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Foreword

This is the first special issue of the NICD's Public Health Surveillance Bulletin focussing specifically on COVID-19. These special issues will serve as a vehicle for the critical analysis of current and retrospective COVID-19 disease incidence / public health information in South Africa. Various manuscript types will be considered for publication including surveillance and outbreak reports, reviews, case studies and clinical guidelines. With these special issues, we aim for rapid review and publication of accepted manuscripts so that pertinent information can be distributed timeously.

This issue introduces the NICD's new DATCOV surveillance system. This sentinel hospital surveillance system is designed to monitor and describe trends of COVID-19 hospitalisations and the epidemiology of hospitalised patients in South Africa. The development of DATCOV demonstrates how low- and middle-income countries can establish a surveillance system to rapidly collect data where alternatives are not available.

We trust our readers will find these special issues valuable and informative during this extraordinary time, and thank the authors and reviewers for their inputs.

Prof Basil Brooke, Editor

DATCOV: A SENTINEL SURVEILLANCE PROGRAMME FOR HOSPITALISED INDIVIDUALS WITH COVID-19 IN SOUTH AFRICA, 2020

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Summary

Understanding the characteristics of individuals with severe coronavirus disease 2019 (COVID-19) is important to guide clinical management and prevention strategies. However, data from low- and middle-income countries and those with high HIV prevalence are lacking. In order to monitor and describe trends of COVID-19 hospitalisations and the epidemiology of hospitalised patients in South Africa, the National Institute for Communicable Diseases (NICD) established a sentinel hospital surveillance system, DATCOV. The system also aims to provide data needed to inform the country's pandemic response.

Public and private hospitals across all nine provinces of the country were informed of DATCOV and invited to register as users. Once signed up and authenticated, hospitals are able to report the following data elements on COVID-19 admissions: demographic data; clinical information including comorbidities; clinical care including intensive care unit admission, ventilation and drugs received; and outcomes such as death, discharge, transfer or continued admission. As of 31 May 2020, 218 hospitals (comprising 161 from private sector and 57 from public sector) had submitted data on 4 718 hospitalised COVID-19 cases.

INTRODUCTION

In order to address the prevention and treatment needs of COVID-19 in the South African context, it is important to understand the characteristics of the illness and to define who is at highest risk of hospitalisation and severe illness. These data will enable rational decision-making for preparation of

treatment, hospital beds and interventions for the most vulnerable population groups. There are many publications about the profile of COVID-19 in high-income countries⁶⁻⁸ and the risk factors for mortality seem to be similar throughout, but there are still many unknowns in the South African setting. Firstly, the local population is much younger than in some countries with established epidemics (5.3% of the population is over 65 years in South Africa compared to 18.4% in the United Kingdom and 15.8% in the United States of America). Secondly, South Africa also has a unique disease profile with epidemics of both infectious (HIV and tuberculosis) and non-communicable diseases such as diabetes, heart disease and cancers.⁹ Lastly, the country has an overburdened public health system that struggles to cope with caseloads even in the best of circumstances.

The current body of knowledge on COVID-19 includes little information from low- and middle-income countries (LMIC), and on people with the comorbidities of HIV and TB. There are currently almost 8 million people living with HIV in South Africa, and at least 2 million are not on treatment.^{10,11} The estimated TB incidence in South Africa in 2018 was over 300 000 (with a 59% TB incidence in HIV-positive patients).¹² Of these, over 155 000 people were put on TB treatment with a treatment success rate of 76%.¹³

In order to address this knowledge gap, the National Institute for Communicable Diseases (NICD) established an electronic hospital-based surveillance system, DATCOV. Here we describe the implementation of the DATCOV surveillance system. We also describe key attributes of the system and its contribution to national COVID-19 surveillance in South Africa.

DESCRIPTION OF THE SYSTEM

Objectives and purpose of DATCOV

In response to the emergence of COVID-19 in South Africa, the NICD implemented an online platform, DATCOV. The platform allows public- and private-sector hospitals to submit data on hospital admissions for patients diagnosed with COVID-19. It is an active, prospective sentinel surveillance programme. The main aim of the programme is to monitor trends in COVID-19 admissions and describe the epidemiology of COVID-19 in hospitalised patients in South Africa, to enable appropriate allocation of resources to where they are most needed. DATCOV has specific clinical and programmatic objectives.

