The HEARTS Costing Tool

User guide

Version 1.0

August 2021

About

This User Guide supports use of the HEARTS Costing Tool for estimating costs of implementation of the HEARTS Technical Package. More information on the HEARTS Technical Package may be accessed via the World Health Organization's HEARTS [homepage](#).

Acknowledgements

Disclaimer

The contents of the User Guide are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention (CDC), the Department of Health and Human Services, The Task Force for Global Health, Inc. or Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET).

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Contents

1. Overview

The HEARTS technical package is part of the Global Hearts Initiative to provide primary care health systems with best practices and tools for prevention of cardiovascular disease (CVD). The Initiative was launched in 2016 by the World Health Organization (WHO) with support from the United States Centers for Disease Control and Prevention (CDC) [1]. The HEARTS technical package consists of six action modules. These cover the following areas: **H**: healthy-lifestyle counseling, **E**: evidence-based treatment protocols, **A**: access to essential medicines, **R**: risk-based CVD management, **T**: team-based care, and **S**: systems for monitoring. A full description of the modules is available on WHO's HEARTS homepage.

The HEARTS Costing Tool was created to assess the costs of implementing and operating the HEARTS program in primary healthcare facilities at the country or district level. Information on costs is crucial to inform national authorities about budget needs and resource allocation.

The HEARTS Costing Tool provides decision-makers with a standardized costing platform to assess the local costs of program implementation. This user manual provides detailed instructions on how to use the Tool. It begins by providing background on the Tool's costing principles and methods, and guidance on how to navigate the Tool's Excel-based platform. Next, it provides instructions on how the user should enter local data to generate the cost estimates. Finally, it provides guidance on reviewing the tool's cost estimates, by component of the HEARTs technical package. Appendices detail the tool's cost parameters, the equations it uses to generate each estimate, and additional insights regarding the assumptions and underlying data in the Tool.

2. Costing the HEARTS program

2.1. Principles of costing with the HEARTS Tool

The purpose of the HEARTS Costing Tool is to enable country-based district-level program managers to forecast the cost of implementing and operating HEARTS. The Tool is intended for use by individuals who do not have significant experience costing health programs. The aim is to support these stakeholders to evaluate the annual financial costs of HEARTS, helping to inform budgeting, financial planning, and/or estimation of resource requirements.

Table 1 summarizes the Tool's approach, drawing on methodological principles and terminology outlined in the Global Health Cost Consortium's Reference Case.

Table 1. Global Hearts Costing Tool Approach

Methodological Principle	Global Hearts Tool method
Purpose	Budgeting; estimation of resource-requirements
Perspective	Healthcare system
Type of Cost	Financial cost, Full cost (not incremental, i.e. no comparison scenario); guideline cost
Time Horizon	One year (one budget cycle)
Resource Measurement Method	Bottom-up

The Tool estimates financial costs. Financial costs represent money that health system providers will spend on resources required to implement and operate HEARTS during a single budget cycle. Given that capital costs have impacts beyond a single budget cycle, users can choose whether to annuitize these costs—spreading them over a designated number of years following common financial accounting principles.

The Tool organizes the costs separately for each of the HEARTS modules and sums those costs to provide total cost of the program. Estimates are from a healthcare provider perspective (i.e. a perspective that considers how much it costs to deliver the services). The Tool examines the full cost of HEARTS implementation from a zero base, rather than the incremental cost of moving from the status quo—existing health system operations—to a health system operating according to HEARTS protocols.[1]

The Tool was created to prospectively inform decision-makers about the annual future cost of implementing and operating HEARTS. Estimates are "guideline costs", meaning that they describe the costs of implementing HEARTS as described in the Technical Package. Real-world considerations such as patient failure to adhere to treatment regimens or health provider failure to initiate an intervention are not considered.

The Tool uses a bottom-up costing approach, meaning it catalogues the individual resource inputs required to implement and operate a given HEARTS module. This allows users to apply the tool to their individual context.

2.2.   Costed interventions

Like the HEARTS technical package, the Tool assumes that HEARTS interventions will be implemented in a primary care setting.

The interventions are applied to all adults who present at a health facility (age group specified by user). Under HEARTS guidelines, participating patients receive a comprehensive screening consisting of queries about health history, a physical exam (including blood pressure measurement), and diagnostic tests to assess diabetes status and cholesterol levels. Health providers assess 10-year CVD risk and communicate with patients. Health personnel develop a treatment plan for patients with elevated risk.

Health providers offer healthy lifestyle counselling to patients with behavioral risk factors for CVD (i.e. tobacco use, harmful or hazardous use of alcohol, physical inactivity). Lifestyle counselling consists of advising patients to change unhealthy behaviors, assessing whether the patients are willing to change/quit, assisting and counselling patients on how to succeed in making the behavioral change, and arranging to follow up with the patient later.

Patients who are diagnosed with metabolic risk factors (i.e. hypertensions, diabetes, hyperlipidemia) are assigned a standardized pharmacological treatment regimen and follow-up primary care appointments to monitor progress.

The Costing Tool's structure includes additional program elements that either facilitate conducting these interventions (e.g., training of health personnel), alter the way in which health personnel carry them out

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[1] Users may wish to adapt its costing structure for analyses different than those that the Tool is designed for.

(i.e. task shifting to lower-level health personnel), or monitor and evaluate program operation (e.g. setup of information systems).

2.3.   Cost categories

Cost categories covered in the HEARTS Costing Tool include:

- Human resource costs
    - Health personnel (e.g., doctors, nurses, community health workers, lab technicians)
    - Other personnel (e.g., administrative staff members)
    - Savings in health personnel costs due to task shifting
- Medicines, diagnostics, equipment, and supplies
- Supply chain costs (the logistical costs of procuring, warehousing, shipping, and distributing) medication, diagnostics, and related resources)
- Training (e.g., hiring trainers, rental facility meeting space costs, training material, per diems and transportation)

Cost categories not covered in the tool include:

- Indirect health system costs (e.g. primary care center building or rental costs, utilities, administrative costs)
- Opportunity costs (e.g., the opportunity cost of health personnel time spent in trainings)
- Patient and family costs (are not taken into account (e.g. of their time, transportation).
- Real world costs (e.g., expenses associated with inefficiencies that may unexpectedly occur during implementation—such as poor adherence to treatment regimens)

2.4.   Limitations

The HEARTS Costing Tool has several limitations. The selection of a provider perspective—in contrast to a societal perspective—limits cost estimates to direct costs associated with the HEARTS technical package rather than the package's cost to a patient, a household, or a community or to the macroeconomy. Since the focus of the technical package is on improving primary-care CVD services, the package and the tool do not consider costs associated with secondary or tertiary-level care. Moreover, it does not account for real-world complications that may lower or raise costs—such as patient adherence to treatment regimens.

For 16 countries, default estimates for various parameters are embedded in the Tool. These may be used in place of local data when local data are not available. Default data are sourced from national-level surveys or international sources, which means that they may not be representative of the local context. In general, users should be cautious about using the embedded default values and use local information wherever possible.

3. Introduction to the Tool: Background and practical guidance

3.1.   Tool platform, structural layout, and navigation

The HEARTS Costing Tool was developed in Microsoft Excel 365 in 2020. Basic knowledge of Excel is required to operate the Tool. It has not been validated for use on older versions of Excel nor on an Apple operating system, both of which may reduce Tool functionality. Users should set English as the primary language and enable macros for the Tool to run correctly.

The Tool is contained in one Excel workbook with 13 active worksheets. Broadly, worksheets fall into four functional categories: 1) Introductory information, 2) User input, 3) Viewing results, and 4) Data and assumptions. Users may view the intended function of the worksheets on the *Introduction* worksheet, and functions are also color-coded on the tabs viewable at the bottom of the Excel window (see **Figure 1**).

Figure 1. Costing Tool structure
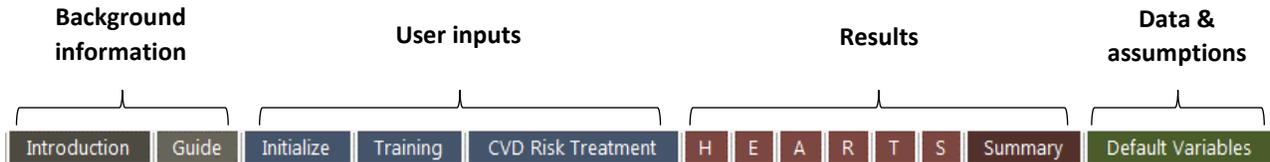
- **Grey worksheets** provide background information and answer basic questions about the Tool.
- **Blue worksheets** require users to input data on the populations who will be served by the HEARTS program, the types of interventions that they will receive, and the costs of providing those services.
- **Red worksheets** report annual resource requirements to operate the HEARTS program, and the cost of the stated resources. The *H*, *E*, *A*, *R*, *T*, and *S* worksheets break down costs by HEARTS program component, while the *Summary* worksheet reports the annual program cost.
- The **green worksheet** displays the default data underlying the tool and data sources and describes background assumptions about treatment regimens.

Figure 2. Top-of-worksheet navigational boxes
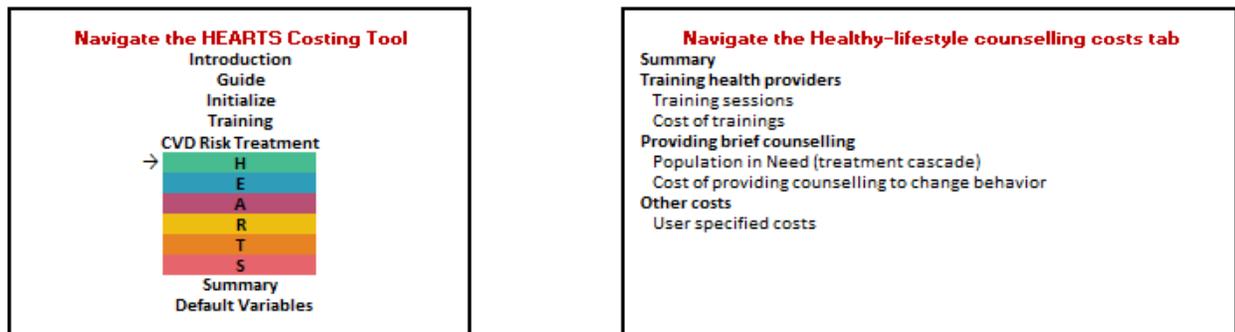
Hidden sheets contain more information that informs the Tool's structure and calculations, but the worksheets are not directly relevant to the user. These sheets may be unhidden by right-clicking on one of the tabs at the bottom of the Excel screen, selecting unhide, and entering the password HEARTS.

3.2.   User-guidance features

The basic task of each user is to enter data that describes the population in need of treatment, the resources that will be used to administer treatment to the population in need, and the cost of those resources. Several features help guide users on where—and how—to enter information, and what kind of information is needed.

Background information. The top of each worksheet contains background on how the requested information relates to the HEARTS program, and the top of each section within a worksheet contains user instructions and background on how the requested information relates to the HEARTS program.

Color-coded cells. Certain cells are highlighted BLUE to signal to users that they have the option of entering local data or information that is representative of their context. Most blue cells are on the *Initialize*, *Training*, and *CVD Risk Treatment* worksheets. Once users have entered data in these cells, they may review cost estimates on the *H*, *E*, *A*, *R*, *T*, *S*, and *Summary* worksheets. The "Results" worksheets contain a few additional options for users to enter any costs that the Costing Tool does not consider by default.

Cells highlighted in GREEN show default data for the country of interest. Default values represent best-available data gathered from publicly available sources. Sources are viewable on the *Default Variables* worksheet. Default values are typically international- or national-level estimates of Tool inputs. Users may apply default values where no local information is available but should do so with caution given that the default data may or may not represent the examined context.

