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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

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Technical Appendix to the WHO paper: "Projected health-care resource needs for an effective response to COVID-19 in 73 low and middle income countries"

I. Objective

This study aims to quantify the additional resource requirements within the health sector to detect the COVID-19 virus, limit human-to-human transmission , to care for those affected, and to maintain essential health services, based on the 9 pillars in the Strategic Preparedness and Response Plan (SPRP) from the World Health Organization.[1] These pillars are listed in table A1.

Table A1. The 9 Pillars of the COVID-19 Response

Pillars
1. Country-level coordination, planning and monitoring
2. Risk communication and community engagement
3. Surveillance, rapid-response teams, and case investigation
4. Points of entry, international travel and transport
5. National laboratories
6. Infection prevention and control
7. Case management
8. Operational support and logistics
9. Maintaining essential health services and systems

II. Scope

The costing covers 73 low- and middle-income countries (Annex1), accounting for 93.4% of the total population in low and middle-income countries. The resource needs that are estimated are those that are expected to be borne by the health sector, and costs related to any social mitigation interventions such as cash or in-kind transfers are excluded. The costing covers all start-up (including capital) and recurrent costs over a 4 week and a 12 week timeframe, starting 26 June 2020. During this time, the course of the pandemic may change, depending on many factors including but not limited to, decisions taken by national leaders on either maintaining, loosening, or tightening large-scale public health and social measures (PHSM). In an attempt to account for this, for each of the timeframes, three scenarios are analyzed with the effective reproduction number ("Rt"), which can be thought of as the number of contacts that a case infects being either unchanged, increased or decreased.

III. Approach

Resource needs are estimated using an ingredients-based costing approach, splitting each component into its respective quantities and unit prices. Where prices vary by country, there is an attempt to use country specific prices from publicly available information, while the prices of international goods are the same for all countries, such as internationally purchased medical goods and equipment.

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[1] https://www.who.int/publications/i/item/draft-operational-planning-guidance-for-un-country-teams

The quantities of costed items were driven by several factors. Many items will be determined by the number of cases and follow the epidemiologic forecasting, while for other items, the quantities reflect the organization of the public sector and the health system, such as the number of subnational administrative units in a country, or the number of health facilities and hospitals involved in the response. Furthermore, the scale of implementation of certain activities changes depending on the transmission stage of the epidemic in the country:[2] The four transmission stages are given as the following:

- No cases: with no confirmed cases
- Sporadic cases: with one or more cases, imported or locally detected
- Clusters of cases: experiencing cases, clustered in time, geographic location and/or by common exposures

  exposures
- Community transmission: experiencing larger outbreaks of local transmission defined through an assessment of factors including, but not limited to: large numbers of cases not linkable to transmission chains; large numbers of cases from sentinel lab surveillance; and/or multiple unrelated clusters in several areas of the country/territory/area
- Widespread community transmission[3]: following the same definition above, but for a significant %percent of the population.

The transmission stages also reflects that the relative number of cases in a country are important for some items, in placing the country in a stage of epidemic evolution, rather than the absolute number since country size varies. Thus, for some inputs, the responses in countries were costed in preparation for the next higher transmission stage of the epidemic than the one they were currently experiencing at the time of the costing.

Consultations with technical experts within and outside of WHO were conducted to establish the values of quantities for key items. Costs are reported in 2020 United States Dollars (USD).

IV. The Essential Supplies Forecasting Tool (ESFT)

The COVID-19 response costing tool builds on the Essential Supplies Forecasting Tool (ESFT)[4], which was developed by Clinton Health Access Initiative with support from the WHO. This tool was developed for countries to forecast the need for critical supplies within the COVID-19 clinical response, and it brings together information on country capacity constraints in terms of existing human resources and diagnostic capacity.

[2] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports

[3] This is not part of the WHO official classification, however, this allows for costing countries where the relative case burden is higher than that implied by entering the category of community transmission (i.e. the categories are based on notions of absolute cases).

[4] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/covid-19-critical-items

A second version the tool, ESFT v.2, also incorporated an epidemiologic model using SEIR equations. Given the functionality of the ESFT tool in terms of translating epidemiologic inputs to supply quantities needed for COVID-19, we decided to build our Excel-based costing model to easily integrate with ESFT v.2.

V. Epidemiologic Modeling

The Epidemiologic model that has been developed to estimate the cases of Covid-19, comes from Imperial College Medical Research Council (MRC) Infectious Disease Epidemiology (IDE) modeling group.[5] The model is validated on confirmed deaths from COVID-19. Deaths are used for validation by the Imperial College team as it is considered that cases are not as accurately reported in the early stages of an outbreak or pandemic.

This SEIR model is run regularly for all countries in our sample except for a handful where low levels of reported COVID-19 deaths makes the modeling difficult. These countries are: China, Iran, Mongolia, Tanzania, Uganda, and Zimbabwe. For these countries, we ran a separate model provided in R by the Imperial College modelling group to project the cases for these countries. The Rt values taken from the Centre for Mathematical Modeling of Infectious Disease (CMMID) Repository from the London School of Hygiene and Tropical Medicine (LSHTM) available.[6]

The projection of cases is driven by the transmissibility in a given country represented by the R_t value for that country. The model projects cases 12 weeks into the future assuming that the same R_t is maintained. We call this the "Status Quo" scenario. We model an additional 2 scenarios that include a 50% decrease in the R_t and 50% increase in mobility to account for scenarios where mitigation policies are being strengthened or relaxed. The difference in approaches to the reduced and increased transmission scenarios is because decreasing mobility by 50% isn't possible in many of the countries where mobility figures are already significantly reduced.

VI. Resource Requirement Estimates Included by Pillar

- Pillar 1 Country Level coordination
  i. Coordination needs

For the first pillar, there are certain, mostly centralized, capacities that need to be strengthened or put in place. This is principally the creation, training and equipping of incident management and coordination teams, which are assumed to be a central level team for when a country is planning for sporadic cases or clusters of cases, but which expand also to the first subnational level when a country is planning to deal with community transmission. Each coordination team is made up of 5 public health professionals, with a rented office, a satellite communication package, a rented vehicle and driver, monthly fuel costs,5 monthly mobile phone plans, and an international public health emergency

[5] Walker PGT, Whittaker C, Watson OJ et al. (2020) The impact of COVID-19 and Strategies for Mitigation and Suppression in Low- and Middle-Income Countries. *Science* (12 June 2020) DOI: 10.11226/science.abc0035. (Link to data: https://mrc-ide.github.io/global-lmic-reports/)

[6] https://cmmid.github.io/topics/covid19/LMIC-projection-reports.html

coordination consultant. All costs reflect country-specific prices, except for the purchase of the satellite communications equipment and the salary of the international consultant.