- The clinical objective is to describe the epidemiology of the outbreak, including the age, sex, race and comorbidity profile of patients who required hospital admission and developed severe disease. This can be used to inform policy decisions regarding targeted preventive and control measures
- in specific groups of the population, e.g. protection of high-risk elderly persons and back-to-school measures for children.
- The programmatic objective was to describe the distribution of hospital admissions between provinces and between the public- and private-health sectors; and to describe the nature of treatment, including treatment in intensive care units (ICU), requirements for supplemental oxygen and invasive ventilation. This can be used to inform healthcare managers at all levels in both health sectors, to anticipate resource demands and to plan for resource allocation.

While modelling information using international data has been useful in the early stages of the epidemic, the value of local data on hospitalisations, duration of admission, intensity of care required, and risk factors that predict mortality, are vital for further modelling the disease trajectory.

Health system context in South Africa

Given the context of the South African health system, there were some challenges that had to be addressed to establish DATCOV. South Africa has a dual health system with a publicly funded district health system, that serves roughly 84% of the population; and a private health system for those that can afford it and which is largely funded by private health insurance schemes.¹⁴

The private health sector is well-resourced and most private hospital groups have electronic health information systems that allow for patient management and billing.

The public health sector on the other hand lacks electronic health information systems for patient-level data in all provinces except the Western Cape Province, which operates a patient level electronic medical record system. The District Health Information System (DHIS) is used by the National Department of Health (NDoH) for aggregate reporting of caseloads from public sector clinics and hospitals. No system existed to capture patient-level details for COVID-19 hospital admissions.

At time of writing, there was no other national surveillance system in place that captured patient-level data and allowed for epidemiological and risk factor analysis of hospitalised COVID-19 cases.

Development of DATCOV

On 23 March 2020, in response to the growing numbers of COVID-19 cases in South Africa, a team was assembled by the NICD to establish an electronic sentinel hospital surveillance system. The team adapted the case reporting forms developed by the World Health Organization by reducing the number of data fields in the tool so as to reduce the burden on healthcare workers in submitting data. These shortened forms were automated on an existing platform created by ComUnity, a local software development company. The platform was tested internally and then went into production on 30 March 2020.

Implementing DATCOV

The first hospital to pilot DATCOV on 1 April 2020, was Tygerberg Hospital in the Western Cape Province. This facility was selected because of its long history as a surveillance site for the NICD and because it was one of the few public sector hospitals which already had a number of COVID-19 cases admitted at the time. Positive feedback was received regarding the ease of use and the short time required to submit data on patients hospitalised with COVID-19. Following

the successful pilot, the NICD developed a list of all designated public sector hospitals in each province (provided by the National Department of Health (NDoH)) and of all hospitals that had reported admissions of patients diagnosed with COVID-19 from the Notifiable Medical Conditions database. The DATCOV team contacted chief executive officers (CEOs), medical managers and infectious disease specialists in these hospitals by telephone and email, informed them about DATCOV, and invited them to participate in the surveillance system. Enrolling these hospitals relied on the positive proactive stance taken by the CEOs at these hospitals and their willingness to support the project, as well as long-standing relationships with infectious disease doctors at these hospitals and their understanding of the importance of collecting these data. Early sentinel sites that joined included Manguzi Hospital and Greys Hospital (KwaZulu-Natal Province), Tshepong Hospital (North West Province), Livingstone Hospital and Madwaleni Hospital (Eastern Cape Province), Robert Simangaliso Sobukwe Hospital (Northern Cape Province), Polokwane Hospital (Limpopo Province) and Pelonomi Hospital (Free State Province). Participation in the surveillance was voluntary. The Western Cape Province opted not to have hospitals utilise DATCOV for submitting data, but instead to export data to NICD from their electronic information system. This province's health department began sharing daily exports of all hospital admissions in the public sector on 20 April 2020.

The NICD also engaged with the private sector to share hospital admission data from their electronic health information systems. Prior to the establishment of DATCOV, each private hospital group was required to share line lists of hospitalised patients via email to all provinces and NDoH. There was however concern about data being shared by email, and the inefficiency in sharing data in this way. When the NICD engaged the private sector through the Hospital Association of South Africa (HASA), a mutual benefit was identified. Private hospital groups could share their data to one source daily, NICD would merge and clean this data, and then share it with the provincial and national departments of health. The benefit to NICD is that DATCOV would include all private hospital admissions. As a result, by 6 April, the major hospital groups (Netcare, Life Healthcare, Mediclinic Southern Africa, National Hospital Network (NHN), Clinix Health Group, Lenmed) which represent the majority of all private sector admissions nationally, began sharing line lists of all hospital admissions with COVID-19 to NICD. One additional group based in KZN, Joint Medical Holdings (JMH), joined in May. Additional private and public hospitals continue to join this surveillance system and when they do, they capture all admissions of COVID-19 cases, even those that occurred prior to them joining DATCOV.

