**Recommendations for metrics and thresholds for additional restrictions and improved health system monitoring**

**Objective**
1. If additional restrictions are deemed to be potentially effective and therefore necessary in reducing Cobid-19 patent numbers and therefore pressure on health services, what would the best metric to trigger these would be?
2. What would be the best threshold value for this metric that triggers an increase in restriction level?

NB, this framework could be used to flag districts for additional healthcare capacitation, not only to indicate if further social restrictions are required. While we are cognizant that it will not help districts in which health service capacity is already overwhelmed, it will benefit the majority of districts in which this is not yet the case- but only, if the advisory is implemented with speed in the next weeks after the threshold level for action has been identified.

**Methods**
We used three approaches to answer this questions:
1. We reviewed past work on definitions of hotspot and priority districts by the Public Health MAC sub-committee on hotspot identification and updated it with current data availability.
2. We reviewed other countries' metrics and threshold values
3. Based on the two points above, we updated the hotspot framework.

**Process**

**1. Review of original hotspots framework**
The original hotspots framework suggested the following groups of metrics (Figure 1):
- Proportion testing positive
- Case-dependent metrics (doubling time, change in new cases or incidence risk)
- Mortality-dependent metrics (doubling time, change in new deaths or mortality risk)
- Number of admissions or inpatient case fatality rate (CFR).

*Figure 1: The original hotspot identification framework.* Source: Report on Hotspot metrics to the Public Health Sub-Committee of the Ministerial Advisory Committee, 27 May 2020. *Note that of the options mentioned, only admission data is currently available at any*

*level of coverage nationwide.*
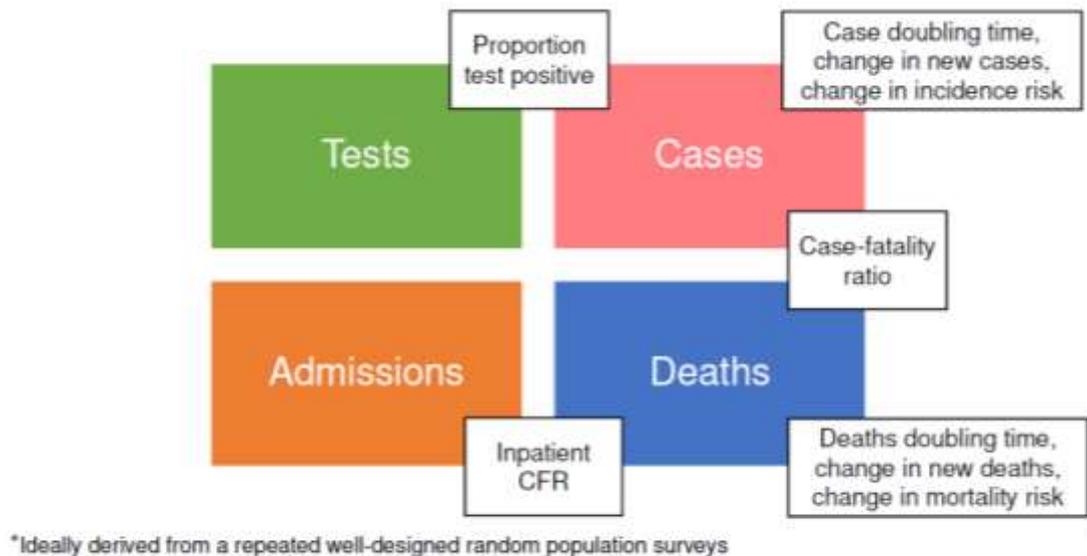


When the Public Health Sub-Committee reviewed these metrics in the end of May, none was available at district level in real time, with the exception of the **number of detected cases**. The report suggested using these to calculate the number of active cases for the last week per 100,000, based on the formula (active cases = cumulative cases – recoveries and deaths). The *suggested threshold* was to be 5 active cases per 100,000 (to be revised as the epidemic progresses); districts with case numbers above 5 per 100,000 were to be defined "Hotspot", and districts with case numbers below, "Vigilance district". In vigilance districts, if there was also an >80% increase in new cases over the last week, the district was to be termed an "Emerging hotspot". However, in the ensuing weeks it became clear that given the severe shortages of SARS CoV-2 PCR test kits and reagents, leading to testing coverage that was both incomplete and highly variable between districts, this metric could not be used.