- Pillar 2 Risk communications and community engagement
    i. Risk communications teams

In this second pillar, the principal components are risk communications teams, who are responsible for engaging and transmitting effective messaging to the general population. For isolated cases, it is expected that only one team can manage the work of risk communications, but for clusters of cases, a team at the first subnational or regional level is activated, and for community transmission, this expands further to the second subnational or district level. Each team is made up of 5 public health professionals, and counts on a driver and vehicle, fuel, an office, and mobile phone plans. Risk communications consultants are engaged as well, with an international consultant at the national level for isolated and clusters of cases, supplemented with national consultants at the first subnational level when a country has to plan for community transmission. The role of these consultants is to work with the risk communications teams and engage with a media campaign, hired centrally to develop and contextualize messaging for the entire country. Media time on the radio, television and in print media is costed as well, with 16 half-minute TV spots and 64 half-minute radio spots being run per day, while a newspaper insert is costed as being distributed every week. The intensity of the media campaign does not vary by the transmission stage a country finds itself in, reflecting the preventive nature of the media campaigns. In parallel to those efforts, posters and flyers with key messages are also costed, to be placed and distributed at key gathering places like health facilities. Their quantities change by the stage of the pandemic a country is planning for, with these scaling up at the central level for isolated cases, the first subnational administrative level for clusters of cases, and the second subnational level for community transmission. A package of communications material consists of 10 large posters and 300 flyers, and it should be noted that the number of these packages doubles across all administrative levels with widespread community transmission. Finally, risk communications also contains messaging for safe care-seeking and proper use of the health system for essential health services, which is noted as a part of pillar 9, but these are assumed to be responsibilities and tasks that can be also carried out by the teams and capabilities built up in this pillar.

    ii. Community efforts

In addition to the capacities noted above, we also cost efforts to engage local communities in effective messaging. Unlike the approaches noted above, this approach focuses on social media, and engages a social media team of 3 communication specialists tasked with managing the social media platforms of the COVID-19 response and safe delivery of essential services. These teams are expected to work remotely, and incur no other costs but salaries, and scale up from being one team at the national level for sporadic and clusters of cases, to being present at the first subnational level once a country has to plan for community transmission. In tandem with the work of these social media teams, local consultants are hired, at the same levels as the social media team to map local 'influencers' and engage with these in a joint effort to transmit or channel key information to these individuals and their platforms.

- Pillar 3 Case investigation, surveillance and rapid response
    i. Contact Tracing

The number of contact tracers follows from the number of confirmed positive tests in each country. This is a product of the number of hospitalized COVID-19 cases, which are tested to confirm the presence of the virus, in addition to a targeted testing approach, whereby 10% of those with mild and moderate symptoms are tested and confirmed to have the virus[7]. Following the weekly number of estimated cases confirmed by testing, we multiply these by a country-specific number of daily contacts. While there are only publicly available numbers of baseline average daily contacts (in a pre-COVID-19 situation), we apply a ratio of the modelled Rt to the initial R(t) in each country (before any social restrictions or mitigation measures were put into place) to yield an updated number of country specific (and scenario specific) average daily contacts. Both average country daily contact numbers and Rt's were provided by the Imperial College London MRC IDE group for consistency. For a few countries, the number of average daily contacts was not available, and these were imputed using other sources. We assume that, following WHO guidance[8], after a positive test, contact tracers will seek to trace contacts for the 2 days preceding the test. In addition, while all mild and moderate cases who test positive but do not require hospitalization will be told to isolate, following considerations made by several contact tracing models[9], we assumed that 20% of this group continue to behave as before and have as many daily contacts as the average person, under the current state of population-wide restrictions. As a result, contact tracers will also have to trace 7 days of further contacts for this proportion of mild and moderate cases.

Once this total number of contacts to be traced is estimated, we assume that there is only an 80% success ratio in reaching contacts, and as such give an updated number of contacts that need to be traced. These are then split between high risk (individuals more likely to be severely affected by COVID-1919, such as the elderly, or those with pre-existed chronic health conditions) and low risk contacts, where low risk contacts are contacted once within a 7 day period and then followed up once in the following 7 day period, while high risk contacts are traced every day for 2 weeks. 40% of contacts are estimated to be high risk and 60% to be low risk, as suggested by colleagues in the Emergency Care unit within the Universal Health Coverage and Lifecourse department of the WHO. This total number of contact sessions is then split between those who can be traced by phone and those who need to be traced in person, determined by the share of the population with an active cell phone, as identified in publicly available International Telecommunications Union (ITU) statistics. Then, based on further input from WHO experts and a contact tracer tool developed by George Washington University, we assumed that a contact tracer can trace 100 contacts in a week, while in-person contact tracers are able to trace half of that number. The costs for contact tracers include wages equivalent to the lowest skill cadre found in our data (at the level of a driver or cleaner), wages for a supervisor (one per 10 two-person contact tracer teams, at wages equivalent to a lab technician), a monthly phone credit plan, an online training course, for those doing in person contact tracing, fuel and maintenance and operations costs for a motorcycle, and basic PPE (2 masks, 4 gloves and hand sanitizer each day). The number of motorcycles purchased is equivalent to the highest number of weekly in person contact tracers required, and estimated only once, while all other costs are estimated weekly. In addition, we noted that contact tracing duties will often be distributed to community-health workers, and assumed that a third of the Community Health Worker (CHW) workforce can be made available to this duty, the number of contact

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[7] The testing strategy consists of testing 10% of those who are suspected of having the virus (who are not hospitalized) where for every 11 suspected cases, only 1 is an actual positive case.

[8] https://www.who.int/publications/i/item/contact-tracing-in-the-context-of-covid-19

[9] COVID-19 Simulator Consortium, https://www.cdc.gov/coronavirus/2019-ncov/covid-data/forecasting-us.html, and https://www.cdc.gov/coronavirus/2019-ncov/covid-data/forecasting-us.html

tracers (and their respective costs) are distributed between the number of CHW contact tracing shifts and new hires. The number of available CHWs are used as a first priority, so that contact tracers are hired only when the weekly need for these exceeds the numbers of CHWs. The cost of CHW contact tracers is identical to new hires, except that they have no additional salary cost (costs for supervision, phone credit, motorcycles and masks, gloves and hand sanitizer are also taken into account.)

ii. Rapid response and surveillance teams

Separate from contact tracing duties, countries need to activate rapid response teams (RRTs) and surveillance teams to keep informed about the development of the pandemic in their countries. Rapid response teams and surveillance teams are made up of 4 individuals, with 2 rented vehicles, with respective driver and fuel costs of a highly mobile team, and mobile phone plans and offices. Rapid response and surveillance teams are assumed to scale up from a team at the central level to one at the first subnational administrative level when a country plans for clusters of cases, and these then double to 2 teams per first subnational administrative level upon moving to community transmission. There is also up to one team also at the second subnational administrative level when planning for widespread community transmission. Surveillance teams, in their vital role in keeping track of the number of active cases, scale up to the second subnational administrative level when a country plans for community transmission. Training workshops, held in person but following social distancing measures, are carried out in line with the scale in which surveillance teams are scaled up, and cover both surveillance and rapid response for COVID-19. To support this, consultants on rapid response and surveillance teams are including, where beyond an international consultant at the central level, national consultants are scaled up to the first subnational administrative level for countries planning for community transmission and one at the second subnational administrative level for widespread community transmission. If a country has more than 500 second level subnational administrative units (such as in a country like India or Mexico) the number of national consultants to be hired to support with this task is capped at 500.

