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National COVID-19 Health and Research Advisory Committee*

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Advice 24: Optimising the speed and efficiency of contact tracing in managing outbreaks of SARS-CoV-2

Focus

This paper seeks to provide evidence-based advice on measures that can be implemented to optimise the efficiency of contract tracing as a part of managing and outbreak of SARS-CoV-2. This includes discussion of what indicators should be used for monitoring contact tracing efficacy and discussion on best practices for contact tracing in the Australian context.

Note

This report is point in time and may need further review as more evidence is available.

This report was developed by a working group of the National COVID-19 Health and Research Advisory Committee (NCHRAC), which was chaired by Professor Kamalini Lokuge, with Professors Brendan Crabb, Raina MacIntyre, Angus Dawson and Fran Baum, Ms Christine Morgan and Dr Katie Allen. External expert advice was provided by Associate Professor Kathryn Glass.

Key points:

- Based on previously circulating strains of COVID-19, approximately 80-90% of contacts need to be traced and isolated to effectively control an outbreak; this may be higher for the Delta variant.
- Digital contact tracing is limited as only contacts who use the app are identified; digital contact tracing should be used in combination with manual methods and not in isolation.
- In order to have an impact, contact tracing must facilitate a turnaround time between successive diagnoses of less than 5-6 days (as contact tracing does not add value if cases self-identify themselves for testing based on symptom development). Ideally, contact tracing should aim to detect and quarantine contacts before they are infectious.
- The key benefits of automation of contact tracing is that it allows mass scaling up when human resources capacity for tracing is exceeded. It may also be faster and a more accurate method, thereby reducing delays to commencing quarantine.

* NHMRC is providing secretariat and project support for the Committee, which was established to provide advice to the Commonwealth Chief Medical Officer on Australia's health response to the COVID-19 pandemic. The Committee is not established under the NHMRC Act and does not advise the NHMRC CEO.

- Technologies can work to allow exploration of prior interactions of people, thereby assisting contact-tracer teams to decide if the level of contact is substantial enough that a person should be isolated.
- Digital (app based) contact tracing is an effective addition to manual contract tracing with any increase in uptake having a small positive benefit. To have a large impact, uptake of 75-90% of the population would be required. Passive digital technology that does not require opt-in can achieve high uptake.
- World-wide, a variety of digital contact tracing technologies have been used. The methods have broadly included automated opt-in technologies (similar to the COVIDSafe app), partly automated methods (such as location-based check-in QR codes), or fully automated such as use of credit card or mobile phone data.
- A key limitation of automated contact tracing is that populations vulnerable to the health impacts of COVID-19 are less likely to access technology required. Thereby, to increase the accuracy of automated tracing in centres like aged care settings, the use of specifically designed devices (such as Bluetooth-enabled tokens) may produce more reliable outcomes. Privacy issues also limit the use of passive digital methods.
- Streamlining of distributed contact tracing capacity (e.g. by having systems that allow contact tracers to rapidly and seamlessly integrate with and work across jurisdictions) will enhance the capacity for contact tracing in jurisdictions with outbreaks.
- Engaging healthcare providers with long-term trusted relationships in the community, and that are providing COVID-19 health services, has potential to improve contact tracing quality and timeliness, including in communities that face challenges accessing mainstream messaging and support.

Summary of evidence

The evidence references below come primarily from settings with widespread transmission, that were not undertaking intensive upstream or downstream contact tracing or secondary contact tracing, and from the period prior to more transmissible strains such as the Delta variant becoming widespread. Therefore, the figures given for optimal efficiency and required capacity may not be relevant to Australia's current context.

Factors that will influence contact tracing requirements: As well as characteristics of individual cases, there are policy decisions based on the characteristics of the virus that will have substantial impacts on contact tracing requirements. Secondary contact tracing and management becomes increasingly important if there are indicators that by the time cases are identified, their contacts are already infectious. Secondary contact tracing will increase workload even further. The definition of close and casual contacts is also important, as this will influence the contact tracing system requirements, given close contacts are more intensively managed than casual contacts. Again, if there is evidence of increased transmissibility (i.e. transmission from minimal/fleeting contact) this will also mean that a much larger number of contacts will need to be managed intensively.

Manual contact tracing

The World Health Organisation (WHO) has provided interim guidance on contact tracing in the context of COVID-19, published on 1 February 2021. In this document, contact tracing is described as a key strategy to interrupt COVID-19 chains of transmission and minimise associated mortality.[1]

In Australia, contact tracing is a state and territory public health function, and each jurisdiction follows the *Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units*. Version 4.7 of these Guidelines, published on 24 June 2021, includes updates to a case definition, release from isolation criteria, and contact management.[2]

On 13 November 2020, the National Contact Tracing Review was published.[3] The review looked at COVID-19 contact tracing and outbreak management systems and processes in all states and territories and made recommendations on preparation, contact tracing, data exchange, outbreak management, technology and communication and trust building with communities. The National Contact Tracing Review emphasised the importance of data exchange between jurisdictions.[3]

Best practice and critical time periods

Researchers have employed various modelling methodologies to provide an evidence base to inform COVID-19 public health policies around the world. Two of the key epidemiological parameters that influence outcomes are the number of secondary cases per infectious case (R_0) and the percentage of transmission that occurs before symptom onset.

A systematic review and meta-analysis investigating the reported reproductive number of COVID-19 determined R_0 (worldwide) to be 2.87 (95% CI, 2.39–3.44).[4] Chang et al. modelled transmission and control of COVID019 in Australia and reported a reproductive number R_0 of 2.77, 95% CI [2.73, 2.83].[5] An R_0 of 2.5 was assumed for many of the analyses discussed below. A detailed meta-analysis breaking-down outcomes based on different R_0 figures is out of scope for this advice. Many studies investigated in this review did not specify the specific SARS-CoV-2 variant examined in their study. The data below should be interpreted with caution as the R_0 of the currently dominant or future strains may be more or less than the figures used in this analysis. For example, the currently dominant Delta variant is thought to be 60% more infectious than Alpha, which indicates an R_0 of 5-7.[6,7]

Community transmission that occurs between people who are asymptomatic or pre-symptomatic can be mitigated with effective contact tracing. The results of modelling studies that have been conducted to investigate the critical time periods and indicators of outbreak control are discussed below.

The percentage of contacts traced and outbreak size

The WHO's benchmark for a successful COVID-19 contact-tracing operation is to trace and quarantine 80% of close contacts within three days of a case being confirmed.[8] Authors of a modelling study based on the New Zealand EpiSurv dataset recommended that effective control is possible if at least 80% of cases are isolated within four days of the index case being identified.[9] Another modelling study fitted to data from the Polymod study for the Netherlands also found that contact tracing coverage of 80% (assuming R_0=2.5 and no delays in contact tracing) results in an effective reproduction number of 0.8 and control of an outbreak.[10] Hellewell et al. investigated how the modification of the basic reproduction number, R_0, impacted contact tracing requirements. The team found that for R_0 of 2.5, more than 70% of contacts had to be traced to effectively control an outbreak, whereas for an R_0 of 3.5 more than 90% of contacts had to be traced.[11] In this study, the incubation distribution estimate fitted to data from the Wuhan outbreak by Backer et al.[12] As the R_0 of the Delta variant is thought to be 5-7, effective control may require an even higher percentage of contacts to be traced in a Delta outbreak.[6,7]

The size of an initial outbreak must be taken into account when discussing contact tracing management. The number of initial cases was found to play a very important role.[11] If only 50% of contacts were traced, outbreaks of five could be controlled in three months for over 60% of the simulations, whereas outbreaks of 40 were only controlled in less than 10%. The impact of the outbreak size was less critical when contact tracing levels were high (80%), with over 70% of simulations controlled in 3 months irrespective of the outbreak size.[11]

Withstanding variations in modelling parameters, the percentage of contacts that are required to be traced (and isolated) to effectively control an outbreak appears to be between 80 and 90%.[9-11,13,14]

Diagnostic serial interval (DSI)

The DSI is the time taken between diagnoses of successive cases in a chain of infection. The DSI is highly relevant to the COVID-19 pandemic because of asymptomatic transmission.[15] There are several milestones in this period including the time taken to identify and test close contacts and the time taken to obtain test results (also referred to as the turn in time). A modelling study based on the New Zealand EpiSurv dataset found that control is possible if at least 80% of cases are isolated within four days of the index case being identified (assuming strong physical distancing measures are in place).[9]

As expected, simulation models have shown short DSIs to be critical for contact tracing to be effective.[16] The largest increase in benefits were observed when the DSI is between two and six days.[16] If the diagnostic serial interval is greater than five or six days, the effectiveness of tracing starts to plateau as contacts self-identify prior to being contacted due to the appearance of symptoms.[9,16]

Upstream/downstream contact tracing and management of secondary contacts

Contact tracing is performed upstream/backwards to identity sources of infection as well as downstream/forwards to identify new cases. How far to trace in each direction can be measured by days or generations of infection from the index case. Modelling studies have emphasised the importance of backwards or upstream tracing to improve effectiveness and to identify more cases which may otherwise result in undetected further transmission.[17-19] Extending the duration of backwards manual tracing (i.e. days traced prior to symptom onset) provides significant advantages.[18] One modelling study found that a backwards manual tracing window of six days pre-symptom onset predicted an effective reproduction number of 42% of the value for a 2-day window.[18] The guidance in Australia is well in excess of this, at 14 days.[2] Extending the time of backwards tracing, whilst beneficial, needs to be balanced with risk of delaying identification of forward/downstream contacts (if resources are limited) and declining recall of movements/contact over longer periods.[19]

Guidelines for the management of primary contacts, once identified, are outlined in the *Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units*.[2] Tracing and managing secondary close contacts (close contacts of close contacts) requires a much larger exercise and by nature affects more people. Rather than outline clear instructions on tracing secondary contacts, the Guidelines provide the following considerations for Public Health Units to consider in tracing and quarantine of close contacts:

- The primary close contact has a higher probability of becoming a case (e.g. exposed at a high-risk setting such as abattoir or hospital).
- The secondary close contact has had extensive and/or ongoing exposure to the primary contact (e.g. living in the same household).
- There was a delay in confirming the initial case or commencement of contact tracing (enabling more time for the primary contact to become infectious prior to quarantine).
- Secondary transmission has already occurred from a primary close contact to a secondary close contact.[2]

Another important consideration, particular given novel variants that have demonstrated increased transmissibility, is the serial interval. Secondary contact tracing will be necessary if there is evidence that the lower range of the serial interval is similar to, or less than, the optimal (or achieved) contact tracing time.

Contact tracing workforce and approaches

Manual contract tracing is a slow, labour intensive task. A workforce of approximately 15 professionals per 100,000 population is required.[20,21] But, these workforce calculations are not directly generalisable to the Australian context as this evidence is based on regions with widespread transmission. When planning a contact tracing workforce, it is vital to take the current prevalence of COVID-19 in the community into account. The WHO interim guidance on contact tracing acknowledges this and has outlined four key epidemiological scenarios and implications for contact tracing approaches. The WHO has also developed a COVID-19 Contact Tracing tool and User Guide to estimate the staff required to track and trace COVID-19 cases (Appendix C).

Table 1: WHO epidemiological scenarios for contact tracing[1]

No cases	A well-trained contact tracing workforce should be identified and ready to deploy and scale up (i.e. have the required tools) to respond to first cases
Sporadic cases	Exhaustive contact tracing and case investigation for all cases is essential for rapidly suppressing transmission.
Clusters	Contact tracing is essential to reduce transmission within clusters and to identify events that have led to high levels of virus transmission. Public health and social measures can then be implemented to reduce the occurrence of such events.

Community transmission	Contact tracing remains an important activity in high-incidence scenarios where capacity to trace and follow-up all contacts may be at the breaking point. Contact tracing activities should be targeted rather than abandoned. It is possible to prioritise tracing of higher risk exposure contacts based on capacity.

Even in locations where these are no COVID-19 cases, the WHO recommends preparing a workforce that can surge if needed.[1] One modelling study found that adding or removing contact tracers when there is intermediate case numbers (relative to capacity) (e.g. secondments of contact tracers to areas of greater need) had a much larger impact than if case numbers were very high or very low. This study suggested that shifting a subset of contact tracers to areas where cases and contacts needing tracing exceed capacity could reduce effective reproduction number in those regions.[20] In Australia, contact tracing surge support has occurred between jurisdictions and the Commonwealth have provided support to Victoria and South Australia. Legislative barriers to this have not been reported.

Improving efficiency of cross-jurisdictional contact tracing support (e.g. by having systems that allow contact tracers to rapidly and seamlessly integrate with and work across jurisdictions) will enhance the capacity and effectiveness of contact tracing in outbreaks.

Contact tracers face several challenges in their work including mistrust, challenges in establishing rapport, diverse community needs and language barriers.[22,23] To address these and other challenges, Celentano et al. developed a conceptual framework for maintaining a COVID-19 contact tracing workforce.[22]

1. Scale workforce (language concordance and recruitment from aligned communities)
2. Training and development (knowledge or lived reality of community members, focus on soft skills)
3. Foster resilience (partnership with community-based organisations)
4. Continuous improvement (coaching and mentorship).

Celentano et al. also suggested that task-shifting contact tracing to community health workers could improve how the existing workforce is leveraged to meet other critical needs of the most vulnerable and most impacted populations (such as the promotion of flu shots or other essential services).[22]

In Australia, experience has shown that engaging healthcare providers with long-term trusted relationships in the community and that are providing COVID-19 health services assists contact tracing, including for communities that may face challenges accessing mainstream messaging and support. This has included public health departments working closely with Aboriginal medical services, GPs, and refugee and migrant health organisations. Further supporting and formalising such engagement in contact tracing is an important strategy for improving quality and timeliness.

Complementary technologies

Manual contact tracing, which requires individuals (cases and contacts) to speak directly to contact tracing staff, is resource intensive, but will always be critical to outbreak management, especially in complex communities. Technology may be necessary when manual capacity is overwhelmed, and can assist in improving recall and response time.[24]

Technology can address some of the limitations associated with contact tracing. Automated surveillance of contact tracing and processing of test results allows the capability to quickly identify and notify contacts who are at risk of infection and scale resources where nessessary.[24] The "recall problem" associated with manual contact tracing can be mitigated with automated digital technology as a supplement to manual methods. Recent results from the United Kingdom, suggest a large number of cases of COVID-19 were averted by contact tracing through the NHS app, with estimates from approximately 100,000 to 900,000.[25]

A key aim of digital contact tracing is to decrease the response time, compared with manual tracing, thereby allowing for quicker tracing of individuals exposed to the virus and reducing delays to quarantine.[24,26] Digital methods can also save work hours; one study concluded that 230–476 hours per year of contact-tracing work was saved by a partly automated infection system in a Singaporean hospital.[24] They also allow automated follow up and monitoring of contacts.

Technologies developed to assist tracing, notification and information sharing in COVID-19 pandemic are listed below and summarised in Appendix A.

- QR Codes
- Credit card payment data
- Mobile Phone Towers - smartphone locations
- Bluetooth
- Google/Apple apps
- Bluetooth-enabled contact tracing devices/tokens.[27]

Appendix B presents a table of the apps and technologies used internationally.

Use of QR codes and Bluetooth apps in Australia

In Australia, all states and territories have developed their own QR codes mandatory check-in systems.[28] It is a mandatory requirement for venues to collect the names and phone numbers of all patrons. Businesses and individuals who fail to use the QR code check-in systems may face fines and the potential temporary closure of the business (Victorian Government, Service NSW, ACT Government).[29]

The Australian public have been encouraged to download the COVIDSafe app, which runs in the background on smart phones.[30] COVIDSafe uses Bluetooth® to look for other devices that have the app and does not record location. It notes contacts, via a digital handshake, securely logs the encrypted reference, date, time and the Bluetooth® signal strength. The information is securely encrypted and stored on the phone for 21 days. Current data suggests that there has been over seven million registrations of the COVIDSafe app, however, it remains unclear how many regular users there are.[31] The COVIDSafe app can create alerts for users who have been within 1.5 metres of each other for a period of 15 minutes or more. There has been recent media commentary that given the increased transmissibility of the Delta variant, the app should be modified to capture contacts of shorter duration than 15 minutes and greater distance than 1.5 metres.[32]

Automated/digital versus manual contact tracing

The digital and manual contact tracing strategies discussed above offer different strengths and weaknesses in mitigating COVID-19 outbreaks. Whereas manual contact tracing is robust but slow and labour intensive, digital methods offer speed, scalability and efficiency.[18,33] Digital contact tracing can complement manual methods, however, for digital contact tracing to achieve a satisfactory reduction in transmission adequate adoption of the apps must be achieved.[26] A key weakness of digital contact tracing is limited uptake/usage, which has been studied with models and simulations comparing the two methods.[18,33-43]

There is significant interest in the proportion of the population that would need to use a digital contact tracing app for the strategy to be effective as a sole contact tracing method. Results in the literature vary, with most finding that uptake between 75% and 95% of the population would be required.[26,38]

Due to the complementary nature of digital and manual contact tracing, modelling of a hybrid approach has been investigated and found to be more effective than either approach in isolation.[18] One study has warned against relying on digital contact tracing in isolation due to its inherent drawback (that only contacts who use the app are identified) and only recommended its use in combination with manual methods.[33] Thus, digital contact tracing is an important complement to manual contact tracing, and there is evidence that even minor increases in usage rates of digital tracing apps lead to an improvement in the epidemic spread mitigation (although the effect remains small unless app adoption is very high).[35]

Correspondence published in Nature Medicine has outline five key epidemiological and public health requirements for contact tracing apps, such as the Australia's COVIDSafe app[36]:

1. Integration with local health policy
2. High user uptake and adherence
3. Quarantine infectious people as accurately as possible
4. Rapid notification
5. Ability to evaluate effectiveness transparently

Ongoing evaluation of the Australian COVIDSafe app is recommended to ensure that it supports manual contact tracing efforts in the best way possible. Continued promotion is important as any increase in uptake assists outbreak control.[35]

Transparent information on how the COVIDSafe app has been used would be valuable to inform recommendations on contact tracing practice, and as information for the general public. An investigation into digital contact tracing usage in Zurich, Switzerland revealed that approximately 1 in 11 notification triggers led to SARS-CoV-2 testing of an exposed proximity contact who subsequently had a positive test results.[40]

Privacy considerations for the use of technology for contact tracing

A major ongoing concern limiting uptake of tracing apps has been the privacy issues amongst populations.[44] Efforts to overcome privacy challenges in the adoption of contact tracing technologies, have included guidance from bodies such as the European Data Protection Board. The WHO has also published ethical considerations to guide the use of digital proximity tracking technologies for SARS-CoV-2 contact tracing.[45] In Australia, legislation (*Biosecurity Act 2015* (Cwth) and *The Privacy Amendment (Public Health Contact Information) Act 2020* (Cwth)) determines the provisions for the use of location data and contact tracing tools intended to mitigate the impact of the COVID-19 pandemic.[46]

Several universities, companies/organisations and governments have developed contact tracing apps that identify when someone has been in contact with other people who have tested positive for the disease. The Google Android and Apple iOS joint approach to contact tracing technology have been paramount for many countries contact-tracing approach. Apple and Google claim that privacy and security are at the forefront of their design; however, privacy concerns are repeatedly raised that contact tracing apps can be repurposed to enable unwarranted surveillance by governments on their citizens, or data harvesting by third parties.[44] The technical, privacy and security problems have hampered the uptake of apps and their impact on the COVID-19 pandemic remains somewhat unevaluated.[25] Controversies about the legitimacy of these apps have largely focused on issues of privacy and surveillance, and commentators emphasise the differences between populations in East Asia's acceptance of state surveillance and a European scepticism towards this practice.[44]

A barrier for Australians is the sensitive nature of privacy issues, even though privacy is protected by laws. Public trust was eroded in Western Australia after police accessed QR code check-in information from the SafeWA app. The Western Australian Health Minister previously assured the public that only authorised contact tracing personnel would be able to access the data.[47]

Background

The aim of **contact tracing** is to interrupt transmission of SARS-CoV-2. It is the process of identifying assessing, and managing people who have been exposed to a disease to prevent onward transmission. When systematically applied, contact tracing will break the chains of transmission of COVID-19 and is an essential public health tool for controlling the virus. For the purposes of routine contact tracing, cases are considered infectious from 48 hours prior to symptom onset. More conservative periods (e.g. 72 hours prior to illness onset) may be considered in high risk settings.

Downstream/forwards contact tracing occurs when the contact tracing officer is trying to identify who has potentially been exposed to a confirmed case during their infectious period to ensure contacts immediately go into quarantine and do not spread the infection further.

Upstream/backwards contact tracing occurs when the contact tracing officer is trying to determine the source of a case. The use of whole genome sequencing, which can demonstrate links between cases, can assist in these scenarios, but it can only support, not replace, contact tracing that establishes epidemiological links between cases. Without that, there is always potential for transmission chains to be missed. Serological antibody testing can be of value for upstream contacts of cases where there is no epidemiological link to identify the source of infection.

The definitions of close, secondary and casual contacts, as described below, are sourced from on the current CDNA Guidelines.[2]

A **primary close contac**t is defined as a person who has:

- had face-to-face contact of any duration or shared a closed space (for at least 1 hour) with a confirmed case during their infectious period (from 48 hours before onset of symptoms until the case is no longer infectious
- the exposure may be any duration depending on risk setting such as: transmission has already been proven to have readily occurred, there are concerns about adequate air exchange in an indoor environment or concerns about the nature of contact in the place of exposure (e.g. the contact has been exposed to shouting or singing)
- been exposed to a setting or exposure site where there is a high prevalence of infection e.g. a country where there is community transmission of COVID-19, or unprotected exposure in a quarantine hotel for returned travellers
- been in a venue where transmission has been demonstrated to have occurred during the time frame in which the transmission would be expected to have occurred.[2]

A **secondary close contact** is also known as a close contact of a close contact. They are contacts who have had face-to-face contact in any setting with a primary close contact from 24 hours after the primary contact's exposure to the case.[2]

A **casual contact** is defined as a person who has been in the same setting with a confirmed case in their infectious period, but does not meet the definition of a primary close contact.[2]

The definitions above are operationally important as they determine how intensively a contact is management, and therefore they have substantial impact on contact tracing capacity requirements. It is important to note that these definitions were developed prior to widespread transmission due to more transmissible variants such as the Delta variant, and may need to be updated to reflect increased risk of transmission from casual contact.[6,7] In practice it appears that states have made decisions to class casual contacts as close contacts when there has been evidence of transmission in settings that would have otherwise been classed as 'casual contact'-type settings.[48,49]

Other considerations

In the course of developing this advice, NCHRAC identified the following considerations that were out of scope for this advice, but are important and related considerations:

- how vaccination data can be used by states and its influence on contract tracing
- evaluation of the uptake and usefulness of QR codes in each state
- how community perception of risk impacts compliance and adherence to COVID-19 non-pharmacological interventions.

Approach

A PubMed search for literature on contract tracing technology with key words [COVID, Technology, Tracing] returned a total of 521 articles. A final set of 12 systematic reviews were used for the synthesised narrative on technology. A PubMed search for literature on contract tracing modelling provided 94 results, 35 of which were relevant to this advice.

Consideration was also give to the National Contact Tracing Review (2020) and the Contact Tracing and COVID-19 Evidence Update (and supplement) published by SAHMRI, Health Translation SA and the Commission on Excellence and Innovation in Health, October 2020.