Conditional formatting. In some cases, entering a value in a cell highlighted blue will cause another cell on a worksheet to become blue, indicating additional information that is required. For example, **Figure 3a** shows a blue cell that prompts users to enter additional staff members who will oversee a training session for health professionals. **Figure 3b** shows that entering "IT Staff" will change a rightward cell blue, prompting users to enter the number of IT staff needed for the session. In addition, below the original blue cell, users are prompted to enter additional staff types if desired.
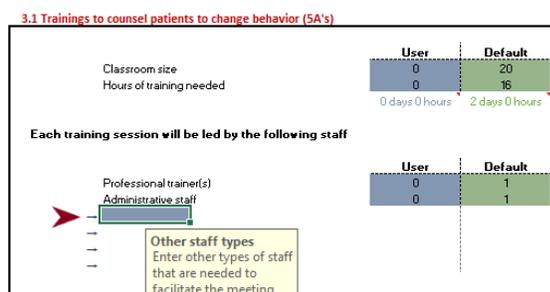
Figure 3a.

Figure 3b.
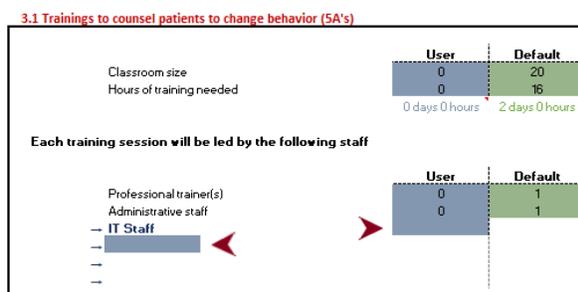
Protected cells and data validation. To protect the Tool's references and formulas, it runs in protected mode, meaning that users can only click on and change specific cells (color-coded blue) on a given

worksheet. Users may remove the protections by selecting the Review tab in the Excel header, selecting "unprotect worksheet", and entering the password HEARTS. With the worksheet unprotected, caution is advised given the potential to disrupt the Tool's embedded links and formatting.

Some cells also bound the number that can be entered (e.g. disallowing negative numbers, or numbers <0 and >1 in the case of percentages). If a user enters a number that is out-of-bounds, a message will pop up providing instructions to the user on how to correct the input.

Greyed-out cells. On certain areas of the *Training* and *CVD Risk Treatment* worksheets, users are provided choices that change whether—and/or where—they need to enter information. For example, on the *Training worksheet*, after entering costs to train healthcare providers to provide brief advice to change unhealthy behavior, users can select whether they want to use the same information to reflect the cost of training health providers to assess CVD risk or cost these trainings differently. If users select that they would like to develop separate costs, the previously grayed-out area will colorize (see **Figures 4a** and **4b**), prompting users to enter information. If an area is grayed out, the Tool will not consider any of the information in the cells in its cost estimates, even if there are numbers or other information in the cells.

Figure 4a.   **Figure 4b.**

4. The User-input worksheets

Initialize, *Training*, and *CVD Risk Treatment* are the primary worksheets on which users are expected to enter information. Several data inputs are required to run the HEARTS Costing Tool, including information on population size; primary care attendance rates; local NCD risk factor distributions; purchasing prices of medications, diagnostics, and supplies; wages of health and non-health personnel; treatment protocols for individuals with hypertension, diabetes, or hyperlipidemia, and the structure and cost of refresher training courses for health personnel. The Tool uses the entered information to calculate the cost of the HEARTS program.

While users will have entered most of the requested information after completing these worksheets, the Results worksheets provide a few additional opportunities to enter additional costs that are not automatically considered by the Tool. These will be described in Section 5.

4.1. Initialize worksheet.

4.1.a. Worksheet structure

The *Initialize* worksheet (A1:I123) provides space for users to enter local data that describes the population in need of treatment, the resources that will be used to administer treatment to the population in need, and the cost of those resources.

The worksheet consists of several tables that group requested data into categories. Blue cells in column H are space for users to enter the specified data. Green cells in Column I display default data. Users who plan to build their own custom diagnostic or pharmacological treatment protocols for metabolic risk factors may skip entering information in Sections 1.4 and 1.5.

4.1.b. Instructions

Users begin by selecting one of 16 countries in which HEARTS is currently being implemented.[2] Once a country is selected, the Tool pulls the country's default parameter estimates into green highlighted cells in Column I.

Next, the user is tasked with entering available information in the blue columns in Column H. Note that leaving a blue cell blank, or putting a value of 0 in the cell, will mean that the Tool does not calculate any relevant cost associated with the parameter. If desired, the user may copy and paste[3] the default parameter into the blue cell.

The first information requested—*adult population* and *primary care attendance rate*—sets the target population to be examined in the cost analysis. Under *adult population*, enter the number of adults in the catchment area of the primary care clinics where the HEARTS program will be implemented. Next, under primary care attendance rate, enter the percent of those adults who are expected to present at the primary care clinics in a given year. This narrows the population that the Tool examines to adults who will encounter HEARTS within the primary care system in the year of the analysis.

Users are then asked to describe prevalence rates among the adult population of interest, including rates of behavioral and metabolic NCD risk factors, and 10-year cardiovascular disease risk. The Tool factors in the entered rates to calculate the number of people in need of treatment (e.g. brief advice to quit tobacco).

Next, users enter the number of doctors, nurses, and community health care workers (CHWs) who serve in the primary care clinics in which HEARTS is being implemented. These numbers feed into the Training tab, where users select how many of these healthcare providers will receive specialized training to carry out HEARTS protocols.

Then, users enter the annual wages (including benefits in monetary terms) in local currency units (LCU) of these healthcare workers. In addition, users are asked to enter annual wages of other personnel types who may form an administrative team overseeing the operation of HEARTS. On the *H*, *E*, *R* and *T* worksheets, the Tool uses provider salaries to calculate the value of the time that providers spend

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[2] While the Tool only has default estimates for 16 countries, nothing precludes a user from examining the cost of HEARTS in a country not currently included in the Tool. To do so, simply fill in the blue-highlighted cells with data from the country or area of interest while ignoring the data in the green-highlighted cells since it will not be relevant to the examined context.

[3] Selecting copy, paste special, values will preserve the cell formatting and paste only the cell value.

operationalizing HEARTS protocols. On the *S* worksheet, the tool provides space to further conceptualize the non-health personnel contributions to HEARTS.

Next, users enter purchasing prices of medications and diagnostics. Importantly, these are per unit costs. For example, the Tool is asking users to enter the price of one 20 mg tab of Lisinopril in LCU. Entered prices feed into the CVD Risk treatment worksheet, where users may prescribe the pharmacological treatment regimens that individuals with hypertension, diabetes, and/or hyperlipidemia receive. Additionally, these prices feed into the *A* worksheet, which sums the total cost of medications for individuals in need[4] of treatment.

Finally, several additional parameters are requested in Table 1.6. The exchange rate is used to convert costs from LCU to USD on the *Results* worksheets.

"Safety stock" allows users to consider a supply chain perspective in which government or administrative policies may require a buffer stock of medications to be on hand to ensure that demand can always be met. For example, if users enter 5% in the cell, on the *A* tab the Tool will factor in that five percent more of each medication is needed than what is predicted based on the treatment population and selected treatment regimens. Conceivably, a user could enter a negative value, aiming to adjust the Tool's calculations of medication costs to account for the fact that not all patients may adhere to medication regimens.

The "on-cost" parameter provides a simple way for users to account for supply chain costs, including those to procure, import, store, and distribute medications, diagnostics, and supplies. The parameter applies an on-cost as a percent of the total calculated medication, diagnostic, and supply costs on the *A* tab. For example, if a user enters 10%, the Tool will assume that the supply chain cost of LCU 10,000 in medications is LCU 1,000.

4.2.   Training worksheet

4.2.a. Background

The *Training* worksheet allows users to designate which health providers will be trained to provide certain aspects of care. In primary health care settings, doctors traditionally provide brief interventions to patients to assist them to change behavior or assess patients' CVD risk (screen) and treat those who are diagnosed with elevated risk. However, HEARTS encourages a team-based care structure in which nurses (and/or CHWs) are trained to take on higher-level responsibilities.

Users may select up to three healthcare provider types—doctors, nurses, and CHWs—to receive training. Users are asked separately to designate which provider types will receive training to provide brief interventions to encourage behavior change and which will receive training to assess and treat patients based on total 10-year CVD risk. If a user indicates that nurses or CHWs will be trained for either, then the Tool assumes that those nurses or CHWs will take over and perform the task in place of the doctor that they work under.

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[4] The Tool assumes that every person in need of treatment receives it and is fully adherent to the prescribed treatment regimen (i.e. it does not currently account for the complex interplay of care accessibility, affordability, and acceptability—all of which play a role in patients' willingness to initiate and adhere to treatment).

A user's training selections have important implications for the Tool's cost estimates. The Tool assumes that:

1. The percent of patients eligible to be given counselling to change behavior, or to be screened and diagnosed for CVD risk, is proportionate to the number of health providers trained for that task. For instance, if 1,000 people who use tobacco present at a health center each year, but only 40 percent of health providers are trained to provide brief counselling (administer the 5 A's) to quit tobacco use, then the tool will assume only 400 of those tobacco users receive brief advice to quit.[5] The number of eligible patients may be viewed on the *H* and *E* worksheets.[6]

2. The cost of the provider time to counsel patients to change behavior or assess patient CVD risk is weighted according to the training ratios. Following the example above, if 50 doctors, 25 nurses, and 25 CHWs are trained to assess patients for CVD risk, the tool will assume that 50 percent of patients have their CVD risk assessed by doctors, 25 percent by nurses, and 25 percent by CHWs. Provider time and human resource costs may be viewed on the *H*, *E*, and *R* worksheets.[7]

3. A trained nurse or CHW takes over the specified task for the doctor that they work under, with resulting savings in human resource costs (given lower salaries for nurses and CHWs) in comparison to a hypothetical scenario in which a doctor would have carried out the role. The savings may be viewed on the *T* worksheet.

4.2.b. Worksheet structure

The *Training* worksheet (A1:N153) contains two sections that flow from the worksheet's top to bottom. In Section 2, users select which healthcare provider types—and how many providers—will receive training. Selections made in Section 2.1 link to Section 2.2.

Section 3 provides space for users to describe the resources (and costs) required to provide each type of training. In the boxes on the left-hand side of section 3, users enter the resources used to provide training. In the boxes on the right-hand side users enter the cost of those resources.

4.2.c. Instructions

In Section 2.1., selecting "Yes" or "No", users indicate whether doctors, nurses, and/or community health workers (CHW) will be trained to provide either of the two designated services. Conditional formatting turns on and off in Section 2.2 based on a user's selection of health providers for the two training types, indicating where additional information is sought.

Enter the number of each type of health professional that will be trained in 2.2. The number cannot exceed the number of doctors that work in the geographic area of interest—as entered by users on the *Initialize* worksheet. This limit is in place because the tool assumes a 1:1 replacement between doctors and nurses or CHWs—where a trained nurse or CHW is assumed to fully take over a task from the doctor that they work under.

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[5] It is assumed that the other 600 patients either a) do not encounter a trained healthcare provider and do not receive the intervention or b) encounter a healthcare provider who was previously trained (pre-HEARTS implementation) to provide the service—and thus that there is no new or additional service to be costed as a result of HEARTS implementation.

[6] Eligible for brief counselling 'H!M56:P62; Screening and diagnosis of CVD risk 'E!M56:P62; Treatment of 10-year CVD risk 'E!J58:K60.

[7] Provider time - 'H!K100:N104; 'E!C106:F111 & J106:M111; 'R!K100:N104. Provider costs - 'H!M69, M74, M79; 'E!F45; 'R!G40

As an example: with 100 doctors in a district, no more than 100 health providers can be trained to provide a given service. If only doctors were selected in Section 2.1, then 100 or fewer doctors could be trained. If doctors, nurses, and CHWs were selected, then the following combinations—among others— could be entered:

- 50 doctors, 25 nurses, and 25 CHWs can be trained.
- 0 doctors, 50 nurses, and 50 CHWs can be trained.
- 10 doctors, 20 nurses, and 5 CHWs can be trained.