Case definitions, patient enrolment and data collection

A COVID-19 case was defined as a person with a positive reverse transcriptase polymerase chain reaction (RT-PCR) assay for SARS-CoV-2 who was admitted to a DATCOV sentinel hospital. The DATCOV platform includes variables listed in Table 1.

Table 1. Variables collected on the DATCOV sentinel hospital surveillance system for COVID-19 cases in South Africa

Category	Variable
Demographic	Patient name, surname, ID number, date of birth, sex, race, pregnancy or within 6 weeks post-partum, occupation as a healthcare worker
Comorbidities	Hypertension, diabetes mellitus, chronic cardiac disease, chronic pulmonary disease, asthma, chronic renal disease, malignancy within past 5 years, HIV, current tuberculosis (TB), past TB, obesity
Complications	Acute respiratory distress syndrome (ARDS), acute renal failure, disseminated intravascular coagulation (DIC), shock
Treatment	Medicines (antivirals, antibiotics, antifungals, immunosuppressants, steroids, immunoglobulins), medical interventions (nasal canula oxygen, high-flow oxygen, prone ventilation, invasive ventilation, renal dialysis, extracorporeal membrane oxygenation)
Setting of care	General ward, high care, intensive care unit (ICU)
Outcomes	Discharge, transfer to higher level care or step-down facility, death

Database management

Data are submitted by public hospital users that have agreed to report COVID-19 admissions through the DATCOV online platform. These public sector sites therefore report on all data fields.

Data from the private sector and from the Western Cape Province public sector are submitted through a daily data export to NICD and imported into the DATCOV database. Owing to the complexities of extracting data on complications, treatment and medical interventions, these data are not supplied. This daily data export therefore contains limited information about each admission.

Once the data are merged, the NICD conducts quality checks that include:

- removing patients that are found to be COVID-19 negative when comparing with the laboratory master list of all COVID-19 cases
- removing duplicate entries
- adding missing data that is extracted from other sources

The other data sources that DATCOV uses to enrich the database are the Notifiable Medical Conditions (NMC) system and the Persons Under Investigation (PUI) databases. The NICD has also requested the private sector to provide billing information and ICD10 coding so that missing complication, treatment and intervention data can be extracted. This is still under discussion.

Data analysis and reporting

DATCOV produces a number of reports:

1. Daily provincial line list with a summary table: The database creates unique line lists for each province on Microsoft Excel. It includes details on all admissions in the public and private sectors as reported on DATCOV for each province. This file is shared with provincial and national managers once patient identifiers have been removed. If patient identifiers are required by the province, the file is shared with password encryption or through a secured shared folder.
2. Daily Microsoft Power business intelligence (BI) report: The database produces an automated PDF report that summarises all admissions to date including trends in admissions, disease severity and deaths. This is shared daily with all provincial and national department of health managers.
3. Weekly national update: Data are analysed for the previous epidemiological week and shared with NDoH, and the two forums created to lead the outbreak response: the Ministerial Advisory Committee (MAC) and Incident Management Team (IMT). This report provides a more detailed analysis and commentary of the hospital admissions, outcomes and associations with mortality.

These reports are used for public health action at many levels. The MAC and IMT use the data to inform modelling and guidelines on clinical and public health measures. Provinces use this data for reporting to NDoH and to inform their allocation of resources to hospitals with large numbers of admissions.

Ethical considerations

Disease surveillance is a critical function of the NICD as a statutory body in South Africa. The NICD has broad ethical approval for essential communicable diseases surveillance and outbreak response investigation activities from the Human Research Ethics Committee (Medical), University of the Witwatersrand (M160667). The committee has recently provided the NICD with specific approval for COVID-19 sentinel hospital surveillance under the same clearance certificate.

The amended regulations that accompany the declaration of a national disaster (Disaster Management Act 2002), provides for healthcare institutions to submit data to NICD on notifiable medical conditions, which includes COVID-19. This encompasses the submission of patient details, their treatment and outcomes.

