trade-offs depending on the chosen modelers

Driver	Trade-off (vs. MSP)	Baseline	SDP 1	SDP 2	SPD 3	MSP
Facilities	**Fewer facilities at a lower cost** to the PHC system, but with **less people within 5km proximity** to a physical facility	☑	☑	☑	☑	☒
HRH	**Implement task-shifting policy as an interim solution by training CHEWS** to provide more complex services, instead of hiring more nurses and CHOs	☑	☑	☑	☒	☒
Services	**Prioritise services for vulnerable population** (e.g., core RMNCH[1]) over cost of providing for the full population	☑	☑	☑	☑	☒
Delivery channel	Outreach **Less frequent outreach visits** driven from Centres only, but at a higher quality with a wider range of services	☑	☑	☑	☑	☒
	Community **Utilise village health workers (VHW), instead of clinical HRH**, to provide health promotion and preventative services in community	☒	☑	☑	☑	☑

1   ANC & PNC (including PMTCT, TB, and malaria), Labour & Delivery, Immunisation, IMCI, IYCF, and Family Planning
2   CORPS: community resource persons

A phased approach over 5 years is proposed, starting with the development of 255 Centres and standardisation of priority services

Jan 2018–Dec 2018

PHASE 1
Prioritise development of 255 Centres

Jan 2019–Dec 2019

PHASE 2
Expand tranformation

Jan 2020–Dec 2020

PHASE 3
Realise transformation, achieving SDP 1

PHASE 4
Deepen transformation, achieving SDP 2

PHASE 5
Realise full transformation, achieving SDP 3

DRIVERS

- **Achieve 255 priority focal Centres**
- **Standardise services** across established facilities, **prioritising core RMNCH**[2]
- **Pilot integrated outreach** model across 50 wards
- **Revitalise WDC** across communities in 100 wards

- **Establish and staff 33 additional Centres and 255 Clinics**
- **Redistribute HRH** in posts across Centres and Clinic
- **Deprioritise**[1] 72 Posts
- **Standardise services** across established facilities, **prioritising core RMNCH**[2]
- **Conduct integrated outreach** and **pilot community services** from established facilities
- **Revitalise 155 WDCs**

- **Establish and staff remaining 393 Clinics**
- **Standardise services** across established centres, with equal priority
- **Expand community services** across established Clinics

- **Staff all clinics to 50% MSP standard and Centres to full MSP standard**

- **Staff all clinics to 100% MSP standard**

1   Distribute existing HRH across other facilities;
2   ANC & PNC (including PMTCT, TB, and malaria), Labour & Delivery, Immunisation, IMCI, IYCF, and Family Planning

Source: Kaduna State Core Team, Team analysis

ENABLERS

- **Obtain required approvals and buy-in of SDP** from key stakeholders e.g., Executive Governor, Commissioner of Budget & Planning, community
- **Draft budget for SDP** and develop plan to secure funding required for the 4 year implementation plan
- **Establish Steering Committee** responsible for SDP delivery
- Complete full transition of all PHC related responsibilities to SPHCDA
- **Develop M&E Plan**

- Conduct monthly PHC SDP committee governance meetings
- Conduct monthly data & performance
- Conduct quarterly meetings with revitalized WDCs
- Provide SDP updates at quarterly Partner Forum
- Roll-out new SCM across established facility
- Conduct training for HRH and volunteer workers

PROOF OF CONCEPT FOR PHC SERVICE DELIVERY: ROUTINE IMMUNIZATION

Description/ Purpose:	• Somewhat similar to the SDP model but focus on a narrowed set of intervention (e.g., Immunization) • Target clinical service delivery
Strengths:	User-friendly; where cost data from ongoing studies and/or expenditure data can be used to build, compare and conduct analyses
Data requirements:	Extensive; may require new data collection
Software:	Excel

Policy questions:

- How will program implementation be affected if healthcare workers get sick from COVID-19?
- How can we best adapt a clinic-based program to changes in patient demand?
- How will a new technology or procedure affect healthcare workers' day-to-day activities in a clinic?
- How can we reduce waste in service delivery activities to free up resources for COVID-19 response?

Scenarios could include:

- **Changing number or type of worker**s (different capacity, skills, cost)
- **Changing number of patients**, and/or their arrival patterns
- **New procedures** such as COVID-19 safety precautions or Lean process interventions
- **New technologies** such as information systems or new product presentations

Example Scenario 1
Greater patient spacing inside clinic

Example Scenario 2
Fewer nurses available due to COVID-19

Example Scenario 3
Fewer nurses available due to COVID-19

Model structure: The POC model was developed in Microsoft Excel using Visual Basic for Applications.

Analysis setup worksheet

- Patient arrival inputs
- Processes to include
- Interruption event inputs
- Values for sensitivity analysis

Baseline process worksheet

- **Inputs:** immunization session characteristics, cost, quality
- **Outputs:** efficiency and quality metrics

Input worksheets for service time, cost, & quality

Intervention process worksheet

Same structure as baseline process

Patient Simulation Worksheets

Compiled scenarios worksheet

One row per scenario, where a scenario is a unique combination of (non-random) input values

Dashboard worksheet

Key statistics for the baseline and intervention processes in one or more scenarios

Model structure: The POC model was developed in Microsoft Excel using Visual Basic for Applications.

1. Define a baseline process

The **baseline process** represents the health facility service or function being analyzed

- Usually one specific part of the facility's overall set of services, e.g., "Routine Immunization"
- Typically composed of a series of sequential steps or activities

Several types of **data inputs** are needed for the baseline process:

- Time to complete each step
- Number of staff available
- Costs of equipment, consumables, and labor
- Quality data, e.g., probability of certain negative outcomes*

2. Define interventions to test

Interventions represent specific changes that affect some aspect of the baseline process, such as:

- **New technologies** that affect service delivery
- **New medical procedures** or methods that change specific steps in a process
- **New administrative tasks** that change the time to complete specific steps

Interventions require the same data inputs as the baseline process – **users define how the baseline process changes as a result of the intervention**

3. Run the model

The model simulates how processes would unfold in a real-world health clinic environment:

- Patients can arrive at random times
- If health workers are busy with another task, a patient must wait until the worker is free
- A process step can take longer for some patients to complete than others, mirroring real-world differences

4. Interpret results

As the simulation is running, the model tracks various output metrics:

- **Facility performance** e.g., number of patients treated per hour
- **Worker time**, e.g., average time spent on patient care
- **Patient experience** metrics like wait time or total time in clinic
- **Bottleneck analysis,** e.g., steps that have the longest average wait time

* The "Quality" component of the model is currently aspirational due to a lack of data on how interventions might affect vaccination safety and efficacy.