In Section 3, users describe the specific resources required to train the healthcare providers. In 3.1, for training to provide brief interventions, users indicate: **1)** how many health professionals each training session will serve ("classroom size")[8] **2)** The number of training hours that are needed for health professionals to acquire the skillset; **3)** the number and type of staff who will lead each session; **4)** the number and type of materials that are required for each session, and; **5)** whether there are relevant facility, food, and/or per diem costs.

As users enter information in Section 3.1, conditional formatting will cause corresponding cells to turn blue in Section 3.2. Enter the per unit costs—described in pop-up boxes that emerge when users click on a blue cell—in these cells. After finishing Sections 3.1 and 3.2, users have completed the inputs that are used to cost training to provide brief advice.

Section 3.3 begins with a choice about how to cost training health providers to assess and treat CVD risk. "Cell G123 asks users whether they would like the Tool to assume the same resource use and costs as developed for trainings for brief advice or develop separate costs for CVD risk trainings. Selecting "Yes" in the dropdown box colorizes the section, inviting users to duplicate the process that they underwent to cost trainings to provide brief advice. Selecting "No" grays out the section. The Tool will assume the costs to train providers on CVD risk protocols are the same as those to train them to provide brief advice, and users may move on to the CVD Risk Treatment worksheet.

4.3.   CVD Risk Training worksheet

4.3.a.   Background

The *CVD Risk Treatment* worksheet sets the stage for users to frame the resources involved in patient care. The Global HEARTS Technical Guides to Healthy-lifestyle Counselling, Evidence-based Treatment Protocols, and Risk-based CVD management lay out envisaged patient touch points with the healthcare system, as well as pharmacological regimens for patients with hypertension or diabetes.

Users can indicate how much time healthcare professionals are expected to spend on specific tasks related to CVD screening and diagnosis. In addition, they can specify patient medication regimens: either indicating that patients follow HEARTS protocols or developing custom regimens that follow local treatment strategies or national or sub-national guidelines.

The Tool costs the following care pathway. The Tool assumes that all adults who present at a health center are assessed for CVD risk in the year of the analysis. Health providers take down patient history;

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[8] WHO recommends that class room sizes do not exceed 30. If following this recommendation, users should take care to ensure that the classroom size that they select is divides evenly into the number of providers that need to be trained. For example, if 40 health providers need to be trained, select a classroom size of 20 to create two separate training session of 20 health providers.

administer a basic physical exam and arrange diagnostic tests[9] to assess metabolic risk factors (i.e. hypertension, diabetes, and hyperlipidemia), and administer questions to assess behavioral risk factors (e.g. tobacco and alcohol use, and physical inactivity). Patients who report behavioral risk factors receive brief counselling (the 5 A's) to assist them to change behavior. Health providers analyze results from the screening process to determine total 10-year CVD risk and then report results to patients and discuss a care regimen (needed follow-up visits and/or pharmacological treatment) based on their CVD risk level. The Tool assumes that all patients attend all required follow-up visits and that they adhere to prescribed medication regimens.[10]

Human resource time devoted to screening and diagnosis is reported on the *H, E* and *R* worksheets. The costs of diagnostics, medications, equipment, and other supplies are costed on the *A* worksheet.

4.3.b. Worksheet structure

The *CVD Risk Treatment* worksheet (A1:BK204) contains five major sections that flow from left to right on the worksheet. In Section 4, users enter the amount of time (in minutes) that a health provider needs to screen, diagnose, and treat CVD risk, as well as the amount of time lab technicians need to administer and analyze diagnostic tests. In addition, users describe the resources required to deliver brief interventions that aim to change unhealthy behavior.

Sections 5 provides space for users to enter the diagnostic tests administered to all patients who present at the healthcare center in the year of the analysis. Sections 6 to 8 describe the pharmacological treatment regimens of individuals with hypertension, diabetes, or hyperlipidemia.

At the top of Sections 5 to 8, dropdown boxes allow users to select whether they would like to use the Tool's embedded (i.e. default) diagnostic or medication protocols or design their own custom protocol for the population in need. Selecting "default" colorizes the top part of a given sub-section for user entry, while selecting "custom" grays out the top sub-section, inviting users to enter information in the bottom sub-section where users can fill out the newly colorized protocol boxes to design their own custom protocol.

4.3.c. Instructions

Section 4 provides space for users to describe the amount of time that doctors, nurses, and/or CHWs spend screening, diagnosing, and treating patients with high CVD risk.

All patients who present at the health center in the year of the analysis are screened for CVD risk. Section 4.1 illustrates basic health provider tasks during the screening: 1) asking about patients' health history (all patients); 2) providing brief interventions to patients with behavioral risk factors (only patients who identify as tobacco users, harmful alcohol users, or who are physically inactive); 3) providing a physical exam (including relevant metabolic screenings) to assess patients' CVD risk, and 4) assessing patient risk using a CVD risk chart, counselling patients, and documenting results. In column J, enter the estimated time (in minutes) that a health provider will take to complete each task.

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[9] The default values for minutes to administer a physical exam assume that diagnostic tests are outsourced to a laboratory setting. However, users may assess a scenario in which point-of-care diagnostic tests are administered to patients. See instructions section.
[10] If desired, users may alter this assumption to account for real-world considerations that may prevent perfect adherence to prescribed regimens. See instructions section for details.

The Tool's default time estimate for "providing a physical exam" assumes that a basic physical exam is administered (including blood pressure measurement), and that assessing diabetes status and cholesterol levels is outsourced to laboratory staff (costed in Section 5).

> **Note**: In some settings, laboratory analysis may not be readily available, and users may instead wish to cost the human resources devoted to point-of-care testing. In this case, users should reconsider the time value entered in cell J53 for time to provide a physical exam.[11] Then, the physical exam would consist of blood pressure measurement and POC diagnostic testing for diabetes status and cholesterol levels. Users may enter the time to test for all three metabolic risk factors. Suggested time estimates for POC testing are included in the pop-up box that can be viewed by selecting K53.

Next, users may outline additional resources (i.e. informational materials) distributed to individuals who use tobacco, use alcohol harmfully/hazardously, or who are physically inactive for the "brief advice" intervention. Enter the number and cost of informational materials provided to each patient. An option is also provided for users to cost information campaigns or materials distributed digitally.

Section 4.2 covers outpatient visits prescribed by CVD risk level, and the human resources required to administer those visits. For example, under the follow-up visits section, if, after screening, a patient diagnosed with CVD risk ≥10% and <20% should follow up at the primary care level two more times in the coming year, enter "2". Note that the Tool assumes that all patients at that CVD risk level will adhere to the recommendation and present for two follow-up visits. Users who wish to build in non-adherence can simply input the weighted average of the projected visits. For example, if 60 percent of the those at the CVD risk level will attend two visits, 30 percent will attend 1, and 10 percent will attend 0, enter 1.5.[12]

Finally, users describe who is envisaged to attend to the patient during follow-up visits by specifying how many minutes each health care provider type will spend with the patient.

Section 5 assesses the cost of diagnosing diabetes status and cholesterol levels. In Section 5.1, the tool shows basic blood and urine diagnostic tests that a patient may receive during an initial visit. Users who wish to administer this basic testing protocol may select "Use default protocol" in cell R49. In this case the tool assumes that 100 percent of individuals who present at health centers receive one diabetes test (users may choose between fasting blood glucose tests, random blood glucose tests, and A1C tests using the dropdown list in R55), one blood lipid panel to assess cholesterol, and one urine analysis. The tool pulls user entered costs from the *Initialize* tab into U55:U57 and calculates the cost per patient. As previously mentioned, the Tool assumes that samples for these tests are collected and analyzed by laboratory staff. Users enter the amount of time that laboratory staff spend on these tasks for blood and urine tests in cells U63:64.

Protocols in some areas may dictate that a different set of diagnostic tests is administered to patients to screen and diagnose CVD risk. To cost a different protocol, select "Design a custom protocol" in cell R49. Section 5.2 will colorize; cell Q71 highlights blue to indicate where the first information is required. Under "Target" enter the risk factor that the diagnostic test is meant to assess (e.g. diabetes). A dropdown box provides choices for users to select (i.e. diabetes, cholesterol, other). Based on the user's

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[11] Note: in Section 5.1, users would also enter "0" for the lab technician time to administer and analyze each type of test—cells U63:U64, or if a custom protocol is selected, they would enter "0" by any diagnostic test NOT analyzed by a lab technician in cells S82:S89.

[12] (2*0.6)+(1*0.3)+(0*0.1)/(0.6+0.3+0.1)=1.5

selection, a second dropdown box will populate cell R71. Users may select from the suggestion list, or enter a different diagnostic test.

Next, enter the # of tests that a patient will receive during their initial screening (e.g. one fasting blood glucose test) and the percent of patients who will receive the one test (e.g. 100%). Enter the per unit purchasing price (in local currency units) of the diagnostic test and the tool will calculate the cost per case in the final column of the table. Users may proceed to enter additional tests if desired.

While this section is generally meant to cost the diagnostic tests administered during an initial screening visit, some users may also wish to assess the cost of additional diagnostic test for patients who are diagnosed with a given condition and need additional tests to monitor their condition over the course of a year. In this case, enter the diagnostic tests on a separate line. For example, if an individual with diabetes needs four fasting blood glucose tests per year, enter "4" in the *# of units* column. Then, since only individuals with diabetes will receive the additional 4 tests, enter the percent of all individuals who present at a health center who are diagnosed with diabetes in the *% receiving* column.[13]

After completing a row in Section 5.2, the diagnostic test will appear in section 5.2.a, where users are asked to enter the laboratory staff time to collect and analyze the test.

In Section 6, users set the pharmacological treatment regimens that is prescribed to patients with hypertension. Like Section 5, users may choose to use a default protocol or design their own protocol (cell AB44). If users choose the default protocol option, they may select from several default protocols (cell AF48) in which different medication classes—diuretics, calcium channel blockers (CCB), or Angiotensin-converting enzyme (ACE) inhibitors and Angiotensin Receptor Blockers (ARBs)—serve as the first-line treatment. Or users may choose to initiate patients on two or medication classes.

Selecting a first-line treatment populates the tables labeled "Hypertension Protocol Step" with a specific HEARTS protocol and pulls up a corresponding picture from the Global HEARTS Technical Guide to Evidence-based Treatment Protocols (see AJ51:AM87) that illustrates the treatment regimen. In general, the titration process is such that patients initiate on one to two medications at low doses. Patients who do not exhibit side effects and show non-responsiveness to the medication (i.e. the medication regimen does not control their blood pressure) move on to the next protocol step to receive an intensified regimen (e.g. a higher dose, additional medication, or both).[14]

Figure 5 shows the first two steps of a protocol in which diuretics are the form of first-line treatment. Patients initiate their regimen taking one diuretic. Selecting the medication name pulls up a dropdown list from which users may select different diuretic medications (e.g. Chlorthalidone, Indapamide SR)—providing some customization option to allow users to select the medications that are used in their area. Unit indicates the medications strength (e.g. 12.5mg). Then, the number of times per day and number of days per year that a patient takes the medication. Unit per case is the calculated number of 12.5 mg

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[13] Note: The Tool does not incorporate diagnostic tests' specificity and sensitivity—nor real world considerations such as the way in which failure to adhere to best-practice may lead to false positive or false negatives. Thus, if an individual with diabetes receives a diagnostic test, they are assumed to correctly be diagnosed with diabetes. Further, it is assumed that all diagnosed individuals adhere to the prescribed treatment regimen and will present at health centers for requisite follow up visits. Under these assumptions, a user can enter the diabetes prevalence from the Initialize worksheet ('Initialize!H49) in the *% receiving* cell. The Tool will then cost the additional diagnostic tests only for the population with diabetes.

