The prevalence of SARS-CoV-2 infection in an Academic Department of Anaesthesiology

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

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Declaration

I, Bhavin Daya, declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

03 October 2022

Abstract

Background

Anaesthetists are frontline workers who perform aerosol-generating procedures (AGPs) in enclosed environments which exposes them to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and increases their risk of contracting SARS-CoV-2 infection and Coronavirus disease 2019 (COVID-19). This study describes the prevalence of SARS-CoV-2 infection in the Academic Department of Anaesthesiology of the University of the Witwatersrand prior to vaccination.

Methods

A cross-sectional, contextual, descriptive research design, using an anonymous, electronic questionnaire, was followed in the study. Consecutive and convenience sampling methods were used. A p-value of <0.05 was considered statistically significant. Descriptive statistics and linear correlations using R 4.0.2 for Windows 1989, 1991 Free Software Foundation, Inc with interface R Studio Version 1.3.959 were used for data analysis.

Results

A total of 147 participants met the inclusion criteria. There were 90 (61.22%) females and 57 (38.78%) males. The mean age was 35.26 years for the 36 participants who tested positive (26.47%) for SARS-CoV-2. Hospital admission was required by 2.78% participants with COVID-19. Male participants had a higher prevalence of having SARS-CoV-2 infection ($p = 0.045$). There were no statistically significant associations between SARS-CoV-2 infection and pregnancy ($p = 0.09$), asthma ($p = 0.11$), autoimmune disease ($p = 0.77$), obesity ($p = 0.9$), diabetes ($p = 0.96$), hypertension ($p = 0.9$) and smoking ($p = 0.69$). Commonly reported COVID-19-like symptoms included fatigue (68.33%), headaches (61.67%) and myalgia (58.33%). Of the participants with a positive SARS-CoV-2 test, 38.46% had reported traveling within 14 days of testing positive ($p <0.001$).

Community-exposure to a person with SARS-CoV-2 was associated with participants contracting SARS-CoV-2 infection ($p = 0.001$).

Conclusion

AGPs are not a significant risk factor for anaesthetists in the context of work or community transmission of the virus. There was a statistically significant predisposition for contracting SARS-CoV-2 infection among males, participants who travelled and participants who had community-exposure to a SARS-CoV-2 infected person. HCWs need to be protected through this pandemic and measures need to be institutionalised to maintain the functioning of the healthcare system.

Acknowledgements

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Abbreviations

AGPs: Aerosol-generating procedures

BiPAP: bilevel positive airway pressure

COVID-19: Coronavirus Disease 2019

CPAP: continuous positive airway pressure

HCWs: Healthcare workers

PPE: Personal protective equipment

PUI: Person under investigation

SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2

Wits: University of the Witwatersrand

Statement

The Research Report consists of a literature review, draft article, study proposal and appendices. The study proposal is included for background reference and is not for examination.

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the rest of the Research Report to comply with the author guidelines of the Southern African Journal of Anaesthesia and Analgesia (SAJAA), the journal to which it is intended to be submitted.

Section 1: Review of the literature

1.1 Introduction

On 31 December 2019 the World Health Organization (WHO) was notified of a cluster of viral pneumonias of unknown aetiology, now known to be Coronavirus disease 2019 (COVID-19). COVID-19 is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a novel coronavirus strain (1). This followed a report of atypical pneumonias in the city of Wuhan, China (1). A global pandemic was declared on 11 March 2020, where over 114 countries had reported cases of COVID-19 (1). By 5 June 2022, there had been over 532 million confirmed cases and over 6 million deaths due to COVID-19 (2,3).

COVID-19 was first detected in South Africa on 5 March 2020 and has spread rapidly throughout the country (4). By 5 June 2022, South Africa had experienced over 3.9 million confirmed cases of COVID-19, more than 101 000 deaths, and over 3.8 million recoveries – a 96.7% recovery rate (5). South Africa ranked 29th in the world in terms of total number of confirmed cases as of 5 June 2022 (2). There have been five waves in South Africa as of 5 June 2022, with the peaks of the respective waves occurring in July 2020, January 2021, July 2021, December 2021 and May 2022 (5).

COVID-19 is epidemiologically related to transmission from animals to humans, and subsequently humans-to-humans (6–9). The incubation period of SARS-CoV-2 is reported to be four to seven days (6). The reproductive number is estimated to be 2.2 from a study done by Li et al. (8). Within the initial days of being infected, viral shedding and transmission occurs (8). However, symptomatic patients are thought to be infectious from two to three days prior to symptom onset, to 14 days after symptom onset (4). The SARS-CoV-2 virus is spread by aerosolization of respiratory secretions, through contact, droplet, or airborne routes (4). Transmission risk is dependent on proximity and duration of contact to a patient with COVID-19 (10). A study by Nishiura et al. (11) estimates an 18.7–fold higher risk of transmission indoors than outdoors. Public transportation and hospitals,

where patient-staff, staff-staff, and staff-patient transmission may occur, are considered high-risk environments (10).