- Pillar 4 Points of Entry

For this pillar, we cost enhancing capabilities at points of entry (POE).). For effective preparedness and response to COVID-19, we assume that points of entry should be reinforced with a team of 5 health professionals, with a vehicle and driver (which is expected to have relatively little driving duties and fuel costs), an office, and monthly mobile phone plans. Key staff at each point of entry, and the regional/1st (first level) subnational health authorities in which the POE is found, will also participate in in-person workshops in order to develop guidelines, standard operating procedures and emergency plans for dealing with the risk of individuals entering the country through points of entry while being active COVID-19 cases. To carry out duties of screening and testing, we cost testing kits for each POE to carry out 1250 tests per week including: swabs and viral transport medium, triple packaging boxes, safety boxes, and an extraction kit well as 5 infrared thermometers. In addition, we cost daily ‘full personal protective equipment’ packages for 5 individuals, including gowns, scrubs, aprons, gloves, and masks or face shields, as well as a stock of 5 ‘reserve’ sets of PPE, in case of additional need. These costs are then scaled for the ‘designated points of entry’ as communicated to the WHO by member states, as part of their annual reporting requirements for satisfying the International Health Regulations (2005).

We also cost remote training workshops on duties to support POEs, which scale up from the national level to the first subnational level when a country plans for clusters of cases, to the second subnational level when planning for community transmission. When a country plans for widespread community transmission, noting the likelihood of individuals coming through POEs carrying the COVID-19 virus, these training workshops expand to also include the nearest health facilities, effectively doubling their number. To support this task, as well as the development of SOPs and guidelines, we include the cost of one international consultant at the country level who is an expert on points of entry and public health emergencies.

We do not cost additional isolation facilities, or specialized equipment to be used at POE as part of the COVID-19 response.

- Pillar 5 National Laboratory Systems
    i. Diagnostic tests

The number of diagnostic tests is estimated completely within the ESFT v.2. There, the tool assumes that every severe and critical case (which is hospitalized) is tested while in addition to those who are mild and moderate cases, a large number of suspected cases present themselves to health facilities, and only 9% of these non-severe and critical cases are tested (capturing only 9% of mild and moderate cases). The hospitalized severe and critical cases are tested once and, if the result is positive, they are tested twice more to demonstrate a negative result., before release from the hospital. Furthermore, this testing load, which is estimated daily, is constrained by each country's existing diagnostic capacity.

ii. Diagnostic instruments

After repeated consultation with diagnostic experts at CHAI, we do not include any procurement of additional diagnostic instruments, given that there are severe supply chain constraints with component providers that make the production and export of these instruments very unlikely in the next half year. There is an inclusion of automated extraction platforms to increase the throughput of manual instruments, in countries where testing capacity is smaller than testing need. These are assumed to be purchased at a quantity no greater than the existing number of manual diagnostic instruments that a country currently has, and is also limited by the existing number of available lab technicians a country has to operate manual diagnostic instruments[10].

In addition, our modelling incorporates programmatic interventions for diagnostic instruments, mainly increasing the number of shifts that diagnostic instruments are run per day, and days the diagnostic instruments are operated per week, increasing the existing diagnostic footprint without the need to purchase more diagnostic equipment.

Finally, in order to provide guidance on COVID-19 related diagnostic testing, we include costs for an international expert for each country. We do not include any costs of transporting samples for testing (assuming that all the testing takes place in health facilities) or consider anything except PCR-based tests, thereby not taking into account any rapid antigen or antibody tests.

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[10] The quantity of lab technicians needed to operate manual instruments are also decreased from 1 per instrument to 2 per instrument with the acquisition of an automated extraction capacity, for those instruments who are then used in combination with these platforms.

- Pillar 6: Infection Prevention and Control
    i. Hand Hygiene

In order to estimate the resource requirements to allow for frequent handwashing of the general population in every country, we sought to estimate the installation of temporary handwashing stations in areas where people are unable to wash their hands at health facilities or at home.

We identify which health facilities did not have running water, we used data from WHO UNICEF JMP database that assesses how many facilities lack WASH services.[11] We then assumed that each health facility would receive two hand washing stations. We only costed handwashing stations for health facilities and assumed that a hospital would already have access to handwashing stations.

To identify the quantity of handwashing stations in the community, we drew on the work by Hutton and Varughese (2016)[12] that estimates the costs related to meeting the SDGs on drinking water, sanitation and hygiene. From this work, we identified the shares of the urban and rural population of countries without handwashing capabilities in the home. These proportions were then multiplied by the most recent numbers of rural and urban populations to give a country-specific estimate of people without access to handwashing at home. Then, using UNICEF guidance (2010)[13] which identified that for all water needs a point source could cover 250 individuals, we assumed that the same proportion could apply to handwashing stations, yielding a result of necessary handwashing stations per country.

In terms of price, we drew on a Thinkwell report, which referred to the work of Freedman et al. (2017)[14][15], who costed the implementation of portable handwashing and drinking water stations in rural health facilities in Kenya. Using the profile of the largest handwashing station in the Thinkwell report, we combine the fixed cost of the station with the recurrent cost for soap and sought to add the recurrent cost for water. As suggested from WASH experts at the WHO, using water only for initial wetting and final rinsing with 20 seconds of lathering and scrubbing with soap, each handwash would be expected to use .25 L of water. As seen in Beale et al (2020)[16], we assume each person should be washing their hands six times a day to minimize the chance of infection with COVID-19, which was multiplied by the 250 people in the catchment area to yield a daily quantity of water needed. When there was access to potable water, we assumed each station would be installed with a connection to this potable water source, such as next to a health facility or school, and we thereby multiplied the daily, and then

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[11] https://washdata.org/

[12] Hutton, G., & Varughese, M. (2016). *The costs of meeting the 2030 sustainable development goal targets on drinking water, sanitation, and hygiene*. The World Bank.

[13] Baumann, E., Montangero, A., Sutton, S., & Erpf, K. (2010). WASH technology information packages. *Copenhagen (Denmark): UNICEF*.

[14] Banks, C., & Boonstoppel, L. Immunization campaigns during the COVID-19 pandemic. (2020). Thinkwell.

[15] Freedman, M., Bennett, S. D., Rainey, R., Otieno, R., & Quick, R. (2017). Cost analysis of the implementation of portable handwashing and drinking water stations in rural Kenyan health facilities. *Journal of Water, Sanitation and Hygiene for Development*, *7*(4), 659-664.