Out of scope

- Modelling of primary data
- Examination of the socioeconomic impacts of short lockdowns
- Lockdowns[a]

Attachments

Attachment A: Contact Tracing Technologies

Attachment B: Worldwide use of Apps and Technology

Attachment C: WHO User Guide for COVID-19 Surge Planning Tools [weblink]

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[a] Lockdowns are discussed in NCHRAC Advice 23: The epidemiological benefits of short-term lockdowns in managing outbreaks of SARS-CoV-2

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Appendix A: Contact Tracing Technologies

A variety of complementary digital contact tracing technologies such as, location-based services (including QR codes and COVID Safe Apps), geospatial technologies, proximity awareness technology, machine learning algorithms, and automated decision making are available. These technologies give authorities the ability to scrutinize population movements and trace potentially infected people, locate close contacts, and enforce lockdowns.[1,2]

- QR Codes

A QR code is a machine-readable barcode matrix. The check in QR-Codes are a contactless, secure and convenient way for everyone to sign into various locations across States and Territories in Australia. QR codes are displayed at a range of businesses and other public locations in Australia. People who visit them need to check in to the location as a way of making it easier for health authorities to find where people have been in the event of a coronavirus outbreak. Thereby assisting with faster contact tracing.

In Australia the COVIDSafe app does not include QR functionality. However, the State's and Territory's managed QR check-in approach further assists in the improvement of public contact tracing surveillance. The method allows individuals to scan QR code check-ins at locations with the summary available for public authority analysis if required.[3] The QR code scan system works as a means to assist in the contact tracing of individuals and, therefore, possible exposure sites.

Upon release of the Australian COVIDSafe app there were a series of limitations that impaired the performance of the app.[4] Firstly, iPhone users were required have the app open (in the foreground) for Bluetooth functionality to work. Secondly, older Android devices (five years or older), were unable to run the app. Thirdly, if a person was within close contact with a device that did not have the COVID Safe app installed and running in the background on their devices a registration would not take place. Fourthly, there has been confusion regarding privacy issues such as where user data is sent, how it's stored, and who can access it.[5] This confusion has possibly lead to the initial target of 40% not being reached to make it viable in the Australian population. In addition, exposure notification such as the Apple-Google system (*not available in Australia)* aren't regarded as pure contact tracing systems as they do not allow public health authorities to identify exposed or infected individuals.[6]

Internationally, Singapore, UK and New Zealand have national QR code check-in systems.

- Card payment data

Based on the principle action for the World Health Organisation contact tracing to "go hard, go early and never fall behind"[7] another method recommended by the Finkel review is to allow authorities to use card payments as a method to find close contacts.[8,9] It has been noted that in Australia this has been utilised with consent of those being traced (pers. coms. 24.06.2021 NHMRC).

- Mobile Phone Towers - smartphone locations

Internationally governments reportedly use smartphone locations as a clear method to contact trace where people are and for how long.[10,11] Since April 2020 the Australian media have reported anonymised mobile phone location data has been utilised on request from NSW Department of Customer Service and the federal Department of Prime Minister and Cabinet to monitor whether people are following social distancing restrictions amid the coronavirus pandemic.[12] In addition, the medical experts and the media have used location data from transport apps such as CityMapper, to assess how people move in Australian cities (e.g. Sydney and Melbourne) with public transport.[13]

- Bluetooth

Bluetooth low-energy (BLE) beaconing technology records when a smart phone comes into close proximity with anyone other device using the appropriate contact tracing app to track and trace infections.[14] To approximate distance, the Bluetooth system compares the signal strength between the two devices in contact. The closer the devices are, the higher the signal strength recorded. This estimated signal strength can vary significantly based on a series factors. The identification of each device is created and modified periodically.[15] The conclusions from Kolasa et al. detailed review, suggest Bluetooth to be the most commonly utilised method in contact tracing (*see also*: Appendix A), which was adopted in 18 of the 21 (86%) apps, while 5 (24%) only used GPS, or in addition to Bluetooth.[16]

Bluetooth technology used with smartphone apps are limited in that the most vulnerable populations to the health impacts of COVID-19 are also less likely to own smartphones. Technology limitations exist in smart phone tracing technology as apps cannot account for risk modifying factors such as effective personal protective equipment; separation by screens or walls—where a Bluetooth signal can pass through but a virus cannot.[17] Thereby, to increase the accuracy of automated contract tracing the use of specifically designed devices, instead of smartphones, may increase the usability and reliability (i.e. same room, distance between people, barriers between people). Technological proposals have included, smart watches (including for people in Aged Care settings) with digital tracing abilities to increase chance that devices are in the line of sight.[1,18]

- Google/Apple

On April 10, 2020, Google and Apple announced an exposure notification solution that relies on Bluetooth technology harnessed through mobile phones to aid in contact tracing efforts. Advantageously, the approach works across both Google Android and Apple iOS smartphone operating systems, and therefore, the approach provides a uniquely universal contact-tracing app. The Digital Transformation Agency and the Department of Health have indicated that testing is ongoing to see how it can be applied in Australia.[19]

The application is designed to improve and complement local contact tracing efforts and not replace them. Like COVIDSafe, the Apple/Google app uses Bluetooth to creates a log of other devices that come into close range. Both companies have released software that enables Exposure Notifications from public health authorities that work across Android and iOS devices. Importantly, each user is required to turn on the technology. For users who turn on the app, exposure notification data is stored and processed on device.[15]

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Appendix B: International use of Technology and Apps developed to assist tracing, notification and information sharing in COVID-19 pandemic

Country or Software	Application	Technology	Outcome
Singapore[c]	TraceTogether	Exchanges Bluetooth signals between mobile phones in close proximity	Modern contact-tracing method
Hong Kong[c]	StayHomeSafe app And Wrist band	Geofencing technology to help catch violators	Enforce mandatory 14-day quarantine upon entry for all overseas arrivals. Violation of quarantine may face up to six months in prison and a $3,200 fine.
South Korea[c]	Corona 100m	Collects public government data and alerts users of any diagnosed Covid-19 patient within a 100-meter radius	Privately developed app that supplement official government contact tracing efforts Business Insider reported – second most-downloaded app in Korea.
South Korea	Credit-card transactions	Tracing	Strategy includes Testing, contact tracers, and surveillance of individuals i.e. credit-cards
Taiwan[c]	Mobile phone tracking	To enforce quarantines	Government reinforces tracking via calls to those in quarantine twice a day, to ensure they do not leave phones at home.
China[c]	SenseTime and Megvii,	AI-based contactless temperature detection software	SenseTime deployed a "Smart AI Epidemic Prevention Solution" integrated AI infrared thermal technology, detects a fever within 0.3 C accuracy and

Country or Software	Application	Technology	Outcome
			identifies individuals not wearing a face mask with over a 99% success rate.
USA[c]	PrivateKit app Private Automatic Contact Tracing (or PACT)	Voluntary download Encrypted, open-source and Bluetooth technologies	Ensures no private information is revealed. MIT-led teams
Google and Apple [abc]	Exposure Notifications System	opt-in basis,	Identity is not shared with other users, Google, or Apple.
White House, Federal Emergency Management Agency, The Centers for Disease Control and Prevention	Apple COVID 19 USA	Tool to help understand what to do next about COVID-19.	Information distribution, Self-assessment
Thrive Health Company	Canada COVID-19	Phones exchange random codes (5 min) Estimates proximity of app users by the strength of their Bluetooth signals	Information distribution, self-assessment
World Health Organization	WHO Info WHO Academy	The official WHO information app Academy's developed specifically for health workers -to enable them to expand their life-saving skills to battle COVID-19	information distribution, -virtual workshop
UAE - Ministry of Health and Prevention	COVID-19 UAE TraceCovid	 The app is mostly decentralized, but	Information distribution Contact trace Self-assessment

Country or Software	Application	Technology	Outcome
		citizens can be fined for refusing install or register for the app.	
Brazil – Ministry of Health	CORONAVIRUS SUS		Information distribution, Find nearest health unit, Self-assessment
Pakistan - National IT Board	COVID-19 GOV PK	Posts about the total affected numbers. Dashboards for each province and state as a whole, Gadget with features Self-Assessment, Radius Alert, Pop Up Notification by reminding them of their personnel hygiene	Information distribution, Contact trace Self-assessment
USA - The Centers for Disease Control and Prevention	CDC		Information distribution Self-assessment
Jamaica - Ministry of Health and Wellness	JamCOVID19	Self-reporting and monitoring portal, latest data and statistics	Information distribution, Self-assessment
Oman - Ministry of Health	Tarassud	Updates about the COVID-19 virus disease	Information distribution, Self-assessment
Vietnam - Ministry of Health	Covid-19 BlueZone	Feb 1, 27 million downloads of application Tracers check data -such as Facebook or Instagram posts and mobile-phone location data — to verify movements reported to contact-tracers	information distribution, teleconsultation, Find nearest health unit
Digital Transformation Agency Australian Department of Health	Coronavirus Australia COVIDSafe		Information distribution, Self-assessment contact trace

Country or Software	Application	Technology	Outcome
Western Australia Tasmania	G2G PASS app	Facial recognition and phone location data to ensure people in quarantine remain at their registered address mandated quarantine period	Covid-19 travel restrictions. Remote checks on people in quarantine.
Australian QR Code apps: Western Australia NSW Victoria South Australia Queensland Northern Territory ACT Tasmania	 SafeWA app Service NSW app Service Victoria app COVID SAfe Check-In Check In Qld app The Territory Check In Check In CBR App Check in TAS App	QR codes Manual check in	Mapping contacts and contact tracing
United Kingdom (UK)	NHS COVID-19 App	Bluetooth	Launched Sept 24 faces criticism for being confusing and ineffective. Works with apps in Northern Ireland, Jersey, Republic of Ireland, Scotland, Gibraltar and Wales.
Turkey	Hayat Eve Sığar	Bluetooth Location	Mandated people for those who test positive download the app and can then share data with police.
Tunisia	E7mi	Bluetooth	Tunisia's government says the app will remain voluntary so long as download rates are high.
Thailand	MorChana	Bluetooth Location	Thailand paired the proximity contact tracing app with a QR code check-in system, called Thai Chana
Switzerland	SwissCovid	Bluetooth, DP-3T, Google/Apple	Swiss opted to use DP-3T instead of the Google/Apple API. Now it looks they will be using both.
South Africa	COVID Alert SA	Bluetooth, Google/Apple	South Africa tried several other contact tracing strategies

Country or Software	Application	Technology	Outcome
			before moving to this privacy-protecting option.
Saudi Arabia	Tabaud	Bluetooth, Google/Apple	Tabaud uses Google-Apple system, its privacy policy notes "external links" in the apps, which the app bears no privacy responsibility for. It's unclear what the "external links" are. Tabaud is also not open source.
Qatar	Ehteraz	Bluetooth, Location	Mandatory for all citizens and requires access to photos. It also had a major security breach upon launch.
Poland	ProteGO Safe	Bluetooth	Initial version of this app criticized for privacy concerns. The latest version has been adapted to be more secure.
Philippines	StaySafe		launched in April and has serious privacy concerns which sparked a letter demanding better protections from major organizations
Norway	Smittestopp	Bluetooth, Google/Apple	Second app deployed in Norway. The first was discontinued after privacy concerns. Message if have been near a person who has coronavirus and is using Smittestopp
Northern Ireland	StopCOVID NI	Bluetooth, Google/Apple	Works with apps in England, Jersey, Republic of Ireland, Scotland, and Wales.
North Macedonia	StopKorona	Bluetooth	Android and iOS apps were launched in mid-April.

Country or Software	Application	Technology	Outcome
New Zealand	NZ COVID Tracer	Bluetooth, QR codes	Check-in system using QR codes in public areas. App revamped early Dec. 2020 to include Bluetooth and Apple/Google tech.
Mexico	CovidRadar	Bluetooth	Specific privacy and data policies for the Mexican app are currently quite thin and vague.
Malaysia	MyTrace	Bluetooth	Permissions for data use are overly broad. Originally only available for Android, now also available for iPhone
Kuwait	Shlonik	Location	Amnesty International report highlighted Kuwait's app as one of the most invasive in the world.
Japan	COCOA	Bluetooth, Google/Apple	Riddled with issues since it launched, and has been suspended at least twice.
Italy	Immuni	Bluetooth, Google/Apple	launched their app in early June.
Israel	HaMagen	Location	App is not sufficiently accurate because it is based only on GPS and voluntary information.
Israel [f]	Cell phone data	Location	Retrace the movements of those who tested positive for the coronavirus. As of March 14, Israel may only employ cellphone tracking in cases where Israelis refuse to cooperate with contact tracers
Ireland	Covid Tracker	Bluetooth, Google/Apple	Google/Apple API from the outset. Northern Ireland's app works with apps in England, Jersey,

Country or Software	Application	Technology	Outcome
			Republic of Ireland, Scotland, and Wales.
Indonesia	PeduliLindungi	Bluetooth Location	Uses individuals' location data to cross reference telecommunications provider data
India	Aarogya Setu	Bluetooth Location	India's court rules government can't share app data with other government departments and agencies.
Iceland	Rakning C-19	Location	Not using Bluetooth because it was too unreliable and instead uses location data
Hungary	https://virusradar.hu/	Bluetooth	The voluntary app alerts people who came within 2m of an infected person for at least 20min.
Germany	Corona-Warn-App	Bluetooth, Google/Apple	Germany opted for the Google/Apple API after initially aiming to build a centralized system
France	TousAntiCovid	Bluetooth	France negotiated with Apple and Google but decided against using their standards.
Finland	https://koronavilkku.fi/en/	Bluetooth, Google/Apple	Finland's pilot app is no longer in use. The current app's privacy policy is well-documented.
Fiji	CareFiji	Bluetooth	CareFiji launched at the end of June and is modeled after the Singapore app TraceTogether
Estonia	HOIA	Bluetooth, DP-3T, Google/Apple	Notified people they had been exposed
Denmark	Smitte|stop	Bluetooth, Google/Apple	Anonymously notifies close contacts if diagnosed with COVID-19

Country or Software	Application	Technology	Outcome
			Error: notified people they had been exposed when they had not, due to a technical error
Czech Republic	eRouska	Bluetooth	One part of the Czech government’s larger "smart quarantine" plan. The app relaunched in September to address issues with the first version
Cyprus	CovTracer	Bluetooth, Google/Apple Exposure Notification (GAEN) protocol	Cypriot app was one of the earliest efforts to launch, all the way back in February
Canada	COVID Alert	Bluetooth, Google/Apple Exposure Notification (GAEN) protocol	Canada's app has rolled out to 8 provinces and territories. Its website contains usage numbers and clear explanations of how it works
Bulgaria	ViruSafe	Location	launched their app in early April and began lifting movement restrictions in early May
Belgium	Coronalert	Bluetooth, Google/Apple, DP3T	Based on Germany's Corona-Warn app. It's open source and well-documented
Bangladesh	Corona Tracer	Bluetooth	Built by Shohoz, an "online ride-sharing and ticketing platform." Months after its June release, the app had not proven to be very effective.
Bahrain	BeAware	Bluetooth, Location	25% of the country has downloaded BeAware, there is little public information about the app. As of Jan 2021,

Country or Software	Application	Technology	Outcome
			users can also schedule vaccine appointments via the app.
Austria	Stopp Corona	Bluetooth, Google/Apple	One of the first major European nations to align with the Google/Apple API.
Algeria	Algeria's App		Investigated by Amnesty International.
China	Chinese health code system Health Code, developed by Alipay and WeChat	Location, Data mining	Little information available to the public about how China's technology works. Colour-based code can determine people's exposure risks and freedom of movement based on factors like travel history, duration of time spent in risky areas, and relationships to potential carriers
Ghana	GH COVID-19	Location	Tracker Ghana's app is focused on collecting users' location data. Users near you Self quarantine management
Gibraltar	Beat Covid Gibraltar	Bluetooth	Launched on June 18th and over 25% of the population has downloaded it. Works with apps in Northern Ireland, Jersey, Republic of Ireland, Scotland, England and Wales.

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USER-GUIDE for COVID-19 WORKFORCE SURGE PLANNING TOOLS – RAPID AND REMOTE COVID WORKFORCE ASSESSMENT

November 2020

CONTENTS

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The *Covid-19 workforce surge planning tools – rapid and remote COVID workforce assessment – a user guide* was developed for the WHO Regional Office for Europe by IntraHealth International, Cris Scotter (WHO Regional Office for Europe), Alexandre Lourenco (Associação Portuguesa de Administradores Hospitalares) and Graham Willis (independent contractor).

It supports implementation of the WHO surge planning tools developed to assist Member States of the WHO European Region to assess the impact of COVID-19 on human resources for health. This project was led by Cris Scotter, supported by Pryanka Relan and Teresa Kortz (WHO headquarters). The Adaptt Surge Planning Support Tool software was developed by Alexandre Lourenco and Ricardo Gil Santos, Steeve Ferreira and Liliane Costa (Glintt), and the Health workforce estimator Tool and Contact Tracing software were developed by Graham Willis for the WHO Regional Office for Europe with the assistance of Sion Cave (Decision Analysis Services Ltd).

The user guide was prepared by the following IntraHealth International, Inc. staff: Pamela A. McQuide, Global Healthcare workforce Technical Advisor; Amy Finnegan, Data Scientist; Andrew Brown, Senior Director, Healthcare workforce Development; and Katherine Terry, Nurse Practitioner, IntraHealth Nursing Now Fellow.

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The hope is that Member States of the WHO European Region and other users will find the user guide helpful in supporting implementation of the tools during this unprecedented global COVID-19 crisis.

DEFINITIONS

TERMS

The **Adaptt Surge Planning Support Tool** was developed by the WHO Regional Office for Europe and allows for visualization of needs during a surge, including the number of hospital beds and human resources required, dates of predicted shortages, contact tracing and home-care needs.

An **attack rate** refers to the estimated percentage of the population that is expected to contract the disease during a specified time period.

Available working time is the number of hours or days that a health worker is available to work, taking holidays, sick days and other absences into account.

The **Contact Tracing Tool (CTT)** was developed by the WHO Regional Office for Europe and is used to estimate the staff required to track and trace confirmed COVID-19 cases, with the aim of preventing onward transmission.

The **Health workforce estimator (HWFE)** was developed by the WHO Regional Office for Europe and is used to estimate the number of each cadre of health worker needed based on the number of mild, moderate, severe and critical patients per day. It also highlights workforce gaps so that countries can plan for projected shortages.

Horizontal substitution refers to the process of using work groups who are not currently in the Healthcare workforce to substitute for current roles. This may be necessary to meet workforce needs during a surge. For example, a recently retired nurse can be substituted into the role of a nurse.

A **midnight census** is a tool that captures the number and severity of patients who are in the hospital at a specific point in time each day. It should show the number of people who have been admitted into or discharged from the hospital in the previous 24 hours, the number of deaths and the current number of people hospitalized, by severity.

Vertical substitution refers to the process of upskilling or repurposing current work groups to assist other cadres. This may be necessary to meet workforce needs during a surge. For example, a ward nurse may use part of his/her time to assist a critical care nurse, which would then allow the critical care nurse to use his/her training to care for more patients.

Workload Indicators of Staffing Need (WISN) is a tool that uses service statistics to assess staff workloads and estimate human resource needs according to professional standards. It is used in many countries to assess health worker needs by cadre.

ABBREVIATIONS

ECMO	extracorporeal membrane oxygenation
HCW	health worker
HRH	human resources for health
ICU	intensive care unit
SIR	susceptible, infected and recovered (models)

INTRODUCTION

The coronavirus pandemic and COVID-19 has impacted the entire world. As it continues to spread it has pressing implications for health workers and Healthcare workforce staffing, particularly in low- and middle-income countries, which will need to rapidly increase their preparedness, readiness and response to the pandemic (Bong et al., 2020).

Health workers (HCWs) – nurses, midwives, community health workers, doctors, pharmacists and other cadres who provide care directly to their communities – play a critical role during disease outbreaks. They are the backbone of a country's defences to limit or contain the spread of disease, testing and treating patients while providing key community messaging regarding how to respond to the disease. In these pandemic settings, governments need to ensure that HCWs are available, sufficiently well trained and supported to perform their jobs safely, and meet the surge in demand for services due to the pandemic, while safeguarding the availability of other essential health services.

In addition to COVID-19 responses, HCWs are required to continue providing other essential services, including maternal and child health, HIV/AIDS, malaria, tuberculosis and voluntary family planning services. The Healthcare workforce is also affected by school closures, which puts tremendous strain on families because most health workers are women (Wenham et al., 2020).

Ministries of health and human resources for health (HRH) departments within them need access to a rapid and responsive Healthcare workforce deployment plan to secure HCW availability and distribution to ensure ongoing front-line health services.

WHO has created three tools to meet this need. The Adaptt Surge Planning Support Tool allows for visualization of needs during a surge, including the number of hospital beds required, dates of predicted bed shortages and human resource needs (WHO Regional Office for Europe, 2020a). The Health workforce estimator (HWFE) is used to estimate the number of each cadre of health worker needed based on the number of mild, moderate, severe and critical patients per day, demonstrating workforce gaps so countries can plan for projected shortages (WHO Regional Office for Europe, 2020b). The Contact Tracing Tool (CTT) is used to calculate the staff required to support the process of identifying, assessing and managing people who have been exposed to the disease to prevent onward transmission.

This Rapid and Remote COVID Workforce Assessment implementation user guide for predicting COVID-19 Healthcare workforce staffing needs has been developed to serve as a guide for implementing WHO's Adaptt, HCWFE and CTT tools, adjusted to countries' cadres and available services to prepare for pandemic surges.

The user guide was developed remotely from experience with two pilot programmes conducted by IntraHealth International, Inc. in Kenya and Mali. Although it provides a roadmap for the process, implementation will look different in various places, and flexibility will be required to implement the approach successfully. It is important to read through and understand the toolkit before beginning the implementation process. Included in the toolkit are the lessons learned from the pilot programmes so that applicable steps can be followed for other situations.

OVERVIEW

The toolkit is designed to be implemented in four steps over a six-week period. Implementing partners include in-country office experts, with technical support from IntraHealth International, Inc. office in Chapel Hill, North Carolina, United States of America. The toolkit is summarized in Table ES.1.

Table ES.1. Toolkit summary

	Activity	Timeline					
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Before you begin	Engage key stakeholders						
	Assemble your team						
Step 1	Define region of interest	X					
	Define health-worker categories	X					
	Assemble essential data collection sheets:						
	• Professional Activities Data Collection Sheet		X	X			
	• Available Working Time		X	X			
	• Staffing Data Collection Sheet		X	X			
	• COVID-19 Daily Reported Data		X	X	X	X	X
	• Facility Data Collection Sheet		X	X			
	Assemble optional data collection sheets:						
	• Role Substitution Data Collection Sheet		X	X			
	• Midnight Census		X	X	X	X	X
Step 2	Review data collection sheets to ensure they reflect local realities			X	X	X	X
Step 3	Populate Adaptt, HWFE and CTT				X	X	X
	Check the modelled tools, validate assumptions				X	X	X
Step 4	Scale results to rest of country						X

BEFORE YOU BEGIN

Assemble your team

Implementing a rapid and remote COVID workforce assessment successfully requires a team-based approach. The following roles are recommended at a minimum for successful implementation, and we recommend that the team on the ground mirrors the remote team with the roles shown in Table 1.