Similarly, the proportion testing positive and all other **case-dependent metrics** (doubling time, change in new cases or incidence risk) would depend on a high testing coverage and were therefore deemed to be of not much use.

The sub-committee also realised that the suggested **mortality-dependent metrics** (doubling time, change in new deaths or mortality risk) tended to identify hotspots but with a time lag, and would most likely increase once health system capacity had been overwhelmed. Additionally, records of deaths due to Covid-19, especially outside of hospitals, are incomplete, with data missingness again being highly variable between districts.

**2. Review of other countries' monitoring frameworks**
We reviewed the metrics used in other countries' frameworks as part of a larger study estimating the impact of restrictions on case numbers using data from 40 countries and 51 US states (Esra, forthcoming). Across the board, the leading metrics are based on direct cases numbers or ratios or on development in case-dependent metrics such as incidence, reproductive number, etc, often with an additional notion of testing coverage taken into account. A number of countries additionally use mortality-dependent or health systems indicators such as hospital bed availability, but the first consideration is always based on cases.

**3. Update to hotspot framework**

Based on above, our suggestion is to a) focus on health service utilisation data and b) flag districts for intervention not based on their current status but on their likely situation in 1 month, in order to allow for enough time for potential interventions or restrictions to take effect. We propose a **metric of available non-ICU beds in 28-35 days within a district**, with a **threshold of 65% of non-ICU beds occupied**. We define non-ICU beds as all non-ICU/ general ward beds in either the public sector, or, once contracts with the private sector have been finalised in a province, in the public as well as private sector. Based on this metric, districts would then categorised into the following three categories:

*Green* – local health services are unlikely to be overwhelmed in the next 28-35 days
*Yellow* – local health services are likely to be overwhelmed in the next 28-35 days
*Red* – local health services are overwhelmed, or likely to be overwhelmed <28 days

There are a number of important considerations in this.

*a) Timing:* Using a forward-looking metric of 28-35 days allows for 1-2 weeks of preparation and announcement of any restrictions and additional 2 weeks for the effect of the restrictions on transmission and potential presentation of severe cases in hospital to take hold.
*b) Use of non-ICU beds as proxy for health capacity*: We chose non-ICU beds as their (non-)availability has the largest impact on mortality, given that they are needed to supply oxygen and drug treatments such as (intravenous) dexamethasone to patients- two of the options with currently the highest potential impact on mortality. They are less likely to be overwhelmed than ICU beds of which fewer are available, and their capacity will be breached later in most provinces; also, access to ICU beds has a smaller impact on mortality, given current evidence. Field hospital beds could be added to the non-ICU bed number once it has been established that enough oxygen can be delivered to these facilities. In some districts with very low baseline availability of beds, transferring of patients into neighbouring districts should be included in the calculation of available beds. Likewise, the voluntary transfer of staff between provinces should be encouraged and organised in order to maximise the benefit to be gained from different provinces peaking at different times, and in order to spread the most constrained resource the furthest. Importantly, the regular update of the number of available beds has to take these fluctuations into account.
*c) Threshold value*: The 65% cut-off used here assumes some fungibility of human and other resources across Covid and non-Covid beds, even while taking 10-20% Covid prevalence in healthcare workers into account. For this it is absolutely necessary that healthcare workers of any cadre are made available across departments in the same facility, and as much as possible also across facilities in the same district, and where necessary, province, as needed.
*d) Data needs*: While data on the *currently available* beds is available from the NDOH, data on *currently occupied* beds need to be made available by the NDOH, possibly through the CSIR data lake or an improved version of the NICD's DATCOV system on a daily basis to a central data dashboard such as the one maintained by the CSIR. The beds *expected to be occupied* in each district in 28-35 days from now will then be calculated in the same dashboard based on relatively simple extrapolation methods, optimally in keeping with the latest updates from the South African Covid-19 Modelling Consortium projections. This allows the categorisation of at-risk districts in real time. (Note that as though the decision to flag a district as "red" will be made based on the forward projection for the next month, data for the past 7-14 days is necessary for calculating the trend for the next month).Table 1 summarises the data sources needed for this metric.