[16] Beale, S., Johnson, A. M., Zambon, M., Hayward, A. C., & Fragaszy, E. B. (2020). Hand and Respiratory Hygiene Practices and the Risk and Transmission of Human Coronavirus Infections in a UK Community Cohort. *Flu Watch, Hand and Respiratory Hygiene Practices and the Risk and Transmission of Human Coronavirus Infections in a UK Community Cohort (3/8/2020)*.

monthly, quantity of water to be used by the country-specific price of piped water. This price, as many of the country-specific prices used, come from the WHO choice database[17].

For areas where there is no piped water, we assume that water would have to be brought in by truck, which would be a factor of households without basic water source at the household level. To ensure there is no need for handwashing stations to be replenished extremely frequently, a 5000L water storage tank would be added to each hand washing station set up in areas without access to piped water, with a price drawn from country projects in sub-Saharan Africa. The price for trucked water ranges significantly between countries, but given that this is likely to vary in line with the price of piped water, we assume a price that is a fixed multiple of the price of piped water, as point estimates for countries with available prices of trucked water fall, on average, very close to this adjusted price. In addition, to prevent vandalism and theft of the hand washing station and its components, we assume that a community volunteer is present to watch over each station, as well as serving to ensure users follow safe distancing practices. As they are assumed to be volunteers, they have no respective wage or salary costs, but the costs of masks, gloves and hand sanitizer are taken into account.

ii. PPE, including masks and gloves, and other hygiene commodities

The volume of personal protective equipment and their related resource needs are the product of calculations in the ESFT. PPE assumptions vary depending on the type of health worker included in the model. Health workers that interacted directly with COVID-19 patients get "full PPE" which includes medical masks, a gown, gloves, eye protection, and an apron. Respiratory therapists, even if not dealing with COVID-19 patients, get “full PPE”. Those health workers that have no direct contact with patients (such as pharmacists, clerks, and case managers) receive masks, gloves and hand sanitizer. Details of the equipment received by different cadres of health workers can be found in the table below. All of these are quantities assumed to be used by these cadres of health workers per day.

In addition to PPE, there are also a series of hygiene commodities, used as part of COVID-19 care, either at the individual level for health workers, such as alcohol based hand-rub and liquid soap, but also for cleaning health facilities who host or have hosted COVID-19 patients, including Chlorine, and for disposing of possibly contaminated material, including bio-hazardous materials bag. It should be noted that the actual cost of disposal of all items mentioned above, including PPE would require significant resources, but these have not been estimated here.

Table A2. Personal Protective Equipment Profile for different Health Worker Cadres[18]

Cadre	Full PPE	If not full PPE, what kind of protection
Doctors and nurses who work with COVID-19 patients and respiratory technicians	Yes	
Laboratory technicians	No	• Medical mask • Eye protection • Gown

[17] Taken from WHO CHOICE database.
[18] https://apps.who.int/iris/bitstream/handle/10665/331498/WHO-2019-nCoV-IPCPPE_use-2020.2-eng.pdf

		• Gloves
Radiologic technicians (with direct contact with covid 19 patients)	No	• Medical mask • Gown • Gloves • Eye protection (goggles or face shield)
Pharmaceutical technicians (in pharmacies, not in wards), clerks, medical assistants(administrative tasks, no patient direct contact)	No	• Masks • Gloves
Cleaners	No	• Medical masks •Gown • Heavy-duty gloves • Eye protection (if risk of splash from organic material or chemicals is anticipated) • Closed work shoes
Patient support (physiotherapists, health assistant, social workers and case managers, counsellors) (with direct patient contact but not doing aerosol generating procedures)	No	• Medical mask • Gown • Gloves • Eye protection (goggles or face shield) • Perform hand hygiene
Safe burial teams	No	• Medical masks • Gown • Gloves • Eye protection (goggles or face shield)
Contact tracers POE (screeners; not in isolation rooms)	No	• Medical masks • Gloves

iii. Re-usable cloth masks

Following the issuance of WHO guidance on mask use for the general public for those that are unable to physically distance[19], we estimate the provision of re-usable cloth masks to populations in need and who are unable to purchase such masks for themselves. We estimate this cost for all contacts who will be traced by the contact tracing teams in person. We assume that not having a cellular phone is an indicator of household resource constraints, and where households would not have the money to buy cloth masks if they cannot afford cellular phones. For the price of re-usable masks, given no international reference prices, we took the average of several spot prices of masks from a handful of middle-income countries, who have begun industrial, mass-production of re-usable cloth masks.

iv. IPC capabilities

[19] https://apps.who.int/iris/rest/bitstreams/1279750/

As in other pillars, there is a series of capabilities related to coordination that have been costed within this pillar. This includes a team of five staff, with costs for an office, a vehicle, a driver, and mobile phone plans for each staff member. This team scales up from the national level to the first subnational level when planning for clusters of cases and to the second subnational level when planning for community transmission. If a country is planning for widespread community transmission, the number of teams at the second subnational administrative level double. Training on infection prevention and control with health and other essential workers, carried out by these teams (and therefore scaling with planning for the different levels of the pandemic) is also taken into account, carried out in person but following social distancing guidelines. Costs here include the price of meeting rooms, fees for trainers, and per diems for participants and trainers. To support these training sessions, and also provide general guidance for the IPC teams, we also include costs for consultants. The number of consultants scales up from 1 international consultant at the national level to one national at the first subnational administrative level when planning for community transmission, and one national consultant at the second subnational administrative level in the case a country expects to respond to widespread community transmission. If a country has more than 500 second subnational administrative units, the number of consultants at that level is capped at 500.

- Pillar 7: Case Management
    i. Human Resources

For estimating the additional resource requirements for the health workforce, we identified the number of health workers required to respond to COVID-19 in each country who are re-distributed from their regular tasks. In countries where there are expected to be more than 500 new cases of COVID-19 over the forecasted period, all health workers who interact directly with COVID-19-patients receive hazard pay, estimated at 25% of their standard pay[20]. These are estimated for those recruited to be part of the COVID-1919 response, by adjusting the numbers produced by the ESFT. The ESFT, in seeking to only quantify the number of necessary supplies and commodities, groups together health worker cadres that will use similar types of commodities in caring for COVID-19 patients, such as PPE. To estimate the non-commodity costs, we estimated the number of workers involved, disaggregated by cadre. To do this, we drew on the HW estimator tool[21], developed by the WHO, which uses a task-based approach, and estimates the number of minutes translated into weekly shifts for 9 different cadres of health workers for each of the 4 severity types of COVID-19 cases. In order to maintain consistency, and use the correct number of cases and commodities for a country, the number of estimated weekly shifts of generic 'health care workers' in the ESFT to treat one mild, moderate, severe and critical case are adjusted into weekly shifts of each cadre, as guided by the HW estimator. The two tools take very similar approaches for the number of health workers needed to treat severe cases, but they vary in the resulting numbers for the other cases, based on their approach. Since the HW estimator tool analyzed each task required for each case type, in terms of minutes, by cadre, it follows that in addition to disaggregating the number of health workers required, changing their number with inputs from the HW estimator tool presents a more accurate representation of health worker requirements. In addition we adjust the calculation of necessary lab technicians for COVID care used by the ESFT, where the number