The POC model estimates a variety of efficiency metrics…

KEY POC MODEL OUTPUTS

Cost
- Total cost per patient treated
- Breakdown of cost components (e.g., labor)

Time
- Overall process duration
- Average patient time in system (processing time)
- Idle vs. active time for workers and patients

Flow
- Overall patients treated per hour
- Process bottleneck (step with longest wait time)

Equity
- Distribution of wait times across patients – do some patients wait/stay longer than others?

2. COSTING AND BUDGETING TOOLS

Tool	Disease	Purpose	Functionality				Data needs	Outputs	Developers
			Costing/ budgeting	Disease/Health impact projections	Resource allocation	Optimization			
Optimized Treatment Costing Tool	Single/ ART	Designed to calculate total and unit costs of different optimized treatment scenarios for antiretroviral therapy (ART). When national level data are entered, the tool can help policymakers undertaking overall national strategic planning.	Yes	No	Yes	No	Local Limited	Cost estimate Cost comparisons of different service delivery scenarios	Avenir Health
PrEP-it	Single/ PrEP	Helps with national or subnational target-setting, allowing users to generate and analyze numerical targets based on population-based coverage or service delivery capacity	Yes	No	Yes	No	Local Limited	Cost estimate Cost projections based on coverage	PrEP Watch/ USAID funded
MBB	Multiple	Identifies bottlenecks and model impact of reducing them to increase coverage of interventions	Yes	No	Yes	No	Local Limited	Cost estimate Cost projections based on coverage	
CorePlus	Single/ Multiple	Estimates the cost of individual services within integrated service facilities as well as the total cost of the facilities.	Yes	No	Yes	No	Local Limited	Cost estimate Cost projections based on coverage	MSH
PCBF	Single/ Multiple	Estimates budget based on goals/ targets	Yes	No	No	No	Limited	Cost estimate	MSH
RH Costing Tool	Multiple	Estimates cost to scale up a package of reproductive health services	Yes	No	No	No	Limited	Cost estimate	WHO
PHC Service Delivery Plans (SDP)	Multiple	Aims to estimate cost of a PHC plan [human resources (personnel cost), facility, operation, supply chain, drugs & commodities, governance, outreach, and referrals]	Yes	No	Yes	No	Local Intensive	Cost estimate Cost projections based on different PHC plan	Nigeria Government/ Gates funded Tool being developed
U of Michigan's Electronic Laboratory	Single or multiple	Estimate efficiency matrix based on different service delivery scenarios	Yes	No	Yes	No	Local Limited	Cost, time (changes in procedures, process, technology), # of patients treated per hr, etc.	University of Michigan Gates funded Tool being developed
PHC- CAP Tool	Multiple	Costs a package of PHC based on local context at district level	Yes	No	Maybe	No	Local Intensive	Cost estimates	MSH Gates funded Tool being developed

Section 3
HEALTH SECTOR-WIDE PLANNING & RESOURCE ALLOCATION TOOLS

KEY CHARACTERISTICS OF SECTION 3 TOOLS:

- Open-access, cloud-based software and modeling platform
- Can aid in the health planning & budgeting for single health intervention or multiple health interventions; however, many are HIV /AIDS focused
- Most can project health impacts or disease progression
- Some can provide resource optimization (HIPTool, Optima)
- Can aid in the health decision making process based on scenario comparisons
- Data can be pre-loaded but most require local data entry (manually)
- Data not being updated frequent enough
- Data requirement: often substantial (demographic, epidemiological, program coverage, effectiveness, cost)
- Often require external TA to perform analysis
- Most can project health impacts based on disease progression
- Limited interoperability ability

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SPECTRUM SUITE

Description/ Purpose:	• Software suite that can make projections about the health impact as well as support decisions about resource allocations • Best suited for making decision on what interventions to be included in a package of interventions for a single-disease program • Applications: HIV, TB, Malaria, STIs, child heath, FP, NCD
Strengths:	Excel workbook; simple to use
Data requirements:	Some data are pre-loaded, but overall data requirement is substantial
Reach:	Considerable, global
Available at:	http://www.avenirhealth.org/software-spectrum.php

Key impact models:

- **The AIDS Impact Model (AIM)** projects the consequences of the HIV epidemic.
- **The Goals Model** shows how the amount and allocation of funding is related to the achievement of national goals, such as reduction of HIV prevalence and expansion of care.
- **The Resource Needs Model** estimates the costs of implementing an HIV program, including costs for care and treatment, prevention programs, and policy and program support.
- **TIME: TB Impact Model and Estimates** – Epidemiological and cost-effectiveness analysis of TB control strategies

Modules included in Spectrum and applications

DemProj	Demography
FamPlan	Family Planning
LiST	Lives Saved Tool (Child Survival)
AIM	AIDS Impact Model
Goals	Cost and impact of HIV Intervention
Resource Needs Module	Costs of implementing an HIV/AIDS program
RAPID	Resources for the Awareness of Population Impacts on Development
TIME	TB Impact Model and Estimates – Epidemiological and cost-effectiveness analysis of TB control strategies
Malaria	Impact of malaria interventions
STI	Estimation of burden and trends in Sexually Transmitted Infections
NCD	Non-communicable diseases and mental health, substance abuse, and neurological disorders

Description/ Purpose:

- Is an HIV costing module within the Spectrum suite
- RNM calculates the total resources needed for prevention, care, and orphan and vulnerable children support for HIV/AIDS on a national level. RNM is linked to other HIV impact modules such as AIM and Goals to model HIV interventions
- The RNM also includes TB prevention and treatment
- RNM is linked with GOALs. These two together support strategic planning by linking cost and impact of HIV Intervention