All personal information concerning patients, their health status, treatment, or stay in a health establishment, are kept confidential. Patient information is coded to anonymise the data. All data are de-linked from patient identifiers. Reports utilise aggregated patient information, and no identifying patient information is included in reports or presentations of DATCOV data. The names of hospitals are also anonymised when reporting the findings of the review in a public forum. All data stored in DATCOV are only shared with individuals involved in the surveillance with password encryption.

ATTRIBUTES OF THE DATCOV SYSTEM

Representativeness of the DATCOV data

Figure 1 describes the cumulative increase in the numbers of hospitals reporting on DATCOV and the numbers of admissions reported to DATCOV.

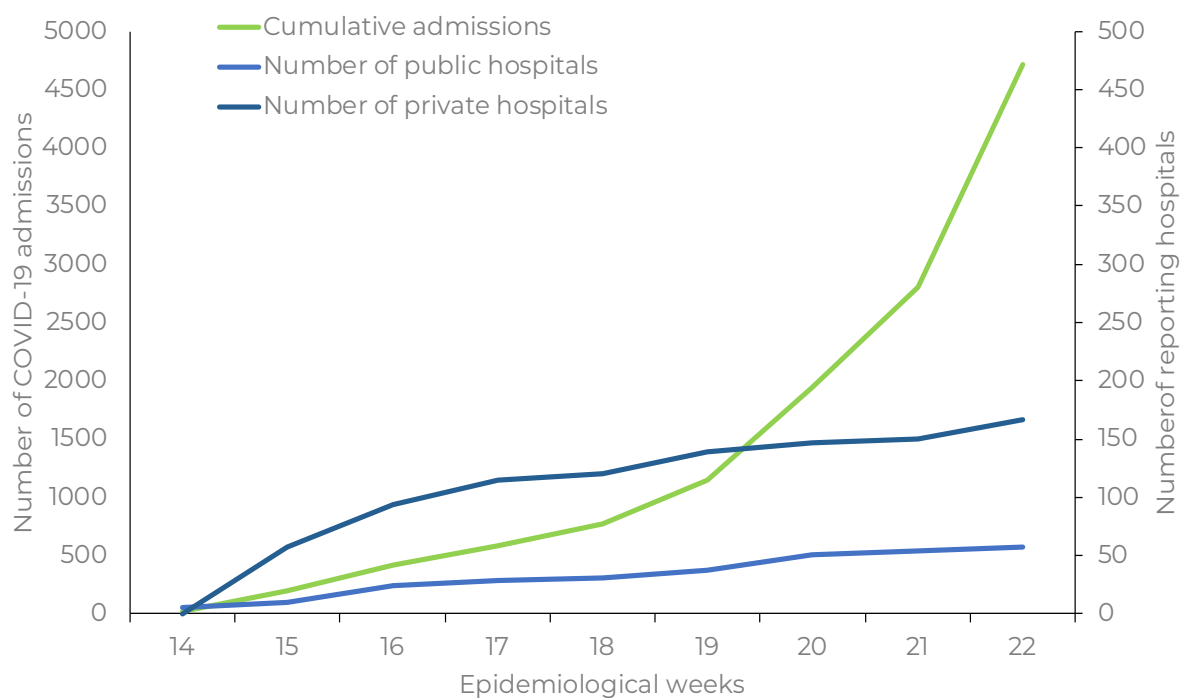
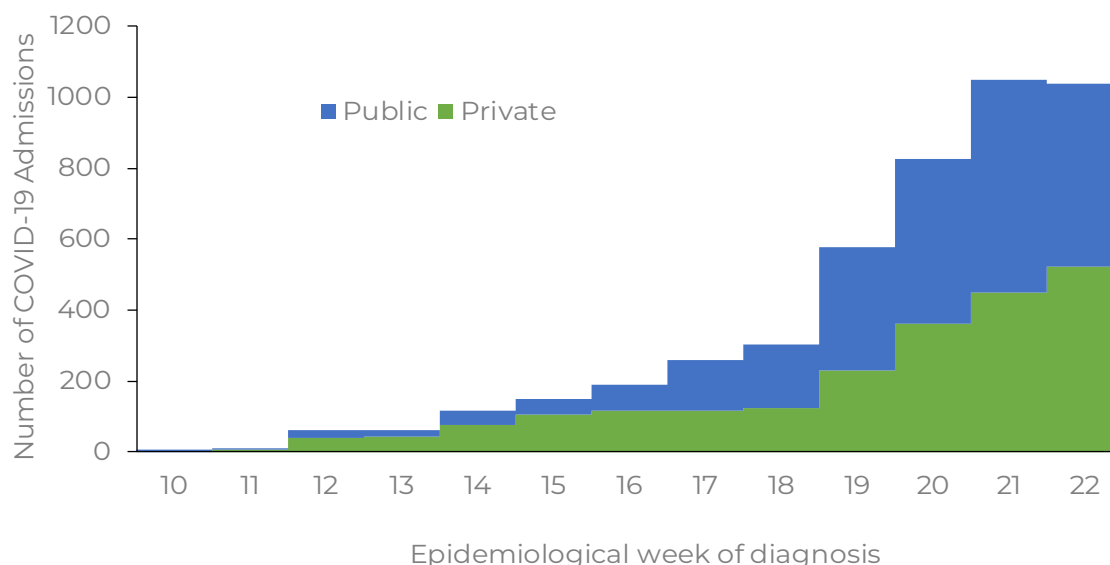