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[20] https://www.ccisua.org/wp-content/uploads/2016/04/ICSC_70_CRP.15_HazardPayComparison.pdf
[21] https://www.euro.who.int/en/health-topics/Health-systems/pages/strengthening-the-health-system-response-to-covid-19/surge-planning-tools/health-workforce-estimator-hwfe

of lab technicians was a fixed number dependent on the number of labs in operation. Instead we estimate the number of lab technicians working on COVID-19 tasks as a factor of the number of shifts of lab technicians needed to run the diagnostic instruments that are required to deliver the number of tests calculated by the ESFT. This is also capped by the number of lab technicians found in each country, where it is assumed 1/3 could be prioritized for COVID-19 work. The number of these, as with the number of doctors and nurses come from the World Health Observatory. Unlike with other cadres dealing with COVID-19 care, the number of necessary lab technicians and cleaners estimated by the HW estimator are not used, and are instead a product of the ESFT, given both their similarity in quantities, but given their required numbers stemming not from the number of cases (the main input of the HW estimator, and the tasks related to each case) but rather the number of tests to be administered, and the number of facilities and labs prioritized for COVID-19 care, numbers estimated by the ESFT.

We model that all those workers prioritized for COVID Care receive hazard pay, which include all cadres except for clerks, medical assistants and other administrative workers with no direct patient contact. Similarly, we model that no health workers recruited as part of efforts to maintain the delivery of essential health services receive hazard pay, with the exception of additional respiratory technicians given the higher level of risk exposure.

All health care workers that are prioritized to work on the COVID-19 response also receive a payment incentive, to ensure an adequate response, estimated as 50% of their standard pay[22], meaning that these workers receive 1.75X their standard monthly pay.

ii. Field hospitals

In order to increase the capacity of health systems to deliver COVID-19 care, we include the costs for countries to set up 20-bed field hospitals for the exclusive use of treating severe and critical COVID-19 cases or as a replacement. These include costs for facilities and basic infrastructure, energy, and water and sanitation. These are only modelled as being necessary when a country expects to have more than 10,000 cases within the modelled period and expects community level transmission. If this is the case, a temporary field hospital sis set up in each second level subnational administrative unit, adjusted by the percent of the population that lives in urban areas. If a country is planning to respond to widespread community transmission, the expected number of field hospitals in a country is doubled. The prices of these reflect the prices paid at the country level in previous instances of WHO-supported efforts to set up field hospitals during public health emergencies, such as during the Ebola outbreaks in the DRC and in West Africa.

Places for quarantine of mild and moderate cases not needing hospitalization but are unable to self-isolate are not included in the costing. Such efforts may potentially be borne by another sector, usually the ministry on social welfare, or the local governments.

iii. Drugs and consumables

As a direct outcome of the estimations calculated by the ESFT, from the number of cases projected from the epidemiological modelling, after being disaggregated by severity, we are able to present the total cost for drugs and consumables for delivering COVID-19 care. This takes into account the supply constraints in countries, both from available inpatient and ICU beds, as well as skilled health workforce

[22] https://blogs.worldbank.org/governance/how-increase-compensation-health-workers-during-covid-19

to provide treatment. Quantity assumptions are those found in the ESFT and prices used were updated from the WHO COVID-19 supply portal.

iv. Biomedical equipment

Just as noted in the previous section with drugs and consumables, we draw upon the calculations of the ESFT based on forecasted cases as calculated by epidemiological modelling, to estimate the quantities of necessary biomedical equipment to deliver COVID-19 care. The prices for these were drawn from the ESFT and updated with the WHO COVID-19 supply portal. Among the equipment included were patient ventilators, CPAPs, ultrasound machines, ECG machines. Consumables used to operate this equipment are included in the drugs and consumables component above.

v. Body bags

Drawing from published case fatality ratios, disaggregated by case severity, and by whether the cases receive inpatient care or not, we estimate the number of COVIDCOVID-19 deaths during the modelling period, and estimate the cost of body bags required. The prices of these were drawn from the ESFT list of commodity prices.

vi. Safe burial teams

Noting the particular strain felt by certain countries in managing the large numbers of COVID-19 casualties within short periods of time, we include the costs of safe burial teams. These are comprised of a team of 5 workers, including a driver, a rented truck, with minimal levels of fuel, and full sets of personal protective equipment. These scale up from the central level to the first subnational administrative level when planning for community transmission and to the second subnational administrative level when planning for widespread community transmission. In addition, when there are expected to be more than 50000 cases, we include the costs of an additional safe burial team for each second-level administrative unit, adjusted by the share of the urban population (given that the management of COVID-19 fatalities will come under strain in health facilities mostly in urban environments). To support in this task, we also include the costs of experts in mass casualty management. These scale only from one international consultant the national level to an additional national consultant at the first subnational administrative level when planning for community transmission, doubling in number when expecting widespread community transmission.

- Pillar 8 Logistics and Supply Management

i. Logistics management

In this pillar, we cost support for logistics management for responding to COVID-19 at the national level. This includes a logistics team, comprising of a team of 4 logistical specialists, with 2 vehicles, each with a driver, mobile phone plans for each, logistical specialist, an office, as well as setup equipment. These scale up to being implemented at the first subnational administrative level when a country moves to planning for community transmission, and then to a 40% of second subnational administrative level when planning for widespread community transmission. In addition, to help countries plan for the additional burden placed on the logistics system from responding to the COVID-19 pandemic, we include the cost of experts in logistics, which scale from an international consultant at the central level to national consultants at the first subnational administrative level once a country begins planning for community transmission.

ii. Warehouse rental

To help countries prepare for responding to COVID-19 care, we cost the rental and operation of additional warehouses, for the prepositioning of essential commodities and personal protective equipment. This is estimated as the cost to rent a 2000 pallet warehouse, estimated as being 2880 sqm in size and varying in line with local rental prices of commercial real estate. The rental costs include the cost of operation of warehouses, including essential recurrent costs such as security and utilities, but does not include any staff, and as such, wages for 5 warehouse operators are costed separately. These scale-up from being only found at the central level for isolated cases to being rented at the first subnational administrative level for clusters of cases and at the second subnational administrative level for community transmission.

- Pillar 9: Maintaining Essential Health Services

Pillar 9 has a more detailed division within 8 different sections. Here, the activities costed represent direct responses to the responsibilities and capabilities presented in each section, as well as other resource needs not mentioned directly, but understood to be necessary for maintaining essential health services.

In line with the idea of integrated health systems and avoiding siloed actions, several activities that may be expected to figure in a particular section are missing, where they have been understood as being captured by activities in one of the other 9 pillars.