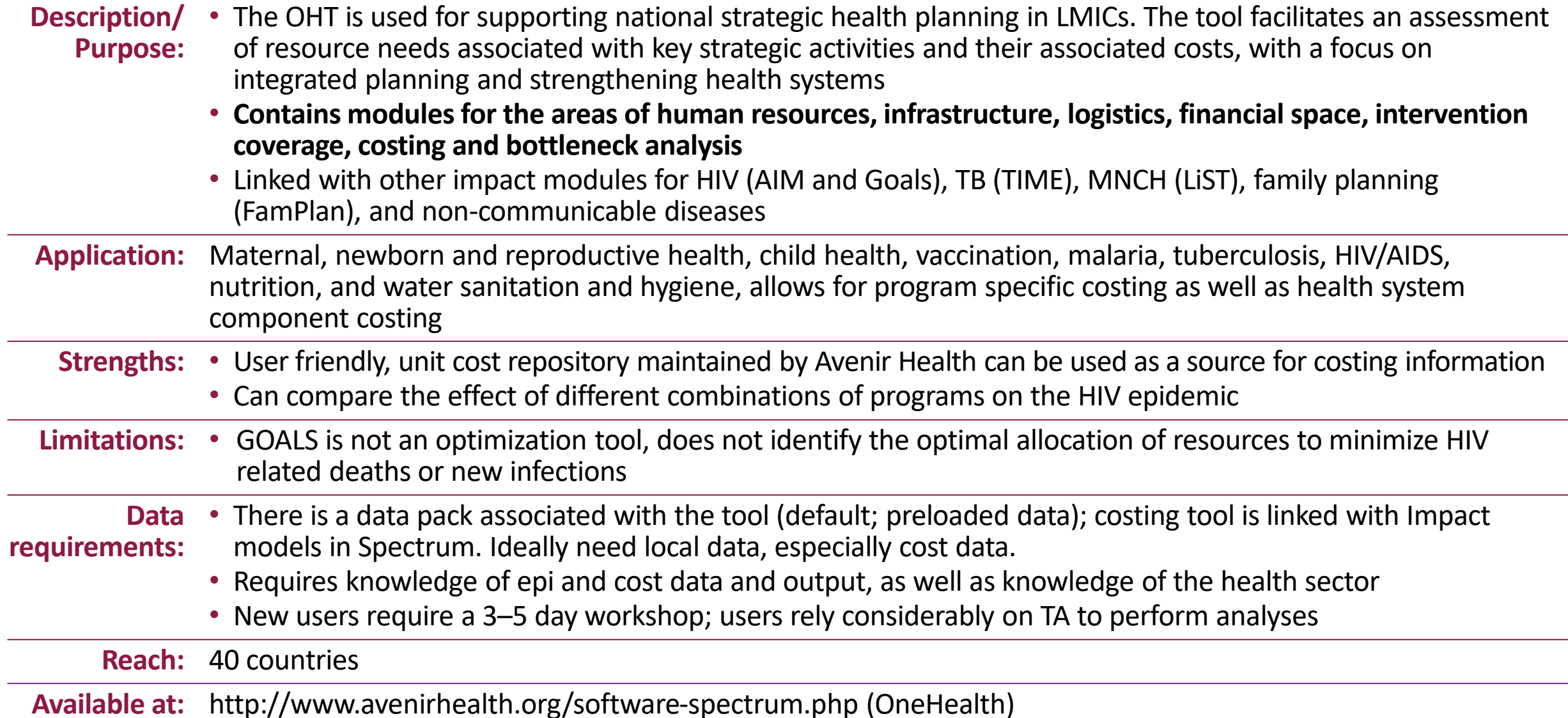|	
Description/ Purpose:	• Is built and linked with Spectrum, OneHealth and RNM • Goals includes a compartmental deterministic model whose core is the transmission of the virus among discordant partnerships. HIV transmission depends on the individual characteristics (behavioral and biological) of the susceptible individual and the population characteristics of the infected partner • It is used to estimate and compare the financial resources required to achieve program targets for HIV prevention, treatment & care, and mitigatio • Program areas cover condom promotion and distribution, STI treatment, VCT, PMTCT, blood safety, ART, OI prophylaxis, interventions targeting high risk groups, support to PLWHA, Male circumcision, behavior change programs, PrEP, vaccines
Strengths:	• User friendly, unit cost repository maintained by Avenir Health can be used as a source for costing information • Can compare the effect of different combinations of programs on the HIV epidemic
Data requirements:	Requires population size, behavioral data, HIV and STI prevalence, number of partners per year, number of sex acts per partner per year and condom use in each population group; including behavioral data, data regarding intervention coverage and unit cost data for programs such ART, PMTCT, community mobilization, mass media, counseling and testing, condom promotion, FSW, MSM and PWID outreach, blood safety and STI treatment.
Reach:	Considerable, global
Available at:	http://www.avenirhealth.org/software-spectrum.php

ONE HEALTH TOOL (OHT)

Description/ Purpose:	• The OHT is used for supporting national strategic health planning in LMICs. The tool facilitates an assessment of resource needs associated with key strategic activities and their associated costs, with a focus on integrated planning and strengthening health systems • **Contains modules for the areas of human resources, infrastructure, logistics, financial space, intervention coverage, costing and bottleneck analysis** • Linked with other impact modules for HIV (AIM and Goals), TB (TIME), MNCH (LiST), family planning (FamPlan), and non-communicable diseases
Application:	Maternal, newborn and reproductive health, child health, vaccination, malaria, tuberculosis, HIV/AIDS, nutrition, and water sanitation and hygiene, allows for program specific costing as well as health system component costing
Strengths:	• User friendly, unit cost repository maintained by Avenir Health can be used as a source for costing information • Can compare the effect of different combinations of programs on the HIV epidemic
Limitations:	• GOALS is not an optimization tool, does not identify the optimal allocation of resources to minimize HIV related deaths or new infections
Data requirements:	• There is a data pack associated with the tool (default; preloaded data); costing tool is linked with Impact models in Spectrum. Ideally need local data, especially cost data. • Requires knowledge of epi and cost data and output, as well as knowledge of the health sector • New users require a 3–5 day workshop; users rely considerably on TA to perform analyses
Reach:	40 countries
Available at:	http://www.avenirhealth.org/software-spectrum.php (OneHealth)

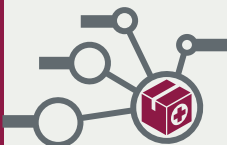## Modules included in Spectrum and applications

OneHealth – Configuration	Allows for the configuration of elements used within multiple OneHealth modules
Human Resources	Allows the costing of salaries, benefits, and incentives for health service providers
Infrastructure	All facilities providing medical interventions are planned for and costed within the Infrastructure module
Budget Mapping	Can be used to allocate intervention and health system costs across budget categories established by the user
Governance	The governance module includes costing templates for assessing the costs of governance activities
Logistics	Allows for the planning of warehouses and vehicles needed to move commodities/drugs and supplies from central warehouses to the endpoints. It is also where planning for commodities/drugs and supplies that are not included in the Intervention costing module
Health Financing	Is used to estimate the costs of implementing health financing programs such as vouchers, subsidies, or cash transfers
Financial Space	Is used to analyze the financial space within which health plans are expected to be executed
Health Information Systems	Includes costing templates for assessing the costs of implementing a health information system