[14] While the HEARTS protocols move patients forward to a new protocol step after assessing progress month-to-month, for costing purposes the Tool assumes that a user is in their final protocol step for the entire year.

tablets of Chlorthalidone that a Pattie takes per year (Times per day * Days per Case). The tool pulls user entered costs from the *Initialize* tab ('Initialize!H85:H96) into the unit cost cell and multiples units per case by the unit cost to arrive at the cost per case.

Figure 5. Diuretics as a form of first-line treatment

Cells highlighted green show the proportion of all patients with hypertension who receive the regimen specified in the protocol step. For example, 41 percent of individuals with hypertension are on a monotherapy regimen (Chlorthalidone only), while 12.5 percent advance to dual therapy in which Lisinopril is added to the initial Chlorthalidone dose. The source of the displayed distributions is discussed in Appendix III. Users may wish to alter the distributions. Reasons for doing so may include to account for the fact that a proportion of hypertension patients may be able to manage their condition with behavioral changes, or to build in non-adherence to medication regimens.[15]

Users who wish to design their own custom protocols should select that choice in cell AB44, and then proceed to fill out the protocol steps in Section 6.2 (AA103:AH204). Users need fill out only as many protocol steps as relevant (i.e. there is no need to provide information in as many boxes as are provided).

Section 7 and Section 8 provide space for users to select default regimens or design custom regimens for patients with diabetes and hyperlipidemia[16]. Users who wish to cost these regimens should proceed to fill out the sections. Unlike for hypertension, multiple default regimens are not available for diabetes or hyperlipidemia.

5. Results worksheets

Based on entered data in the user input tabs, the *Results* worksheets display calculated costs and estimates of the health provider time to administer HEARTS protocols. Appendix X reports calculations underlying the cost estimates.

The *H*, *E*, *A*, *R*, *T*, and *S* worksheets separate costs by HEARTS component. For example, users can see all costs associated with healthy lifestyle counselling on the *H* worksheet. **Table 2** reviews default cost

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[15] The tool assumes that all individuals with a given metabolic risk factor receive pharmacological treatment. i.e. it does not currently consider patients lost-to-follow-up in the cascade of care caused by issues with care availability, affordability, and acceptability. Thus, all individuals who are diagnosed with a metabolic risk factor are prescribed a treatment regimen and are assumed to adhere to that regimen.

[16] The default protocol for hyperlipidemia derives from the American Heart Association's 2018 Guidelines on Management of Blood Cholesterol.

categories included in the Tool and describes where various cost types are reported by HEARTS component. The *Summary* tab displays the overall cost of the HEARTS program.

Table 2. Worksheets reporting costs for specific categories

Cost category	H	E	A	R	T	S
Health personnel (doctor, nurse, CHW, lab tech)	x	x		x		
Savings in health personnel costs due to task shifting					x	
Medicines, diagnostics, equipment, and supplies		x	x			
Other personnel						x
Supply chain			x			
Training	x			x		

At the top of all Results worksheets a text box provides a description of the worksheet page (including explanation of any additional information that needs user input), background on the HEARTS component that is being costed on the worksheet, basic assumptions made in the cost calculations, a table containing the HEARTS components total cost—also broken down by subcomponents—, and a cell containing a drop-down list that lets the user switch between a display of costs using the Tool's default data versus costs using data entered by the user.

5.1.   The *Healthy Lifestyle Counselling*, *Evidence-based protocols*, and *Risk-based CVD management* worksheets (*H*, *E*, and *R*)

Based on values previously entered on the *Training* worksheets, the *H* and *R* worksheets begin by reporting the number of health providers trained to provide brief advice to address unhealthy behaviors or to screen and diagnose CVD risk. In addition, based on values entered on *Initialize* and *Training*, the *H*, *E*, and *R* worksheets report the number of patients eligible to be screened, diagnosed, and treated for a given condition.

For example, **Figure 6** illustrates how the Tool winnows down the population receiving treatment. Consider the results for a user who entered that the area of interest contains 6,147 adults, 70 percent of whom (4,303) will visit a primary care center in the year of the analysis. Around half of all doctors were trained to provide brief advice, meaning that all things being equal, the 4,303 adults have a 50 percent chance of encountering a trained health provider who will ask patients about their lifestyle—i.e., 2,151 adults eligible to receive brief advice. Assuming that there is no difference between individuals who present at a health center versus those that do not—e.g., that tobacco users are as likely to present as non-tobacco users—the trained health provider will encounter tobacco users, individuals who use alcohol harmfully, and those who are physically inactive in proportion to their population prevalence. Thus, for example, when trained health providers query 2,151 adults about tobacco use, with tobacco use prevalence at 9.2 percent, 198 tobacco users will respond that they are tobacco users triggering the remainder of the 5A's intervention.

Figure 6. Funnel of population in need of healthy lifestyle counselling

Providing brief counselling
Population in Need (treatment cascade)

Adult population
6,147
↓
Adults who present at health center
4,303
↓
Eligible to receive brief advice
2,151

Tobacco users   Physically inactive
198   955
Harmful alcohol
144
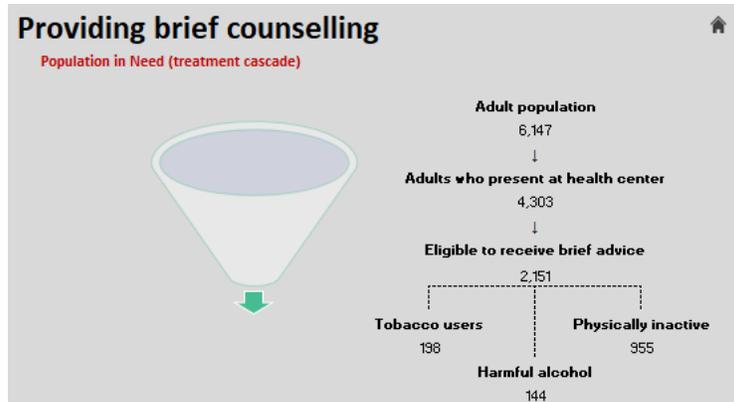
Similarly, the funneling of the population that is screened, diagnosed, and treated for various levels of CVD risk and for specific risk factors is depicted on the E and R worksheets.

Drawing on the summaries of the population receiving treatment or training, the worksheet reports costs of individual resources. In addition, the tool summarizes the total health provider time spent on a given task. For example, in the above example, trained health providers encounter 198 tobacco users, 144 harmful users of alcohol, and 955 individuals who are physically inactive. If it takes an average of 16.5 minutes to administer the 5 A's to these individuals, trained health providers will spend a total of 21,406 minutes or nearly 45 working days on the task.

Finally, to consider costs that are unaccounted for in the Tool, the *H*, E, and R worksheets have sections titled "Other costs" ('H!R47:W59 'E!O52:U64 'R!Q46:W58). Cells are highlighted blue, inviting user input. If there are other anticipated costs associated with these HEARTS components, enter them here and the Tool will add them to the sub-totals at the top of the worksheet.

5.2.   The Access to Medicines worksheet (*A*)

Based on values entered on the *Initialize* and *CVD Risk Treatment* worksheets, the *A* worksheet reports the total cost of medications and diagnostics. In addition, the worksheet provides space for users to quantify costs that are not automatically considered by the Tool, including medications, diagnostics, equipment, supplies, medication disposal, and others.

The worksheet begins by summarizing the costs of antihypertensive, diabetes, and lipid-lowering medications. The Tool pulls the default or user-developed protocols from the CVD Risk Treatment worksheet and summarizes how many of each medication (by strength) is required based on the population in need of treatment. The tool initially displays up to 10 medications for each risk factor. If more medications are considered in the analysis, users may click the "+" sign at the left of the screen to reveal additional rows.

Figure 7 illustrates antihypertensive medication costs. The table lists the included medications names, category, form, and strengths. The Tool pulls in the unit price entered on the *Initialize* tab, and then calculates the quantity of the medicine strength that is needed based on the number of adults with hypertension, and the distribution of those adults within the protocol steps on the CVD Risk Treatment tab. If users entered that a surplus safety stock is required, the Tool factors in the additional quantity needed to meet the obligation. If users wish to take into account that local storage facilities already

have some quantity of the medication on hand, they can enter the amount in the "safety stock currently available" column. For example, the estimated annual demand for 12.5 mg Chlorthalidone tablets is 51,606 tablets (factoring in safety stock), but 500 tablets already have been purchased and are available on local shelves. Entering 500 leads the Tool to subtract 500 from 51,606, leading to a final estimate of 51,106 tablets that need to be purchased to meet demand. The quantity is multiplied by the unit cost to calculate the total cost of the medication strength.

Figure 7. Illustration of safety stock calculations

Calculated costs

Medicines and Technologies	Category	Form	Unit/strength	Unit price	Quantity required based on target population	Required amount (factoring in safety stock)	Safety stock currently available at the facility	Total required	Cost
Medicines and Supplies									
Antihypertensive medications									
Chlorthalidone	Drug	Tab	12.5 mg	0.05	49,149	51,606	500	51,106	2,441
Lisinopril	Drug	Tab	20 mg	0.10	51,852	54,445	0	54,445	5,702
Amlodipine	Drug	Tab	5 mg	0.04	8,355	8,773	0	8,773	337
Amlodipine	Drug	Tab	10 mg	0.07	8,355	8,773	0	8,773	629
							0		
							0		
							0		
							0		
							0		
							0		
								Subtotal	9,108

Costs are similarly calculated for diabetes medications, lipid-lowering medications, and diagnostics. Below these tables, in "Other Costs" section, a list of common NCD medications, diagnostic technologies, and supplies is provided to prompt users to account for any resources that are not automatically counted by the Tool. Users may enter the unit price of any additional resources that they wish to cost, and the number of the resource required based on the population in need.

A few resources are capital investments with a useful life extending well beyond the year of the analysis. Following financial accounting principles, some users may wish to annuitize these costs over the life of the product rather than account for the total cost of the product in one year. Annuitization allows users to account for the decreasing value of their capital cost input (i.e., the useful life of equipment is finite, and the value of equipment is spread out over several years).

Users who do wish to annuitize capital costs may select "Yes" in cell M224. For example, a medication storage refrigerator that costs 20,000 local currency units (LCU) has a useful life of 10 years. If users select annuitize costs, instead of pulling LCU20,000 into the cost column, the Tool will use a *straight-line depreciation* approach (i.e. total costs divided by the years of useful life of the product) to calculate the costs of a capital outlay on an annual basis—LCU 2,000 for the refrigerator (LCU 20,0000/10 years).

Figure 8. Illustration of annuitization of capital costs

Diagnostic technologies, machines, and supplies	Category	Form	Useful life (yrs)	Unit price (LCU)	Quantity required based on target population	Required amount (factoring in safety stock)	Safety stock currently available at the facility	Total required	Cost (LCU)
Thermometer	Diagnostic tool	each	5			Not applicable		0.00	0
Stethoscope	Diagnostic tool	each	5			Not applicable		0.00	0
Blood pressure measurement device	Diagnostic tool	each	6			Not applicable		0.00	0
Measurement tape	Diagnostic tool	each	5			Not applicable		0.00	0
Weighing machine adult	Diagnostic tool	each	10			Not applicable		0.00	0
HbA1c Test Kit	Diagnostic tool	each				Not applicable		0.00	0
HbA1c Test Strips	Supply	test strip	.			0.00		0.00	0
Glucometer	Diagnostic tool	each	8			Not applicable		0.00	0
Finger prick needles for glucose test	Supply	each	.			0.00		0.00	0
Blood glucose test strips	Supply	test strip	.			0.00		0.00	0
Urine protein test strips	Supply	test strip	.			0.00		0.00	0
Urine ketones test strips	Supply	test strip	.			0.00		0.00	0
Blood cholesterol assay	Diagnostic test	test	.			Not applicable		0.00	0
Lipid profile	Diagnostic test	test	.			Not applicable		0.00	0
Serum creatinine assay	Diagnostic test	test	.			Not applicable		0.00	0
Troponin test strips	Supply	test strip	.			0.00		0.00	0
Urine micro albuminuria test strips	Supply	test strip	.			0.00		0.00	0
Tuning fork	Diagnostic tool	each	.			Not applicable		0.00	0
Electrocardiograph (ECG)	Diagnostic tool	each	7			Not applicable		0.00	0
Electrodes for ECG	Supply	set	.			0.00		0.00	0
Electrode gels	Supply	tube	.			0.00		0.00	0
Defibrillator	Machine	each	5			Not applicable		0.00	0
Centrifuge	Machine	each	7			Not applicable		0.00	0
Storage Refrigerator	Machine	each	10	20,000.00	1.00	Not applicable		1.00	2,000
Enter other diagnostic technologies/machines/supplies here									
Enter Diagnostic Technology/Machine/Supply						Not applicable		0.00	0
Enter Diagnostic Technology/Machine/Supply						Not applicable		0.00	0
Enter Diagnostic Technology/Machine/Supply						Not applicable		0.00	0
Enter Diagnostic Technology/Machine/Supply						Not applicable		0.00	0
							Subtotal		2,000

Annutize capital costs?
Yes

Finally, users have the option to add costs for any additional tools to facilitate HEARTS, medication disposal, and other relevant miscellaneous costs.