Table 1. Team roles

Role	Functions	Characteristics
Project manager/team leader	Oversees the team, leads the initiative, plans the details of implementation, monitors progress, and reports outcomes Obtains agreement from key stakeholders, approval from government and ministry of health	
Epidemiologist/data scientist	Monitors and tracks the epidemic, gathering daily statistics on the trajectory of the infection Uses the data to populate the Adaptt and HWFE tools, documents assumptions made for calculations	Should be comfortable with statistics, have experience analysing data, and extensive knowledge of Excel Familiarity with susceptible, infected and recovered (SIR) models would also be helpful
Healthcare workforce/human resources focal point	Obtains existing Healthcare workforce data, assists with completing professional activities	Should be familiar with the iHRIS Healthcare workforce Information Systems Software or other human resources databases, District Health Information Software 2 (DHIS2) or another Healthcare workforce database
Health systems focal point	Reports on hospital systems, obtains data from local hospitals, assists with completing professional activities	Should be a clinician or public health practitioner who understands the health systems and health worker cadres
Country leader	Obtains permission to acquire and use data Ensures that WHO and other stakeholders are involved in the process	May be a representative from the ministry of health or WHO country office
Local WHO focal point		In-country and/or regional WHO representative

In addition to the in-country team roles listed in Table 1, the remote office will offer technical support to review assumptions and ensure that the tools are implemented correctly.

Understand the data

Before implementing the Adaptt and HWFE tools, your team will need to complete the following data collection forms. With these forms, you will be able to supply the appropriate data for the tools. We suggest using the forms to collect the data first and then input them into the tool so that the team can use one version of the tool, since some of the data needs to be reshaped to fit into the tools.

Essential data collection sheets

A brief description of the essential data collection sheets required to complete the WHO tools is provided below. Details on each of the forms are provided in Step 1, and blank templates can be found in Annex 1.

- **Professional Activities Data Collection Sheet**: this form collects information about the key activities to care for COVID-19 patients by cadre and level of severity and the average time it takes to perform these activities per patient per 24 hours. The WHO professional activities for Europe are found in Annex 2. It will be helpful to compare your standards to those developed by WHO so you capture the essential service delivery activities.
- **Available Working Time:** this form collects information about the number of days and hours the average staff person of a specific cadre works in one year.
- **Staffing Data Collection Sheet**: this form collects Healthcare workforce data per cadre per facility by level of severity.
- **COVID-19 Daily Reported Data**: this form requires daily COVID-19 case data to be inputted, including confirmed new cases, total number of confirmed cases and suspected cases. The data should be specific to the area in which you are working. For example, if you are working in the region of Mombasa, you should use Mombasa data for the tool, not data from all of Kenya.
- **Facility Data Collection Sheet**: this form tracks facility resources, including the total number of beds available, number of beds allocated to COVID-19, intensive care unit (ICU) beds and mechanical ventilators. If your facility also does extracorporeal membrane oxygenation (ECMO) and renal dialysis, those data are also collected.

Optional data collection sheets

A brief description of the optional data collection sheets is provided below. Details on the forms are provided in Step 1, and blank templates can be found in Annex 1.

- **Role Substitution Data Collection Sheet**: this form collects information on utilizing new sources of health workers who can substitute with existing health worker roles to increase health worker capacity during a surge.
- **Midnight Census**: this form requires daily hospitalization data for the target facilities, including the number of admissions, discharges, deaths and number of cases currently hospitalized that day by level of severity. These data allow the user to compare the model with what is happening on the ground, and may be especially useful for facility managers.

Data collection checklist

With access to the completed data collection sheets, you will be able to complete the Adaptt and HWFE tools. A suggested checklist is provided in Table 2 to assist your team with collecting the appropriate data.

Table 2. Data collection checklist

Data Collection Checklist				
Completed	**Data collection sheet**	**Frequency of Completion**	**Where It is Used**	**Who is Responsible for Collecting the Data**
	Professional Activities Data Collection Sheet	*Once initially, then updated as needed*	**HWFE tool**, Staff Category tab	
	Available Working Time	*Once initially, then updated as needed*	**Adaptt tool**, Surge_Predicted_Impact tab, Human Resources section (used with Professional Activities Data Collection Sheet to calculate ratios)	
	Staffing Data Collection Sheet	*Once initially, then updated as needed*	**HWFE tool**, Health Care Resources tab; **Adaptt tool**, Surge_Predicted_Impact tab, HR Capacity (to COVID patient) section	
	Facility Data Collection Sheet	*Once initially, then updated as needed*	**Adaptt tool**, Surge_Predicted_Impact tab, Installed Capacity (to COVID patients) section	
updated daily	COVID-19 Daily Reported Data	*Daily*	**Adaptt tool**, COVID19_DailyReportedData tab	
	Role Substitution Data Collection Sheet (*optional)*	*Once initially, then updated as needed*	**HWFE tool**, Role Substitution tab	
updated daily	Midnight Census (*optional)*	*Daily*	**HWFE tool**, Required Staff tab	

Note: this checklist may be helpful when assigning tasks to your team members. It is important to assign the data collection sheets to team members with the appropriate experience.

STEP 1. ASSEMBLE YOUR DATA

DEFINE YOUR REGION OF INTEREST

Initially your team will need to decide where to begin.

It is recommended to start with one region or facility before implementing the tools throughout the country. This will allow you to understand the data needed, how to customize the tools to the local context and ways to adapt the tools to fit your needs. It will also allow you to see the epidemic spread; as the infection becomes more prevalent, you can scale the approach to look at implications down the road. We suggest selecting a region in conjunction with the ministry of health that has available data and experienced partners. After you have successfully implemented the tool in your first selected region, you can then scale it countrywide.

DEFINE YOUR STAFF CATEGORIES

Your team will then need to define the staff categories of interest who will be caring for patients with COVID-19. This may include general physicians, specialist physicians, general ward nurses, critical care nurses, facility cleaners, social workers and laboratory and respiratory technicians.

BEGIN TO ASSEMBLE YOUR DATA COLLECTION SHEETS

Your team can then begin to gather the data needed for the data collection sheets, beginning with the following data sheets. There are five essential data collection sheets that are necessary for populating the Adaptt and HWFE tools, and two optional data collection sheets that provide additional helpful data. Don't worry if you don't have all the necessary data available when you begin populating these tools. If certain data are not available, you may choose to estimate the data using the assumptions or proxies provided. Be sure to record any assumptions made.

When to use the data collection sheets versus the Adaptt tool and HWFE

The data collection sheets are designed to be updated as needed by pertinent team members. They should be stored on a shared drive folder so team members may update the same version of the sheet.

However, it is strongly encouraged to keep the Adaptt and HWFE tools locked by one or two users so they are updated by the same person. This will reduce the possibility of errors being introduced.

Listed below are the data collection sheets, accompanied with sample data and explanations. As you begin to fill in the data collection sheets, make a note of data gaps and consider appropriate assumptions or estimations that could be made to fill those gaps.

Professional Activities Data Collection Sheet

- ***What** is this form and how will it be used?*
    - Professional activities identify the amount of time it takes for a skilled professional of a specific cadre to perform certain tasks to professional standards. They may vary from country to country depending on local contexts.

- When developing your local professional activities, you may review the professional activities for mild, moderate, severe and critical patients with COVID-19 that are listed in the Reference tabs of the HWFE (see Annex 2 for examples of professional activities for patients in a European context). It is important to review these professional activities sheets, but you will need to adapt them and use only the activities that are pertinent to your country so they are appropriate and relevant to your country context.
- In Step 3, you will use the Professional Activities Data Collection Sheet to fill out the Staff Category tab in the HWFE.

- ***Who** will populate this form?*
  - The Healthcare workforce/human resources expert, health systems expert and/or country leader will populate the form.
- ***How** will the data be obtained?*
  - If your country has implemented WISN, it is recommended that you review your WISN activity standards for hospitalized patients and compare them to those provided in the Reference tabs of the HWFE. The HWFE activities were developed for the European context, so you will need to remove any activities that are not performed in your context and estimate the amount of time per activity to reflect the local context.
  - If your country has not implemented WISN, it is recommended that you review the professional activities provided in the Reference tabs of the HWFE by level of severity, also provided in Annex 2 in the toolkit. It is important to review these professional activities, but you will need to adapt them to fit your local context. For example, if you do not provide ECMO in your local context, you will need to remove that activity. You will then need to consult with local health workers per cadre, in addition to relying on personal experience, to calculate the number of hours per day that a health worker spends with one COVID-positive patient in a 24-hour period per level of severity. As you are filling out this form it is important to document any assumptions made.

> **Workload Indicators of Staffing Need (WISN)**
>
> WISN is a tool that uses service statistics to assess staff workloads and estimate human resource needs according to professional standards. It is used in many countries to assess health worker needs by cadre.

- ***How** to calculate the data?*
  - If your country has implemented WISN, it will be helpful to compare the provided reference sheets with local activity standards your country has already completed from a previous WISN study. It may be sufficient to compare the provided activity standards/professional activities with local activity standards and adjust the times appropriately. In this case, you may simply transfer the occupational titles and update the time per patient. In Kenya, we inflated the activity standards by 6% based on the WISN conducted there as part of a previous HRH programme.
  - If your country has not implemented WISN, you may estimate your professional activities by reviewing activities per cadre from the tabs in the tool – Mild Patient Needs, Moderate Patient Needs, Severe Patient Needs, Critical Patient Needs – and then calculate the number of hours per day that a specific health worker cadre spends with one COVID-positive patient in a 24-hour period per level of severity. This 24-hour period will include multiple shifts, so it is important to consider the 24-hour time period rather than professional activities per shift. In addition to direct medical care, make sure to consider non-medical activities, such as patient teaching, bathing and assisting critical patients with toileting.

- For example, let's calculate the professional activities for a nurse caring for a patient who is critically ill. First you will review the reference sheets and consider all activities that the nurse may perform in your country context. After considering each activity performed over each of the three eight-hour shifts in a 24-hour period, you may find that it will take 3.5 hours per shift or 10.5 hours/24-hour period.

- ***What** should I do if the same duties are shared by different cadres?*
    - If duties are shared by different cadres, then you may need to apply a ratio to obtain these values.
    - For example, let's say that a medical practitioner spends three hours per 24-hour period with one critical patient. However, the critical care unit is staffed with both a specialist medical practitioner (critical care) and a medical practitioner (general). If the specialist medical practitioner (critical care) cares for 80% of the critical care patients, and the medical practitioner (general) assists in the care of the other 20%, you may apply a ratio to determine the amount of time that each medical practitioner spends with a critical patient. In this example, the time per patient per 24 hours for the specialist medical practitioner (critical care) is 2.4 (three hours multiplied by 0.8), and the time per patient per 24 hours for the medical practitioner (general) is 0.6 (three hours multiplied by 0.2) (see Fig. 1 for a visualization of these calculations in the data collection sheet).

Fig. 1. **Sample professional activities sheet**

Professional Activities by Facility Type: Hospital				
	Number of hours that a health worker spends with one patient in a 24-hour period			
Health Worker Cadre	**Mild**	**Moderate**	**Severe**	**Critical**
Medical practitioner (general)		0.5	0.75	0.6
Specialist medical practitioner (critical care)				2.4
Nursing professional (outpatient)	0.15			
Nursing professional (ward)		2	3	
Nursing professional (critical care)				10.5
Pharmaceutical technician		0.15	0.15	0.15
Laboratory technician		0.15	0.15	0.15
Pharmacist		0.25	0.25	0.5
Hospital support (cleaner/helper)		0.1	0.1	0.1

=3*0.2

=3*0.8

Note: the Professional Activities Sheet displays how many hours a health worker spends with one patient in a 24-hour period by severity. These values may be obtained from WISN data or by estimating the amount of time per patient based on professional standards. It is important to consider the professional activities of a health worker for each patient by level of severity. Fig. 1 also includes an example of how to calculate the professional activities for staff categories who may share the same duties, such as the medical practitioner (general) who cares for 20% of critical patients and the specialist medical practitioner (critical care) who cares for 80%. As you are filling out this form, it is important to document any assumptions or estimations that are made.

Available Working Time

- ***What** is this form and how will it be used?*
  - Available working time is the number of hours or days that a health worker is available to work, taking holidays, sick days and other absences into account (see a sample sheet in Fig. 2).
  - In Step 3 this form will be used in conjunction with the Professional Activities Data Collection Sheet to calculate the ratio of staff to patients that will go into the Adaptt Tool, Surge_Predicted_Impact tab, Human Resources section.
- ***Who** will populate this form?*
  - The Healthcare workforce/human resources expert, health systems expert and/or country leader will populate the form.
- ***How** will the data be obtained?*
    - If your country has implemented WISN, the team will need to access WISN data to obtain staff category working times per region.
    - If your country has not implemented WISN, you may obtain these data by consulting local human resource experts at the facilities.
- ***How** do I calculate the estimates in the worksheet?*
  - Staff category: these roles should be listed according to the categories of interest determined by your team.
  - Working days per week: if your staff work a 40-hour work week, you should keep this value at five, even if some staff work do not work their 40 hours in five days.
  - Hours per working day: if your staff work a 40-hour work week, you should keep this value at eight even if some staff work more or fewer than eight hours per day but total 40 hours per week.
  - Annual leave: this is the amount of annual leave staff are allowed, even if they do not choose to take their entire annual leave.
  - Public holidays: the number of public holidays available to staff in addition to annual leave.
  - Sick leave: this should be the average number of hours that people take per year for sick leave. You likely will not have precise data for average amounts of sick leave, but you can estimate the average number of days that a person was unable to work due to illness in the past year. You may choose to include maternity and paternity leave.
  - Unplanned absences: this includes absences for unplanned reasons, such as attending a funeral or other unexpected event.
  - Training days: this refers to the number of days that a staff member will not be available to work at the facility due to training events such as continuous professional development training. This does not include in-service training or extended study leave.
  - Total non-working days per year: this is the sum of all the days a person does not work during the expected work week, including annual leave, public holidays, sick leave, unplanned absences and training days.
    - For example, the total non-working days per year for a medical practitioner (general) = 20 + 12+ 5 +2 +5 = 44.
  - Working days per year: a person who works five days per week and eight hours per day with no absences will work 260 days. To calculate working days per year, you should subtract the total non-working days per year from 260.

- For example, the working days per year of a medical practitioner (general) = 260 – 44 = 216.
  - Working weeks per year: you may calculate working weeks per year by dividing the number of working days per year by five days/week.
    - For example, the working weeks per year of a medical practitioner (general) = 216/5 = 43.2.
  - Working hours per year: you will calculate working hours per year by multiplying the working days per year by eight hours per day = 216*8 = 1728.

Fig. 2. **Sample Available Working Time Collection Sheet**

Available Working Time										
Staff Category	**Working days per week**	**Hours working per day**	**Annual leave**	**Public holidays**	**Sick leave**	**Unplanned absences**	**Training days**	**Total non-working days per year**	**Working days per year**	**Working weeks per year**
Medical practitioner (general)	5	8	20	12	5	2	5	44	216	43.2
Specialist medical practitioner (critical care)	5	8	20	12	5	2	5	44	216	43.2
Nursing professional (outpatient)	5	8	20	12	7	2	3	44	216	43.2
Nursing professional (ward)	5	8	20	12	7	2	3	44	216	43.2
Nursing professional (critical care)	5	8	20	12	7	2	3	44	216	43.2
Pharmaceutical technician	5	8	20	12	5	2	2	41	219	43.8
Laboratory technician	5	8	20	12	5	2	2	41	219	43.8
Pharmacist	5	8	20	12	5	2	5	44	216	43.2
Hospital support (cleaner/helper)	5	8	20	12	5	2	2	41	219	43.8

Do not change if staff have 40-hour work week

=260 - total non-working days/year

= working days per year/5

Note: this form demonstrates the number of days that a health worker is available to work in a year, taking into account planned and unplanned absences. It will be used to calculate staff-to-patient ratios. As you are filling out this form, it is important to document any assumptions or estimations that are made.

Staffing Data Collection Sheet

- ***What** is this form and how will it be used?*
  - This form provides a visual of staff available for COVID-19 per facility by severity.
  - It will be used in Step 3 in the Adaptt Tool, Surge_Predicted_Impact tab, HR Capacity (to COVID patient) section, as well as in the HWFE Tool, Health Care Resources tab to calculate workforce needs during a surge.
- ***Who** will populate this form?*
  - The Healthcare workforce/human resources expert, health systems expert and/or country leader will populate this form.
- ***How** will the data be obtained?*
    - If your country uses HRIS, the team will need to access HRIS data to obtain staff numbers by facility. If possible, you should use the number of health workers employed per severity level.
    - If your country does not use HRIS, you may obtain these data by consulting local facilities to obtain the numbers of full-time staff employed per cadre and severity level.
- ***What** should I do if I have access to the number of staff employed per cadre, but I don't know how many staff are assigned to COVID-19?*

- If you cannot access data on how many staff are assigned to COVID-19, you will need to use a ratio to distribute the staff appropriately.
- For example, Hospital A in Fig. 3 was able to provide the total number of staff per cadre, but they were not able to obtain the numbers of staff dedicated to patients with COVID-19. However, they shared that they had allocated approximately 25% of all their staff to patients with COVID-19. Using this information, it was possible to estimate the number of staff dedicated to COVID-19 by multiplying the total number of staff per cadre by 0.25 to obtain an estimated value. When creating an assumption, it is important to document the assumption so it can later be validated.

- ***What** should I do if I have access to the number of staff employed per cadre, but I don't know how many staff are assigned per severity level?*
    - If you cannot access data on how many staff are assigned per severity level, you will need to access the number of staff assigned to COVID-19 cases, then calculate an estimate using the ratio of severity level of patients with COVID-19.
    - For example, in Fig. 3 we were able to estimate the number of staff dedicated to COVID-19 per cadre in Hospital A. We were unable to obtain number of staff by severity level, so it was necessary to use a ratio to estimate these values. Local data informed us that 5% of hospitalized COVID-19 cases were critical, 15% were severe and 80% were moderate. We know that critical care doctors and nurses care only for critical patients at this facility, so those numbers remained the same. The health systems expert on the team was able to obtain data on the distribution of pharmaceutical technicians, laboratory technicians and pharmacists by severity. This leaves us to make an estimate for medical practitioners (general), nursing professionals (ward), nursing professionals (critical care) and hospital support.

      To make this estimate, let's look at nursing professionals (ward). Ward nurses care only for moderate and severe patients, so we need to use a ratio to estimate how many ward nurses should be assigned to moderate and severe patients. If 95% of all patients are either moderate or severe, then we can use the ratio 95/100 = 0.8/x, which allows us to see that 84% of ward nurses will care for a moderate patient. Using the ratio 95/100 = 0.15/x, we can see that 16% of ward nurses will care for a severe patient. Of the 150 ward nurses who care for patients with COVID-19, 24 will be assigned to severe patients and 126 will be assigned to moderate patients.

      Whenever assumptions are made, it is important to document the assumptions so they can be validated when comparing the tools with actual data.

Fig**. 3. Staffing Data Collection Sheet**

Staffing Data Collection Sheet											
Hospital Personnel Dedicated to COVID-19 by Facility											
		Staff Category	Medical practitioner (general)	Specialist medical practitioner (critical care)	Nursing professional (outpatient)	Nursing professional (ward)	Nursing professional (critical care)	Pharmaceutical technician	Laboratory technician	Pharmacist	Hospital support (cleaner/helper)
Facility Name	**Level of Severity**										
Hospital A (500 beds total)	**Staff total (Hospital A)**		**200**	**40**		**600**	**120**	**20**	**120**	**80**	**120**
Hospital A (125 beds COVID)	**Staff total COVID (Hospital A)**		**50**	**10**		**150**	**30**	**5**	**30**	**20**	**30**
Hospital A	Critical			10			30	3	10	5	2
Hospital A	Severe		8			24		1	10	5	5
Hospital A	Moderate		42			126		1	10	10	23
Hospital A	Mild										
Percent of hospitalized cases that are critical: 5%											
Percent of hospitalized cases that are severe: 15%											
Percent of hospitalized cases that are moderate: 80%											

Note: this form depicts how many staff are available to treat patients with COVID-19 per facility, staff category and severity. It may be necessary to apply assumptions and estimates if not all data are available. In this example, we were able to obtain total number of beds, and the facility informed us that 25% of all beds were designated for patients with COVID-19. This allowed us to estimate number of beds and health workers for COVID-19. We also needed to estimate the distribution of medical practitioners (general), nursing professionals (ward) and hospital support (cleaner/helper) caring for COVID-19 patients by applying the ratio obtained from local data that 5% of hospitalized cases were critical, 15% were severe and 80% were moderate. Whenever assumptions are made, it is important to document them to validate the tools.

Facility Data Collection Sheet

- ***What** is this form and how will it be used?*
    - The Facility Data Collection Sheet provides a view of the bed capacity of the local health facilities in the region (Fig. 4).
    - This form will be used to populate the Adaptt tool so your country can see what the total bed capacity is for COVID-19 and can plan for anticipated bed shortages during the surge.
- ***Who** will populate this form?*
    - The Healthcare workforce/human resources expert, health systems expert and/or country leader will populate this form.
- ***How** will the data be obtained?*
    - The team will need to communicate with local health facilities to collect these data.
- ***How** are each of the columns defined?*
    - Region: specify the region of interest.

- District: specify the district of interest.
- Facility Name: name of health facility.
- Type of Facility: please use categories specific to the country's health system, such as main hospital, regional hospital, community health centre, etc.
- Total Beds: this refers to the total number of beds available in the facility.
- COVID-Designated Beds (Moderate): this is the number of beds designed to the care of patients with moderate cases of COVID-19.
- COVID-Designed Beds (Severe): this is the number of beds designed to the care of patients with severe cases of COVID-19.
- ICU Beds: this refers to the number of ICU beds dedicated to COVID-19.
- Mechanical Ventilators: please specify how many mechanical ventilators are available in the facility.

Fig. 4. **Sample Facility Data Collection Sheet**

Facility Data Collection Sheet								
Region	**District**	**Facility Name**	**Type of Facility**	**Total Beds**	**COVID-Designated Beds (Moderate)**	**COVID-Designated Beds (Severe)**	**ICU Beds**	**Mechanical Ventilators**
Region 1	District 2	Hospital A	Hospital	500	75	25	24	24
Region 1	District 2	Hospital B	Hospital	250	40	10	10	8
Region 1	District 2	Hospital C	Hospital	100	15	5	5	1

Note: this form allows you to see the bed capacity of local health facilities per region, as well as how many beds are designated to COVID by severity. As you are filling out this form, it is important to document any assumptions or estimations that are made.

COVID-19 Daily Reported Data

- ***What*** *is this form and how will it be used?*
  - This form tracks daily and cumulative cases of COVID-19 in the region of interest (Fig. 5).
  - It is used to populate the COVID19_DailyReportedData tab in the Adaptt tool.
- ***Who*** *will populate this form?*
  - The epidemiologist/data scientist, health systems expert and/or country leader will populate this form.
  - This form requires daily input of new confirmed cases and cumulative confirmed cases. Number of deaths is an optional data point that may be useful in your context.
- ***How*** *will the data be obtained?*
  - The team will need to communicate with local health facilities and government agencies to collect these data.
  - The data are specifically for the geographic location of interest, not the entire country.
- ***How*** *are each of the columns defined?*
  - Date: the data will need to be manually inputted daily.

- Confirmed Cumulative: the cumulative number of cases in the region for that date.
- Confirmed New: the newly confirmed number of cases in the region for that date.
- Deaths: number of deaths for the date listed. You may choose to include deaths only for that day, or you may decide to document cumulative number of deaths, depending on which data are available for the region. Whichever data you decide to use, make sure they are consistent throughout the document.

- ***What** do I do if I have total cases for the country, but not the geographic region?*
    - It is likely that you may not have primary data available daily from the region of interest. In this case, you will need to decide how to determine the best daily estimate, and make sure to check these assumptions regularly to see if they have changed.