- Interventions are costed using the ingredients or bottom-up approach. The model calculates both total and incremental cost. The current focus is on drugs and supplies costs

- The module also attempts to provide estimates of the staff time requirements linked to an intervention as well as estimates regarding the number of visits (and hospital days where necessary) per average case

- An attempt is also made to also identify any other major other cost items that can be directly linked to an intervention such as training or IEC without which the intervention could not be delivered
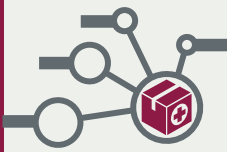
Disease categories:

1. Maternal/newborn and reproductive health
2. Child health
3. Vaccination
4. Malaria
5. TB
6. HIV/AIDS
7. WASH
8. Nutrition
9. Non-communicable diseases
10. Mental health, neurological and substance abuse disorders

Policy questions:

- What is the investment needed to a health intervention (e.g., TB, HIV)?
- What is the unit cost of delivering a specific health interventions (e.g., TB, HIV)?
- How can we demonstrate the potential cost savings that can be achieved from integrating health interventions rather than delivering the same interventions alone?
- What is the impact on new infections and deaths, and cost implications of different health investment decisions?

SPECTRUM AND OHT

Strengths:
- Applicable to multiple diseases/ interventions
- It incorporates planning and costing for health areas and health systems building blocks: human resources, facilities, equipment and transportation, medicines and supply chains
- It also linked to multiple health impact models to estimate the health impact of the intervention activities (inter-disease).

Limitations:
- Require intensive data collection
- Require TA, often use at the national level
- Not widely used especially at sub-national level
- Pre-loaded data are not being updated frequently enough
- Static; not linked to routine program data

OPTIMA SUITE

Description/ Purpose:	• Combines a disease progression component with an economic and financial analysis framework • Optima is a deterministic, compartmental model. Optima compartmentalizes a disease, such as HIV into four categories: undiagnosed, diagnosed, on treatment, and treatment failure. Each of the four infected categories are further divided into disease stage compartments • Optima is not a costing or budgeting tool—it can inform investments, but actual budgeting for implementation requires other tools
Application:	HIV, TB, Malaria, Nutrition
Strengths:	• The only disease modeling tool with an optimization function, calculates optimal allocation of resources to different program areas to address the specified objective given fixed costs, or to minimize costs given specific targets • It can project populations as well as patterns of disease transmission and disease progression • Flexible and can use for unlimited number of sub-population groups at once
Data requirements:	Substantial, including population data, epi data, program coverage and cost data, and intervention effectiveness
Reach:	Global for Optima HIV, more limited for other diseases
Available at:	http://www.optimamodel.com

Example of Optima output

- The annual budget is assumed constant at USD 51.4M until 2035
- Relative to the current allocation, an optimized allocation of current spending could:
  - **Reduce the number of active TB infections** in 2035 by 46%
  - **Reduce the number of TB-related deaths** per year in 2035 by 45%
  - **Reduce the rate of TB incidence per 100k** in 2035 by 26%

Estimated impact of an optimized allocation of 2017 expenditure on total number of active pulmonary TB infections

Estimated impact of an optimized allocation of 2017 expenditure on annual number of pulmonary TB-related deaths

Policy questions:

- What is the projected future trajectory of the country's HIV epidemic with or without investment in specific programs?

- What are impact of different spending scenarios on TB related deaths and new TB cases?

- What is the amount of funding needed to achieve the country's HIV national strategic goals?

HIPTool HEALTH INTERVENTIONS PRIORITIZATION TOOL

Description/ Purpose:	• Recently developed tool supporting decision-making in prioritizing health interventions and defining national health benefits packages – Allows countries to use data on cost, effectiveness and coverage to optimize resource allocation with a model-based algorithm to maximize DALYs averted, equity, and financial risk protection • Loaded with default data from the Disease Control Priorities (DCP3) interventions, which facilitates using global data. DCP3 includes 218 interventions across 21 essential packages of care across five platforms (population health interventions, community, health center, first-level hospitals, and referral hospitals)
Strengths:	• Multiple health areas
Data requirements:	Substantial; countries often don't have enough cost data for the interventions included in the health benefit package
Reach:	Limited, Zimbabwe, Côte d'Ivoire, Armenia
Available at:	http://hiptool.org/#intro

Policy questions:

- **What is the impact of current health spending?**
  When setting priorities for a health benefits package, countries may want to compare any changes against current spending and service provision. The HIPtool can compare the impact of different packages so that stakeholders can compare the gains and losses that may result from any changes.

- **How might current spending be allocated to maximize system objectives?**
  The HIPtool includes an optimization algorithm and offers the option to estimate allocations of spending to maximize health outcomes, equity, and financial risk protection.

- **How will an "optimal" budget allocation differ from current spending and what would be gained?**
  The HIPtool can be used to estimate the impact of different spending scenarios to help inform decision-makers about (a) which services would benefit most from additional funding, (b) which services might be prioritized if overall funding decreases, or (c) to help advocate for additional future funding by quantifying the impact of different funding scenarios

Example of HIPTool output

Allocation of current and optimized spending across levels of care $1.4B total health spending in 2016; changes in boxes

Level of care	Change
Health Center	-12%
First-level Hospital	-12%
Community	68%
Referral and Specialty Hospital	19%
Population-based Health Interventions	31%

$- $400.00 $800.00

Millions

■ Current ■ Optimized

Current and optimized DALYs averted across levels of care increase from **9.1M to 11.1M DALYs averted**; changes in boxes

Level of care	Change
Health Center	22%
First-level Hospital	22%
Community	19%
Referral and Specialty Hospital	37%
Population-based Health Interventions	122%

-    2.00   4.00   6.00

Millions

■ Optimized ■ Current

WHO CHOICE (being updated)

Description/ Purpose:	• Used to input local evidence into existing generalised cost effectiveness analysis to provide country contextualisation of results • Applies to a wide range of health interventions. Takes into account synergies between interventions on the costs and effectiveness from a health system perspective • Produces Incremental Cost Effectiveness Ratios (ICERs) that are context specific, based on a country's burden of disease, and compared to "no treatment" as an alternative scenario
Data requirements:	WHO-CHOICE tools, including disease models and costing tools, are pre-set with regional average data. For a contextualization, data including epidemiology, intervention impacts, and prices can be replaced by local data.
Available at:	http://www.