- Section 1. Establish simplified purpose-designed governance and coordination mechanisms

As part of this first section, activities have been costed in response to fulfilling two separate actions, not covered by the coordination and governance pillar, noted above. These were the establishment or adaptation of simplified mechanisms to govern the delivery of Essential Health Services (EHS), in coordination with response protocols, and the establishment of triggers/thresholds for activating phased protocols. To ensure this, we estimate the costs for consultants to create protocols governing EHS delivery, and assessing the delivery of EHS in order to map referral pathways, as well as the process for activating phased protocols, as well as an online workshop for their validation. The development of a training package on EHS and how to activate protocols was also included, and as the other points, is a task necessary for all countries to go through once at the national level, or at each respective level where the relevant authority has been decentralized. In addition, training for each EHS focal point on the protocols is included, and scales depending on the extent of the COVID-19 outbreak, given the likelihood of having to activate these protocols increases as the pandemic progresses. Finally, a standardized team was estimated as being necessary for coordinating the maintenance of EHS, including the responsibilities mentioned above, such as coordinating the activation of protocols, but also monitoring health facilities, the health workforce, and medical supplies, and whether responses are necessary to adjust any of these components in order to ensure the delivery of EHS. These teams move from being an individual centralized team to being implemented at the regional level when a country begins planning to be in a situation with community transmission of COVID-19 cases.

- Section 2. Identify context-relevant essential services

As part of this second section, cost are estimated as part of generating a country-specific list of essential services. This is a task carried out by a consultant, implemented once centrally, but could possibly be scaled up to relevant subnational authorities in decentralized contexts, or where different service packages already exists for subnational populations.

- Section 3. Optimize service delivery platform

As part of this section, resource needs are estimated to respond to two principal actions; conduct a functional mapping of service delivery platforms, and concentrating (non-COVID-19) acute care at 1st level hospital emergency units. A first step is the creation of a database after surveying existing datasets and database of health services and the delivery platforms in which they are delivered. This resulting functional mapping would then go through an online workshop for validation, and its costs are included here. In order to help guide the movement of acute care into 1st level hospital emergency units, a support team would become active to help manage these units, scaling to the first subnational administrative unit from just the central level when a country begins to plan for community transmission of COVID-19 cases. Part of this is directing concerns of the population of whether they should seek care for health issues or if these could be postponed until a stage where the pandemic is less widespread, and as such, there is a resource estimate for a hotline for individuals to call to and receive guidance on where they should still seek care within health facilities. These will quickly go from existing just at the national level to being at the regional level as soon as there are clusters of cases, to being at the subnational level when there is community transmission of COVID-19 cases. Paired with this, complex care, which will shift from higher level facilities to 1st level hospitals, will also need support and as such, health practitioners who have little experience with such type of care will be able to contact a hotline with specialists to give guidance on questions health workers may have related to more complex care. This will scale from just existing at the central level to the regional level as countries prepare for community transmission of COVID-19 cases. As a precursor to managing complex care at 1st level facilities, complex care patients need to be relocated to 1st level facilities, and as such a series of patient transport vehicles need to be rented. Since we expect all facilities that have an ambulance will see their ambulances repurposed to focus on COVID-19-care, we find that transport vehicles need to be rented for each 1st level hospital.

In addition to those activities noted in the PSRP, there are several capabilities that need to be in place to implement the optimization of service delivery platforms. First, most if not all 1st level hospital acute care units would not be ready to receive all acute care, and we estimate the resource requirements to re-purpose or bring to capacity health facilities into 1st level emergency or acute care units. This is done only when a country is planning for community level transmission, and expects over 10,000 COVID-19 cases during the forecasted period. The cost to equip facilities in this way is assumed to only be necessary for one facility per second level administrative unit, adjusted by the % of the population living in urban areas, where 1st level hospital capacity is likely to be exceeded. In addition, health workers without much experience in managing complex or acute care will need to receive training in managing this kind of care, which is implemented in line with the number of additional health workers.

- Section 4. Establish effective patient flow at all levels

In order to manage patient flow, comprising of screening, triage and targeted referral at all levels of the health system, several things need to be implemented. These have been split into three separate tasks, to be described in order. The first is to disseminate information to prepare the public and guide safe care-seeking behavior. Here we include the costs for the development or contextualization of communications material for safe care-seeking by the public, to be carried out by a local firm. The actual printing and dissemination of materials are included within the Risk Communications pillar, as well as media of this same messaging, including social media. The content related to safe care seeking is also part of the resources attributed to developing a media campaign as part of pillar 3, integrating safe care seeking message into the general COVID-19 messaging. The second task is to establish screening of patients at all health care sites, using the most up to date guidance. Activities costed for this task include developing protocols for screening of all patients, which is carried out by a national-level consultant, as well as supporting the management of the patient screening program carried out by existing staff of the national and subnational health authorities. In addition, development or contextualization of training materials for COVID-19 screening and triage are included, and the training on specialized screening and triage for health care workers are costed as scaling by the number of health facilities in a country. Finally, the third task is comprised of establishing mechanisms in all care sites for isolation of patients meeting the COVID-19 case definition, which comprise resources for the development of protocols and mechanisms for patient isolation and criteria for referral pathways, carried out by a national level consultant. Costs for making facilities capable to isolate patients, such as preparing and equipping temporary spaces for quarantine functions, or additional stocks of full PPE when needing to activate isolation mechanisms have not been included.

- Section 5. Rapidly re-distribute health workforce capacity

In order to maintain the delivery of essential services when a significant share of the health workforce has been prioritized to deliver COVID-19 care will not be easy for any country. To make this a realistic possibility, health authorities need to develop ways to rapidly re-distribute the health workforce capacity they do have, making best use of those health workers that remain to deliver essential care, re-assigning workers between areas, and implementing task-sharing and task-shifting. This activity is split into 5 tasks which have additional resource requirements estimated in our model. The first is the mapping of health workforce requirements, in terms of critical tasks needed and time usage, in the COVID-19 transmission scenarios the country has yet to experience. While the ESFT and HW estimator have created a stylized model of tasks and time usage in delivering COVID-19 care, guidelines and approaches to care may vary by country, and a national level consultant will be called upon to support care specialists in this task. The second task relates to maintaining the health and safety of health workers, and begins with training on proper use of personal protective equipment and infection prevention and control for health workers. This includes costs for the development and contextualization of a training course on PPE and IPC for health workers, and the implementation of the remote learning course to be taken by all health workers. As with training for screening and triage at all facilities, this is only implemented at all facilities when planning for community transmission of COVID-19. To support health workers in this most unusual moment, we include costs for counselors on occupational safety, to scale from the national level to the first subnational administrative level when planning for clusters of cases, and to the second subnational level when planning for community transmission. In addition to counselors, national level consultants in IPC and occupational safety are also included, scaling in the same way as the counselors. The third task in this area is rapid training mechanisms and job aids for key capacities needed to do task-shifting and task-sharing, including diagnosis, triage, clinical management and essential IPC. These are rapid mechanisms and job aids aimed mostly at workers re-entering the public health system, hired to replace those delivering COVID-19 care, and also include a remote course to be taken by workers of every health facility as a group when countries plan to deal with community transmission. For this course, costs for a course supervisor or tutor, per health facility, are also included. Finally, the actual redistribution of the workforce requires some additional resources. This includes an additional pair of administrators whose sole task is to manage HW needs and numbers for essential service delivery, which scale up additional administrators from the central level to the first subnational administrative level when planning for community transmission and to the second subnational administrative level when planning for widespread community transmission. In addition to this, we also include costs for additional outreach teams to support community health workers in delivering essential care that has been moved out of health facilities and to community or outreach-based delivery. The number of additional outreach teams move from one at the first subnational administrative level to one per hospital when moving planning for clusters of cases to planning for community transmission.