Figure 1. Cumulative numbers of reporting hospitals and COVID-19 admissions, South Africa, 5 March - 31 May 2020

Table 2. Number of hospitals reporting data on COVID-19 admissions by province and sector, South Africa, 5 March-31 May 2020

Name of province	Public Sector	Private Sector
Eastern Cape (EC)	5	11
Free State (FS)	3	6
Gauteng (GP)	3	61
KwaZulu-Natal (KZN)	4	32
Limpopo (LP)	1	4
North West (NW)	2	7
Northern Cape (NC)	1	5
Western Cape (WC)	38	31
Mpumalanga (MP)	0	4
South Africa	57	161

Between 5 March and 31 May, 4 718 COVID-19 admissions had been reported from 218 hospitals in all nine provinces of South Africa. Of these admissions, 2 267 (48.1%) and 2 451 (51.9%) were reported in the private and public sector, respectively. Most reported admissions were initially in the private sector, but as of week 16, an increasing proportion of total admissions was reported in the public sector (Figure 2).



By comparison with aggregate reports submitted by provinces to NDoH by 31 May 2020, DATCOV's coverage of all reported current admissions in hospital was 81.3%, with low coverage of admissions notable in Gauteng and KwaZulu-Natal provinces due to the small number of public sector hospitals in those provinces registered to use the online platform at that time.

Timeliness and completeness

With public sector hospitals using the online platform, there may be some delays in submitting patient data where large caseloads in the wards limit available time for the doctors to submit data. The private sector and Western Cape Province data exports reflect admissions that occurred until midnight on the day preceding the report. There are delays between testing and confirmation of COVID-19 results, which also delays the inclusion of patients on the line list each day.

Private sector and Western Cape Province public sector data exports include a limited number of fields resulting in incomplete information on treatment and complications. In the public sector, there is complete submission of all data fields because they are using the online platform (with the exception of Western Cape Province). NICD personnel continue to enrich the missing data using other databases or by contacting the hospitals to obtain the missing information.

Race and comorbid disease, two important variables for understanding risk factors for mortality, have not been well captured. Of the 4 718 admissions by 31 May 2020, there were 2 430 (51.5%) patients for whom race was unknown and 981 (20.8%) patients for whom comorbid disease information was not known.

Acceptability and usefulness of the DATCOV system

In the early weeks of implementation, the NDoH had intended to implement a new system to capture hospital admissions for COVID-19 in all public and private hospitals. DATCOV was therefore not sanctioned as the national information system for COVID-19 hospital admissions. However, NICD implemented it as a sentinel surveillance system in the interim to allow for the collection of data until the new national system was implemented. By the time of this report, the national system had not been implemented and DATCOV was the only system collecting patient-level data on hospitalised COVID-19 cases. DATCOV began reporting data into the NDoH data lake on 23 May 2020, and continues to fill an important gap in providing insight into COVID-19 disease and outcomes of hospitalised cases.

DATCOV flexibility and responsiveness

It was never the intention to create parallel data collection systems, and where possible NICD adapted to what the prevailing resources would permit. While DATCOV was conceptualised as an online platform for data entry, when it became apparent that groups with electronic health information systems could provide daily line lists, the system evolved to allow for these data imports.