AIDS EPIDEMIC MODEL (AEM)

Description/ Purpose:	• Excel workbook used to assess the epidemiological impacts of programs and combinations of different interventions as they are scaled up • AEM can generate scenario comparisons to conduct direct assessment of alternative combinations of program interventions. For each scenario, data about the epidemic such as sources of new infections, future prevalence trends assuming that behaviors remain unchanged, impacts of different interventions on new infections, deaths, and future treatment costs are evaluated
Application:	• Applicable for concentrated epidemic and key population programs
Data requirements:	• Substantial including Epi, behavioral data, program coverage, cost, and intervention effectiveness, often requires external T
Software:	Excel; workbook also includes a simple cost model that provides estimates of total costs for a specific intervention program.
Available at:	http://www.aidsdatahub.org/sites/default/files/documents/The_Asian_Epidemic_Model_a_process_model_for_exploring_HIV_policy_and_program_alternatives_in_Asia.pdf.pdf

Policy questions:

• What is the impact of different prevention efforts on the future course of the HIV epidemic and what are their comparative costs?

• What is the necessary coverage level and investment required to achieve a specific epidemiological impact (e.g., halving incidence or reversing prevalence growth) with future programs?

• What are the primary groups and transmission modes driving HIV transmission in the country?

• What are the estimated number of people in need of ART, costs and the potential impact of ART on mortality and number of new and current infections?

3. RESOURCE ALLOCATION AND PRIORITIZATION TOOLS

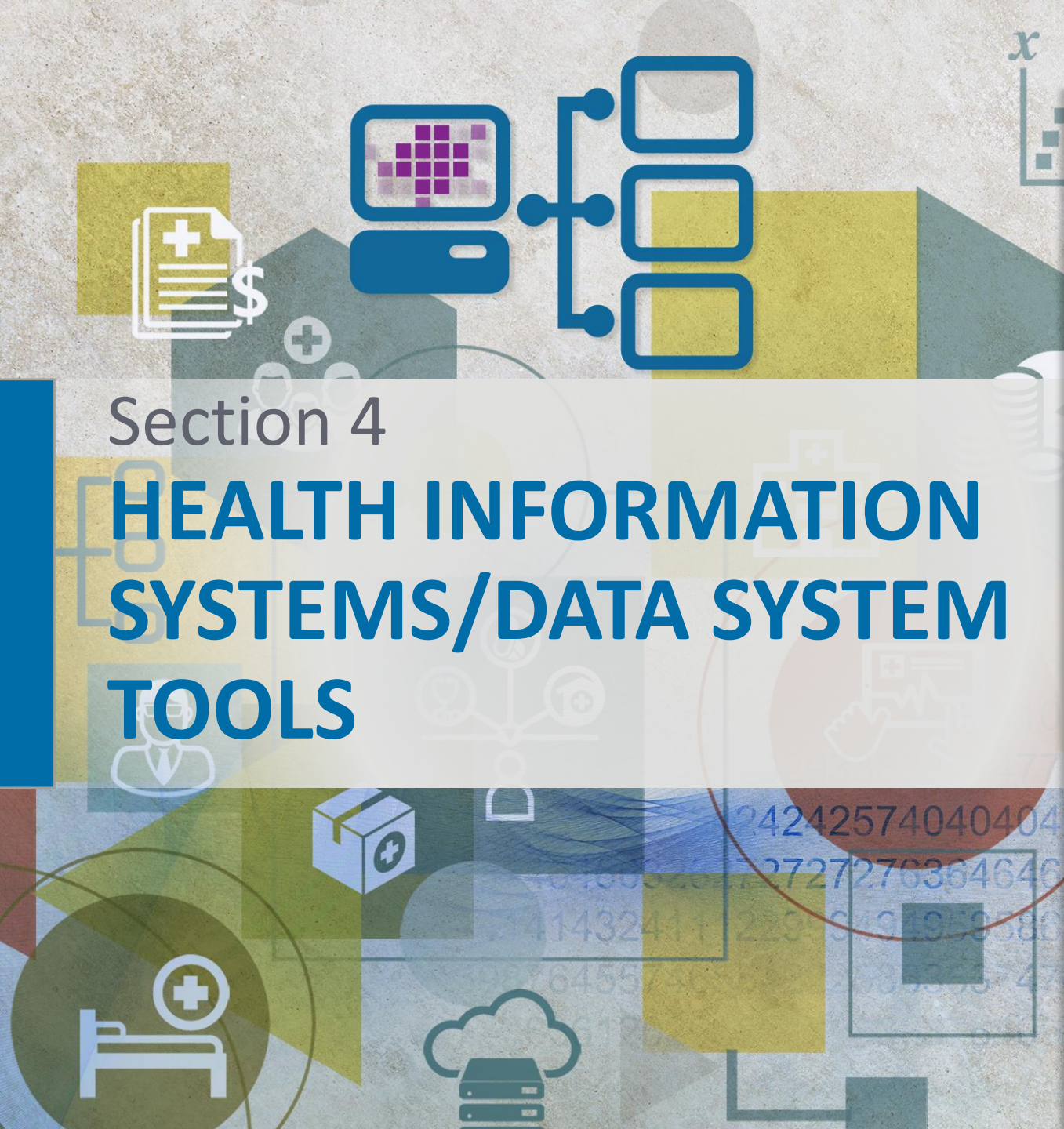| Tool	Disease	Purpose	Functionality				Data needs	Outputs	Developers
			Costing/ budgeting	Disease/Health impact projections	Resource allocation	Optimization			
HIP Tool	Multiple	Prioritization of health services to inform a defined Health Benefits Package and improve allocative efficiency across potential health services.	No	Yes	Yes	Yes	National Intensive	Health impact (in DALYs) for a given amount of spending (by intervention or overall Health Benefits Package).	UCL
Optima Suite	Single	Prioritization of health services to inform disease-specific responses.	No	Yes	Yes	Yes	National or subnational/ intensive	Past/current epidemic trends and future epidemic (incidence, prevalence, death) trajectories. Estimate optimal mix of interventions that minimizes incidence, prevalence and mortality. Estimate resource needed to reach a target.	Burnett Institute/ World Bank
Spectrum suite (GOALS, AIM, RNM)	Single	Prioritization of health services to inform disease-specific responses.	Yes	Yes	Yes	No	National or subnational Intensive	Past/current epidemic trends and future epidemic trajectories. Combined with OHT to determine intervention costs and health impact.	Avenir Health
OneHealth Tool	Multiple/ Health system	Costing tool to inform budgetary planning and implementation. Linked with Spectrum impact models to predict health impact.	Yes	Yes	Yes	No	National Intensive	Microcosting Estimation of health system requirements to determine type and amount of resources required to most efficiently implement a set of health services.	WHO, WB, and other UN agencies
CHOICE	Multiple	Method of inputting local evidence into existing generalized cost effectiveness analysis. Linked with Spectrum impact models to predict health impact.	Yes	Yes	Yes	No	Extensive	Generates a league table of most cost-effective interventions for a specific context to inform health service prioritization	WHO
AEM	Single	Assess the epidemiological impacts of scaled up different HIV interventions	Yes	Yes	Yes	No	Extensive	Generates scenario comparisons to conduct direct assessment of alternative combinations of program interventions	East-West Center