Fig. 5. **Sample COVID-19 Daily Reported Data Collection Sheet**

COVID-19 Daily Reported Data			
Date	Confirmed Cumulative	Confirmed New	Deaths
15-Mar-20	1	1	0
16-Mar-20	1	0	0
17-Mar-20	1	0	0
18-Mar-20	4	3	0
19-Mar-20	4	2	0
20-Mar-20	6	3	0
21-Mar-20	9	6	0
22-Mar-20	15	7	0
23-Mar-20	22	9	1
24-Mar-20	31	8	1
25-Mar-20	39	8	0

Note: this form captures the confirmed cumulative and new cases of, as well as deaths from, COVID-19 in your region of interest. These data should be specific to the geographic region you're modelling and should be updated daily. As you are filling out this form, it is important to document any assumptions or estimations that are made.

Role Substitution Data Collection Sheet (optional tool)

- ***What** is this form and how will it be used?*
    - This form is used to define potential substitute work groups who can support the existing workforce during the surge, and how they can be utilized as support. Role substitution should only be considered once you have fully populated all other parts of the HWFE Tool and the results appear sensible.
    - Horizontal substitution refers to work groups who are not currently in the Healthcare workforce who may be used to substitute for current roles. For example, a recently retired nurse can be substituted into the role of a nurse.
    - Vertical substitution refers to how current work groups may be uptrained to assist other cadres. For example, a ward nurse may use part of his/her time to assist a critical care nurse, which would then allow the critical care nurse to use his/her training to care for more patients.
    - It is used to populate the Role Substitution tab in the HWFE.

- ***Who** will populate this form?*
  - The health systems expert, the Healthcare workforce/human resources expert and/or the country leader will populate this form.
- ***How** will the data be obtained?*
  - To complete the Horizontal Role Substitution Data Collection Sheet, you will need to consider potential workforce groups that can assist during a surge. This may include newly qualified doctors, newly qualified nurses, retired doctors and nurses, international doctors and contract cleaners. You will then need to consider which existing roles the substituting workforce may support. Finally, you will need to consider how many substitute health workers an existing health worker can supervise. In the example shown in Fig. 6, it was determined that 50% of newly qualified nurses could support outpatient nursing professionals, and that the other 50% of newly qualified nurses could support ward nursing professionals. It was also determined that one outpatient nursing professional could supervise two newly qualified nurses, and that one ward nursing professional could supervise two newly qualified nurses.
  - To complete the Vertical Role Substitution Data Collection Sheet, you will need to consider how you can use existing workforce groups to assist other cadres during a surge. You will need to consider which cadres are most vulnerable to shortages and consider what percentage of time another cadre may assist. Finally, you will need to consider how many substitute health workers the existing health worker can supervise. In the example shown in Fig. 7, it was determined that nursing professionals (ward) could spend 20% of their time assisting nursing professionals (critical care), and that each nursing professional (critical care) could supervise two nursing professionals (ward).

Fig. 6. Sample Horizontal Role Substitution Data Collection Sheet

Horizontal Role Substitution Data Collection Sheet										
Please allocate what % of existing staff categories the supporting workforce will substitute										
	Staff Category	Medical practitioner (general)	Specialist medical practitioner (critical care)	Nursing professional (outpatient)	Nursing professional (ward)	Nursing professional (critical care)	Pharmaceutical technician	Laboratory technician	Pharmacist	Hospital support (cleaner/helper)
Supporting Workforce Group										
Newly qualified doctors		100%								
Newly qualified nurses				50%	50%					
International doctors		50%	50%							
Return of doctors from retirement		90%	10%							
Return of nurses from retirement				50%	50%					
Contract cleaners										100%
Please allocate how many people a current health worker will supervise in the supporting workforce										
Supporting Workforce Group										
Newly qualified doctors		5								
Newly qualified nurses				2	2					
International doctors		5	3							
Return of doctors from retirement		5	5							
Return of nurses from retirement				5	5					
Contract cleaners										10

Note: the Horizontal Role Substitution Data Collection Sheet requires input of supporting workforce groups who may support the current workforce during a surge. You will need to determine which roles the supporting workforce groups will assist, as well as what percentage of the supporting workforce group will assist that cadre. You will then need to indicate how many supporting workers an existing staff member will supervise.

Fig. 7. Sample Vertical Role Substitution Data Collection Sheet

Vertical Role Substitution Data Collection Sheet										
Please allocate what % of time current staff will assist current staff in another category										
	Staff Category	Medical practitioner (general)	Specialist medical practitioner (critical care)	Nursing professional (outpatient)	Nursing professional (ward)	Nursing professional (critical care)	Pharmaceutical technician	Laboratory technician	Pharmacist	Hospital support (cleaner/helper)
Supporting Workforce Group										
Medical practitioner (general)			20%							
Nursing professional (ward)						20%				
Please allocate how many people a current health worker will supervise in the supporting workforce										
Supporting Workforce Group										
Medical practitioner (general)			5							
Nursing professional (ward)						5				

Note: the Vertical Role Substitution Data Collection Sheet considers how existing health workers can support other cadres during a surge. In this example, it was determined that medical practitioners (general) could spend 20% of their time assisting medical practitioners (critical care), and that each medical practitioner (critical care) could supervise three medical practitioners (general). It was also determined that nursing professionals (ward) could spend 20% of their time assisting nursing professionals (critical care), and that each nursing professional (critical care) could supervise two nursing professionals (ward).

Midnight Census (optional tool)

- ***What** is this form and how will it be used?*
  - The Midnight Census is meant to capture the number and severity of patients with COVID-19 who are in the hospital at a specific point in time each day (Fig. 8). It should show the number of people who have been admitted to, or discharged from, the hospital in the previous 24 hours, the number of deaths and the current number of people hospitalized, by severity. It requires daily input of data.
  - This suggested data collection form is optional, depending on the data that can be obtained in your local context. It may be used in the HWFE to calculate daily staffing needs by level of severity and staff category for each health facility.
- ***Who** will populate this form?*
  - The Healthcare workforce expert, health systems expert and/or country leader will populate this form.

- ***How*** *will the data be obtained?*
    - The team will need to communicate with local health facilities and government agencies to collect these data every day.
- ***How*** *are each of the columns defined?*
    - Date: you will need to upload hospitalization data for the current day.
    - Admission: this is the number of patients admitted to the hospital with COVID-19 in the last 24 hours.
    - Discharges: this is the number of patients treated for COVID-19 who were discharged from the hospital in the last 24 hours.
    - Deaths: this is the number of deaths from COVID-19 in the past 24 hours.
    - Mild: only use this column if your facility is hospitalizing ALL COVID-19 cases, including mild or asymptomatic cases who do not require inpatient care. The majority of regions will likely hospitalize only moderate, severe and critical patients.
    - Moderate: this is the number of patients in the hospital that day who are moderately ill with COVID-19. This includes patients who may require inpatient care but do not require oxygen therapy.
    - Severe: this is the number of patients who are in the hospital that day who are severely ill with COVID-19. This includes patients who require oxygen therapy, including non-invasive positive pressure ventilation.
    - Critical: this is the number of patients who are in the hospital that day who are critically ill with COVID-19, including those who require mechanical ventilation.
- ***What*** *do I do if I cannot access the number of currently hospitalized patients by severity?*
    - If you are unable to obtain the number of currently hospitalized patients by severity, you will need to apply a ratio to estimate these values. You will likely be able to access some of the data, but not all. As you are considering how to apply ratios, be sure to remember that the goal is to have an estimate of *how many patients with COVID-19 per severity are in a bed at one specified time point per day* so you can estimate the staffing needs at the facility.

Fig. 8. Sample Midnight Census Collection Sheet

Midnight Census								
Date	**Admissions**	**Discharges**	**Deaths**	**Mild**	**Moderate**	**Severe**	**Critical**	**Total Currently Hospitalized**
1-May-20	2	0	0	0	2	0	0	2
2-May-20	4	0	0	0	4	1	1	6
3-May-20	4	0	0	0	7	1	2	10
4-May-20	5	0	0	0	9	3	3	15
5-May-20	8	0	1	0	14	3	5	22
6-May-20	7	0	0	0	21	3	5	29
7-May-20	7	2	1	0	26	2	5	33
8-May-20	5	3	2	0	26	3	4	33
9-May-20	9	2	2	0	30	3	5	38
10-May-20	11	4	2	0	32	4	7	43
11-May-20	9	2	3	0	31	5	11	47

Note: this example assumes you will have access to all pertinent data. but it is likely that not all data will be available. In these cases, it will be necessary to apply a ratio to obtain an estimate for how many patients per severity are in a bed for COVID-19 treatment at a certain point in the day. In this example, you will see there are no mild cases listed because only moderate, severe and critical patients are hospitalized in this country. As you are filling out this form, it is important to document any assumptions or estimations that are made.

STEP 2. REVIEW YOUR DATA

You may begin Step 2 even as you are compiling the data sheets described in Step 1. For this stage of the process, you will need to critically review the data you are gathering to be sure it is reasonable. You will also need to locate any gaps in your data and determine where you need to use ratios or estimates from other data, or how you can use the data you have to approximate the missing pieces.

CONTINUE YOUR DATA COLLECTION SHEETS

As you are compiling the data collection sheets, it is important to update them regularly. In particular, the COVID-19 Daily Reported Data and the Midnight Census require data to be input daily. It is important to continue compiling the data even as you continue through the next steps of the process.

As you are compiling your data collection sheets, you may find it helpful to make note of the comorbidities of people presenting to the hospital to help predict the level of severity that they might experience during their hospitalization with COVID-19. The facility management teams may find these data useful in predicting which patients may end up critically or severely ill. This suggestion is optional and not necessary to populate the Adaptt and HWFE tools, but it may prove useful to facility managers.

DOCUMENT AND CHECK YOUR ASSUMPTIONS

You will likely find that you do not have access to all the data requested for the data collection sheets. Even if you don’t have perfect data, you can still use the sheets and populate the Adaptt and HWFE tools by using estimates and ratios. When you do use estimates and ratios, it important to document all assumptions so that they can be referenced and checked regularly.

STEP 3. POPULATE THE TOOLS

Once you have gathered the data collection sheets and documented the assumptions made to address data gaps, you may begin to populate the Adaptt and HWFE tools. It is important to populate the tools in the correct order listed below.

ADAPTT SURGE PLANNING SUPPORT TOOL

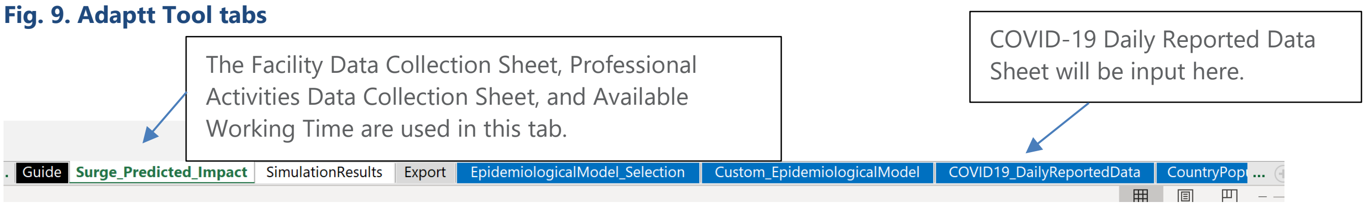
You will need to reference the instructions and tutorial (Box 1) to familiarize yourself with the tools. Once you have a working knowledge of the tools, you may then begin to load the data.

Follow the Adaptt instructions and tutorial for inputting data into the tool. Once you have followed the tutorial, you may have further questions about where to input data from the data collection sheets. Fig. 9–16 may provide helpful visuals in determining where data should be inputted.

Box 1. Adaptt Surge Planning Tool – helpful links

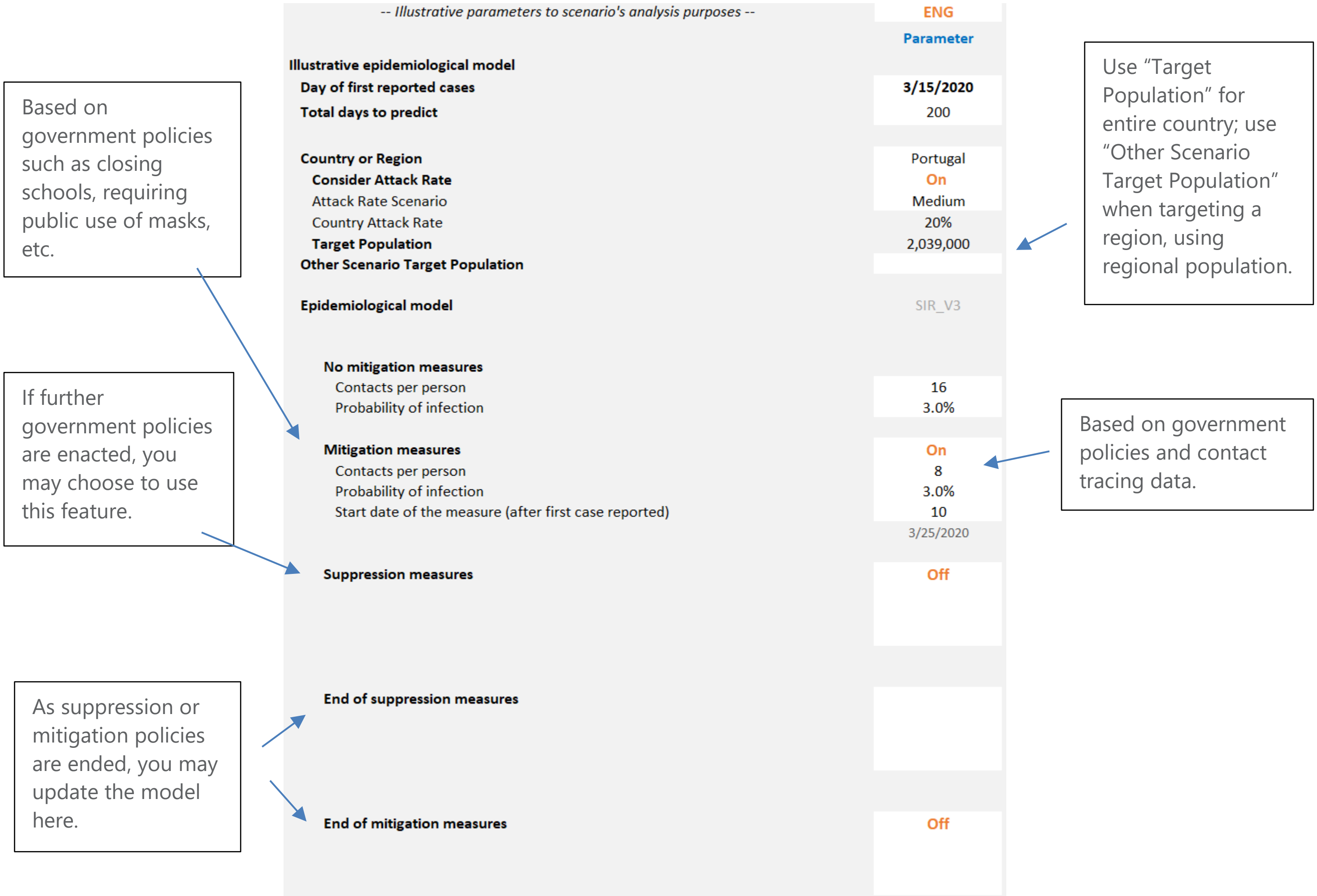
- The main page for the Adaptt Surge Planning Tool describes the purpose of the tool created by the WHO Regional Office for Europe.
- Detailed instructions and a tutorial are available to guide the learning process.
- Please note that the tool used in this toolkit is V02.15. There may be a new version by the time you implement your tool; however, the content is essentially the same and can easily be adapted

Fig. 9. Adaptt Tool tabs



Note: this screenshot demonstrates where data from the data collection sheets will be inputted to populate the Adaptt Tool.

Fig. 10. Adaptt Tool: Surge_Predicted_Impact tab, epidemiological model section



Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, epidemiological model section demonstrates how to customize the surge curve to your local context. When modelling for an entire country, you may leave “Consider Attack Rate” On so it will apply the attack rate to the country population. When modelling for a region, however, you may turn “Consider Attack Rate” Off, multiply the desired attack rate by the region’s population and manually input the result into “Other Scenario Target Population.” Contacts per person can be obtained based on contact tracing data and government policies, and as mitigation or suppression measures can be accounted for as they are enacted or ended. As you are filling out the tool, it is important to document any assumptions or estimations that are made.

Fig**. 11. Adaptt Tool: Surge_Predicted_Impact tab, Hospital activity and practices (in/out) section**

These numbers are obtained from the ministry of health and local experts. They may need to be updated as policies change and more data are available.

You may choose to keep the default fatality rate or update based on your context.

Hospital activity and practices (in/out)	
In	
% of reported cases requiring hospitalization	**8%**
% moderate cases (requiring ward)	53%
% severe cases (requiring oxygen therapy)	41%
% critical cases (requiring mechanical ventilation)	6%
Out	
Moderate cases hospitalization ALoS (days)	7
Severe cases hospitalization ALoS (days)	10
Hospitalization ALoS previous to mechanical ventilation (days)	12
Critical cases mechanical ventilation stepdown ALoS (days)	7
Critical cases mechanical ventilation ALoS (days)	8
	1
	1.0
Average Fatality rate	1.50%

These cells must have the value of 1 and not be deleted; otherwise the surge curve will disappear from your results.

Note: this screenshot from the Adaptt Tool Surge_Predicted_Impact tab, Hospital activity and practices (in/out) section demonstrates how to customize the surge curve to your local context. Please note that for the % of reported cases requiring hospitalization, the data for moderate, severe and critical cases apply only to the number of people hospitalized, not all patients with confirmed COVID-19. These data should be specific to the geographic region you're monitoring. Data about average length of stay are obtained from the ministry of health and local experts. You may also choose to update the average fatality rate to fit the local context. Please note that if your country hospitalizes all COVID-19 cases, you will need to change the % of reported cases requiring hospitalization row to 100% and combine the % moderate and % mild cases together in the % moderate cases (requiring ward) row. As you are filling out the tool, it is important to document any assumptions made.

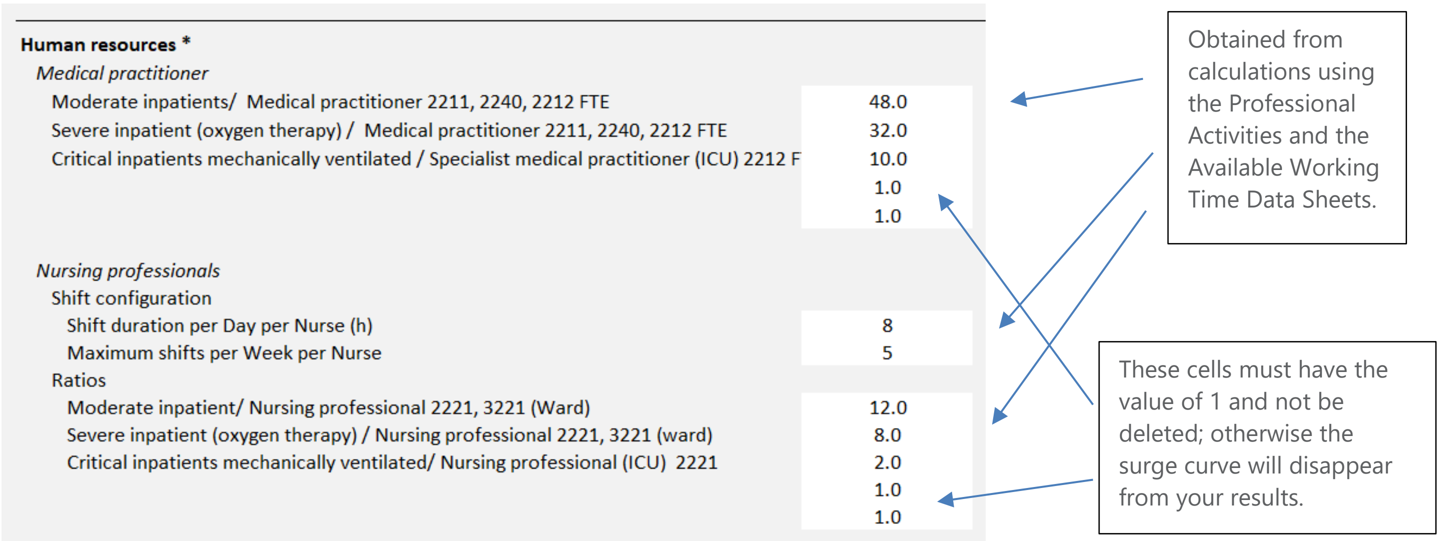
Fig**. 12. Adaptt Tool: Surge_Predicted_Impact tab, Installed capacity (to COVID patients) section**

Installed capacity (to COVID patients)	
Number of moderate cases beds	120
Number of severe cases beds (oxygen therapy)	40
Number of critical beds for mechanical ventilation	33

Obtained from the Facility Data Collection Sheet

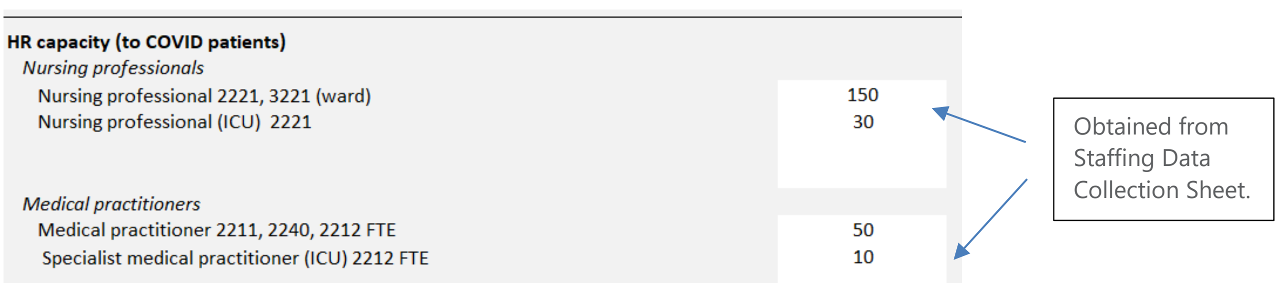
Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Installed capacity (to COVID patients) section demonstrates how to customize the surge curve to your local context. These data are obtained from the Facility Data Collection Sheet and should be specific to the geographic region you're monitoring. Please note that the number of mild case beds are not included because it is assumed that these cases will not be hospitalized. If your country hospitalizes all cases, including mild cases, you will need to add the number of mild and moderate together and incorporate into the Number of moderate cases beds row. As you are filling out the tool, it is important to document any assumptions made.

Fig**. 13. Adaptt Tool: Surge_Predicted_Impact tab, Human resources section**



Note: this screenshot from the Adaptt tool, Surge_Predicted_Impact tab, Human resources section demonstrates how to customize the surge curve to your local context. The Professional Activities Data Collection Sheet and Available Working Time Data Collection Sheet are used together to calculate the data needed for the Human Resources row. The data required are commonly used on defining ward staff and in a simplistic way correspond to the number of health-care professionals per bed. The tool assumes the full-time equivalent medical doctors per bed independently on the shift's configuration. For nurses and health-care assistants, the tool assumes that all shifts are equally composed. So, you should consider the shifts configuration (shift duration per day and maximum shifts per week) and the exact number of health-care professionals per shift. Another way to calculate it is, for example, to look at the Sample Professional Activities Data Collection Sheet and the Sample Available Working Time Templates shown in Fig. 2 and 3. The Sample Professional Activities Sheet shows that a nursing professional (critical care) spends 10.5 hours per patient in a 24-hour period. The Adaptt Tool asks for a ratio of how many patients each nurse can care for during one shift. If we divide 10.5 hours per patient by three shifts, we find that this nurse provides 3.5 hours of care per patient in critical care. To determine how many patients that would be per shift, we need to divide the nurse's number of working hours in a year by 3.5 hours per patient. Using the Sample Available Working Time Sheet, we see that the nurse has 216 available working days, which equals 1728 available working hours. If we divide 1728 hours by the 3.5 hours per patient, then the nurse cares for 494 patients in one year: 494 patients per year/216 available working days = 2.3 patients per shift, which we can round down to 2 in this case.