DATCOV was conceptualised as a hospital surveillance system but it is being adapted for other purposes. Currently in development are three additional features or 'modules' that will soon be implemented:

1. Enhanced surveillance in long-term care facilities. It has been recognised that in other countries large outbreaks and significant mortality has occurred in care facilities for the elderly.^{15,16} NICD developed a module that allows for surveillance in long-term care facilities, to enable the identification of outbreaks and reporting of deaths that occur in these settings.
2. Focused data collection on patients treated in ICU. While the DATCOV tool was made brief to prevent busy healthcare workers from being distracted with data reporting activities during a surge of admissions, it is important to better understand and characterise patients who have severe disease. In collaboration with the Critical Care Society of South Africa, an ICU 'module' will soon be implemented that collects more detailed clinical and treatment parameters on patients treated in ICU.
3. Reporting of deaths outside of hospitals. : NICD is investigating the addition of functionality for provinces to report line lists for patients who die outside the hospital setting and who would not otherwise be captured on DATCOV surveillance.

The NICD is continuously learning about the need to enhance the data being collected. In particular, it has become more urgent to investigate admissions of HIV-infected individuals and severe disease in young individuals in greater depth. The DATCOV team has developed a data enhancement team that contacts hospitals to gain further information on these individuals, in order to better understand and contextualise the data reported in these groups.

Resources needed to implement DATCOV

While the South African government departments and national institutes were focused on identifying and reporting new cases in early March 2020, there was a growing awareness of the need for data on hospitalisation, but also an acute understanding that resources were scarce within NICD to do this. A team of five people was assembled to assist. The team consisted of volunteers, short-term NICD contracted staff and seconded staff from non-governmental organisations (NGOs) and private industry. Funding was made available through the Solidarity Fund and from the NICD budget to resource this team. This team was expanded with the addition of a seconded epidemiologist and three data clerks in May.

There are important lessons for how surveillance can rapidly be done in epidemic situations. Critical success factors were the people involved. There was bold, visionary leadership from senior NICD staff. This was complemented by a willingness to contribute by hospital doctors and managers, and hospital groups who understood the value of collecting these data. The implementation of the DATCOV system was in large part due to the positive attitude of the team that quickly adapted to the demands of this surveillance, and was also upskilled where required to be able to implement a robust surveillance system that produced quality reports in real time.

DISCUSSION AND CONCLUSION

The DATCOV sentinel surveillance system was established within one week and implemented within two months in over 200 hospitals in South Africa. It provides real-time data and produces summary reports daily, and detailed analysis weekly. The system has been continually enhanced and expanded in response to needs. While it began as a sentinel hospital surveillance system, it will soon also include a module on surveillance in long-term care facilities, and an enhanced data collection module for patients treated in ICU. DATCOV hospital surveillance is able to describe the trajectory of the epidemic in South Africa, and importantly identify and provide data for analysis of issues of local importance such as COVID-19 in HIV-infected individuals and those with tuberculosis, given South Africa's high dual burden of these diseases.

South Africa, as with other LMICs across the world, has limitations around health information systems. In the public sector, health data is paper-based and there is only aggregate reporting electronically to higher levels. It was therefore not possible for routine information systems to produce surveillance for COVID-19 as was done in other countries. For example, there are several retrospective analyses of clinical data for patients with COVID-19 admitted to hospitals in China, Italy, the United Kingdom and New York.^{6-8,17,18} It is not possible for LMIC countries to easily reproduce similar analyses of clinical characteristics and outcomes of hospitalised COVID-19 patients without pre-existing, well-established electronic health information and dedicated surveillance systems. Here we demonstrate how a LMIC can establish a system to rapidly collect data even in the absence of alternatives.

LIMITATIONS

DATCOV is a sentinel surveillance system and does not include all hospitals with COVID-19 admissions and therefore may not be truly representative of hospital admissions for COVID-19 throughout South Africa. However, on comparison with the aggregate data on hospital admissions communicated by provinces to the NDoH, NICD was able to ascertain that DATCOV covered at least 81% of all hospital admissions at the time of this report.

DATCOV only reports hospital-based admissions and deaths and therefore does not include deaths occurring outside hospitals. The NICD is currently exploring how its system could be used by provinces to record these deaths.

Data quality in a surveillance system is dependent on the information submitted by healthcare institutions. It is not possible for the NICD to verify or check the quality of all these data. However, the NICD has built-in data quality checks and is considering sampling a subset of records for verification of submitted data compared to the original medical records.

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