Section 4

HEALTH INFORMATION SYSTEMS/DATA SYSTEM TOOLS

KEY CHARACTERISTICS OF SECTION 4 TOOLS:

- ▶ Many systems are mature and have global reach
- ▶ All use similar data standards that allow for health data interoperability
- ▶ Many systems capture routine health records, case base surveillance in real time or near-real time
- ▶ OpenHIE has already addressed the fundamental problems of health data interoperability
- ▶ Have open software codes and a strong community of practice and talents
- ▶ Have established reference technologies that support the component architecture and workflow which can be used in new tools/ systems
- ▶ These platforms can produce data for both health managers/ planners as well as health implementers and clinicians to bolster their decision support capabilities
- ▶ Leverages massive amount of data being routinely collected to potentially reduces manual data collection requirement and fosters big data analytics

OPEN HEALTH INFORMATION EXCHANGE (OpenHIE)

Description/ Purpose: The OpenHIE community of practice formed in early 2013, evolving from the work in Rwanda. Global health practitioners recognized the importance of harmonizing health information systems and understood the importance of an upfront architecture for implementation of health information systems—a way for these systems to better communicate with one another.

- OpenHIE is a community of practice made up of different leadership groups, interest groups, committees and boards
- Aims to provide best practices in interoperability for bringing together different data systems and tools
- Supports country-driven, large-scale health information sharing architectures
- Enabling large-scale health information interoperability
- Offers standard approaches and reference technologies
- Support other's needs through peer technical assistance communities

Principles:
- OpenHIE operates according to principles of openness, transparency and sharing of ideas, software and strategies for deployment and use
- It is important to design highly adaptable processes and technologies to respond to rapidly changing health information needs in complex healthcare environments
- Strong collaborations among health experts and open-source healthcare developers to sustainably build technologies, infrastructure, and human resources to meet local health information needs.
- OpenHIE and local partners benefit from this wide range of valuable talent and experience. Different organizations are encouraged to contribute.

Steering committee
Strategic guidance around community priorities and areas of emphasis

DIRECT →

Operational leadership
Support and guidance over all daily operations and direction of community

SUPPORTING

Architecture review board
Oversee all technical standards-based products of community

Sub-community leadership
Direction, oversight, project management for component sub-committies (i.e., facility, client registry, etc

Interest group leadership
Drive community process around HIE cases and/other areas of emerging interest (i.e., supply chain management, COVID, etc.)

Architecture:
- Open-source software components, all interacting/interoperating to ensure that health information from various external systems is gathered into a unified person-centric medical record
- The exchange normalizes the context in which health information is created across four dimensions:
  - who received health services
  - who provided those services
  - where did they receive the services
  - what specific care did they receive
  - what products may have been involved in treatment.
- Supports interoperability by creating a reusable architectural framework that introduces a service-oriented approach, maxim leverage of health information standards, enables flexible implementation, and supports interchangeability of individual components
- Supports country-driven, large-scale health information sharing architectures

Principles:
- By focusing on the "For Whom","By Whom", "Where", and "What" of a patient's health visit we help to bring relevant information directly to the point of care.
- This supports enhanced decision-making, improves the quality, safety and continuity of care, and facilitates the appropriate use of information to improve population health

Structure:
- Comprises multiple components for managing and sharing the metadata through the Interoperability Layer.

Available at: https://ohie.org/architecture/

OpenHIE: THE INTEROPERABILITY LAYER

Description/ Purpose:

- An interoperability layer is a system that enables easier interoperability between disparate information systems by connecting all of the infrastructure services and client applications together
- In the OpenHIE context, these systems are Health Information Systems (HISs) such as a client registry, provider registry, facility registry, shared health record and terminology service
- The interoperability layer is called OpenHIM (Open Health Information Mediator), an open-source middleware system based on an ESB architecture and currently implemented in Rwanda as part of the RHIE
- More details about this tool are available at openhim.org and the code is available on the Github code repository

OpenHIE: TERMONOLOGY SERVICES

Description/ Purpose:

- "The objective of the Terminology Services component is to provide a central resource for the definitional assets of the HIE, i.e., terminologies, ontologies, dictionaries, code systems, value sets, etc., that can be used by other HIE components to achieve normalization of clinical data and consistent aggregation and reporting."

Description/ Purpose:

- OHIE-TS serves as a central authority to uniquely identify the clinical activities that occur within the care delivery process by maintaining a terminology set mapped to international standards such as ICD10– It is the "What?" in the OpenHIE architecture

- The Mission of the Terminology Service Community is to promote and support the effective capture, exchange (interoperability) and analysis (comparison and aggregation) of clinical information among components of the HIE

We are here

OpenHIE Component layer

TS   CR   SHR   HMIS   FR   HWR

Interoperability services layer

Authentication   ILR   Entity matching

Interoperability layer

External systems

Mobile   Clinic   HMIS   Lab   Hospital

Components included in OpenHIE

OpenHIE Component / Type of Tool	Links to Software
Client Registry	MEDIC CR - GitHub
Client Registry	OpenEMPI - Website
Facility Registry	ResourceMap - GitHub
Health Financing Information Management819px300	openIMIS
Health Management Information Systems	DHIS2 - GitHub
Health Worker Registry	iHRIS.org; Docker Hub; GitHub for Docker
Interoperability Layer	OpenHIM - GitHub
Interoperability Service	GitHub; Docker Hub
Laboratory Information System	OpenELIS Global - GitHub
Logistics Management System	openlmis.org; GitHub; DockerHub
Product Catalog (Registry)	productcatalog.io; GitLab; DockerHub
Terminology Management Service	OCL API – GitHub; OpenHIE Metadata Clearinghouse
Terminology Services	DTS Web site with Links to software