Fig**. 14. Adaptt Tool: Surge_Predicted_Impact tab, HR capacity (to COVID patients) section**



Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, HR capacity (to COVID patients) section demonstrates how to customize the surge curve to your local context. Using numbers of staff per cadre who care for patients with COVID-19, you will be able to see staff capacity as the surge is predicted. Please note that this is only for staff who care for patients with COVID-19 in the region of interest, and that it does not predict per facility.

Fig**. 15. Adaptt Tool: Surge_Predicted_Impact tab, HR occupational risk section**

HR ocupational risk	
Daily Probability of Infection by Health Professionals	1,00%
Number of days in Quarantine or Sick Leave	14
Average HR ratio in quarentine / sick leave	
Nursing professionals	NA
Medical practitioners	NA
Healthcare assistant	NA

Note: this screenshot from the Adaptt Tool Surge_Predicted_Impact tab, HR occupational risk section demonstrates how to customize the surge curve to your local context. You can customize the daily probability risk and the number of days that is defined locally for sick leave and quarantine due to COVID-19. The length of quarantine for health-care workers can depend on the spread of the outbreak and is weighed against the need to maintain services. The daily probability should be used to develop different scenarios according to the local circumstances.

Fig. 16. **Adaptt Tool: Surge_Predicted_Impact Tab, Human resources to contact trace & home care follow-up section**

Human resources to contact trace & Home care follow-up	
Contact tracing	
Ratio of Suspected cases / Active patients	10,0
Ratio error deviation	15,00%
ALoS contact trace	10,0
Suspected patients / Contact tracer professional (First day)	5,0
Sensitive Analysis (+ X Suspected patients / Contact tracer professional)	1,0
Suspected patients / Contact tracer professional (Following days)	25,0
Sensitive Analysis (+ X Suspected patients / Contact tracer professional)	1,0
Home care follow-up	
% of hospital discharge patients requiring follow-up at home	5,00%
Deviation	25,00%
% of mild cases followed exclusively at home	10,00%
ALoS of follow-up (days)	20
Mild patients in follow-up / Healthcare professional	3,0
HR capacity to contact trace & Home care follow-up	
Contact tracing	12 000
Home care follow-up	

Average number of contacts per case

Duration of contact follow-up (days) and capacity to contact trace (first contact and follow-ups)

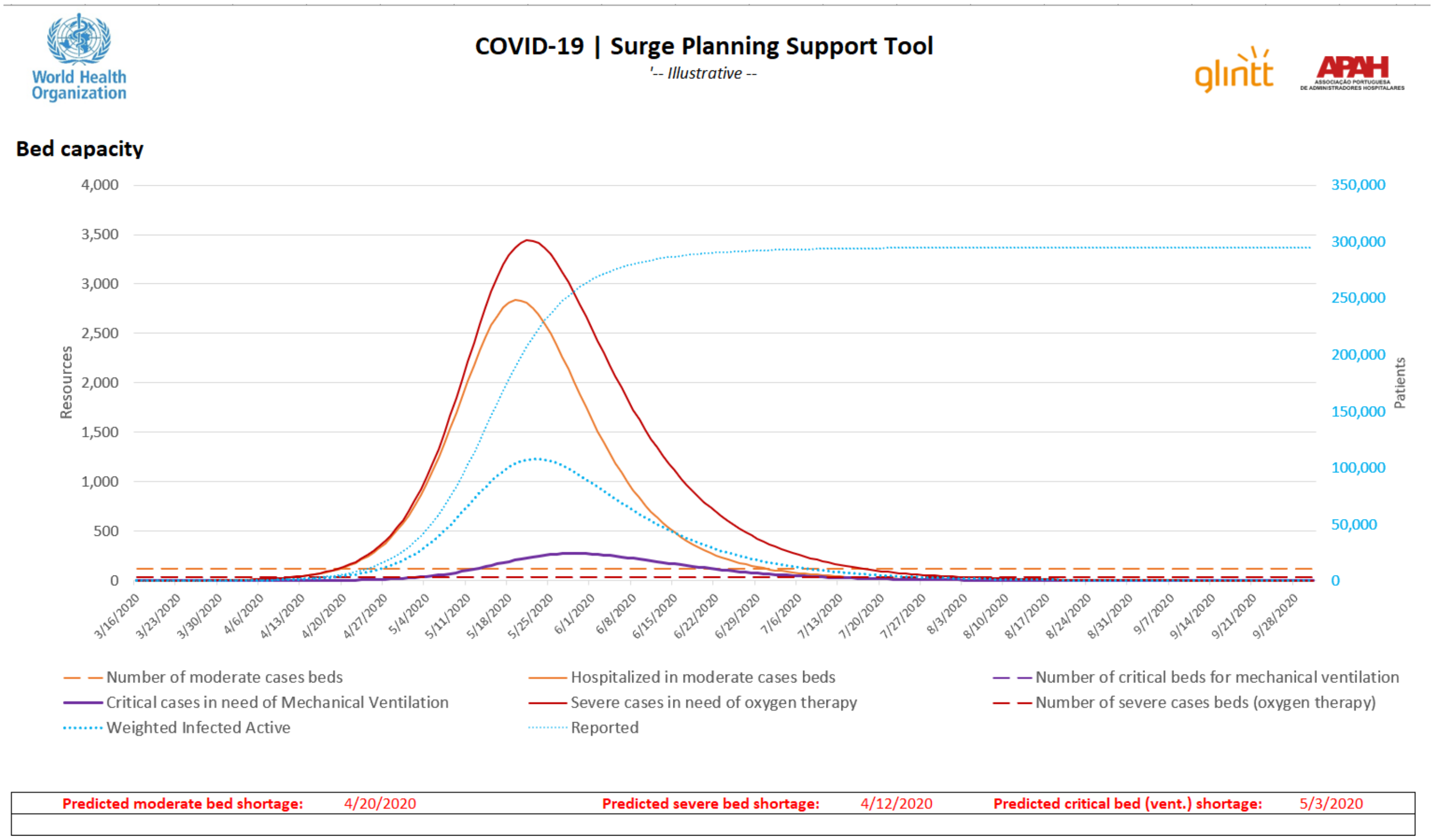
Note: this screenshot from the Adaptt Tool Surge_Predicted_Impact tab, Human resources to contact trace & home care follow-up demonstrates how to customize the surge curve to your local context. You can customize the number of contacts per case. Usually, it varies from 2–3 close contacts during lockdown and 7–20 close contacts pre-lockdown. Monitoring activities vary by country and depend on the spread of the outbreak, ranging from daily active follow-up by phone call or text message, to less frequent active follow-up (every other day or once a week) or no active follow-up (the contact calls the public health team if they develop symptoms). The average time was estimated to be between 45 minutes and one hour (up to two hours for complex cases). During the interview, the list of contacts and their classification into high- and low-risk exposure is developed. The average time per contact is estimated to be between 3.5 and 20 minutes per phone call. This call is to inform the contacts of their exposure and give them information about self-quarantining, hand hygiene, monitoring for symptoms and what to do if they develop symptoms. High-risk contacts are asked to self-quarantine for 14 days following their last exposure. The home-care follow-up considers the number of patients followed exclusively at home and the percentage of cases discharged from the hospital that require home-care follow-up.

View your results

After following the Adaptt instructions and tutorial and studying the additional information provided in the toolkit on how to translate the data collection sheets, you should now have data to show the predicted impact of the surge for your region based on the data you have entered.

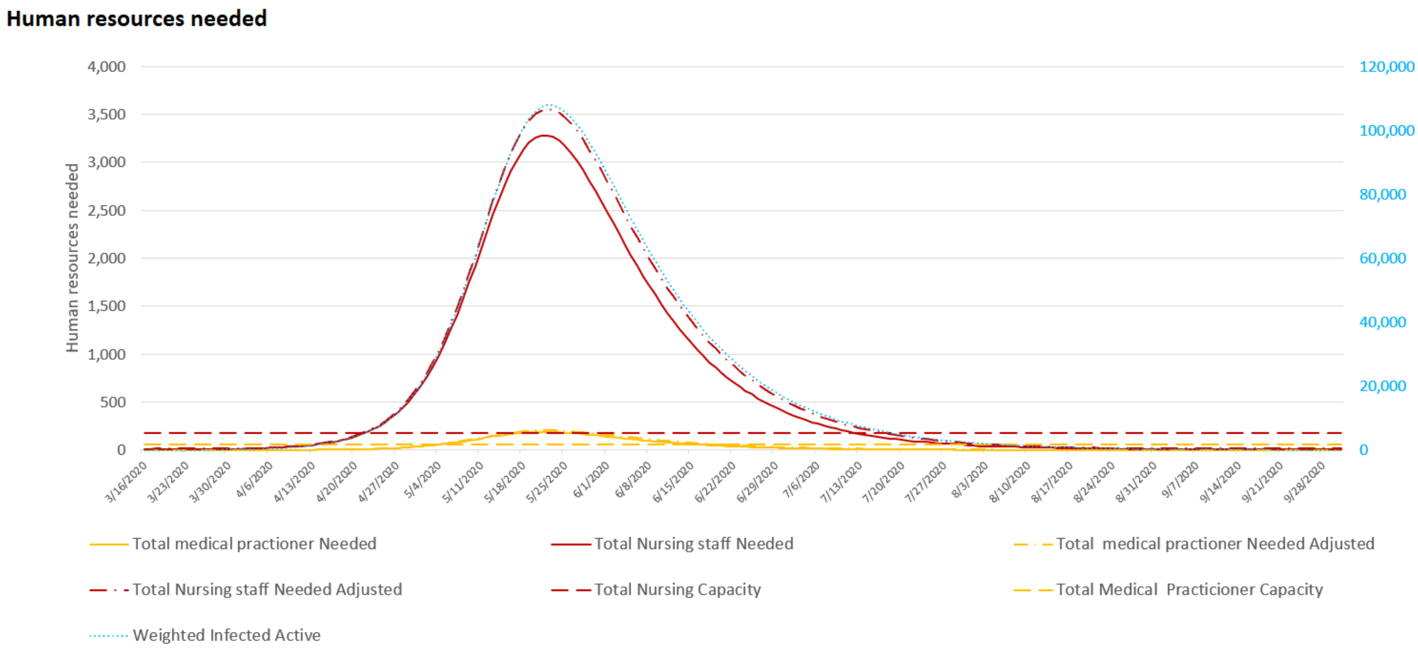
Fig.s 17–21 show the results of the data entered into the Adaptt Tool. It is very important not to stop after viewing the results; a vital step that needs to occur at the same time is validating your assumptions, as shown in the Validate the Data and Check Your Assumptions section of the toolkit (see Box 2).

Fig. 17. **Adaptt Tool: Surge_Predicted_Impact tab, Bed capacity graph**



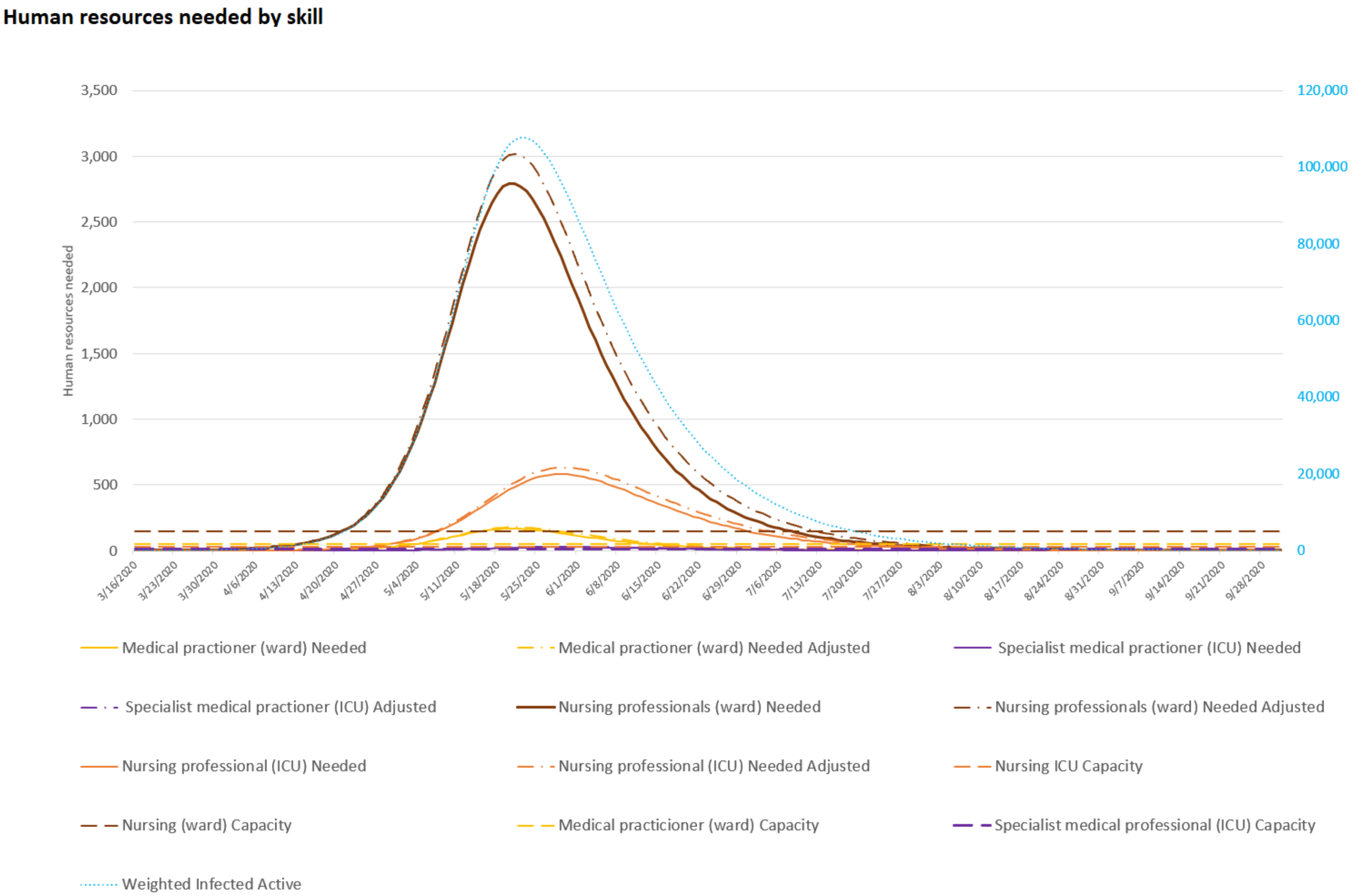
Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Bed capacity graph provides a visual of the results related to bed capacity after all data have been inputted. Please note that the y-axis on the left is specific to resources, while the y-axis on the right is specific to the number of active patients. In this example, the predicted moderate bed shortage is 24 April 2020, predicted severe bed shortage is 12 April 2020, and predicted critical care (ventilated) bed shortage is 3 May 2020. The surge is predicted to hit its peak around 25 May 2020. It is important to verify the model by checking your assumptions and comparing the modelled data with the actual data, as shown in Box 2.

Fig**. 18. Adaptt Tool: Surge_Predicted_Impact tab, Human resources needed graph**



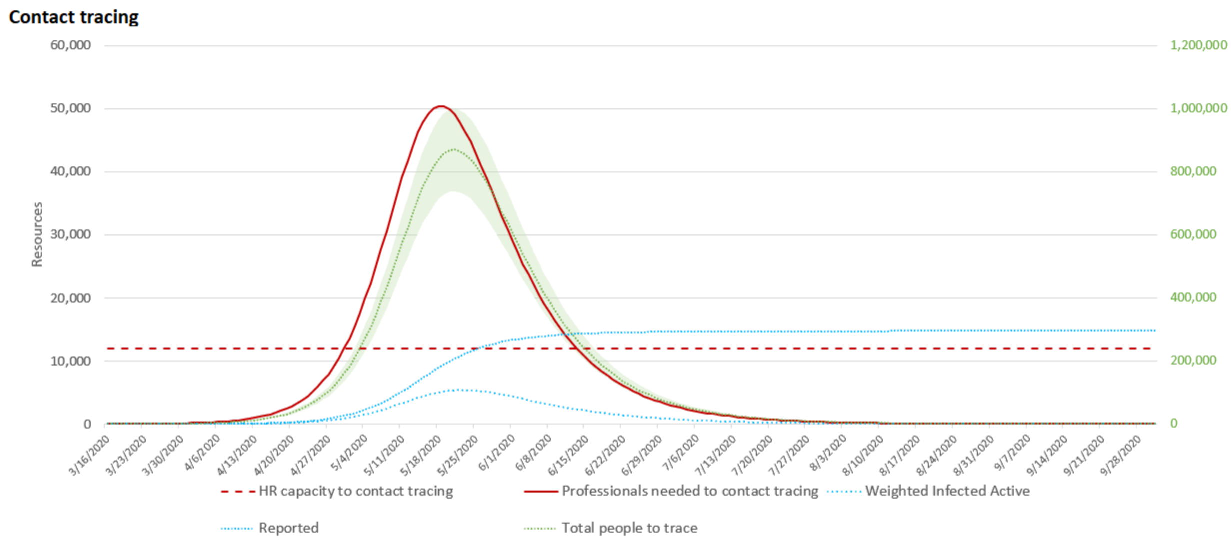
Note: This screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Human resources needed graph provides a visual of the results related to human resources after all data have been inputted. Please note that the y-axis on the left is specific to human resources, while the y-axis on the right is specific to the number of active patients. In this example, the total number of medical practitioners needed will exceed capacity around 4 May 2020 and the total number of nursing staff needed will exceed capacity around 20 April 2020. Please note that the graphics for health professionals "Needed Adjusted" takes into account the daily probability of infection by health professionals and days missed due to COVID-19 infection or quarantine, and therefore represents a higher number of health professionals needed.

Fig**. 19**. **Adaptt Tool: Human resources needed by skill graph**



Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Human resources needed by skill graph provides a visual of the results related to human resources needed by skill after all data have been inputted. Please note that the y-axis on the left is specific to human resources, while the y-axis on the right is specific to number of active patients. In this example, the number of medical practitioners (ward) needed will exceed capacity around 27 April 2020, the number of specialist medical practitioners (ICU) needed will exceed capacity almost immediately, the number of nursing professionals (ward) needed will exceed capacity around 20 April 2020, and the number of nursing professionals (ICU) needed will exceed capacity around 20 April 2020. Please note that the graphics for health professionals "Needed Adjusted" takes into account the daily probability of infection by health professionals and days missed due to COVID-19 infection or quarantine, and therefore represents a higher number of health professionals needed.

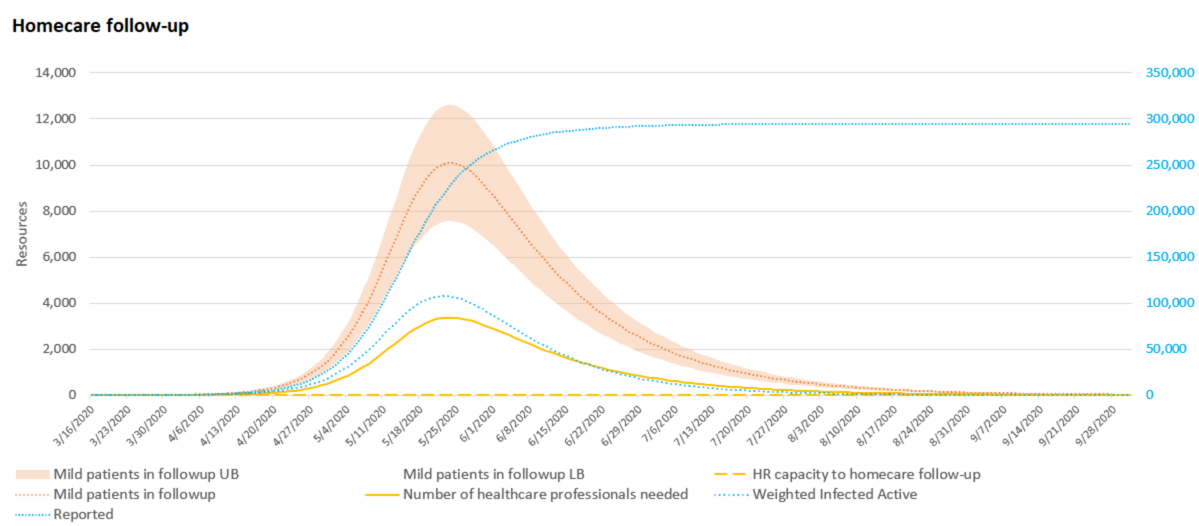
Fig**. 20**. **Adaptt Tool: Contact tracing graph**



1 additional patient / contact tracer, allows a 3709 saving in the maximum professionals needed for 1st contact tracing 17%
1 additional patient / contact tracer, allows a 1203 saving in the maximum professionals needed for tracing contacts of suspected patients in following days 4%

Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Contact tracing graph provides a visual of the results related to human resources needed to contact trace. Please note that the y-axis on the left is specific to the human resources needed, while the y-axis on the right is specific to the number of people to trace, active patients and total patients. Below the graph, you can have an overview of increasing the capacity of contact to trace per contact tracer.

Fig. 21. Adaptt Tool: Home-care follow-up graph



Note: this screenshot from the Adaptt Tool, Surge_Predicted_Impact tab, Home-care follow-up graph provides a visual of the results related to human resources needed to provide home care. Please note that the y-axis on the left is specific to the number of patients that require home-care follow-up and the human resources needed, while the y-axis on the right is specific to the number of active patients and total patients.

Validate the data and check your assumptions

Now you have viewed your results, it is time to validate the data to be sure they are appropriate and make sense for your context. You may need to adjust some of the parameters to fit the local context, such as applying suppression or mitigation measures depending on local health policies, adjusting the number of contacts, or adjusting the attack rate depending on the context. Box 2 demonstrates how you can validate the data from the Adaptt Tool by comparing the modelled predictions with actual data from your region.

It is important to check your assumptions regularly, especially as you obtain new data, or if you need to change your assumptions based on reality on the ground. For example, perhaps your region hospitalized all positive COVID-19 cases at the beginning of the epidemic, but once a facility ran out of beds, it hospitalized only those who needed inpatient medical care. This new policy will impact the number of hospitalized cases in the Adaptt Tool, and if it is not updated, you will have inaccurate estimates. In particular, it will be important to regularly update the average length of stay per severity and the rates of hospitalization.

Box 2. How can I be sure that the Adaptt Tool's predictions are realistic?