- Section 6. Maintain availability of essential medications, equipment and supplies

To ensure the availability of essential medications, equipment and supplies, we include resource requirement estimates for 3 tasks. The first task is to map the list of essential services prioritized by the country to their respective resource requirements, in terms of medications, equipment and supplies, per case. A country-level consultant is given this task, and in charge of coordinating a rapid review and an on-line consultation of the resulting resource list. A second task is identifying the providers of these resources, which includes the creation of a survey of existing datasets and databases to create a map of suppliers, including both public and private pharmacies and equipment suppliers. This is entrusted to a national consultant, that is also responsible for hosting a web-based consultation of the resulting mapping exercise. A third task is the creation of a platform for reporting inventory of the three types of inputs mentioned above, noting existing and projected stockouts, and for coordination the re-distribution of supplies. We include the costs for a local IT developer to create and program a central communication platform to keep track of essential inventory, as well as a national consultant to create quantitative plans for strategic prepositioning of essential supplies.

- Section 7. Reduce financial barriers for essential services

In this section, we include resources for the possibility to redistribute financing in order to ensure the delivery of essential services. This is divided into two tasks, the first of which being the creation of a coordination mechanism between finance and health authorities, tasked with creating a mechanism acceptable to both authorities, to allow for more rapid financing of the health system, in order to ensure the delivery of essential services, including changes in existing allocations at the service delivery level. This rather complex task is entrusted to a team of local consultants, in consultation with representatives of both the national health and finance authorities. The second task is the actual assistance in financing essential services, which can either take the form of the elimination of user fees or the creation of cash transfers to promote the demand of essential care. These would take the form of financial compensation to health facilities when suspending co-payments and user fees at the point of care, or cash transfers for vulnerable populations, to be distributed at health facilities. The creation of a cash transfer program would also require additional resources for a team of administrators to manage the cash transfer program. However, while these are presented as options, the resources to actually implement either of these initiatives are not included in our costing, given the inability to determine the size of compensation needed to be provided to health facilities for each country, or the size of cash transfers to be implemented, both of which depend on the utilization of services and their local prices, which are inputs not publicly available for all countries in our sample.

- Section 8. Communication to support essential services

In this pillar, many components would be already included in other sections or pillars, as part of efforts to encourage the use of essential services. In addition, we include resources to bolster local associations to generate and disseminate community based support initiatives, which specifically include training members of the community in initiatives in health, with a focus on supporting isolated and vulnerable community. These training courses would be carried out with 5 different groups of community leaders, health activists, or organizers every month, and would scale up to the first subnational administrative level when planning for community level transmission and to the second subnational administrative level when planning for widespread community level transmission.

- Section 9. Additional considerations

Beyond the capacities and activities noted in the sections specified by the PSRP, we note that countries will find themselves in significant difficulty in being able to maintain the delivery of essential health services with the existing health workforce in place, particularly as the costing considers the share of the workforce that is prioritized to responding and delivering COVID-19 care. While there are many health services which can be postponed or delayed as part of prioritizing care as part of a health system faced with the COVID-19 pandemic, decreasing the burden upon the workforce, the additional burden faced because of the pandemic itself and cases of severe and critical severity make it highly unlikely that low and middle income countries are able to continue the delivery of essential care while prioritizing some of its workforce to COVID-19 care. Therefore, we include the resource requirements for replacing half of those workers who are no longer fulfilling their regular duties but instead focusing on COVID-19 care (estimated up to a maximum of 60% of the current health workforce). The quantities of these are simply half of those identified in pillar 7, but unlike costs in pillar 7 are full salaries, as these are new workers that have to be hired to replace those identified in pillar 7. Given that none of these health workers are expected to be interacting directly with COVID-19 patients, they do not receive any hazard pay, except for respiratory technicians hired to replace those who would be working with severe COVID-19 patients, given the higher impact on their individual health if a patient they work with may be an undiagnosed COVID-19 case.

Caveats:

The first is that the costing is primarily driven by the epidemiologic model used. Running an epidemiologic model and making projections for many countries is fraught with uncertainty, especially given the assumption that the Rt remains fixed over the four week and 12 week time frame. For COVID-19, most epidemiological models project two weeks to one month into the future, and rarely go as far projecting up to three months, as in our case. In this exercise, to cope with this uncertainty, scenarios with different Rts were projected to provide higher and lower bounds to the base case estimate.

In terms of scope, as mentioned, this costing exercise did not include the isolation or quarantine costs of mild to moderate cases and their contacts that are unable to successfully isolate or quarantine themselves in their own homes, and where mass quarantine shelters or facilities would need to be set up. This could potentially be a large cost, but it is usually borne by local governments or ministries of social welfare. The use of international market prices, without freight, insurance and import tariffs as we have done in this exercise, also underestimate the costs. However, countries have been known to allow time-bound, tariff-free entry for supplies and medicines for COVID-19. In addition, countries would have to bear costs of waste management of the COVID-19 response, primarily for non-durable PPE, which are not included in our estimates, but could require significant amounts of resources. Finally, these costs would increase significantly once directly acting medicines or vaccines are proven to be effective against COVID-19 and added to standard treatment or prevention protocols.

In addition, some assumptions were used in the model that probably vary across countries, but were held constant, as country-level information was not readily available. This is particularly the case with supply constraints in the health system including the availability of health workers in domestic markets, and access to additional laboratory diagnostic kits and other supplies in international markets.

VII. List of countries (by World Bank income classification) included in the costing

Low Income		Low-Middle Income		Upper-Middle Income	
1	Afghanistan	28	Angola	54	Algeria
2	Benin	29	Bangladesh	55	Azerbaijan
3	Burkina Faso	30	Cameroon	56	Brazil
4	Burundi	31	Comoros	57	China
5	Central African Republic	32	Congo, Rep.	58	Colombia
6	Chad	33	Cote d'Ivoire	59	Dominican Republic
7	Congo, Dem. Rep.	34	Egypt, Arab Rep.	60	Ecuador
8	Ethiopia	35	Eswatini	61	Iran, Islamic Rep.
9	Gambia, The	36	Ghana	62	Iraq
10	Guinea	37	India	63	Jordan
11	Guinea-Bissau	38	Indonesia	64	Kazakhstan
12	Haiti	39	Kenya	65	Malaysia
13	Liberia	40	Kyrgyz Republic	66	Mexico
14	Madagascar	41	Mongolia	67	Peru
15	Malawi	42	Morocco	68	Romania
16	Mali	43	Myanmar	69	Russian Federation
17	Mozambique	44	Nigeria	70	South Africa
18	Nepal	45	Pakistan	71	Sri Lanka
19	Niger	46	Philippines	72	Thailand
20	Sierra Leone	47	Senegal	73	Turkey
21	South Sudan	48	Sudan		
22	Syrian Arab Republic	49	Tunisia		
23	Tajikistan	50	Ukraine		
24	Tanzania	51	Uzbekistan		
25	Togo	52	Zambia		
26	Uganda	53	Zimbabwe		
27	Yemen, Rep.				