**Table 1: Data sources for bed availability metric**

| Data point | Source |
| --- | --- |
| Current beds occupied (and time trend over last 7-14 days) | Full admission dataset (improved DATCOV dataset) |

| Currently available beds | Regular updates of available bed data via NDOH/ CSIR |
|---|---|
| Expected beds occupied in next 28-35 days | Simple district bed calculator |
| Expected beds available in next 28-35 days | NDOH/ CSIR |

**Caveats**

There are a number of caveats associated with this approach.

### a) *Uncertainty in calculation of expected beds*

Whichever method is used for the forward projection of bed needs will be associated with uncertainty. We believe that this uncertainty is still better than the current situation of noticing a hotspot once beds have run out and capacity has been breached.

### b) *Unavailability of real-time occupancy data*

Despite large efforts, the current data collection of available and occupied bed data in real time is fraught with uncertainty. Regulations already obligate hospitals to report this data and should be enforced more stringently. It is also important to note that this framework is of most use in districts that have not yet breached capacity, and in which some spare human resource time might be available for reporting. We however fully acknowledge that a good reporting system is the backbone of this framework; but we believe that bed capacity is easier to tally in real time and relatively homogenous across districts relative to cases (which need additional activities such as testing) and more relevant for the prevention of deaths than mortality.

### c) *Availability of human resources as well as beds*

We acknowledge that just because a general ward bed is available, it does not necessarily have the staff or other supplies (in particular oxygen) attached to it for it to make a difference. We however think that it will be hard to additionally tally up staff at all relevant levels (nurses, doctors, porters, cleaners and other support staff) in real time in order to set additional metrics based on these. Having a district be declared a "red' district one month before capacity is irredeemably breached would allow all decision-making levels to rally around the cause of making additional human resources and supplies available, and potentially avoiding the breach through additional restrictions.

**Recommendation:**

1. Use available non-ICU beds (including field hospitals if enough of the beds will have $O_2$ concentrators; including private sector beds and encouraging such contracts have been set up) in 28-35 days compared to projected needed non-ICU beds as a decision criterion for potential additional interventions.
2. Available beds will be tracked in a dashboard provided by CSIR or NDOH, and hospitals will be obligated to update daily, through the midnight tally approach or similar. As it is unlikely that a new information system will become available in time to collate this information from all hospitals in real time, alternative methods such as daily phone calls from NDOH or CSIR staff to all facilities might have to be used. Bed needs will be projected forward by a month using a simple formula in the dashboard.
3. If <65% of beds will be available in 28-35 days, consider additional interventions to a) strengthen bed and human resource capacity and b) potential additional restrictions.
4. Healthcare workers of any cadre be made available across departments in the same facility, and as much as possible also across facilities in the same district, and where necessary, province, as needed.
5. In districts with very low baseline availability of beds, transferring of patients into neighbouring districts should be included in the calculation of available beds. Likewise, the voluntary transfer of staff between provinces should be encouraged

and organised in order to maximise the benefit to be gained from different provinces peaking at different times, and in order to spread the most constrained resource the furthest. Importantly, the regular update of the number of available beds has to take these fluctuations into account. Consideration should be given to recruiting health and support staff from the military if the situation demands this.