- One way to validate the Adaptt Tool is to compare the model's predictions with your actual case data gathered from confirmed cumulate cases recorded in the COVID-19 Daily Reported Data Collection Sheet.
- To compare the predictions with actual case data, you may add columns in the COVID19_DailyReportedData and copy the simulated data so you can see if the modelled data are appropriate.
- If the modelled and confirmed cases vary significantly, you may need to check your assumptions on the numbers of contacts/person, the attack rate, in the population, the probability of infection, or other assumptions.

copy

Day	Reported	Weighted Infected Active	Hospitalized in moderate cases beds	Severe cases in need of oxygen therapy
3/15/2020	1	1.0	0.0	0.0
3/16/2020	1	1.4	0.1	0.1
3/17/2020	2	2.0	0.1	0.1
3/18/2020	3	2.9	0.1	0.1
3/19/2020	5	4.1	0.2	0.1
3/20/2020	7	5.9	0.2	0.2
3/21/2020	10	8.4	0.3	0.3
3/22/2020	14	11.9	0.4	0.4
3/23/2020	20	17.0	0.6	0.6
3/24/2020	28	24.2	0.9	0.9
3/25/2020	40	34.4	1.3	1.2
3/26/2020	57	49.0	1.8	1.8
3/27/2020	81	69.8	2.6	2.5
3/28/2020	116	99.5	3.7	3.6
3/29/2020	165	141.7	5.3	5.1
3/30/2020	236	201.8	7.5	7.2
3/31/2020	336	287.4	10.7	10.3
4/1/2020	478	409.3	15.2	14.7
4/2/2020	681	582.8	21.6	20.9
4/3/2020	969	829.6	30.7	29.7
4/4/2020	1,379	1,180.5	43.7	42.3
4/5/2020	1,962	1,679.1	62.2	60.1
4/6/2020	2,790	2,386.7	88.4	85.4
4/7/2020	3,963	3,389.2	125.5	121.3
4/8/2020	5,622	4,806.4	177.9	172.0

... SimulationResults | Export | EpidemiologicalModel_Selection

Adaptt tool: SimulationResults tab. Simulation data from the model ("Reported" column) copied from here .

Paste from data sheet

Paste from Simulation Results

date	confirmed	confirmed_new	suspected	modeled (cumulative)	difference modeled - confirmed
3/15/2020	1			1	0
3/16/2020	1			1.495998378	0
3/17/2020	1			2.202581546	1
3/18/2020	4			3.2091557	-1
3/19/2020	4			4.643084165	1
3/20/2020	6			6.685800647	1
3/21/2020	9			9.595761368	1
3/22/2020	15			13.74113728	-1
3/23/2020	22			19.64637681	-2
3/24/2020	31			28.0585183	-3
3/25/2020	39			40.04161709	1

Adaptt tool: COVID19_DailyReportedData tab. The data highlighted from the SimulationResults tab was pasted into the modeled (cumulative) column to allow us to visualize the appropriateness of the model. The difference of the modeled and confirmed cases are seen in the far right column. When comparing the two columns, it seems like the model is appropriate. If it's not, you may need to review the health policies and check assumptions to ensure an accurate predictive model.

HWFE

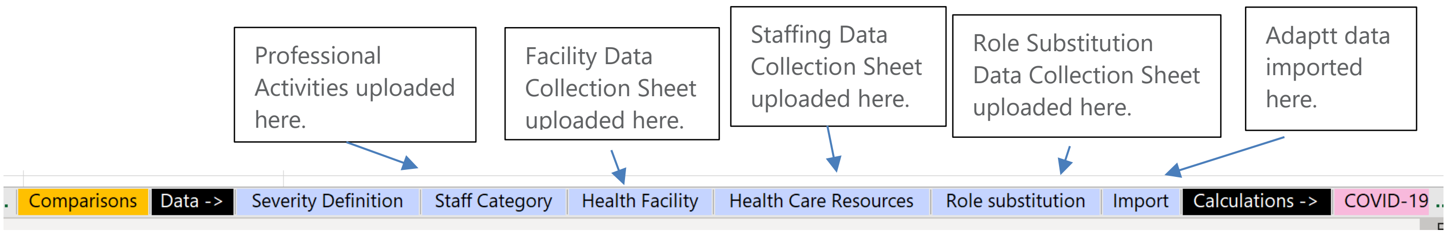
You will need to reference the user guide (Box 3) to familiarize yourself with the HWFE. Once you have a working knowledge of the tool, you may then begin to load the data. After viewing the user guide, you may still have questions about where to upload information from the data collection sheets. Fig. 22–25 may be helpful in guiding this process. The HWFE needs to be populated by starting with the Staff Category tab first, then Health Facility tab, then Health Care Resources tab, then the Role Substitution tab. Note that all cells highlighted in yellow are unlocked for data input, grey highlighted areas are locked and cannot be changed, and green text or numbers are linked to other worksheets and

Box 3. Health workforce estimator – helpful links

- The main page for the HWFE describes the purpose of the tool created by the WHO Regional Office for Europe.
- A detailed user guide is available to guide the learning process.
- Please note that the tool used in this toolkit is V3.0. There may be a new version by the time you implement your tool; however, the content is essentially the same and can easily be adapted.

should not be changed. One exception is explained below for adjusting professional activities based on your context.

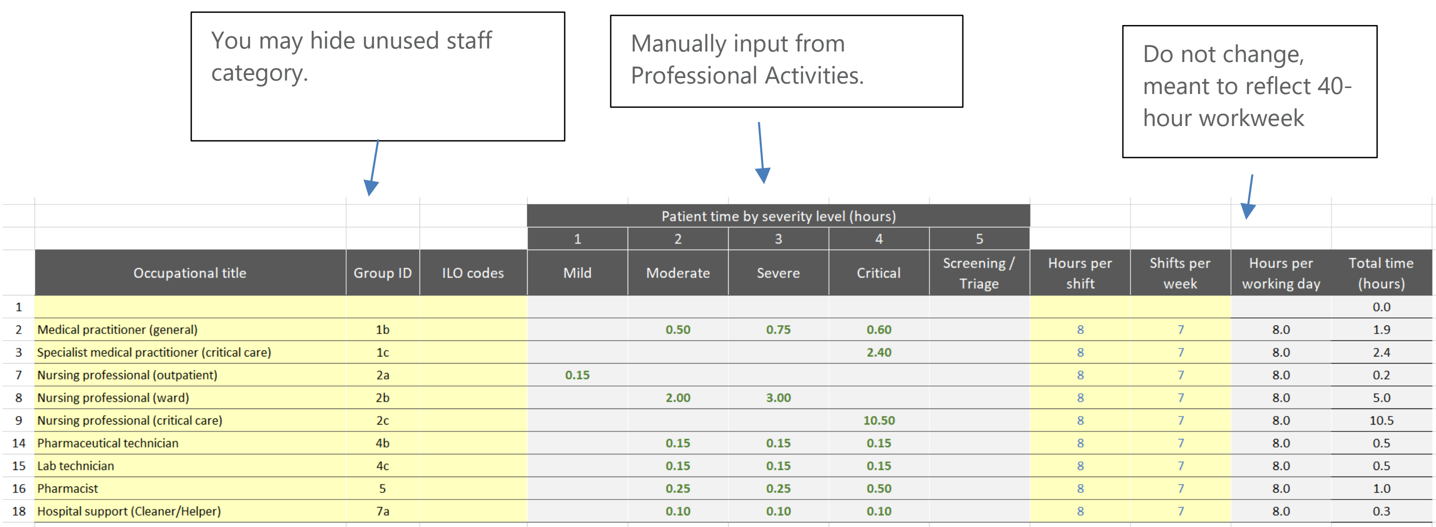
Fig. 22. HWFE Tool tabs



Note: this screenshot demonstrates where data from the data collection sheets will be inputted to populate the HWFE tool.

Note that the HWFE can be used with the inbuilt professional activity standards linked to the group ID in Fig. 23. However, if some activities are not appropriate for your context (ECMO may not be available, for instance), you may replace the grey cells with green text in the Staff Category sheet to reflect your own activity standards.

Fig. 23. HWFE Tool: Staff Category tab



				Patient time by severity level (hours)								
				1	2	3	4	5				
	Occupational title	Group ID	ILO codes	Mild	Moderate	Severe	Critical	Screening / Triage	Hours per shift	Shifts per week	Hours per working day	Total time (hours)
1												0.0
2	Medical practitioner (general)	1b			0.50	0.75	0.60		8	7	8.0	1.9
3	Specialist medical practitioner (critical care)	1c					2.40		8	7	8.0	2.4
7	Nursing professional (outpatient)	2a		0.15					8	7	8.0	0.2
8	Nursing professional (ward)	2b			2.00	3.00			8	7	8.0	5.0
9	Nursing professional (critical care)	2c					10.50		8	7	8.0	10.5
14	Pharmaceutical technician	4b			0.15	0.15	0.15		8	7	8.0	0.5
15	Lab technician	4c			0.15	0.15	0.15		8	7	8.0	0.5
16	Pharmacist	5			0.25	0.25	0.50		8	7	8.0	1.0
18	Hospital support (Cleaner/Helper)	7a			0.10	0.10	0.10		8	7	8.0	0.3

Note: this screenshot demonstrates the HWFE Staff Category tab, where you will manually input data collected from the Professional Activities Data Collection Sheet. You should update the Occupational title based on the health worker cadres used in your Professional Activities but do not change the Group ID column. These titles will be populated across the rest of the spreadsheet, so do not need to be re-entered. You may then hide unused staff category rows if desired.

Fig. 24. **HWFE tool: Health Facility tab**

Reference	Sample data			

	Facility name	Work unit	Severity level	Number of beds	Description
1	Hospital A	Critical level care	4	24	Major hospital critical care
2	Hospital A	Severe level care	3	25	Major hospital severe care
3	Hospital A	Moderate level care	2	75	Major hospital moderate care
4	Hospital B	Critical level care	4		Major hospital critical care
5	Hospital B	Severe level care	3		Major hospital severe care
6	Hospital B	Moderate level care	2		Major hospital moderate care
7	Hospital C	Critical level care	4		Regional hospital critical care
8	Hospital C	Severe level care	3		Regional hospital severe care
9	Hospital C	Moderate level care	2		Regional hospital moderate care

Note: this screenshot from the Health Facility tab of the HWFE Tool requires manual input of facility name, work unit, severity level, number of beds available for COVID-19 and description. It will then link facility names in the Health Care Resources tab. In this example, we have inputted the number of beds available for COVID-19 at Hospital A by severity.

Fig. 25.

HWFE Tool: Health Care Resources tab

Manually input from Staffing Data Collection Sheet.

	Facility Name	Work unit	Severity level	Medical practitioner (general) 2	Specialist medical practitioner (critical care) 3	Nursing professional (outpatient) 7	Nursing professional (ward) 8	Nursing professional (critical care) 9	Pharmaceutical technician 14	Lab technician 15	Pharmacist 16	Hospital support (Cleaner/Helper) 18	Total
1	Hospital A	Critical level care	4		10.0			30.0	3.0	10.0	5.0	10.0	**68.0**
2	Hospital A	Severe level care	3	15.0			50.0		1.0	10.0	5.0	10.0	**91.0**
3	Hospital A	Moderate level care	2	35.0			100.0		1.0	10.0	10.0	10.0	**166.0**
4	Hospital B	Critical level care	4										
5	Hospital B	Severe level care	3										
6	Hospital B	Moderate level care	2										
7	Hospital C	Critical level care	4										
8	Hospital C	Severe level care	3										
9	Hospital C	Moderate level care	2										
	Total workforce			**50**	**10**		**150**	**30**	**5**	**30**	**20**	**30**	**325**

Note: this screenshot from the Health Care Resources tab of the HWFE Tool shows how data from the Staffing Data Collection Sheet should be manually inputted. Please note that this is the number of staff designated for patients with COVID-19.

If your team elected to fill out the optional Role Substitution Data Collection Sheet, you may upload the data into the Role Substitution tab, which allows you to see the impact of identifying potential workforce groups to augment the current workforce (Fig. 26). This tab could be of particular help to hospital administrators who need to decide how to substitute the existing workforce with other potential sources.

Fig. 26. **HWFE Tool: Role Substitution tab**

Role substitution

This worksheet is for defining potential workforce groups for supporting or supplementing the existing workforce.
For each supporting groups, define which of the existing workforce groups they are supporting. This could be all their effort going to one group (100%) or distributed across several ones. The total should be 100%.
In the section at the bottom you can also define how many of these new staff can be supervised by one existing staff member. This will vary according the experience of the supplementary workforce. If no supervision is required enter 0 at the apporpriate location. It is assumed that the supervision is at the level of workforce being supplemented.

Reference	Sample data

	Supporting workforce group (Horizontal substitution)	Description	Medical practitioner (general) 2	Specialist medical practitioner (critical care) 3	Nursing professional (outpatient) 7	Nursing professional (ward) 8	Nursing professional (critical care) 9	Pharmaceutical technician 14	Lab technician 15	Pharmacist 16	Hospital support (Cleaner/Helper) 18	Total
1	Newly qualified doctors	Newly qualified and final year medical students	100%									100%
2	Newly qualified nurses	Newly qualified and final year nursing students			50%	50%						100%
3	International doctors	International doctors at final stage of their conversion programme	50%	50%								100%
4	Return of doctors	Return of former doctors, e.g. recently retired or left workforce	90%	10%								100%
5	Return of nurses	Return of former nurses, e.g. recently retired or left workforce			50%	50%						100%
6	Contract cleaners	Contracted cleaning staff									100%	100%
	Supporting workforce group (Vertical substitution)											
1	Nursing professional (ward)	Ward nurses who will assist critical care nurses					20%					20%
2	Medical practitioner (general)	Medical practitioners (general) who will assist with critical care		20%								20%

	Supporting workforce group (Horizontal substitution)	Description	2	3	7	8	9	14	15	16	18
1	Newly qualified doctors	Newly qualified and final year medical students	5								
2	Newly qualified nurses	Newly qualified and final year nursing students			2	2					
3	International doctors	International doctors at final stage of their conversion programme	5	3							
4	Return of doctors	Return of former doctors, e.g. recently retired or left workforce	5	5							
5	Return of nurses	Return of former nurses, e.g. recently retired or left workforce			5	5					
6	Contract cleaners	Contracted cleaning staff									10
7											
	Supporting workforce group (Vertical substitution)										
1	Nursing professional (ward)	Ward nurses who will assist critical care nurses					5				
2	Medical practitioner (general)	Medical practitioners (general) who will assist with critical care		5							
3	Pharmacist										

Note: the Role Substitution tab allows the user to see the impact of supplementing the existing Healthcare workforce with other qualified roles, such as newly qualified professionals, recently retired individuals and contract workers. In this example, it was decided where each supporting workforce group could horizontally substitute. As can be seen, 100% of newly qualified doctors will be used as medical practitioners (general). Of the newly qualified nurses, 50% will be allocated as nursing professionals (outpatient) and 50% as nursing professional (ward). It was also determined how many supporting workers a current health worker could supervise. For example, a medical practitioner (general) is able to supervise five newly qualified doctors in this case. It was also determined how health worker cadres could be vertically substituted. In this example, a nursing professional (ward) can spend 20% of their time supporting nursing professionals (critical care), and a nursing professional (critical care) would supervise five nursing professionals (ward).

With the data properly inputted, you can now look at the Analysis tabs to see the results, validate the data and check your assumptions.

View your results

After following the HWFE user guide and studying the additional information provided in the toolkit on how to translate the data collection sheets, you should now have data to show the health worker needs for your region based on the data you have entered.

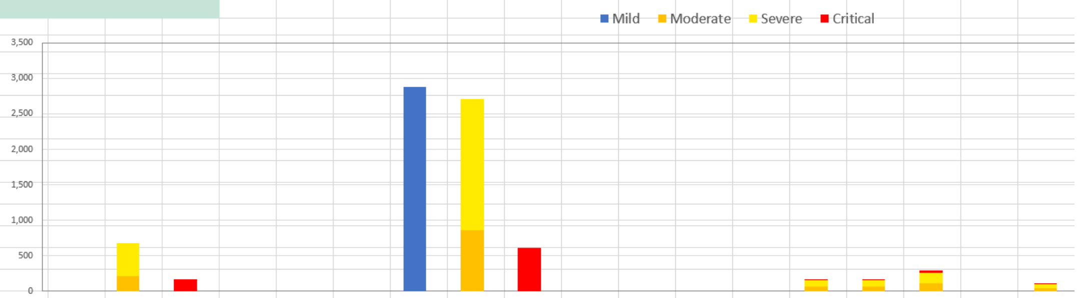
Fig. 27–31 show the results of the data entered into the HWFE Tool. It is very important not to stop after viewing the results; a vital step that needs to occur at the same time is validating your assumptions, as shown in the Validate the Data and Check Your Assumptions section of the toolkit.

Fig. 27. **HWFE: Required Staff tab**

Required Staff

This worksheet allows you to estimate the staff numbers to treat a specified number of COVID-19 cases (patients per day), or the numbers required at defined future date (if data has been imported from the Adappt tool).

Select Input	Date
Select Date	4/15/2020



	Severity level	User Value	Date Value	Cases per day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Mild	100,000	153,388	153,388							2,876											
2	Moderate	1,000	3,431	3,431		214						858						64	64	107		43
3	Severe	50,000	4,939	4,939		463						1,852						93	93	154		62
4	Critical	5,000	465	465			174						610					9	9	29		6
5	Screening / Triage	10,000	0	0																		
6	Not used		0	0																		
7	Not used		0	0																		
				Total workforce		**677**	**174**				**2,876**	**2,710**	**610**					**166**	**166**	**291**		**110**
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
						Medical practitioner (general)	Specialist medical practitioner (critical care)				Nursing professional (outpatient)	Nursing professional (ward)	Nursing professional (critical care)					Pharmaceutical technician	Lab technician	Pharmacist		Hospital support (Cleaner/Helper)

If not using the Screening/Triage or Not used columns, you may go to *COVID-19 Cases* tab and clear contents from these columns

Note: the Required Staff tab of the HWFE allows for visualization of health worker needs. You may manually input projected data in the User Value column, or you may select a date if you have imported data from the Adappt Tool. In this example, we selected a date to use data from Adappt from 15 April 2020, which predicted that there would be a need for 677 medical practitioners (general), 174 specialist medical practitioners (critical care), 2876 nursing professionals (outpatient), etc.

Fig. 28. **HWFE: Policy Options tab**

Policy options

This worksheet shows the results of different policy options. These are selected using the **Workforce estimate** drop-down:
Capacity today - the maximum capacity of the current workforce, and the corresponding workforce numbers. Any increase in cases would cause one (or more) workforce groups to be in under-supply.
Beds today - the workforce needed to deliver the current bed capacity.
Future cases - the workforce needed to deliver the specified number of cases.
The peak surge requirements are also shown, together with capacity (for the selections above) and the gap (if any).

			Current		Future		Workforce estimate									
								Medical practitioner (general)	Specialist medical practitioner (critical care)	Nursing professional (ward)	Nursing professional (critical care)	Pharmaceutical technician	Lab technician	Pharmacist	Hospital support (Cleaner/Helper)	
Facility Name	Work unit	Severity	Beds	Capacity	Cases	Beds	Future cases	2	3	8	9	14	15	16	18	Totals
Hospital A	Critical level care	4	24	23	50	-26	50	0.0	-8.8	0.0	-35.6	9.1	9.1	1.9	9.4	-15
Hospital A	Severe level care	3	25	133	100	-75	100	5.6	0.0	12.5	0.0	8.1	8.1	1.9	8.8	45
Hospital A	Moderate level care	2	75	320	500	-425	500	3.8	0.0	-25.0	0.0	0.6	0.6	-5.6	3.8	-22
Hospital B	Critical level care	4														0
Hospital B	Severe level care	3														0
Hospital B	Moderate level care	2														0
Hospital C	Critical level care	4														0
Hospital C	Severe level care	3														0
Hospital C	Moderate level care	2														0

Demand-Supply gap (without substitutions)	2	3	8	9	14	15	16	18	Totals
	9	-9	-13	-36	18	18	-2	22	8

Hospital cases	Peak surge	Capacity	Gap
Moderate	6,607	500	-6,107
Severe	7,076	100	-6,976
Critical	465	50	-415

Note: the Policy options tab of the HWFE allows you to see Healthcare workforce gaps based on current capacity, current number of beds, or future number of cases, depending on the drop-down selected from the Workforce estimate column. Current capacity refers to the maximum number of cases that the current workforce can accommodate. In this example, Hospital A has 25 severe-level beds, but the capacity to care for 133 severe-level patients. Current number of beds compares the current beds to the capacity and shows the gap in the workforce. Future cases can be inputted manually; in this example, we are planning for 50 critical patients, 100 severe patients and 500 moderate patients. With these future case numbers, we can see that Hospital A will be short of nine specialist medical practitioners (critical care), 13 nursing professionals (ward), 36 nursing professionals (critical care) and two pharmacists. It will also have an oversupply of medical practitioners (general), pharmaceutical technicians, lab technicians and hospital support. These data can help Hospital A to plan for a shortage and determine how to use their oversupply of some cadres to support the undersupply of others.

Fig. 29. **HWFE: Skill Mix tab**

Skill mix

This worksheet shows the results of different options for bringing in additional or supplementary staff to support the workforce. The workforce groups are as defined in the **Role Substitution** worksheet. The staff numbers are specified in this worksheet, and then adjusted to take account of the workforce needed to supervise them. Note that the Demand-Supply Gap(without substitutions) should be set to "Future cases" in the **Policy options** worksheet for a valid comparison.

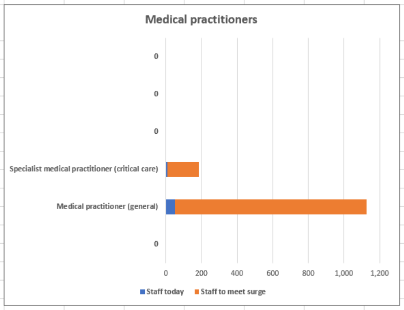
		Medical practitioner (general)	Specialist medical practitioner (critical care)	Nursing professional (outpatient)	Nursing professional (ward)	Nursing professional (critical care)	Pharmaceutical technician	Lab technician	Pharmacist	Hospital support (Cleaner/Helper)	
Workforce for substitution (Horizontal)	Number	2	3	7	8	9	14	15	16	18	Total
1 Newly qualified doctors	10	8									8
2 Newly qualified nurses	40			10	10						20
3 International doctors	5	2	2								4
4 Return of doctors	5	4	0								4
5 Return of nurses	40			16	16						32
6 Contract cleaners	50									45	45
Workforce for substitution (Vertical)	Number	2	3	7	8	9	14	15	16	18	Total
1 Nursing professional (ward)	50					8					8
2 Medical practitioner (general)	20		3								3
3 Pharmacist	3										
	Total workforce	14	5	26	26	8				45	123
Demand-Supply Gap	Future cases	0	-65	0	-50	-233	15	15	-11	20	-309
	Horizontal changes	14	2	26	26	0	0	0	0	45	113
	Vertical changes (gains to new group)	0	3.2	0	0	7.5	0	0	0	0	11
	Vertical changes (losses to providing group)	-4	0	0	-10	0	0	0	0	0	-14
Demand-Supply Gap (with substitutions)		10	-60	26	-34	-225	15	15	-11	65	-199

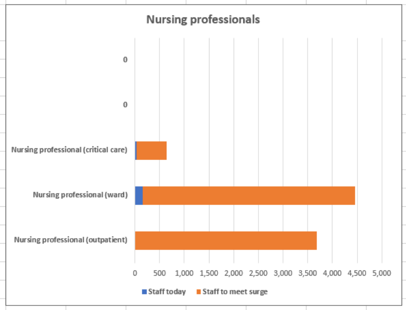
Note: the Skill mix tab of the HWFE shows an analysis of how alternate workforce groups may be used to augment the existing Healthcare workforce. The number of workforce available for substitution is manually inputted into the yellow boxes. The table then pulls data from the Role Substitution tab to calculate the impact of adding substitute health workers into the system. For example, we can see that if we are able to use 10 newly qualified doctors, the cumulative impact will be an additional eight available new medical practitioners (general) (the cumulative impact is less than the number of substitute staff because it takes into account existing health workers who will be needed to supervise the substitute staff. In this example, one medical practitioner (general) can supervise five newly qualified doctors. So, two current medical practitioners (general) will not be practising at their full capacity because they will be supervising the 10 newly qualified doctors: 10 – 2 = 8). Additionally, we can see that when using vertical substitution of nursing professionals (ward) to assist the nursing professionals (critical care), the 50 nursing professionals (ward) will spend 20% of their time in critical care, as was determined by the Role Substitution tab, and one nursing professional (critical care) will supervise five nursing professionals (ward), as was also determined by the Role Substitution tab. Vertically substituting these 50 nursing professionals (ward) will create a cumulative effect of eight new nursing professionals (critical care) (50 ward nurses x 20% = 10. Two critical care nurses will not be practising at full capacity because they will be supervising the 10 ward nurses: 10 – 2 = 8).