DHIS2

Description/ Purpose:	District Health Information Software 2 (DHIS2) is an open source, web-based Health Management Information System (HMIS) platform.
Application:	Has been applied to HIV/AIDS; tuberculosis; malaria; reproductive, maternal, newborn, and child health; neglected tropical diseases; highly communicable and noncommunicable diseases; water, sanitation, and hygiene; food security; crisis response; integrated management of childhood illness and community case management; facility electronic medical records; and immunization.
Platform:	• DHIS2 has interoperability with iHRIS, the most widely applied open source human resources information system and OpenLMIS, the largest open source logistics management information system • The open application programming interface (API) makes it easy to connect DHIS2 to other external software/ data tools
Reach:	More than 100 countries
Website:	https://www.dhis2.org/

COMMCARE

Description/ Purpose:	CommCare is an offline-capable mobile data collection and service delivery platform designed for everything from simple surveys to comprehensive longitudinal data tracking
Application:	CommCare has been used in child health, nutrition, and maternal and newborn health to Ebola, HIV/AIDS, tuberculosis, and supply chain.
Platform:	• Dimagi's MOTECH is a CommCare-based interface that supports the integration of scalable mobile services and health information systems • MOTECH implements the OpenHIE standards (See more about OpenHIM next), which are emerging as the global standards for interoperability of health information systems. MOTECH supports integration with DHIS2 and OpenMRS
Reach:	Large, global
Website:	https://dimagi.com/commcare/

OPEN HEALTH INFORMATION MEDIATOR (OPEN HMI)

Description/ Purpose:	Middleware component designed to ease interoperability between disparate information system. It provides secure communications and data governance and support for routing, orchestrating, and translating requests as they flow between systems.
Application:	Some examples of common workflows:

- Saving a patient's clinical encounter to a shared health record so that authorized health care providers are able to access key clinical data that can inform better care.
- Retrieving relevant information about patient encounters and care plans for authorized health care providers.
- Receiving aggregate reporting information from a client system and sending this to an aggregate datastore.
- Managing health facilities.
- Tracking of a patient's activity within and between health care organizations and across the continuum of care

Reach:	Rwanda, South Africa. Tanzania, Zimbabwe.
Website:	http://openhim.org/#about

OpenMRS

Description/ Purpose:	Is a software platform and a reference application that enables design of a customized medical records system (MRS).
Application:	OpenMRS is a reference tool used for the shared health record component of OpenHIE and as the source for individual-level clinical data from visits and encounters.
Platform:	It has a shared health record (SHR), which facilitates the sharing of clinical information between the health information system, allowing different services to share health data stored in a centralized data repository.
Reach:	64 countries.
Website:	Website https://openmrs.org

OPEN SMART REGISTER PLATFORM (OpenSRP)

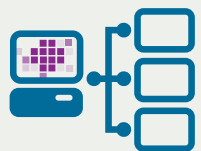|	
Description/ Purpose:	(OpenSRP) is an open source platform to empower frontline health workers and provide program managers and policymakers with current data for decisionmaking and policymaking.
Application:	OpenSRP has been used to build localized applications for reproductive, maternal, newborn, child, and adolescent health; immunization; early childhood development; and tuberculosis treatment management.
Platform:	OpenSRP integrates with OpenMRS to provide scalable data management across large geographic areas. OpenSRP can also integrate with third-party systems like DHIS2 for automated reporting.
Reach:	64 countries.
Website:	https://smartregister.org

LOGISTICS MANAGEMENT INFORMATION SYSTEM (OpenLMIS)

Description/ Purpose: OpenLMIS is a cloud-based electronic logistics management information system (LMIS)

It automates LMIS business processes throughout the entire supply chain, reducing the burden on health workers while improving data accuracy, data timeliness, and data visibility

Application: OpenLMIS can manage multiple vertical health programs concurrently

Each health vertical/business can leverage the following features to support the management of its supply chain:

- **Inventory management:** Capture inventory data and stock movements
- **Mobile integration:** Leverage mobile tools to track stock movements
- **Reporting and analytics:** Easy-to-use dashboards and reporting metrics across all programs
- **Order fulfillment:** View and fulfill orders from other facilities and send shipments to initiate a receiving process.
- **Requesting and ordering:** Use stock data to generate orders using the configurable approval process.
- **Cold chain inventory management**
- **Inventory management:** Capture inventory data and stock movements

Platform:
- Has standards-based interoperability
- OpenLMIS can work with a country's existing health information system to increase supply chain efficiency

Reach: Benin, Côte d'Ivoire, Guinea, Malawi, Mozambique, Tanzania, Zambia.

Website: http://openlmis.org/

HUMAN RESOURCE INFORMATION SYSTEM (iHRIS)

Description/ Purpose:
- iHRIS enables countries to easily collect, maintain, and analyze health workforce data and manage health workforce at all levels
- iHRIS Plan is a predictive modeling tool used to project the likely changes in the health workforce under different scenarios and compare them with projected needs

Application: iHRIS is a package of software built on a flexible framework that can be adapted to meet a wide variety of needs for managing health workforce information:
- iHRIS Manage supports MOH and other service delivery organizations to track, manage, deploy, and map their health workforce
- iHRIS Qualify enables professional councils and associations to maintain a database of registered and licensed health professionals to support increased quality of care
- iHRIS Train is a new iHRIS application to track and manage health worker training activities, including pre-service education and in-service continuing education

Platform:
- iHRIS Retain is a cloud-based tool developed in collaboration with the World Health Organization to help countries plan and cost retention interventions
- iHRIS applications are designed to work together but may also be deployed independently or integrated with other health information systems
- iHRIS has built-in functionality to exchange data with other information systems using including DHIS2. Multiple iHRIS installations can use the OpenHIE Health Worker Registry to share data
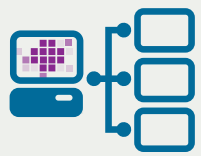
Reach: Botswana, Chad, Côte d'Ivoire, Democratic Republic of the Congo, Dominican Republic, Ghana, Guatemala, Guinea, India, Kenya, Lesotho, Liberia, Malawi, Mali, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, Tajikistan, Tanzania, Togo, Uganda.