5.3. The **T**eam-based care worksheet (*T*)

Unlike other Results worksheets, the *T* worksheet calculates cost-savings rather than the financial costs of implementing or operating HEARTS. For this reason, the Tool offers users an option to turn off the worksheet (cell M44) and forgo incorporating the results in the final estimations on the *Summary* worksheet.

If, on the *Training* worksheet, users indicated that nurses or CHWs are trained for a perform a given task, then the T worksheet estimates the cost savings of having the lower-level health worker perform the task in place of a doctor. The Tool assumes that a trained Nurse or CHW takes over the task full-time for the doctor that they work under. Calculating how many nurses or CHW's are operating in place of doctors and how long they spend providing brief advice to patients, the Tool calculates the cost of the lower-level health worker performing the task compared to a hypothetical scenario in which a doctor had performed the task. The difference represents savings in cost from task-shifting.

5.4. The Systems for monitoring worksheet (S)

The S worksheet provides space for users to build out a programmatic approach to monitor and evaluate (M&E) HEARTS, including through development of paper-based or electronic monitoring systems.

While future iterations of the Tool may build a framework for estimating the resources required to conduct M&E and attendant costs, default estimates are not currently provided. Users may build a programmatic vision of who will participate in M&E and the resources that they will require to effectively assess the roll-out and operation of HEARTS.

For example, Figure X shows a hypothetical example where a Program Director will devote five percent of their time to managing M&E, a program manager 10 percent, and an IT worker will manage an electronic information system full-time. The Tool multiplies the full-time equivalent by the workers' annual salaries to estimate the human resource costs of a team dedicated to M&E. Users may also enter technology and other costs to facilitate M&E.

Figure 9. Programmatic costs

Resources

Cost categories	FTE quantity (user)	Quantity (default	Unit	Cost (LCU) per unit	Total cost (LCU)
Human resources					
Program Director	0.05		employee	63,059	3,153
Program Manager	0.1	0	employee	42,008	4,201
Medical Officer/Doctor		0	employee	68,207	0
Administrative Assistant		0	employee	19,652	0
Clerical Officer		0	employee	32,309	0
Secretary		0.0	employee	32,309	0
IT Personnel	1	0	employee	25,945	25,945
Statistician		0	employee	42,008	0
Enter 'Other'			employee		0
Enter 'Other'			employee		0
Enter 'Other'			employee		0
				Subtotal	33,298
Technology					
Computer			computer		0
Software			package		0
Enter 'Other'					0
Enter 'Other'					0
Enter 'Other'					0
				Subtotal	0
Supplies					
Enter 'Other'					0
Enter 'Other'					0
Enter 'Other'					0
Enter 'Other'					0
Enter 'Other'					0
				Subtotal	0
Training					
Training cost			Enter total cost of training (LCU) --->		

6. Appendices

6.1.　HEARTS Costing Tool Parameters

Table A1. Country-Specific Variables

Variable Definition	Excel-based variable name	Location (Worksheet: Cells)	Default Sources
Economic Variables			
Country Name	Country	Default Variable: B25-B40	Note: Bolded names have STEP Surveys.
Income Status (2020)	Income Status	Default Variables: C25-C40	The World Bank. (2020). World Bank Country and Lending Groups for the Fiscal Year 2020. Retrieved from <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>. Accessed 2/11/2020
Gross Domestic Product per Local Currency Unit (2018)	GDP (2018) per capita (LCU)	Default Variables: D25-D40	World Bank Database. GDP per capita (current LCU). Accessed 2/11/2020. <https://data.worldbank.org/indicator/NY.GDP.PCAP.CN>
Local Currency Unit	Currency	Default Variables: E25-E40	
Official exchange rate (LCU per US$, period average), converted manually to USD per LCU.	Conversion to USD 2018	Default Variables: F25-F40	World Bank Database. Official exchange rate (LCU per US$, period average), converted manually to USD per LCU. Accessed 2/11/2020. <https://data.worldbank.org/indicator/PA.NUS.FCRF?end=2018&start=2016>
Health Personnel			
Doctor Annual Wages Annual compensation for the specified healthcare provider including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Doctor Annual Wages WagesDoctor	Default Variables: G25-G40	Source: Serje J, Bertram MY, Brindley C, Lauer JA. Global health worker salary estimates: an econometric analysis of global earnings data. Cost Eff Resour Alloc. 2018;16:10. Published 2018 Mar 9. doi:10.1186/s12962-018-0093-z. Table 4.<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5845154/> Note: GDP per capita x healthworker-specific GDP-per-capita multiplier

Health Worker/ LabTech/ Administrative Staff Annual Salary **Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)**	Health Worker/ LabTech/ Admin Annual Salary WagesCHW	Default Variables: H25-H40	Source: Serje J, Bertram MY, Brindley C, Lauer JA. Global health worker salary estimates: an econometric analysis of global earnings data. Cost Eff Resour Alloc. 2018;16:10. Published 2018 Mar 9. doi:10.1186/s12962-018-0093-z. Table 4.<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5845154/> Note: GDP per capita x healthworker-specific GDP-per-capita multiplier
Nurse Annual Wages **Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)**	Nurse Annual Wages WagesNurses	Default Variables: I25-I40	Source: Serje J, Bertram MY, Brindley C, Lauer JA. Global health worker salary estimates: an econometric analysis of global earnings data. Cost Eff Resour Alloc. 2018;16:10. Published 2018 Mar 9. doi:10.1186/s12962-018-0093-z. Table 4.<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5845154/> Note: GDP per capita x healthworker-specific GDP-per-capita multiplier
Program Supplies			
Computer	Computer	Default Variables: K25-K40	
Diagnostics	Fasting blood glucose test, blood lipid panel, urine test	Lists: AD12:AF17	Pharmacological regimens and unit prices – UN interagency OneHealth Tool
Leaflets (each)	Leaflets (each)	Default Variables: J25-J40	
Medications	10 anti-hypertensive medications; three oral diabetes medications; two lipid-lowering medications	Lists: B12:S72 & W12:AA47	**Pharmacological regimens** – Hypertension, Diabetes: Global HEARTS Evidence-based Treatment Protocols Cholesterol - *2018 Guideline on the Management of Blood Cholesterol.* Journal of the American College of Cardiology, 2019. **73**(24): p. e285-e350. **Unit prices** – See Appendix IV
Software System	Software System	Default Variables: L25-L40	
Useful life of medical equipment	Thermometer, stethoscope, BP measurement device, weight scales, electrocardiograph,	*A* worksheet E224:E247	Source: American Hospital Association, 1998, 'Estimated Useful Lives of Depreciable Hospital Assets', American Hospital Association, Chicago, USA.

	defibrillator, centrifuge, storage refrigerator		<http://www.open.edu/openlearncreate/pluginfile.php/23096/mod_oucontent/oucontent/404/none/none/hctguide2annex3.pdf?forcedownload=1>
Non-Clinical Personnel			
Statistician Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Statistician Yearly Salary WagesStatistician	Default Variables: M25-M40	
Program Director Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Program Director Salary WagesProgramDirector	Default Variables: N25-N40	
Program Manager Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Program Manger Salary WagesProgramManager	Default Variables: O25-O40	
Accountant Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Accountant Salary WagesAccountant	Default Variables: P25-P40	
Supplies Manager Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Supplies Manager Salary WagesSupplyManager	Default Variables: Q25-Q40	
Custodian/ Security Officer Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Custodian/ Security Officer Salary WagesCustodian	Default Variables: R25-R40	

IT Staff Member Annual Salary Annual compensation for the specified personnel including **salary/wages and** **any benefits (e.g., health insurance, retirement, etc.)**	IT Yearly Salary WagesIT	Default Variables: S25-S40	
Pharmacist/Chemist Annual **Wages** Annual compensation for the **specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)**	Pharmacist/Chemist Annual Wages WagesPharmacist_Ch emist	Default Variables: T25-T40	
Prevalence of CVD Risk Factors			
Prevalence of Insufficient **Physical Activity for Adults** **(18+ years old), Both Sexes** **(Crude, Base Estimate) (%)** (2016) Percent of defined population attaining less than 150 minutes of moderate-intensity physical activity per week, or less than 75 minutes of vigorous- intensity physical activity per week, or equivalent.	Prevalence of insufficient physical activity adults, 18+, both sexes (crude, base estimate) (%) - 2016 PhysInactivityPrevale nce	Default Variables: U25-U40	WHO Global Health Observatory. "Prevalence of insufficient physical activity among adults, Data by country", Accessed 12/27/2018. <http://apps.who.int/gho/data/node.mai n.A893?lang=en>
Prevalence of Alcohol Use **Disorders for Adults (15+ years** **old), Both Sexes (%)** (2016) Including alcohol dependence ("whereby the drinker's self- control over his or her drinking is impaired, often involving alcohol-induced mental disorders such as depression or psychoses") and harmful use of alcohol ("defined according to the national context as alcohol per capita consumption within a calendar year in litres of pure alcohol").	Prevalence of alcohol use disorders, adults age 15+, both sexes (%) - 2016 AlcoholPrevalence	Default Variables: V25-V40	WHO. (2018). Global Status Report on Alcohol and Health. Country Profiles. <http://apps.who.int/iris/bitstream/handl e/10665/274603/9789241565639- eng.pdf?ua=1>
Tobacco Use Prevalence for **Adults (15+ years old), Any** **Tobacco Product** Prevalence rates were **extracted for all tobacco** **products, unless otherwise** **noted. Some data given as** **male and female prevalence** **rates. Used 2018 World Bank**	Tobacco use prevalence, any tobacco product, age 15+ TobaccoPrevalence	Default Variables: W25-W40	2019 tobacco country profiles latest country survey estimates <https://www.who.int/news/item/19-12- 2019-who-launches-new-report-on- global-tobacco-use-trends>

ratio of females to males to calculate prevalence across both sexes.			
Prevalence of Raised Blood Pressure among Individuals (40+ years old) **Raised Blood Pressure is defined as Systolic Blood Pressure ≥140 or Diastolic Blood Pressure ≥80.** Weighted averages of the data taken with 2015 population figures to arrive at overall prevalence for the population.	Prevalence raised blood pressure (SBP≥140 or DBP ≥80) HypertensionPrevalence	Default Variables: X25-X40	Age-specific data obtained from emailed correspondence with NCDRisC.org. http://ncdrisc.org/index.html
Prevalence of Diabetes among Individuals (40+ years old) **Weighted averages of the data taken with 2015 population figures to arrive at overall prevalence for the population.**	Prevalence diabetes DiabetesPrevalence	Default Variables: Y25-Y40	Age-specific data obtained from emailed correspondence with NCDRisC.org. http://ncdrisc.org/index.html
Prevalence of Hyperlipidemia among Individuals (25+ years old) (%) **Hyperlipidemia is defined as raised total cholesterol (≥6.2 mmol/L)**	Prevalence of hyperlipidemia HyperlipidemiaPrevalence	Default Variables: Z25-Z40	Unless otherwise noted, Global Health Observatory. (2008). Raised total cholesterol (≥6.2 mmol/L) Data by country. Accessed 5/16/2019. Age 25+ <http://apps.who.int/gho/data/node.main.A887?lang=en>
Prevalence of Cardiovascular Disease Risk of 0-<10%	CVD Risk 0 - <10% LowCVDRiskPrevalence	Default Variables: AA25-AA40	Data embedded in the Tool is derived from Figure 4 in: World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health, 2019. 7(10): p. e1332-e1345. Note: All highlighted cells are country specific. Other cells are regional averages. No averages found for Central or Andean Latin America. For these regions, southern Latin America figures are used.