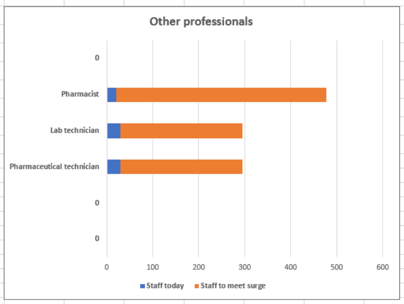
Fig. 30. **HWFE: Surge tab**

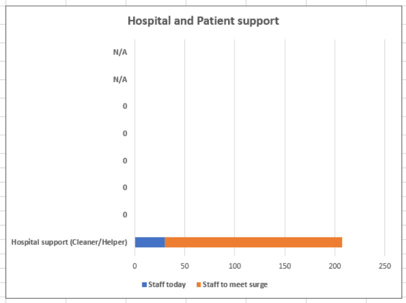
Surge

Comparison between current workforce numbers, and the workforce required to meet the peak (maximum) of the surge. The table shows the percentage change needed.





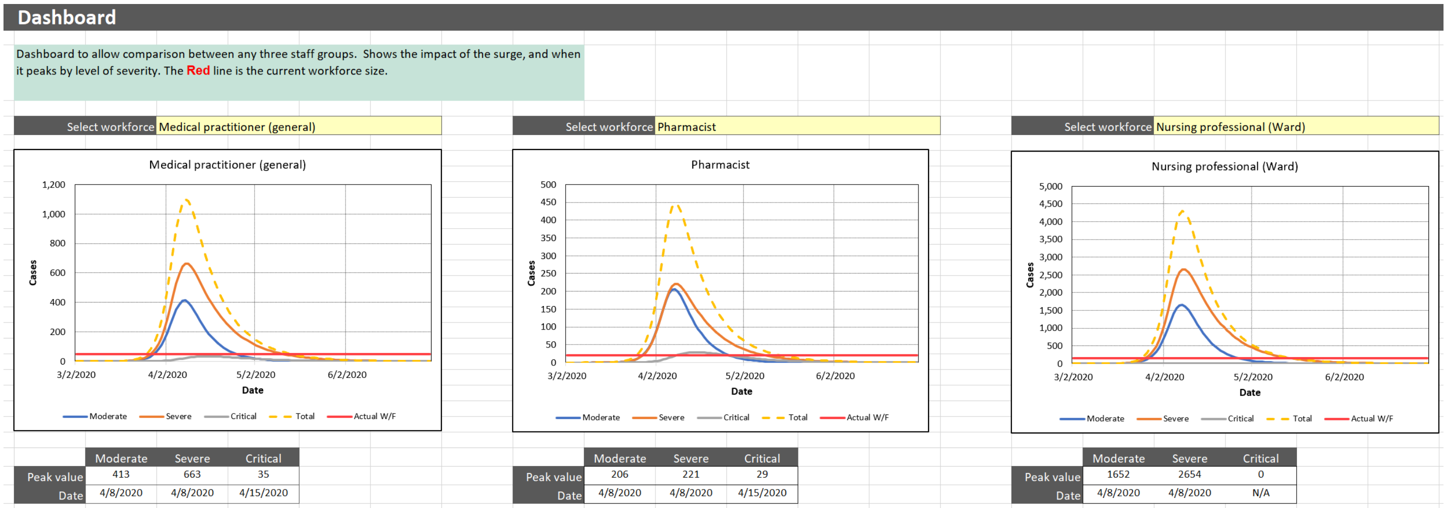




Workforce group	Current	Peak	Percent change
0		0	
Medical practitioner (general)	50	1,076	2053%
Specialist medical practitioner (critical care)	10	174	1644%
0		0	
0		0	
0		0	
Nursing professional (outpatient)		3,688	
Nursing professional (ward)	150	4,305	2770%
Nursing professional (critical care)	30	610	1934%
0		0	
0		0	
0		0	
0		0	
Pharmaceutical technician	30	265	784%
Lab technician	30	265	784%
Pharmacist	20	457	2183%
0		0	
Hospital support (Cleaner/Helper)	30	177	490%
0		0	
0		0	
0		0	
0		0	
0		0	
N/A		0	
N/A		0	

Note: the Surge tab of the HWFE compares the current workforce numbers with the numbers needed to meet the surge. The surge is calculated based on data from the Required Staff tab. In this example, we can see that although we have 50 medical practitioners (general) in the region, we will need 1076 to meet the needs of all patients during the surge. The table on the right allows you to see which health-worker categories will be most vulnerable during the surge. In this example, the greatest shortage will be for nursing professionals (ward).

Fig. 31. **HWFE: Comparisons tab**



Note: the Comparisons tab in the HWFE provides a dashboard so that the impact of the surge can be compared among any three staff groups. In this example, the medical practitioner (general), pharmacist and nursing professional (ward) roles were selected. We can see that the peak for moderate and severe cases for pharmacists is 8 April 2020, when 206 pharmacists will be needed for care for moderate patients and 221 pharmacists will be needed to care for severe patients. The peak for critical cases is 15 April 2020, when 29 pharmacists will be needed.

Validate the data and check your assumptions

As you upload the data, you will need to validate them to make sure they are reasonable and make sense for your country context. You will also need to reflect on assumptions made throughout the data collection process regularly and update the data as needed. The best way to validate your data is to compare projected figures with actual data collected on the ground.

The most important part of validating your results from the HWFE is reviewing the professional activities to be sure they reflect the local context appropriately. If the health-worker predictions match local data, you may need to consult with health workers again to better understand how many hours they spend with a patient in a 24-hour period.

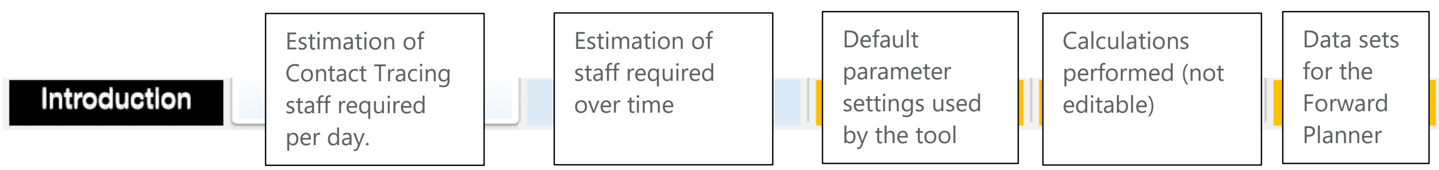
CONTACT TRACING

You will need to reference the user guide (Box 4) to familiarize yourself with the CTT. Once you have a working knowledge of the tool, you may then begin to load the data. After viewing the user guide, you may still have questions about where to upload information from the data collection sheets. Fig. 32–35 may be helpful in guiding this process. Note that all cells highlighted in yellow are unlocked for data input, and grey highlighted areas are locked and cannot be changed.

Box 4. Contact Tracing tool – helpful links

- The main page for the CTT describes the purpose of the tool created by the WHO Regional Office for Europe.
- A detailed user guide is available to guide the learning process.
- Please note that the tool used in this toolkit is V2.0. There may be a new version by the time you implement your tool; however, the content is essentially the same and can easily be adapted.

Fig. 32. CTT tabs



Introduction

The COVID-19 Contact Tracing tool has been developed by the WHO Regional Office for Europe to estimate the staff required to track and trace COVID-19 cases. It may be used with default settings to estimate changing staff requirements over a four-month period, where forecast case numbers are available. Different categories of staff are not distinguished.

The spreadsheet models the following contact tracing process.

Identify

- **Confirmed cases** are identified to the **contact tracers**. A **confirmed case** is an individual infected with COVID-19, confirmed by a positive laboratory test result. Contact tracing may be performed for probable cases if comprehensive testing is not available (WHO, 2020).
- A **case interview** is conducted by contact tracing staff. This may be done by telephone, or travel may be required to interview the contact face to face. The percentage of interviews that require travel can be defined. **Travel time** can be adjusted for urban or rural settings, or a combination.
- **Case contacts** are identified. A **contact** is defined as anyone with exposure to a COVID-19 case from two days before to 14 days after the onset of illness (WHO, 2020). The number of contacts per case is influenced by the level of **social distancing.** Contacts per case can be set for different levels of social distancing.
- Details of the case interview are entered into a **database**, and the contacts are classified and prioritized as either high or low risk. The time to perform the case interview, collect and classify the information and enter into the database can all be defined.

Inform

- **Contact interview**s are held with each identified contact to collect information about the nature and duration of their contact with the infected individual and factors that may influence their vulnerability to COVID-19.
- Details of the contact interview are typically entered into a **database**. The interview time and database update time can be defined. As for case interviews, the percentage requiring travel for face-to-face meetings can be set.

Manage and monitor

- Contact tracers **monitor** these contacts for signs and symptoms over a **follow-up period**.
- The **database** is updated with any changes. Again, interview and database update times can be set, as well as travel parameters.

Test and isolate

- Contacts may be identified that have symptoms of COVID-19, either by the contact tracers or self-reported by the contacts themselves.
- Contacts are notified (if not aware already) and may be **tested** if **symptomatic** and asked to self-isolate or potentially **referred to care**. Travel and times for referral can be defined.

Use of digital tools

A variety of **digital tools** may be used to assist the contact tracing process. These include:

- **outbreak response tools** to provide contact tracers with support for online surveys, collecting and storing data sources, managing contact lists and flagging action;
- **proximity tracing tools** using GPS or Bluetooth technology to find and trace people who may have been exposed to an infected person; and
- **symptom tracking tools** for contacts to report their own symptoms that may indicate COVID-19 infection.

The digital tools, if in use, speed up the above stages to a greater or lesser degree. The percentage speed-up and the percentage of use of each tool will need to be adjusted to reflect local circumstances.

Using the tool

The CTT has six tabs as follows.

1. **How to use** – a quick start guide.
2. **Contact Tracing** – a simple estimator of the staff required per day to trace a specified number of confirmed contacts.
3. **Forward Planner** – to estimate the staff required to trace new confirmed contacts arriving over an eight-week period.
4. **Parameter** – to set the parameters used in the calculation. Default settings are provided but these should be confirmed.

5. **Calculations** – a locked worksheet that shows the calculations used in the **Contact Tracing** and **Forward Planner** worksheets. This is provided to show how the results are calculated.
6. **Country Data** – data on the number of new contacts per day over a specified time period, used in the **Forward Planner**.

Contact Tracing tab

The **Contact Tracing** tab is used to calculate the number of staff that would be required to monitor a steady-state number of COVID-19 cases, per day (Fig. 33). Steady state is where the number of cases arriving each day to contact trace has been the same for at least the length of the follow-up period. For example, if there are 100 confirmed cases per day and the follow-up period is 14 days, then the number of ongoing cases will increase to 1300 and then on day 14 the earliest 100 cases will close. In this situation, the number of cases arriving and the number of cases finishing at the end of the follow-up period will become stable. The number of staff required, using this estimate, represents the maximum that is likely to be needed to monitor the specified number of cases.

The parameters required are grouped into areas:

- **situation** – the confirmed COVID-19 cases to track per day and the level of social distancing
- **contacts per case** – expected from the level of social distancing in place
- **policy options** – actions we can take that effect the number of staff required for contact tracing
- **use of digital tools** – usage and uptake of digital tools, if available.

Fig. 33. **CTT: Contact Tracing tab**

	Situation	Setting	
1	Average confirmed COVID-19 cases to track per day over follow-up period	1,000	
2	Level of social distancing (Low, Medium, High, User defined) ->	High/Strong	Text updated

	Contacts per case	Number
3	Low/None social distancing, e.g. advice only	15
4	Medium/Weak social distancing, e.g. travel restrictions	10
5	High/Strong, e.g. stay at home regulations	5
6	User defined contacts per case	4

Contract tracers required	3,682

	Policy options	Setting
7	Follow-up period (days)	14
8	Percent contacts followed-up (Case interview done & all contacts notified)	100%
9	Average working hours per day	8.0

	Use of Digital Tools	Percentage
10	Outbreak response	100%
11	Symptom tracking	50%
12	Proximity tracking/tracing	0%

The following steps should be taken (numbering follows Fig. 33 above).

1. Define the average number of **confirmed COVID-19 cases** to track per day.
2. Select the level of **social distancing** in the drop-down box. The number of contacts per confirmed case is pre-defined if Low, Medium or High is selected, or user-defined where its value can be input. Pre-defined values are set in the **Parameters** tab and may be edited.
3. Social distancing may be **Low/None** – for example, advice but no enforcement. The pre-selected value in the above example is 15 contacts per case.

4. Social distancing may be **Medium/Weak** – for example, with movement and travel restrictions. The pre-selected value is 10 contacts per case.
5. Social distancing may be **High/Strong** – for example, stay at home regulations with penalties for breaking them. The pre-selected value is five contacts per case; as this option has been selected in (2), it is highlighted in red.
6. Define the **follow-up period**. This is the length of time in days to check contacts for signs of any COVID-19 symptoms. It typically is 14 days. It is assumed that contacts are followed-up on a daily basis until this period finishes.
7. Define the **percentage of contacts followed-up**. The default is 100%, which means that all contacts are followed-up. If it is set to zero, then the initial case interview is completed, all contacts are notified, but the contacts are not followed-up. It should only be reduced below 100% if there are insufficient resources.
8. Define the **average working hours per day**. This is the average daily working hours of a contact tracer and is set to "8" in the example above.
9. Define the use of **outbreak response tools.** Zero per cent means the tool is not used. One hundred per cent means the tool is used for all confirmed cases being traced, as shown above.
10. Define the use of **symptom tracking tools**. Fifty per cent here means the tool is effective for only half of all cases (that is, the take-up by the population is 50%).
11. Define the use of **proximity tracking/tracing** tools. As for the other tools, this can be any value between 0% and 100%. The setting of zero means the tool is not being used.

Process to follow

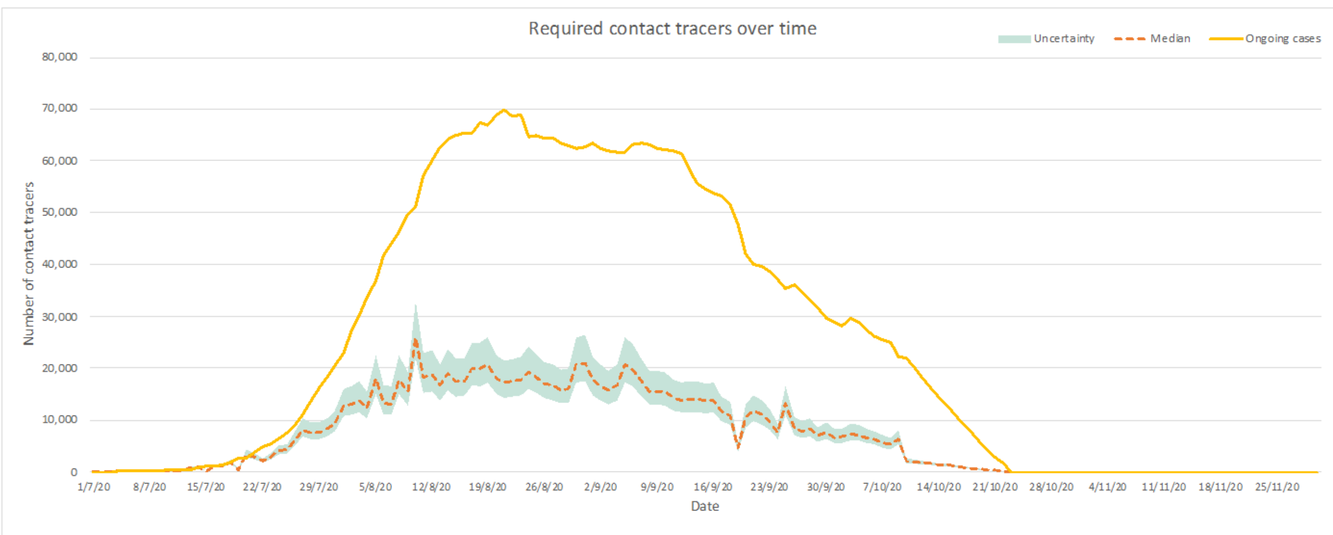
Once all the settings and decisions have been made, the corresponding number of contact tracers required will be displayed. The number calculated will reflect the above settings and the values defined in the **Parameter** tab. As many parameters can be varied, a process is needed to arrive at sensible values. The following is suggested.

1. Set the number of confirmed cases at a reasonably large value, say 1000 cases per day.
2. Set the policy options: all contacts followed-up, 40 hours worked per week, no digital tools.
3. Review the effect of changing the level of social distancing. This will have a substantial impact on the number of contact tracers required, so it is important to understand the level of uncertainty. A good approach is to get a small group of people to estimate a credible range of contacts per case: the upper and lower bounds (we would be surprised but not amazed if the true value lay outside of this) and the median. Use the median to understand the expected future and the upper and lower bounds to think about the uncertainty.
4. Investigate the impact of digital tools, individually setting them to 100%, and them setting all to 100%. Decide which ones you are likely to use and the likely take-up. Put these values in.
5. Consider fine-tuning the settings in the Parameters tab to reflect your local situation.
6. If the number seems too large, consider increasing the working hours per week and/or the percentage of contacts followed-up.

Forward Planner tab

The **Forward Planner** tab can be used to obtain an estimate of the staff required over a period of time up to four months. The drop-down is used to select data from the **Country Data** worksheet. Fig. 34 shows the number of ongoing cases (the solid orange line) and the number of contact tracing staff required (the dashed line). A range of uncertainty is also presented (the shaded area) to highlight that many parameter values are not certain and we can only provide estimates.

Fig. 34. CTT: Forward Planner tab – contract tracers required over time



Parameters tab

The **Parameters** tab is where the parameter settings for the calculation are held. It is populated with default values, but these may be changed to reflect the local situation. It is recommended that changes are made only once an initial analysis has been performed using the **Contact Tracing** and **Forward Planner** worksheets. Changes to the parameter settings, if required, should be made one at a time to understand their impact.

The parameters are grouped into areas:

- **Generic parameters** that are applied across several stages of the contact tracing process
- **Stage parameters** that apply to the individual stages of the process
- **Digital tool parameters** that apply to each tool.

Generic parameters

The following parameters are defined (Fig. 35).

Fig. 35. **CTT: Parameters tab – Generic parameters**

Generic parameters

1. Percentage uncertainty	20%		
2. Effect of social distancing (contacts per case)	Median	Min	Max
Low/None	15	12.0	18.0
Medium/Weak	10	8.0	12.0
High/Strong	5	4.0	6.0
User Defined	4	3.2	4.8
3. Travel time for interviews including return trip	42	42	42
Urban settings (minutes)	45		
Rural settings (minutes)	30		
Percentage interviews requiring travel (not by telephone)	20%	0%	30%
Percentage time that is for rural travel (0% is all urban)	20%	20%	20%

1. **Percentage uncertainty.** This percentage is applied to the median number of confirmed cases for each level of social distancing. It is used to generate an upper (max.) and lower (min.) range of values for the **Forward Planner**.
2. **Effect of social distancing (contacts per case)**. This is either Low/None, Medium/Weak, High/Strong or User Defined. These are selected from the drop-down in the **Contact Tracing** worksheet. The Min. and Max. values are calculated from the **Percentage uncertainty** above.
3. **Travel time for interviews including return trip** – travel times have a significant impact on the overall time for contact tracing, so upper (maximum) and lower (minimum) bounds can be set outside of the percentage uncertainty discussed previously. This covers the time to and from a face-to-face interview where the interview cannot be conducted by telephone. The top row (shaded) shows the time taken *where there is travel*. The **Percentage interviews** give the percentage requiring travel, and the uncertainty. The percentage that is rural can also be defined. Zero per cent is all urban, 100% is all rural. In the example above, 20% of travel is rural.

Stage parameters

The following parameters are defined (Fig. 36).

Fig. 36. CTT: Parameters tab – Stage parameters

4. Identify	Length of case interview (mins)	60		
	Time to retrieve information for each contact (mins)	6		
	Time to classify each contact as high or low risk (mins)	5		
	Time to create contact list (mins)	120		
	Time to enter case interview into database (mins)	15		
5. Inform	Length of initial contact interview (mins)	10		
	Time to enter interview from each contact into database (mins)	10		
6. Manage and monitor	Length of daily monitoring interview (mins)	10	10	10
	Time to update contact status in database (mins)	10	10	10
7. Test and isolate	Notification, consultation & triage of symptomatic contact (mins)	45		
	Percentage of contacts that become symptomatic	10%		
	Percentage of symptomatic contacts that require treatment	20%		
	Time to refer to care per symptomatic contact (mins)	60		

The parameters follow the stages of the contact tracing process.

4. **Identify.**

- **Length of case interview (mins)**. The time to conduct a case interview excluding any travel time.
- **Time to retrieve information for each contact (mins)**. The time to collect details about each individual contact so they can be interviewed (next stage).
- **Time to classify each contact as high or low risk (mins)**. The risk needs to be assessed as a decision is needed as to whether all contacts are followed-up. The percentage followed-up is set in the **Contact Tracing** worksheet and the default is 100% (all contacts).
- **Time to create contact list (mins)**. This is the time to construct a classified list of all the contacts and their details.
- **Time to enter case interview into database (mins)**. This is the time to input all the above information into a database or data repository.

5. **Inform.**

- **Length of initial contact interview (mins**). Note that this is repeated for each of the contacts, irrespective of whether they are followed-up.
- **Time to enter interview from each contact into database (mins)**. This is repeated for each of the contacts.

6. **Manage and monitor.**

- **Length of daily monitoring interview (mins)**. This is repeated for each contact being followed up. Because there may be many contacts, this time has a significant impact on the overall time for contact tracing, so upper (maximum) and lower (minimum) bounds can be set outside of the percentage uncertainty discussed previously.

- **Time to update contact status in database (mins)**. This is repeated for each contact being followed-up.

7. **Test and isolate.**

- **Notification, consultation & triage of symptomatic contact (mins)**. This is for contacts that become symptomatic.
- **Percentage of contacts that become symptomatic**. Not all contacts will become symptomatic; this sets the percentage that does.
- **Percentage of symptomatic contacts that require treatment**. Not all symptomatic contacts will need treatment; this sets the percentage that does.
- **Time to refer to care per symptomatic contact (mins)**. This is for those symptomatic contacts requiring treatment.

Digital tool parameters

The following parameters are defined (Fig. 37).

Fig. 37. CTT: Parameters tab – Digital tool parameters

7. Efficiency gain for same activity but done via online platform / tool	Percentage
Outbreak response	10%
Symptom tracking	10%
Proximity tracking/tracing	75%

Each digital tool will lead to a measure of efficiency gain, as compared with the same activity performed without the tool. The efficiency or speed-up gain is the percentage reduction in task time; this is not the same as the use of digital tools defined in the Contact Tracing worksheet, which represents the take-up.