Website: https://www.ihris.org/

REVEAL

Description/ Purpose:	Is a spatial mapping and monitoring platform that optimizes health intervention coverage through spatial planning, tasking, navigation support, and built-in decision-making protocols to drive intervention planning. REVEAL optimizes intervention coverage with data accuracy and transparency.
Application:	Reveal has been used to monitor malaria interventions. But it is applicable to multiple health verticals, including but not limited to neglected tropical diseases, vaccinations, community and reproductive health, and drug access.
Platform:	Reveal's app is built on OpenSRP and can be linked to DHIS2. Reveal's geospatial tool relies on OpenStreetMap
Reach:	Been used for Malaria programming in 49 districts in Zambia.
Website:	https://akros.com/mspray/

SURVEILLANCE OUTBREAK RESPONSE MANAGEMENT AND ANALYSIS SYSTEM (SORMAS)

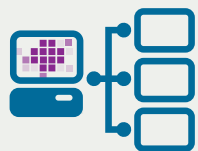|	
Description/ Purpose:	Is an open source software designed to organize and facilitate disease control and outbreak management procedures.
Application:	Digitalized notification at the health facility level, bidirectional information flow, contact follow-up management, and user-centered design.
Platform:	SORMAS has a modular and flexible architecture and is adaptable. It has a fully functional application program interface (API) with other third-party platforms, including DHIS2 and meet OpenHIE standards.
Reach:	Nigeria, Ghana.
Website:	https://sormas.org/

VANTAGE

Description/ Purpose:	Vantage is an AI-enabled cloud platform that uses advanced analytics, artificial intelligence and machine learning to mine data and transform it into insights and clear recommendations.
Application:	Able to automate reports, providing clarity on current performance, analytics to visualize risks and opportunities, and facilitating solutions to achieve targets.
Platform:	Has ability to meet functional requirements; platform flexibility, scalability and interoperability; and ease of use and intuitive user interface.
Reach:	Vantage is widely used in Southern Africa for multiple virtual health intervetions, and has great potential to be applied in other settings.
Website:	https://www.broadreachcorporation.com/vantage-technologies/

JEMBI HEALTH SYSTEM

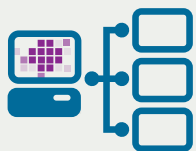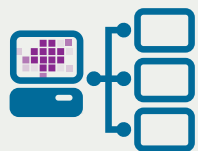|	
Description/ Purpose:	• Aims to design human-centered, open-sourced health information systems. • Produces insights that empower decision-makers, health-workers and patients
Application:	Health system wide including MNCH, HIV, TB, RH.
Platform:	Jembi is one of the founders and leaders of the OpenHealth Information Exchange and is responsible for the interoperability layer
Reach:	Sub Saharan Africa.
Website:	

4. HIS TOOLS

HIS Tool	Purpose	Ease of use	Standard operability	Built-in analytics	User interface	Reach	Publicly available software codes	Developer
Open Health Information Exchange (OpenHIE)	A platform that brings other HIS tools together via the interoperability layer	n/a	Yes	Yes, through the linked tools like DHIS-2 or OpenMRS	Yes, through the linked tools	Global; well known among HIS community; similar to DHIS-2	Yes, active developer forum	Started in Rwanda, now an open community platform https://ohie.org/architecture/ (Jembi health is one of the leader)
OpenMRS (Medical Records System)	A reference tool used health record sharing/ a component of OpenHIE and as the source for individual-level clinical data	Yes	Yes	Yes	Yes	64 countries	Yes	pen community platform https://openmrs.org
OpenHIE Terminology Service	A central authority to uniquely identify the clinical activities by maintaining a terminology set mapped to ICD10	n/a	Yes Aim to set standards for disease categories	n/a	n/a	Global, similar to OpenHIE	Yes	Open community platform Github code repository https://ohie.org/architecture/
Open Health Information Mediator (OpenHIM)	A middleware component designed to ease interoperability between disparate information systems	n/a	Yes	n/a	n/a	Part of OpenHIE Global	Yes	Open community platform http://openhim.org/#about
Open Logistics Management Information System (LMIS)	Automates LMIS business processes throughout the entire supply chain	Yes	Yes	Yes	Yes	Benin, Côte d'Ivoire, Guinea, Malawi, Mozambique, Tanzania, Zambia	Yes	Open community platform http://openlmis.org/
Human Resource Information System	Enables countries to easily collect, maintain, and analyze health workforce data and manage health workforce at all levels	Yes	Yes (a package of software for multipurpose)	Yes	Yes	About 25 countries	Yes	Open community platform https://www.ihris.org/
DHIS-2	HIS for all health-related program (data collection, analysis; on and offline)	Yes	Yes, is link to human resource and logistical system	Well developed	Yes	100 countries	Yes	U of Oslo https://www.dhis2.org/ BAO Systems is a popular host platform/ source of TA
COMCARE	Data collection but is linked to Open MRS, DHIS-2	Yes	Yes	Yes	Yes	Global, nearly 100 countries	Yes	Dimagi Inc. https://dimagi.com/commcare/

SUMMARY TABLE

4. HIS TOOLS

HIS Tool	Purpose	Ease of use	Standard operability	Built-in analytics	User interface	Reach	Publicly available software codes	Developer
Open Smart Register Platform (OpenSRP)	A platform to empower frontline health workers/ program managers and policymakers with data for decision making	Yes	Yes Links with OpenMRS and DHIS-2	Yes	Yes	Bangladesh, Indonesia, Kenya, Pakistan, Zambia.	Yes	Open community platform https://smartregister.org https://github.com/OpenSRP (WHO supported)
Surveillance Outbreak Response Management and Analysis System (SORMAS)	Used to organize and facilitate disease control and outbreak management procedures	Yes	Yes, link with DHIS-2 and OpenHIE	Yes, via DHIS2	Yes, via DHIS2	Nigeria, Ghana Applicable to COVID19 monitoring	Yes	Developed by a consortium of German and Nigerian public health, research institutions. Now, an open source community ion Rehttps://sormas.org/
Reveal	A spatial mapping and monitoring platform that optimizes health intervention coverage through spatial planning, tasking, navigation support, and built-in decision-making protocols to drive intervention planning.	Yes	Yes, links to OpenSRP and DHIS-2 and OpenStreetMap	Yes	Yes	Zambia	Yes	Akos https://akros.com/mspray/
Vantage	An AI-enabled cloud platform that uses advanced analytics, artificial intelligence and machine learning to mine data and transform it into insights and clear recommendations	Yes	Yes, across different data types	Yes	Yes	South Africa, Zambia	No	BroadReach https://www.broadreachcorporation.com/vantage-technologies/ Microsoft supported, not open source
Jembi Health System	Produces insights that empower frontline health-workers and decision makers	Yes	Yes. Links to OpenHIE, OpeHIM	Yes	Yes	Widely used in sub-Saharan Africa	Yes	Jembi Health https://www.jembi.org/