Prevalence of Cardiovascular Disease Risk of 10-<20%	CVD Risk 10 - <20% MediumCVDRiskPrevalence	Default Variable: AB25-AB40	Data embedded in the Tool is derived from Figure 4 in: World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health, 2019. 7(10): p. e1332-e1345. Note: All highlighted cells are country specific. Other cells are regional averages. No averages found for Central or Andean Latin America. For these regions, southern Latin America figures are used.
Prevalence of Cardiovascular Disease Risk of ≥20%	CVD Risk ≥ 20% HighCVDRiskPrevalence	Default Variables: AC25-AC40	Data embedded in the Tool is derived from Figure 4 in: World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. Lancet Glob Health, 2019. 7(10): p. e1332-e1345. Note: All highlighted cells are country specific. Other cells are regional averages. No averages found for Central or Andean Latin America. For these regions, southern Latin America figures are used
Health System Variables			
Density of Physicians (per 10,0000 population) Includes generalists, specialist medical practitioners and medical doctors not further defined, in the given national and/or subnational area. Depending on the nature of the original data source may include practicing (active) physicians only or all registered physicians. The ISCO-08 codes included here are 221,2211,2212	Density of physicians (per 10,000 population)	Default Variables: AD25-AD40	WHO. (2019). Density of physicians (per 10,000 population). Global Health Observatory. Retrieved from <http://apps.who.int/gho/data/node.main.HWFGRP_0020?lang=en>. Accessed May 12, 2020 Note: All data from 2018 unless otherwise noted
Density of Nurses (per 10,000 population) Number of nursing and midwifery personnel includes nursing personnel and midwifery personnel in the given national and/or subnational area. Depending on the nature of the original data source may include practicing (active) nursing and	Density of nurses (per 10,000 population)	Default Variables: AE25-AE40	WHO. (2019). Density of nursing and midwifery personnel (per 10,000 population). Global Health Observatory. Retrieved from <http://apps.who.int/gho/data/node.main.HWFGRP_0040?lang=en>. Accessed May 12, 2020 Note: All data from 2018 unless otherwise noted

midwifery personnel only or all registered nursing and midwifery personnel The ISCO -08 codes included here are 2221,2222,3221,3222			
Density of Community Health Workers Includes community health workers in the given national and/or subnational area. Depending on the nature of the original data source may include practicing (active) only or all registered in the health occupation. The ISCO -08 codes that relate to this occupation is 3253.	Density of CHWs (per 10,000 population)	Default Variables: AF25-AF40	PHCPI. (2019). Community and traditional health worker density (per 1,000 population). Original source WHO Global Health Data Observatory. Retrieved from <https://improvingphc.org/indicator/community-and-traditional-health-worker-density-1000-population#?loc=&viz=0&ci=false>. Accessed April 1, 2019 Note: Data was only available for some countries, and only for LIC, LMIC, and UMIC countries. The data in this column is the average of income groups among the countries included in the PHCPI data source. Countries for which country-specific information was pulled are noted. HIC countries are assumed to have the same density as UMIC countries.
Demographics			
Total Population (Count), Both Sexes Combined, (40+ years old) Population projections for 2020.	Population Age 40+	Default Variables: AH25-AH40	United Nations Population Division. (2017). World Population Prospects: the 2017 Revision - Total Population (both sexes combined) by five-year age group, Medium Variant projection for 2020. Retrieved from <>. Accessed April 1, 2019.
Districts in Country (Count)	Districts	Default Variables: AJ25-AJ40	WHO NCD Costing Tool
Training Staff and Supplies			
Professional Health Educator/Trainer Annual Salary Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)	Annual professional Health Educator/Trainer	Default Variables: AK25-AK40	

Personnel Secretary/Assistant/Receptionist Annual Salary **Annual compensation for the specified personnel including salary/wages and any benefits (e.g., health insurance, retirement, etc.)**	Annual salary personnel secretary/assistant/receptionist WagesAdminAssistant	Default Variables: AL25-AL40	
Per Diem and Travel Allowances (Unit Cost Per Day) **National level estimates for trainers and support staff, in local currency units.**	Per diem and travel allowances (unit cost per day)	Default Variables: AM25-AM40	Estimates from WHO NCD Costing Tool, which is updated following methodology adopted from Shang et al (2018). Shang et al (2018). PLoS One. 2018 Oct 3;13(10):e0204903. doi: 10.1371/journal.pone.0204903. eCollection 2018.
Price of Ream of Paper (500 Sheets)	Ream of paper (500 sheets)	Default Variables: AN25-AN40	Price from the WHO NCD Costing Tool. All costs updated using Shang and colleagues' methodology.
Price of Black Ink Printer Cartridge	Black ink printer cartridge	Default Variables: AO25-AO40	Price from the WHO NCD Costing Tool. All costs updated using Shang and colleagues' methodology.
Daily Rental Cost Per Square Meter (National-level)	Cost per square meter (daily)	Default Variables: AP25-AP40	Cost per month is sourced from the WHO NCD Costing Tool, and the number is then divided by 30.42 to approximate cost per day. While this cost is more applicable to long-term rentals, it is used as a proxy for short-term day to day rentals for lack of other data.

Table A2. Global HEARTS Program Variables

Variable definition	Excel-based variable name	Location (Worksheet: Cells)	Default Source
Initialize Tab Assumptions			
Percent of adults that visit a health center at least once annually (age 15+)	AttendanceRateUser	Default Variables: G48	Source: Derived from assumptions used in WHO analyses <https://www.who.int/ncds/governance/tobacco_use.pdf?ua=1> Note: 50% of adults will see a general practice provider in a given year, and that these adults are representative of the overall population
Training Assumptions			
Classroom Size	ClassroomSizeDefault	Default Variables: G51	Source: WHO. Strengthening health systems for treating tobacco dependence in primary care: Part III: Training for primary care providers. Building Capacity for Tobacco Control/Training Package . <https://www.who.int/iris/bitstream/10665/84388/4/9789241505413_eng_Part-III_service_providers.pdf?ua=1> Note: "It is recommended that the workshop should be conducted with a maximum of 30 participants."
Time needed for training (hours)	TrainingHoursDefault	Default Variables: G52	WHO. Strengthening health systems for treating tobacco dependence in primary care: Part III: Training for primary care providers. Building Capacity for Tobacco Control/Training Package. <https://www.who.int/iris/bitstream/10665/84388/4/9789241505413_eng_Part-III_service_providers.pdf?ua=1> Note: Sample WHO curriculums for training for healthcare professionals to provide brief advice to quit tobacco use indicate that 2.5 days (20 hours) are required. For training to provide brief interventions to facilitate behavior change: Given that HEARTS protocols ask health professionals to also provide advice not only for tobacco users, but to individuals who use alcohol harmfully and/or are physically inactive, the default assumption of 20 hours is multiplied by a factor of 2.5 (Instead of multiplying by a factor of 3-

			-accounting for three times the subject matter to cover three risk factors--the default estimate assumes that some efficiencies exist after professionals have already learned the 5A's technique for one of the risk factors). "...the duration of the training workshop is 2.5 days. However, the duration and detail covered in each module should be adapted to the needs of the participants. Their needs will depend on their experience and knowledge of the issue, the availability of intensive tobacco dependence treatments, the pattern of tobacco use in the country, and the infrastructure of their health system."
Number of trainers	NumberofTrainersDefault	Default Variables: G53	
Number of admin staff	NumberofAdminStaffDefault	Default Variables: G54	
Number of instructional handbooks	NumberofAdminStaffDefault	Default Variables: G55	Note: One per health provider attending the session
Number of agendas	TrainingNumberofAgendasDefault	Default Variables: G56	Note: One per health provider attending the session
Refreshments per eight hours of training	RefreshmentsPerTrainingDay	Default Variables: G63	WHO. Strengthening health systems for treating tobacco dependence in primary care: Part III: Training for primary care providers. Building Capacity for Tobacco Control/Training Package. <https://www.who.int/iris/bitstream/10665/84388/4/9789241505413_eng_Part-III_service_providers.pdf?ua=1> Note: A sample agenda for the training workshop of 2.5 days shows two coffee breaks per day.
Meals per eight hours of training	MealsPerTrainingDay	Default Variables: G64	WHO. Strenghtening health systems for treating tobacco depndence in primary care: Part III: Training for primary care providers. Building Capacity for Tobacco Control/Training Package. <https://www.who.int/iris/bitstream/10665/84388/4/9789241505413_eng_Part-III_service_providers.pdf?ua=1> Note: A sample agenda for the training workshop of 2.5 days shows one lunch per day (it is assumed that it is paid for by the organizers).

Screening, Diagnosis, and Treatment of High CVD risk Assumptions			
Time to provide brief behavioral advice (minutes)	TimetoCounselDefault	Default Variables: I70	<https://www.cdc.gov/tobacco/data_statistics/fact_sheets/cessation/smoking-cessation-fast-facts/index.html> Note: CDC guidance suggests that asking, advising, and assessing patients to quit tobacco use takes 3-5 minutes, while assisting users takes 4 to 13. We assume the arrange a follow up takes another 3 to 5 (not stated in the CDC document). In total, using the midpoint of each, we assume 16.5 minutes total.
Number of informational pamphlets for patients with behavioral risk factors	NumberCounsellingMaterialsDefault	Default Variables: I71	
Cost of counseling materials	CostCounsellingMaterialsDefault	Default Variables: I72	
Number of annual follow-up visits for patients at low CVD risk (≥0% to <10%)	FollowupVisitsLowCVDRiskDefault	Default Variables: I74	WHO. (2019). Technical package for CVD management in primary health care. Risk-based CVD management. <https://apps.who.int/iris/bitstream/handle/10665/333221/9789240001367-eng.pdf?ua=1> Note: The Global HEARTS technical guide for Risk-based CVD management recommends follow-up visits at 12-month intervals for individuals with CVD risk 0 to 5 percent and at six month intervals for risk between 5 to <10 percent. WHO. (2019). Technical package for CVD management in primary health care. Risk-based CVD management.