- **Outbreak response**. This applies across all contact tracing stages.
- **Symptom tracking**. This speeds-up interviews, particularly contact follow-up.
- **Proximity tracking/tracing**. This speeds-up getting information about contacts, and notification and follow-up.

Calculations tab

This worksheet is locked but may be used to gain understanding of the calculations. There is no user input required. The calculation is performed for the median, and the lower and upper bounds (Fig. 38).

Fig. 38. **CTT: Calculations tab (for information only)**

Contacts per case (from social distancing)	5
Multiplier for hours per working week (not used)	1.0

Summary	Hours	Staff per day	Staff adjusted	Cases per day
Case interview	3.75	0.47	0.47	2.1
Contact notification	0.10	0.01	0.01	82.8
Contact follow-up	0.00	0.00	0.00	0.0
Contact testing	0.16	0.02	0.02	50.8

Staff per day (day 1)	Case interview, Contact notification	2.40
Staff per day (day 2...)	Contact follow-ups, Contact testing	0.10

Stage	Activity in minutes	No digital tools	Outbreak response	Symptom tracker	Proximity tracking	
Case interview	Case interview	60	54	60	60	
	Travel time for case interview (if face-to-face)	8	0	0	0	
	Create full contact list (get personal information)	120	120	120	30	
	Retrieve contact information for each contact	30	30	30	8	
	Enter case interview into database	15	0	15	15	
	Classify and prioritize contact list (high or low risk)	25	25	25	25	
	Hours per case interview	4.31	3.82	4.17	2.29	3.75
	Speed-up by percentage usage		-0.49	-0.07	0.00	
Contact notification	Initial contact interview	10	10	10	10	
	Travel time for initial contact interview (if face-to-face)	8	0	0	0	
	Enter information from contact interview into database	10	0	10	10	
	Hours per contact notification	0.47	0.17	0.33	0.33	0.10
	Speed-up by percentage usage		-0.31	-0.07	0.00	
Contact follow-up	Daily monitoring/contact follow-up	10	9	0	10	
	Travel time for daily monitoring/contact follow-up (if face-to-face)	8	0	0	0	
	Update contact status in database	10	0	0	10	
	Hours per contact follow-up	0.47	0.15	0.00	0.33	-0.09
	Speed-up by percentage usage		-0.32	-0.24	0.00	
Contact testing	Initial notification, consultation & triage for symptomatic contacts	4.50	4.05	4.50	4.50	
	Travel time for those contacts that are symptomatic to administer test	4.20	4.20	4.20	4.20	
	Time for testing and referal to care (for those requiring hospitalization)	1.20	1.20	1.20	1.20	
	Hours per contact test	0.17	0.16	0.17	0.17	0.16
	Speed-up by percentage usage		-0.01	0.00	0.00	

Data tab

The **Data** tab holds a time series of confirmed COVID-19 cases over time (up to four months) (Fig. 39). Sample data are included for a selection of countries, but may be overwritten. Up to 10 time series can be input. The data tab may be populated from epidemiological forecasts where these are available.

The **Start date** can be set to any date required. The **Data source** is selected in the **Forward Planner** worksheet

Fig. 39. **CTT: Data tab**

		1	2	3	4	5	6	7	8	9	10
	Data source ->	Portugal	United Kingdom	Uzbekistan	Armenia	Kyrgyzstan	Other 1	Other 2	Other 3	Other 4	Other 5
Start date ->	01/07/20	0	13	0	0	0	0	0	0	0	0
	02/07/20	2	4	0	0	0	0	0	0	0	0
	03/07/20	0	11	0	0	0	0	0	0	0	0
	04/07/20	3	34	0	0	0	0	0	0	0	0
	05/07/20	3	30	0	0	0	0	0	0	0	0
	06/07/20	5	48	0	0	0	0	0	0	0	0
	07/07/20	7	43	0	0	0	0	0	0	0	0
	08/07/20	10	67	0	0	0	0	0	0	0	0
	09/07/20	0	48	0	0	0	0	0	0	0	0
	10/07/20	11	61	0	0	0	0	0	0	0	0
	11/07/20	18	77	0	0	0	0	0	0	0	0
	12/07/20	0	0	0	5	0	0	0	0	0	0
	13/07/20	53	342	0	2	0	0	0	0	0	0
	14/07/20	57	342	0	12	0	0	0	0	0	0
	15/07/20	76	1	0	8	0	0	0	0	0	0
	16/07/20	86	407	4	24	0	0	0	0	0	0
	17/07/20	117	409	3	26	0	0	0	0	0	0
	18/07/20	0	682	7	32	0	0	0	0	0	0
	19/07/20	337	74	5	12	0	0	0	0	0	0
	20/07/20	235	1,298	10	14	3	0	0	0	0	0
	21/07/20	260	1,053	8	24	8	0	0	0	0	0
	22/07/20	320	674	2	34	0	0	0	0	0	0

STEP 4. SCALE YOUR RESULTS

After collecting local data, populating the tools, documenting assumption, and validating the results based on local contexts and policies, you can now see what the results of the tools mean for your region. These results may help guide decisions from the ministry of health, specifically regarding health policies, facility capacity and staffing resources. It is important to document the successes and lessons learned from the process so you can apply it to other regions.

You may now scale the tools to more regions in your country, making sure you continue collecting data, updating your assumptions and validating the results. You may need to review the average lengths of stay and rates of hospitalization in each region, particularly for areas with higher population densities or more risk factors.

You may find it helpful to take note of health-risk data about comorbidities when collecting data for new regions. This can help you determine which areas are most at risk of severe illness. Taking note of population age per region can be particularly insightful in relation to which areas may experience more severe illness. You may look at DHIS2 data to give guidance, but as you look at actual results you will be able to see if there is variation by region, and if it is linked with age or other comorbidities.

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All weblinks accessed 10 August 2020.

ANNEX 1. TEMPLATE DATA COLLECTION SHEETS

PROFESSIONAL ACTIVITIES DATA COLLECTION SHEET

Professional Activities by Facility Type:				
	Number of hours that a health worker spends with one patient in a 24-hour period			
Health Worker Cadre	**Mild**	**Moderate**	**Severe**	**Critical**

STAFFING DATA COLLECTION SHEET

Staffing Data Collection Sheet											
Hospital Personnel Dedicated to COVID-19 by Facility											
		Staff Category									
Facility Name	**Level of Severity**										

AVAILABLE WORKING TIME

Available Working Time										
Staff Category	Working days per week	Hours working per day	Annual leave	Public holidays	Sick leave	Unplanned absences	Training days	Total non-working days per year	Working days per year	Working weeks per year

FACILITY DATA COLLECTION SHEETS

Facility Data Collection Sheet								
Region	District	Facility Name	Type of Facility	Total Beds	COVID-Designated Beds (Moderate)	COVID-Designated Beds (Severe)	ICU Beds	Mechanical Ventilators

COVID-19 DAILY REPORTED DATA

COVID-19 Daily Reported Data			
Date	Confirmed Cumulative	Confirmed New	Deaths

ROLE SUBSTITUTION DATA COLLECTION SHEETS *(OPTIONAL)*

Horizontal Role Substitution Data Collection Sheet										
Please allocate what % of existing staff categories the supporting workforce will substitute										
	Staff Category									
Supporting Workforce Group										
Please allocate how many people a current health worker will supervise in the supporting workforce										
Supporting Workforce Group										

Vertical Role Substitution Data Collection Sheet										
Please allocate what % of time current staff will assist current staff in another category										
	Staff Category									
Supporting Workforce Group										
Please allocate how many people a current health worker will supervise in the supporting workforce										
Supporting Workforce Group										

MIDNIGHT CENSUS *(OPTIONAL)*

Midnight Census								
Date	**Admissions**	**Discharges**	**Deaths**	**Mild**	**Moderate**	**Severe**	**Critical**	**Total Currently Hospitalized**

ANNEX 2. TIME REQUIRED PER 24-HOUR DAY FOR PROFESSIONAL ACTIVITIES BY CADRE AND LEVEL OF SEVERITY

HCWFE MILD PATIENT NEEDS

Mild Patient Needs

This worksheet defines the workforce needs to treat Mild COVID-19 patients

Reference	WHO Euro research
Notes and assumptions	Does not require inpatient care
Average length of stay (days)	8

Group ID	Occupational title	Intervention	Procedure	Time per procedure (hrs) Median	Lower	Upper	Patients per day	Notes
2a	**Nursing professional (Outpatients)**			**0.16**			150	
		Development of a care plan	Basic exam with vital signs (triage)	0.16				
9	**Health care/Medical assistant**			**0.19**			126	
		Development of a care plan	Collection of NP swab	0.03				
		Development of a care plan	Screening for symptoms	0.08				
		Development of a care plan	Home checks (over the phone or in person to screen for worsening)	0.08				

Note: the Mild Patient Needs tab of the HWFE defines the amount of time it takes to perform professional activities to care for a mild COVID-19 patient in a European context. You will need to reference this worksheet when defining your own professional activities, but the activities and times will vary depending on local context. It is important to document your assumptions.

HWFE MODERATE PATIENT NEEDS

Moderate Patient Needs

This worksheet defines the workforce needs to treat Moderate COVID-19 patients

Reference	WHO Euro research
Notes and assumptions	May require inpatient care, not including oxygen therapy

Average length of stay (days): 11

Group ID	Occupational title	Intervention	Procedure	Time per procedure (hrs) Median	Lower	Upper	Patients per day	Notes
1f	**Specialist medical practitioner (Hospital)**			**0.50**			48.0	These are frontline providers, with task shifting and supervisions a specialist medical practioner could care for more patients
		Development of a detailed care plan	Daily rounds, exam, charting	0.50	0.33	1.00		
2b	**Nursing professional (Ward)**			**3.66**			6.6	Ward ratio typically 1 nurse to 4 patients
		Management of Respiratory Insufficiency/DIB	Continuous pulse oximetry, VS q4	1.00	0.50	2.00	24.0	All patients every day
		Management of Respiratory Insufficiency/DIB	Lab frequency daily	0.16	0.08	0.50	150.0	All patients every day
		Management of Respiratory Insufficiency/DIB	Medication administration q6 hours	1.00	0.33	2.00	24.0	All patients every day
		Development of a detailed care plan	Daily rounds, charting, PPE	1.50	1.00	2.00	16.0	All patients every day
4b	**Pharmaceutical technician**			**0.25**				
		Supportive services	Stocking, dispensing of meds	0.25	0.08	1.00	96.0	All patients every day
4c	**Laboratory technician**			**0.33**				
		Supportive services	Running lab tests	0.33	0.25	1.00	72.7	All patients every day
5	**Pharmacist**			**0.50**				
		Development of prognosis-based detailed care plan	Medication preparation	0.50	0.25	2.00	48.0	All patients every day
7a	**Hopital support (Cleaner/Helper)**			**0.33**				
		Supportive services	Cleaning	0.33	0.08	0.50	72.7	All patients every day
7b	**Patient support (Medical secretary)**			**0.25**				
		Supportive services	Administrative support	0.25	0.10	0.50	96.0	All patients every day
8a	**Patient support (Social work & counselling)**			**0.50**				
		Supportive services	Social support	0.50	0.25	2.00	48.0	All patients every day
8c	**Patient support (Case manager)**			**0.50**				
		Supportive services	Discharge planning	0.50	0.25	2.00	48.00	All patients every day

Note: the Moderate Patient Needs tab of the HWFE defines the amount of time it takes to perform professional activities to care for a moderate COVID-19 patient in a European context. You will need to reference this worksheet when defining your own professional activities, but the activities and times will vary depending on local context. It is important to document your assumptions.

HWFE SEVERE PATIENT NEEDS

Severe Patient Needs

This worksheet defines the workforce needs to treat Severe COVID-19 patients

Reference	WHO Euro research
Notes and assumptions	Requires oxygen

Average length of stay (days)	11

Group ID	Occupational title	Intervention	Procedure	Time per day (hrs)	Time per procedure (hrs)			Occurrences per stay	Probability of occurrence	Patients per day	Notes
					Lower	Median	Upper				
1f	**Specialist medical practitioner (Hospital Medicine)**			**0.78**							These are frontline providers, with task shifting and supervision a specialist medical practitioner could care for more patients
		Management of Respiratory Insufficiency/DIB	Oxygen therapy*	0.18	0.00	0.25	1.00	11	70%		Estimated 70% of severe cases require oxygen, assume needed throughout 11 day hospital stay (Guan et al)
		Management of Respiratory Insufficiency/DIB	NIPPV*	0.11	0.25	0.33	1.00	9	40%		Assumption: Estimated 40% of hospitalized patients need NIPPV, assume NIPPV needed for 9 of 11 hospital days (ref: Huang et al., Chen et al., Wang et al, Guan et al., Yang et al., [illegible]
		Development of a detailed care plan	Daily rounds, exam, charting, PPE	0.50	0.33	0.50	1.00	11	100%		All patients every day
2b	**Nursing professional (Ward)**			**4.66**							Ward ratio typically 1 nurse to 4 patients
		Management of Respiratory Insufficiency/DIB	Continuous pulse oximetry, VS q4	1.00	0.50	1.00	2.00	11	100%		All patients every day
		Management of Respiratory Insufficiency/DIB	Lab frequency daily	0.16	0.08	0.16	0.50	11	100%		All patients every day
		Management of Respiratory Insufficiency/DIB	Medication administration q6 hours	1.00	0.33	1.00	2.00	11	100%		All patients every day
		Advanced Management of Sepsis*	Antibiotic administration	1.00	0.33	1.00	2.00	11	100%		All patients every day
		Development of a detailed care plan	Daily rounds, charting, PPE	1.50	1.00	1.50	2.00	11	100%		All patients every day
3	**Respiratory therapist (RT)**			**3.08**							* this number includes NIPPV, not oxygen
		Management of Respiratory Insufficiency/DIB	Oxygen therapy*	0.23	0.00	0.33	1.00	11	70%		Assumption: Estimated 70% of severe cases require oxygen, assume needed throughout 11 day hospital stay (Guan et al)
		Management of Respiratory Insufficiency/DIB	NIPPV*	0.85	0.00	2.60	3.00	9	40%		Assumption: Estimated 40% of hospitalized patients need NIPPV, assume NIPPV needed for 9 of 11 hospital days (ref: Huang et al., Chen et al., Wang et al, Guan et al., Yang et al., [illegible]
		Management of Respiratory Insufficiency/DIB	Pulmonary toilet, nebulized treatments TID	1.50	1.50	1.50	3.00	11	100%		All patients every day
		Development of a detailed care plan	Daily rounds, exam, charting, PPE	0.50	0.50	0.50	1.00	11	100%		All patients every day
4b	**Pharmaceutical technician**			**0.25**							
		Supportive services	Stocking, dispensing of meds	0.25	0.08	0.25	2.00				All patients every day
4c	**Laboratory technician**			**0.33**							
		Supportive services	Running lab tests	0.33	0.25	0.33	1.00				All patients every day
5	**Pharmacist**			**0.50**							
		Development of prognosis-based detailed care	Medication preparation	0.50	0.25	0.50	2.00				All patients every day
6	**Dietician and Nutritionist**			**0.25**							
		Nutrition management in critically ill or injured	Enteral or parenteral nutrition	0.25	0.25	0.25	0.50				All patients every day
7a	**Hospital support (Cleaner/Helper)**			**0.33**							
		Supportive services	Cleaning	0.33	0.08	0.33	0.50				All patients every day
7b	**Patient support (Medical secretary)**			**0.25**							
		Supportive services	Cleaning	0.25	0.10	0.25	0.50				All patients every day
8a	**Patient support (Social work &**			**0.50**							
		Supportive services	Social support	0.50	0.25	0.50	2.00				All patients every day
8b	**Patient support (Physio &**			**0.50**							
		Supportive services	Early mobility and rehabilitation	0.50	0.25	0.50	1.00				All patients every day
8c	**Patient support (Case manager)**			**0.50**							
		Supportive services	Discharge planning	0.50	0.25	0.50	2.00				All patients every day

Note: the Severe Patient Needs tab of the HWFE defines the amount of time it takes to perform professional activities to care for a severe COVID-19 patient in a European context. You will need to reference this worksheet when defining your own professional activities, but the activities and times will vary depending on local context. It is important to document your assumptions.

HWFE CRITICAL PATIENT NEEDS

This worksheet defines the workforce needs to treat Critical COVID-19 patients

Reference	WHO Euro research
Notes and assumptions	Requires critical care including mechanical ventilation Overall assumptions: - procedures determined by WHO's COVID-19 clinical guidance (Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected Interim guidance 13 March 2020) - no change in severity throughout hospitalization Estimated time per day is calculated as = ((Median x Occurrence)/Length of stay) x Probability (Also for Severe category)
Average length of stay (days)	8

Group ID	Occupational title	Intervention	Procedure	Estimated time per day (hrs)	Time per procedure (hrs) Lower	Median	Upper	Occurrences per stay	Probability of occurrence
1b	**Specialist medical practitioner (Critical care)**			**3.06**					
		Management of Hemodynamic Instability (+/- end organ)	CVL placement*	0.06	0.50	0.50	2.00	1	100%
		Management of Hemodynamic Instability (+/- end organ)	Art line placement*	0.06	0.50	0.50	1.00	1	100%
		Management of Respiratory Failure	Intubation*	0.06	0.50	0.50	1.00	1	100%
		Management of Respiratory Failure	Bronchoscopy*	0.06	0.50	0.50	1.00	1	100%
		Management of Respiratory Failure	Chest tube placement*	0.06	0.50	0.50	1.00	1	100%
		Management of Respiratory Failure	Non-invasive Ventilation	0.50	0.50	2.00	4.00	2	100%
		Management of Respiratory Failure	Mechanical Ventilation	0.75	0.50	1.00	4.00	6	100%
		Development of prognosis-based detailed care plan	Twice daily rounds, exam, charting, PPE	1.00	1.00	1.00	4.00	8	100%
		Coordination of specialist services for multisystem illness	Coordination of specialist services for multisystem illness	0.50	0.00	0.50	2.00	8	100%
1c	**Specialist medical practitioner (Dialysis)**			**0.18**					
		Advanced Management of Electrolyte Derangements, Acid-Base Disorders, and Fluid Status	Renal Replacement Therapy	0.18	0.5	1	2	8	18%
1d	**Specialist medical practitioner (ECMO)**			**0.15**					
		Management of Hemodynamic Instability (+/- end organ)	ECMO	0.15	1.00	2.00	6.00	8	7.50%
1e	**Specialist medical practitioner (Radiology)**			**0.12**					
		Development of prognosis-based detailed care plan	Chest CT	0.04	0.25	0.33	0.5	1	100%
		Development of prognosis-based detailed care plan	Chest XR Daily	0.08	0.08	0.08	0.15	8	100%
2c	**Nursing professional (Critical care)**			**14.81**					
		Management of Hemodynamic Instability (+/- end organ)	Vasoactive preparation and administration	0.31	0.50	1.00	2.00	7	35%
		Management of Respiratory Failure	Suctioning and Repositioning q1-2	1.50	1.00	2.00	4.00	6	100%
		Management of Respiratory Failure	Proning	0.75	0.50	1.00	3.00	6	100%
		Management of Respiratory Failure	Sedation, analgesia, NMB preparation and administration	0.75	0.50	1.00	2.00	6	100%
		Critical Care Monitoring	Continuous monitoring (q1 hr VS)	1.00	1.00	1.00	2.00	8	100%
		Critical Care Monitoring	Lab draw (Lab frequency q1-6)	2.00	1.00	2.00	4.00	8	100%
		Development of prognosis-based detailed care plan	Twice daily rounds, exam, charting	3.00	2.00	3.00	6.00	8	100%
		Development of prognosis-based detailed care plan	Medication administration	2.00	1.00	2.00	6.00	8	100%
		Advanced Management of Sepsis*	IV Antibiotic preparation and administration	1.00	0.50	1.00	1.00	8	100%
		Nutrition management in critically ill or injured patients	Enteral or parenteral nutrition	0.50	0.25	0.50	1.00	8	100%
		Development of prognosis-based detailed care plan	Patient cares (PPE, prophylaxis, changing diapers, gowns, baths, communicating with family and medical team, etc.)	2.00	1.00	2.00	3.00	8	100%

Note: this is the first half of the Critical Patient Needs tab of the HWFE (the rest of the sheet is continued on the following page). This tab defines the amount of time it takes to perform professional activities to care for a critical COVID-19 patient in a European context. You will need to reference this worksheet when defining your own professional activities, but the activities and times will vary depending on local context. It is important to document your assumptions.

Group ID	Occupational title	Intervention	Procedure	Estimated time per day (hrs)	Time per procedure (hrs) Lower	Median	Upper	Occurrences per stay	Probability of occurrence
2d	**Nursing professional (ECMO)**			**1.80**					
		Management of Hemodynamic Instability (+/- end organ)	ECMO	1.80	24	24	24	8	7.50%
2e	**Nursing professional (Dialysis)**			**4.32**					
		Advanced Management of Electrolyte Derangements, Acid-Base Disorders, and Fluid Status	Renal Replacement Therapy	4.32	24	24	24	8	18%
3	**Respiratory therapist (RT)**			**7.60**					
		Management of Respiratory Failure	Non-invasive Ventilation	0.38	1	1.5	3	2	100%
		Management of Respiratory Failure	Intubation*	0.06	0.5	0.5	1	1	100%
		Management of Respiratory Failure	Bronchoscopy	0.06	0.5	0.5	1	1	100%
		Management of Respiratory Failure	Mechanical Ventilation (Equipment check)	0.98	1	1.3	3	6	100%
		Management of Respiratory Failure	Proning	1.13	1	1.5	3	6	100%
		Management of Respiratory Failure	Pulmonary toilet, nebulized treatments q4	4.00	3	4	6	8	100%
		Development of prognosis-based detailed care plan	Twice daily rounds, exam, charting, PPE	1.00	1	1	2	8	100%
4a	**Medical Technician (Radiology)**			**0.29**					
		Development of prognosis-based detailed care plan	Chest CT	0.04	0.25	0.33	1	1	100%
		Development of prognosis-based detailed care plan	Chest XR Daily	0.25	0.16	0.25	0.5	8	100%
5	**Pharmacist**			**1.00**					
		Development of prognosis-based detailed care plan	Medication preparation	1.00	0.25	1.00	2.00		
4b	**Pharmaceutical technician**			**0.25**					
		Supportive services	Stocking, dispensing of meds	0.25	0.08	0.25	1.00		
4c	**Laboratory technician**			**0.50**					
		Supportive services	Running lab tests	0.50	0.25	0.50	2.00		
6	**Dietician and Nutritionist**			**0.50**					
		Nutrition management in critically ill or injured	Enteral or parenteral nutrition	0.50	0.25	0.50	1.00		
7a	**Hospital support (Cleaner/Helper)**			**0.50**					
		Supportive services	Cleaning	0.50	0.33	0.50	0.75		
7b	**Patient support (Medical secretary)**			**0.25**					
		Supportive services	Administrative support	0.25	0.10	0.25	0.50		
8a	**Patient support (Social work & counselling)**			**0.50**					
		Supportive services	Social support	0.50	0.25	0.50	2.00		
8b	**Patient support (Physio & occupational therapy)**			**0.50**					
		Supportive services	Early mobility and rehabilitation	0.50	0.25	0.50	1.00		
8c	**Patient support (Case manager)**			**0.50**					
		Supportive services	Discharge planning	0.50	0.25	0.50	2.00		

Note: this is the second half of the Critical Patient Needs tab of the HWFE. This tab defines the amount of time it takes to perform professional activities to care for a critical COVID-19 patient in a European context. You will need to reference this worksheet when defining your own professional activities, but the activities and times will vary depending on local context. It is important to document your assumptions.