VIII. Panels Tables from Manuscript

Panel 1. Pillars of Strategic Preparedness and Response Plan and Associated Key Cost Items

Pillar	Key Cost Items
1. Country-level coordination, planning and monitoring	Coordination teams and communications equipment
2. Risk communication and community engagement	Risk communications teams, mass media campaigns and materials
3. Surveillance, rapid-response teams, and case investigation	Rapid response, surveillance, and contact tracing teams, including additional human resources for contact tracing
4. Points of entry, international travel and transport	Points of entry teams, training, personal protective equipment, and test kits
5. National laboratories	Diagnostic machines and laboratory consumables
6. Infection prevention and control	Personal protective equipment, cloth masks, hygiene commodities (soap and hand sanitizers, including facilities) and hand washing stations
7. Case management	Human resources for health (incentives and hazard pay), field hospitals, biomedical equipment, drugs and consumables, safe burial teams
8. Operational support and logistics	Logistics teams, warehouses
9. Maintaining essential health services and systems	Coordination teams, salaries of new hires, facility re-purposing, outreach teams, rented ambulances

Table 1. Epidemiologic Profile and Projections for the Four Week and 12 Week (after 26 June 2020) Timeframes

	Number of Countries			Pop.	Oxford Stringency Index (Median)	Number of daily contacts (Average)	% Infected	%infected four weeks after 26 June 2020			%infected 12 weeks After 26 June 2020		
Rt Category	Low Income	Lower-middle Income	Upper-middle Income	At the start				Status quo	Decrease Transmission 50%	Increase Transmission 50%	Status quo	Decrease Transmission 50%	Increase Transmission 50%
< 1	6	1	0	178	74·07	3·47	0·40	0·50	0·44	0·62	0·74	0·45	3·68
1 to < 1.5	11	10	9	3,223	67·56	6·16	1·26	2·87	1·82	3·70	10·71	1·92	24·31
1.5 to < 2	10	13	11	2,690	69·19	8·23	0·93	7·51	2·38	10·70	54·93	3·59	69·24
2 +	0	2	0	8	78·94	8·85	0·82	12·74	3·21	15·77	66·50	7·13	72·28

Table 2. Four Week and 12 Week (after 26 June 2020) Cost of COVID-19 Response by Country Income Group

	Low-Income (population 685,066,000)		Lower-Middle Income (population 2,920,000,000)		Upper-Middle Income (population 2,493,375,000)		Total (population 6,098,441,000)	
	Total Cost (billions)	Cost per Capita	Total Cost (billions)	Cost per Capita	Total Cost (billions)	Cost per Capita	Total Cost (billions)	Cost per Capita
Total Cost (4 weeks, 2020 USD)								
Status Quo	2·25	3·28	24·74	8·48	25·46	10·21	52·45	8·60
Decrease Transmission 50%	1·65	2·41	14·18	4·86	17·24	6·92	33·08	5·42
Increase Transmission 50%	3·30	4·82	30·08	10·30	28·54	11·45	61·92	10·15
Total Cost (12 weeks, 2020 USD)								
Status Quo	6·20	9·06	80·97	27·73	66·69	26·75	153·86	25·23
Decrease Transmission 50%	2·30	3·36	23·28	7·97	26·53	10·64	52·11	8·54
Increase Transmission 50%	10·99	16·04	104·88	35·92	80·98	32·48	196·85	32·28

Table 3. Four Week (after 26 June 2020) Status Quo Cost of COVID-19 Response for 73 Countries by Pillar of Response (2020 USD)

	Status Quo Scenario		Decrease Transmission 50%		Increase Transmission 50%	
	Cost (billions)	% Total	Cost (billions)	% Total	Cost (billions)	% Total
Pillar of the Response						
1. Country-level coordination	0·05	0·1	0·05	0·1	0·05	0·1
2. Risk comms and community engagement	0·59	1·1	0·59	1·8	0·59	1·0
3. Investigation, surveillance and rapid response	7·07	13·5	2·23	6·7	11·32	18·3
4. Points of entry	0·04	0·1	0·04	0·1	0·04	0·1
5. National laboratory system	0·54	1·0	0·43	1·3	0·56	0·9
6. Infection prevention and control	4·48	8·5	3·57	10·8	5·05	8·2
7. Case management	28·40	54·1	18·59	56·2	31·47	50·8
8. Logistics and supply management	0·18	0·3	0·18	0·6	0·18	0·3
9. Maintaining essential services	11·09	21·2	7·39	22·4	12·65	20·4

Table 4. Composition of Costs for the COVID-19 Response for Four Weeks and 12 Weeks (after 26 June 2020)

	4 Week Status Quo	12 Week Status Quo
	% of Total	% of Total
Cost Category		
Human Resources	42%	63%
Commodities	13%	17%
Capital	41%	16%
Other	4%	4%
HR Costs (Billions 2020 USD)		
Low-Income	0·27	2·02
Lower-Middle Income	10·29	51·58
Upper-Middle Income	11·27	43·23
Total	21·83	96·84
	% of Total HR	% of Total HR
HR Cost Components		
Salaries	51%	68%
Hazard Pay	15%	9%
Incentives	34%	23%

IX. Additional table with 12 Week Results

Table 5. 12 Week (after 26 June 2020) Status Quo Cost of COVID-19 Response for 73 Countries by Pillar of Response (2020 USD)

	Status Quo Scenario		Decrease Transmission 50%		Increase Transmission 50%	
	Cost (billions)	% Total	Cost (billions)	% Total	Cost (billions)	% Total
Pillar of the Response						
1. Country-level coordination	0·13	0·1	0·13	0·3	0·13	0·1
2. Risk comms and community engagement	1·76	1·1	1·76	3·4	1·76	0·9
3. Investigation, surveillance and rapid response	44·74	29·1	5·92	11·4	66·98	34·0
4. Points of entry	0·12	0·1	0·12	0·2	0·12	0·1
5. National laboratory system	1·64	1·1	0·92	1·8	1·73	0·9
6. Infection prevention and control	11·29	7·3	5·10	9·8	13·99	7·1
7. Case management	60·15	39·1	24·82	47·6	70·51	35·8
8. Logistics and supply management	0·51	0·3	0·51	1·0	0·51	0·3
9. Maintaining essential services	33·53	21·8	12·83	24·6	41·12	20·9