Number of annual follow-up visits for patients at moderate CVD risk (≥10% to 20%)	FollowupVisitsMediumCVDRiskDefault	Default Variables: I75	WHO. (2019). Technical package for CVD management in primary health care. Risk-based CVD management. <https://apps.who.int/iris/bitstream/handle/10665/333221/9789240001367-eng.pdf?ua=1> The Global HEARTS technical guide for Risk-based CVD management recommends follow-up visits at 3 to 6 month intervals for individuals with medium CVD risk.
Number of annual follow-up visits for patients at high CVD risk (≥20%)	FollowupVisitsHighCVDRiskDefault	Default Variables: I76	WHO. (2019). Technical package for CVD management in primary health care. Risk-based CVD management. <https://apps.who.int/iris/bitstream/handle/10665/333221/9789240001367-eng.pdf?ua=1> The Global HEARTS technical guide for Risk-based CVD management recommends follow-up visits at 3-month intervals for individuals with low CVD risk.
Time generalist/primary care doctor spends with patients during a primary care visit (minutes)	TimeDuringCVDRiskPHCVisitsDoctorsDefault	Default Variables: I78	Health provider time derived from estimates contained in the UN interagency One Health Tool
Time nurse spends with patients during a primary care visit (minutes)	TimeDuringCVDRiskPHCVisitsNursesDefault	Default Variables: I79	Health provider time derived from estimates contained in the UN interagency One Health Tool
Time provider spends to screen patient for total CVD risk (minutes) Asking about a patient's health history	MinutesAskAboutHealthHistoryDefault	Default Variables: I83	Leafloor CW, Liu EY, Code CC, et al. Time is of the essence: an observational time-motion study of internal medicine residents while they are on duty. Can Med Educ J. 2017;8(3):e49-e70. Published 2017 Jun 30. Note: Default estimate from Leafloor et al, 2017. See Table 1. 542 minutes (111.6 hours * .081 * 60 minutes) of time dedicated to taking down patient history over 369 events (4,445*.083). 556 minutes/369 events = 1.5 minutes. Rounding up, the Tool's default is 2 minutes.

| Time provider spends to assess patient for total CVD risk (minutes)
Providing a physical exam | MinutesPhysicalExamtoAssessCVDRiskDefault | Default Variables: I84 | Leafloor CW, Lochnan HA, Code C, et al. Time-motion studies of internal medicine residents' duty hours: a systematic review and meta-analysis. Adv Med Educ Pract. 2015;6:621-629. Published 2015 Nov 17. doi:10.2147/AMEP.S90568

Palma AM, Rabkin M, Simelane S, et al. A time-motion study of cardiovascular disease risk factor screening integrated into HIV clinic visits in Swaziland. J Int AIDS Soc. 2018;21(3):e25099. doi:10.1002/jia2.25099

Note: Default estimate from Leafloor et al, 2017. See Table 1.

508 minutes (111.6 hours * .076 * 60 minutes) of time dedicated to physical exams over 333 events (4,445*.075). 508 minutes/333 events = 1.5. Rounding up, the Tool's default is 2 minutes.

A physical exam consisting of BP measurement and point-of-care testing for fasting blood glucose levels and cholesterol is estimated to take 12 minutes (Palma, 2018). Users may reflect on this estimate in scenarios where POC testing is expected to occur rather than laboratory analysis, zeroing out time for lab estimates and adding estimate POC testing time to the physical assessment task. |

Time provider spends to assess patient for total CVD risk (minutes) Assessing patient with a CVD risk chart, counseling patient, and documenting patient's results	MinutesAssessRiskUsingCVDChartDefault	Default Variables: I85	Leafloor CW, Lochnan HA, Code C, et al. Time-motion studies of internal medicine residents' duty hours: a systematic review and meta-analysis. Adv Med Educ Pract. 2015;6:621-629. Published 2015 Nov 17. doi:10.2147/AMEP.S90568 Palma AM, Rabkin M, Simelane S, et al. A time-motion study of cardiovascular disease risk factor screening integrated into HIV clinic visits in Swaziland. J Int AIDS Soc. 2018;21(3):e25099. doi:10.1002/jia2.25099 Note: Default estimate from Leafloor et al, 2017. See Table 1. 508 minutes (111.6 hours * .076 * 60 minutes) of time dedicated to physical exams over 333 events (4,445*.075). 508 minutes/333 events = 1.5. Rounding up, the Tool's default is 2 minutes. A physical exam consisting of BP measurement and point-of-care testing for fasting blood glucose levels and cholesterol is estimated to take 12 minutes (Palma, 2018). Users may reflect on this estimate in scenarios where POC testing is expected to occur rather than laboratory analysis, zeroing out time for lab estimates and adding estimate POC testing time to the physical assessment task.
Time lab technician spends administering, analyzing, and reporting fasting blood glucose test (minutes)	MinutesAnalyzeBloodTestDefault	Default Variables: I87	Hawkins R. C. (2007). Laboratory turnaround time. The Clinical biochemist. Reviews, 28(4), 179–194. See Table 3 "Draw to reporting" Note: Based on the median reported time taken to draw, analyze, and report a blood sample (for potassium and hemoglobin tests). No similar results found for FBG tests. The Costing Tool takes the lower of the two reported 50th percentile times for K and Hb.

| Time lab technician spends administering, analyzing, and reporting urine test (minutes) | MinutesAnalyzeUrineTestDefault | Default Variables: I88 | Hawkins R. C. (2007). Laboratory turnaround time. The Clinical biochemist. Reviews, 28(4), 179–194. See Table 3 "Receipt to report"

Note: Based on the median reported time taken to analyze and report a blood sample (for potassium and hemoglobin tests). No similar results found for urine tests. The Costing Tool takes the lower of the two reported 50th percentile times for K and Hb. As opposed to the Fasting blood glucose time estimate, which used "draw to reporting" values from the below source, we assume the patient assumes the time burden of extracting the urine and use the receipt to report time. |
| --- | --- | --- | --- |

6.2.   Cost equations, by results worksheet

6.2.a.   Healthy-lifestyle counselling

Training

$RequiredTrainingSessions$ = HPsTrainedCounselBehavior[17]/ClassroomSizeBehaviorChangeTraining

$TrainingSessionLengthDays$ = TrainingHoursNeededBehaviorChange/8 hours[18]

<u>Meeting space</u>

$Facility\ rental$ = Required training sessions * Training session length * FacilityRentalCost

<u>Human Resources</u>

$Professional\ trainers$ = RequiredTrainingSessions * NumberOfTrainers * TrainingHoursNeededBehaviorChangeTraining * HourlyWageProfessionalTrainer

$Administrative\ staff$ = RequiredTrainingSessions * NumberofAdminStaff * TrainingHoursNeededBehaviorChangeTraining * HourlyWageProfessionalTrainer *HourlyWageTrainingAssistant

<u>Materials</u>

$Instructive\ handbooks$ - RequiredTrainingSessions * TrainingNumberofHandbooks * InstructiveHandbooksCost

$Agendas$ - RequiredTrainingSessions * TrainingNumberofAgendas * InstructiveHandbooksCost

<u>Per diem and transportation</u>

$Per\ diem\ staff$ - RequiredTrainingSessions * (NumberOfTrainers + NumberOfAdminStaff) * (TrainingHoursNeededBehaviorChangeTraining/8) * PerDiemStaff

$Per\ diem\ trainees$ - RequiredTrainingSessions * (NumberOfTrainers + NumberOfAdminStaff) * (TrainingHoursNeededBehaviorChangeTraining/8) * PerDiemTrainees

$Transportation\ stipend\ for\ staff$ - RequiredTrainingSessions * HPsTrainedCounselBehavior * (TrainingHoursNeededBehaviorChangeTraining/8) * TransportationStipendStaff

$Transportation\ stipend\ for\ trainees$ - RequiredTrainingSessions * HPsTrainedCounselBehavior * (TrainingHoursNeededBehaviorChangeTraining/8) * TransportationStipendTrainees

<u>Food and beverages</u>

Refreshments - RequiredTrainingSessions * RefreshmentCost

Meals - RequiredTrainingSessions * MealsCost

Counselling

<u>Population in need</u>

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[17] User-selected – total number of health providers in need of training
[18] Assumes one day of a training session is eight hours long

Adult population = PopulationAdults

Adults who present at the health center = PopulationAdults * AttendanceRate

Eligible to receive brief advice = PopulationAdults * AttendanceRate * PercentHPsTrainedCounselBehavior

> **Where**: PercentHPsTrainedCounselBehavior = the total number of HPs who are trained to provide brief advice/the total number of doctors[19]

Tobacco, alcohol, and physically inactive patients who are provided with healthy-lifestyle counselling **=**
TotalLifestyleCounsellingPatients $_{RiskFactor}$ = PopulationAdults * AttendanceRate *
PercentHPsTrainedCounselBehavior*Prevalence$_{RiskFactor}$

Providing counselling to change behavior (costs)

Provider time to administer 5A's = TotalLifestyleCounsellingPatients $_{RiskFactor}$ * TimeToCounsel *
SalaryWeightedCounselling[20]*.000008[21]

Informational materials = TotalLifestyleCounsellingPatients $_{RiskFactor}$* NumberCounsellingMaterials
*CostCounsellingMaterials

Information materials (digital) = TotalLifestyleCounsellingPatients $_{RiskFactor}$* NumberCounsellingMaterials *
NumberCounsellingDigitalMaterialsUser *CostCounsellingMaterialsDigital

Providing counselling to change behavior (total health provider time)

Total healthcare provider time to provide healthy-lifestyle counselling is given as:

> TotalLifestyleCounsellingPatients $_{RiskFactor}$ * TimeToCounsel

Time by healthcare provider type is calculated by weighting trained providers of a given type as a percent of all trained health providers.

6.2.b. Evidence-based treatment protocols
Screening and diagnosis

Population in need

Eligible to receive CVD Risk Assessment = PopulationAdults * AttendanceRate * PercentHPsTrainedCVDRisk

> **Where**: PercentHPsTrainedCVDRisk = the total number of HPs who are trained to assess patients for CVD risk/the total number of doctors[22]

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[19] **Reminder**: The Tool assumes that the number of doctors listed for the area of interest is sufficient to cover the adult population in need (i.e., that there are no availability constraints that would prevent a patient from receiving care). A patients' likelihood of encountering a trained health provider who will ask them about their lifestyle is assumed to be equal to the proportion of trained health providers ('Training!H62)— where the numerator is the # of trained doctors, nurses, and CHWs and the denominator is the total number of doctors. The numerator is confined to being ≤ the denominator. When a nurse or CHW is trained to perform a given task (e.g., administer healthy-lifestyle counselling) the trained nurse or CHW fully takes over a task from the doctor that they work under (i.e., the doctor does not ever provide healthy lifestyle counselling).

[20] **A** patient's likelihood of receiving counselling from a doctor, nurse, or CHW is assumed to be equal to the trained proportion of that health provider among all trained providers. For instance, if 100 health personnel are trained to provide healthy-lifestyle counselling, among them 50 doctors (wages LCU 10,000), 30 nurses (wages LCU 7,500), and 20 CHWs (wages LCU 5,000), then a patient's likelihood of being counselled by a nurse is 30%. SalaryWeightedCounselling is a variable that weights provider salaries according to which provider types administer the intervention. In the example (10,000*0.5)+(7,500*0.3)+(5,000*0.2)= LCU 8,200.

[21] One minute of an employee's time is equal to .0008% of their full-time salary.

[22] See footnotes for Healthy-lifestyle counselling – same principles apply

Cost of screening and diagnosis

<u>Ask about patient history (screening)</u>

Health provider time - Eligible to receive CVD risk assessment * MinutesAskAboutHealthHistory * SalaryWeightedCVDRisk[23]

<u>Assess via physical exam and diagnostic tests</u>

Offer physical exam (HP)

Diagnostic tests – if default protocol

Administer/analyze blood test (lab tech) - Eligible to receive CVD risk assessment * 1[24] * MinutesAnalyzeBloodTest * LabTechWages

Administer/analyze blood test (urine test) - Eligible to receive CVD risk assessment * 1[25] MinutesAnalyzeUrineTest * LabTechWages

Diagnostic tests – if custom protocol

Eligible to receive CVD risk assessment * ((DiagnosticTest$_1$ * MinutesAnalyzeBloodTest$_1$)+(DiagnosticTest$_2$ * MinutesAnalyzeBloodTest$_{2)}$...) * LabTechWages

Diagnostic tests – resource cost

Costed on the *A* worksheet

<u>Total health provider time</u>

Doctors, nurses, and CHWs: Time by healthcare provider type is calculated by weighting trained providers of a given type as a percent of all trained health providers.

Lab technicians – see equations for diagnostic test less "* LabTechWages"

Treatment of 10-year CVD risk

<u>Treatment by risk profile</u>

Treatment by 10-year CVD risk level = EligibleToReceiveCVDRiskAssessment *Prevalence$_{RiskLevel}$

Treatment by metabolic risk factor = EligibleToReceiveCVDRiskAssessment * Prevalence$_{RiskFactor}$

<u>Cost of Treatment</u>

Health provider time by risk level = EligibleToReceiveCVDRiskAssessment * CVDRiskPrevalence$_{RiskLevel}$*FollowupVisits$_{RiskLevel}$*TimeDuringCVDRiskPHCVisits[26] * WeightedWages[27]

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[23] ibid
[24] Assumption – one diabetes urine test per person screened
[25] Assumption – one diabetes urine test per person screened
[26] Total time health providers spend providing treatment during a follow up visit, as entered (by health provider type) in 'CVD Risk Treatment!J68:J70
[27] Weighted average of provider salaries based on time division of labor entered by user in 'CVD Risk Treatment!J68:J70

Cost of medications by risk factor

Costed on the *A* worksheet

Total health provider time

Time by healthcare provider type is calculated based on user-entered values -- CVD Risk Treatment!J68:J70

6.2.c. Access to essential medicines and technology
Diagnostic tests

Diagnostic tests – if default protocol

Diabetes test - Eligible to receive CVD risk assessment * 1[28] * UnitCostDiabetesTest

Where:

UnitCostDiabetesTest = the unit cost of the FBG, RBG, or HbA1c test (test chosen by user)

Cholesterol test - Eligible to receive CVD risk assessment * 1 * UnitCostBloodLipidPanel

Urine test - Eligible to receive CVD risk assessment * 1 * UnitCostUrineTest

Diagnostic tests – if custom protocol

Eligible to receive CVD risk assessment * (($NumberDiagnosticTest_1$ * $UnitCostDiagnosticTest_1$)+($NumberDiagnosticTest_2$ * $UnitCostDiagnosticTest_{2)}$...)

Medications

Costing medication regimens

A patient's treatment regimen consists of monotherapy, dual therapy, or 3-drug therapy. The annual cost of treating a patient with monotherapy is the per unit cost of a medication a patient is taking multiplied by the number of times per day the patient takes the medication multiplied by the number of days per year the patient takes the mediation. For patients on dual or 3-drug therapy, the cost of additional medications is added to the first medication's cost. The per patient cost of a specific regimen is:

PerPatientCost$_{Regimenx}$ = (TimesPerday $_{MedicineType1}$ * DaysPerCase $_{MedicineType1}$ * UnitCost $_{MedicineType1}$) +

(TimesPerday $_{MedicineType2}$ * DaysPerCase $_{MedicineType2}$ * UnitCost $_{MedicineType2}$...)

Where:

Regimen = a combination of medication(s) prescribed to patients (described by the protocol steps on the CVD Risk Treatment worksheet

MedicineType = a specific medicine and strength (e.g. 12.5 mg tab of Chlorthalidone)

TimesPerDay = the # of times per day a patient takes a medication

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[28] Assumption – one diabetes blood test per person screened

DaysPerCase = the # of days per year a patient takes the medication

UnitCost = the per unit cost of the medication

Pharmacological treatment regimens in the Tool align with HEARTS protocols – or in the case of hyperlipidemia treatment, the American Heart Association's 2018 Guidelines on Management of Blood Cholesterol. A regimen can be low-intensity (e.g. monotherapy), or medium or high intensity (dual or 3-drug therapy). Patients with a metabolic risk factor are distributed into a regimen based on their risk factor severity level (see Appendix III). The cost of prescribing a regimen across the population of individuals with hypertension is then:

$CostRegimen_x$ = *Eligible to receive CVD Risk Assessment* * $Prevalence_{RiskFactor}$[29] * *Distribution $_{Regimenx}$* * $PerPatientCost_{Regimenx}$

Where:

Distribution $_{Regimenx}$ = The percent of individuals with hypertension who are placed on the regimen.

The total cost of providing pharmacological treatment to individuals with hypertension is then the sum of the cost of treating all the people within each regimen step.

Cost of pharmacological treatment for a risk factor ($TotalPharmacologicalCost_{RiskFactor}$) = $CostRegimen_1$ + $CostRegimen_2$ + $CostRegimen_3$ + …

Costing of custom protocols operates the same as described for default protocols, with the exception that users design regimens and chooses how many individuals with a risk factor are distributed into those regimens.

To factor in safety stock, the Tool calculates the quantity of each type of medication (e.g., 2,500 12.5 mg tablets of Chlorthalidone) demanded based on specified regimens, the patient population, and the distribution of the patient population by regimen. The additional quantity needed to fulfill safety stock needs is simply the user-specified safety stock factor multiplied by the demanded quantity. For example, a user desires to build in a three percent buffer to medication demand, then the Tool calculates the product of 0.03* 2,500 Chlorthalidone tablets = 75 tablets. Safety stock costs are the unit price of 12.5mg tablets * 75 tablets.

Supply chain costs

Supply chain costs are calculated as a percent "on-cost" to medications, diagnostics, and supplies. The sum cost of these resources is multiplied by the user-specified "on-cost". For example, if users enter "10%", then the tool assesses that supply chain costs are 10 percent of the the cost to procure, store, and distribute medications, diagnostics, and supplies is 10 percent of their total cost.

Other costs

The tool provides space for users to enter additional medications, diagnostics, and supplies not automatically accounted for within the embedded Tool regimens. These costs a simply calculated as the user entered quantity (factoring in safety stock) * the user-entered price.

Users can choose to annuitize capital costs (e.g., of expensive equipment with multiple-year useful life). The tool expresses costs on an annual basis the total cost of the line item divided by its years of useful life.

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[29] **Reminder**: the Tool assumes that 100 percent of individuals who are screened and diagnosed with a given risk factor move on to receive treatment.

6.2.d. Risk-based treatment tab

Trainings

While entered parameters may differ, the cost of training to assess CVD risk is calculated using the same equation structure as for trainings to provide healthy lifestyle counselling.

Estimate risk using risk charts

Health provider time - Eligible to receive CVD risk assessment * MinutesAssessRiskUsingCVDChart * SalaryWeightedCVDRisk

6.2.e. Team-based Care

The tool adds up the number of minutes that nurses and CHWs spend providing healthy lifestyle counselling and assessing CVD risk, calculated on the A, E, and R worksheets.

The cost of the lower-level health provider administering the service versus the cost of the service in a hypothetical scenario where a doctor administered the service is estimated by calculating the difference between the cost of the minutes at a nurse or CHW wage-rate versus that of a doctor.

6.2.f. Systems for Monitoring

The tool provides space for users to enter additional human resources, technology, and supplies. Human resource costs are simply costed as the full-time equivalent time (e.g., 0.5 for an individual who spends half their time working on HEARTS) multiplied by the individual's annual wages. Technology and supply costs are calculated as the user entered quantity multiplied by the user-entered price.

6.3. Estimates of patient distribution within pharmacological regimens

Treatment distributions for hypertension, hyperlipidemia, and diabetes are based on assumptions about what it would take to control individuals at various severity levels of each risk factor.

Hypertension: Findings from Paz et al (2019) provide guidance on how many medications—and in which combinations—are required to achieve specific levels of SBP outcomes given pretreatment SBP levels. Broadly, the authors show that individuals with high systolic blood pressure ranging from 140 to <150 mmHg (Level 1) require 1 drug, on average to achieve control; individuals with blood pressure between 150 to <160 mmHg (Level 2) on average require a combination of 2 drugs, and those with blood pressure 160+ mmHg (Level 3) require a combination of 3 drugs.

HEARTS Costing Tool analysts pulled blood pressure distributions from 16 STEPS recent STEPS surveys, finding that on average, across countries, around 41 percent of individuals with HBP have Level 1 blood pressure, 25 percent have Level 2 and 34 percent have Level 3. Drawing on these findings from STEPS surveys, the Tool distributes a proportion of the population with high blood pressure into treatment regimens substantial enough to achieve—or nearly achieve—blood pressure control.

For example, in HEARTS blood pressure regimens that begin with monotherapy:

- 41 percent of individuals with high blood pressure are place on monotherapy.
- 25 percent are placed on 2-drug regimens[30]
- 34 percent are placed on 3-medication regimens.

For treatment regimens that begin with dual therapy, we assume even splits of 66 percent of individuals with high blood pressure across steps of the protocol that are dual therapy, and that the remainder of the population is split evenly across steps that are tri-therapy.

Cholesterol: The American Heart Association's 2018 Guidelines on Management of Blood Cholesterol indicate that, regardless of CVD risk, individuals with LDL ≥190 mg/dl (4.9 mmol/L) should initiate on high intensity statin regimens, while adults age 40+ with LDL 160 to <190 (4.1 to < 4.9 mmol/L) with total CVD risk 5% or higher should initiate on moderate-intensity statins.

Tool analysts did not identify global sources that estimate the distribution of hyperlipidemia severity within national populations. In place of these estimates, the Tool draws on US NHANES survey data showing that among all people with hyperlipidemia (defined as LDL ≥160 mg/dl), around 33 percent have LDL ≥190 mg/dl, requiring high-intensity intervention. Thus, the Tool assumes that 33.3 percent of all individuals with hyperlipidemia need high-intensity treatment. For the remainder, analysts roughly identify that WHO CVD risk charts show that most of all adults age 40+ with hyperlipidemia have CVD risk at or approaching 5%. Thus, we assume that remaining individuals with hyperlipidemia require moderate-intensity pharmacological treatment.

Diabetes: The American Diabetes Association describes that monotherapy should be considered for individuals who have A1C less than 9%; dual therapy for A1C ≥9 and <10%, and combination injectable therapy for A1C ≥10% (American Diabetes Association; Mendez). Analysts did not identify published global estimates of the distribution of A1C levels. Data on the distribution of A1C levels among adults with diagnosed diabetes in the United States (US Department of Health and Human Services) provides

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[30] Where there are two or more protocol steps with the same number of medications, the Tool evenly splits individuals across protocol steps.

some estimate—imperfect given that some individuals may already pulled down A1C because of initiation of pharmacological treatment—of A1C distributions, showing that about 78 percent of those diagnosed with diabetes have uncontrolled A1C at levels between 6.5 to 9%. Drawing on this information, the Tool splits this population among the three HEARTS monotherapy steps, and assumes that the remainder of the population with diabetes should initiate on dual therapy (combination injectable therapy is not directly included in the HEARTS protocol).

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6.4.   Default medicine prices

In search of medicine prices, Tool analysts searched international medicine databases [1, 2] and national government documents and databases[31] [3-14] and augmented the search via personal correspondence [15] and information that the authors had obtained on medication prices in previous NCD modelling projects [16, 17].

Broadly, obtained prices could be categorized in three groups: 1) pharmacy prices, 2) maximum regulated pharmacy retail prices, and 3) public procurement prices. Limiting use to public procurement prices—to better reflect the economic cost of medications and enhance comparability across countries—analysts compiled information from 25 countries. In total, analysts identified information on 10 common anti-hypertensive medications, three oral diabetes medications, and two cholesterol medications—of various strengths.

For each country, where information was available for the strength of one medicine of interest, but not another strength of interest (e.g. an Amlodipine 5 mg tablet, but not a 10 mg tablet), the cost was adjusted following Attei and colleagues' (2017) [18] assumption that "doubling the dose increases the cost by one-and-a-half times" [18 , Supplementary Appendix, p. 18] (and halving the dose decreases cost by 50 percent).

The median price of a single medication and strength within a given country was then pulled into an agglomerated database with all other countries. Altogether, sourced medication price data spanned from 2010 to 2020. Analysts employed methods in the WHO/HAI manual [19, Annex 8] to adjust prices to 2018 USD, converting medicine prices to USD if prices are not in US dollars—using the year-specific exchange rates from the World Bank—and then adjusting for inflation or deflation using the United States consumer price index.

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