The ‘risk from SARS-CoV-2 infection can be broken down into four types’ (10):

- Infection with SARS-CoV-2 due to environmental factors
- Infection with SARS-CoV-2 due to individual factors
- Hospitalisation or critical illness from COVID-19
- Death from critical illness due to COVID-19

A person under investigation (PUI) is any person with acute signs (less than 14 days), symptoms, or critical illness compatible with SARS-CoV-2 infection; or an asymptomatic person who has had close contact with a confirmed SARS-CoV-2 positive patient (4). A close contact is considered as either face-to-face contact (less than one metre), or being in an enclosed environment with a SARS-CoV-2 positive patient for a minimum of 15 minutes, without appropriate personal protective equipment (PPE) being donned (4). Current South African guidelines, as of 23 February 2022, stipulate that close contacts do not need to quarantine (12). COVID-19 infection is considered a confirmed case once laboratory testing has reported a positive SARS-CoV-2 result, regardless of patient symptomatology (4). Asymptomatic patients do not need to isolate, while those with mild symptoms only need to isolate for seven days from date of symptoms onset (12). Patients with severe symptoms need to isolate for seven days from the date that they no longer require oxygen therapy (12).

The following factors have individually been shown to increase the risk, and severity, of SARS-CoV-2 infection: older age, male sex, hypertension, diabetes, immunosuppression, chronic respiratory, cardiac, or kidney disease (17–20). Liver disease and obesity were also found to be risk factors (20). A population cohort study conducted by the Western Cape Department of Health in South Africa found that patients who had a higher risk of severe disease and mortality were associated with male sex, HIV, hypertension, diabetes, tuberculosis, and chronic kidney disease (21). Mortality may be multifactorial in nature as socioeconomic status may influence occupation, use of public transport, multigenerational housing, and overcrowding (10,16). A study by International Severe Acute

Respiratory and emerging Infection Consortium (ISARIC) found that 21-24% of non-Caucasian patients required intensive care admission when compared to Caucasian patients, where 13% required admission (22). The average case-fatality rate (CFR) among 44 672 patients in China was 2.3% (17). The CFR was higher in certain categories: 5.6% in patients with cancer, 6% in patients with hypertension, 6.3% in chronic respiratory disease patients, 7.3% in diabetic patients, 8% in those aged 70-79 years old, 10.5% in patients with cardiovascular disease, and 14.8% in those 80 years and older (17).

COVID-19 can manifest as a spectrum of clinical signs and symptoms (4). While some patients may be asymptomatic, others experience severe respiratory failure and fatal sequelae (4). Symptoms may last from a few days up to months post infection. El-Boghdadly et al. (13) have described that out of 184 participants, 111 (60%) experienced fatigue, 102 (55%) had a cough, 100 (54%) had a sore throat and 35 (19%) had shortness of breath at a mean follow up of 32 days. A cohort study by Huang et al. (14) comprising 1 733 patients, has shown that at six months post discharge from hospital, fatigue or muscle weakness (63%), sleep difficulties (26%) and anxiety or depression (23%) were the most common symptoms experienced. Seventy six percent of these patients experienced at least one symptom after six months (14). In this study, females, as well as those who experienced severe disease, were noted to have a higher risk for persistent psychological symptoms (14). A study conducted by Xiong et al. (15), which followed up on 538 patients at three months post discharge from hospital, showed that fatigue, post activity tachypnoea, and alopecia were more common in women than in men. The study also described that 49.6% of patients experienced at least one symptom at the three months follow up (15).

A cohort study of 105 healthcare workers (HCWs) conducted in New York City by Morcuende et al. (16) found that 61 (58%) of participants had a work-related exposure of which 16 (26.2%), comprising anaesthetists and intensive care providers, had symptoms. The most frequently reported symptoms from this cohort study were myalgia, fever, sore throat, and diarrhoea (16).

SARS-CoV-2 is transmitted through droplets (6). HCWs, particularly those who perform aerosol-generating procedures (AGPs), have a higher risk of exposure for

contracting COVID-19 (16,23). AGPs include tracheal intubation and extubation, tracheal suction, bronchoscopy, cardiopulmonary resuscitation, high-flow nasal cannula, continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP), and disconnecting from mechanical ventilators (6,24). Anaesthetists fall into this high-risk group of HCWs who perform AGPs daily in enclosed environments (10).

The American Society of Regional Anaesthesia and Pain Medicine (ASRA) and the European Society of Regional Anaesthesia and Pain Therapy (ESRA) have recommended that, wherever feasible, regional techniques should be conducted over general anaesthesia to avoid AGPs (25). The intubateCOVID registry, used in a study by El-Boghdadly et al. (13), reported that 184 (10.7%) of the participants that partook in tracheal intubations either developed COVID-19-like symptoms or tested positive for SARS-CoV-2 over a mean follow period of 32 days. In contrast, a study by Morcuende et al. (16), which surveyed anaesthetists and intensive care providers, suggested that community exposure, as opposed to work-related exposure, contributed to SARS-CoV-2 infection. The study also found that anaesthetists who donned PPE appropriately and who were prepared for managing SARS-CoV-2 were not at risk for severe COVID-19 (16).

While procedures performed by anaesthetists may be considered high-risk exposure, areas within a hospital may be high-risk exposure areas too. These include, but are not limited to, areas with high foot traffic, enclosed areas, areas where infection control precautions are inadequate, or areas where AGPs are performed, such as operating rooms (10). The proximity and duration of contact of HCWs in these environments puts them at high risk of exposure to SARS-CoV-2. Furthermore, not only are HCWs exposed to these environments, and to patients admitted with COVID-19, they are also exposed to asymptomatic colleagues in the workspace (10). A study conducted by Treibel et al. (26) screened 400 HCWs for SARS-CoV-2 using nasal swabs. Forty-four HCWs tested positive, of which 12 (27%) were asymptomatic. A report by Chinese Centre for Disease Control of 72 314 case records (17) showed that 3.8% of individuals infected with SARS-CoV-2 were HCWs. England reported a four to six-fold higher infection rate in HCWs when compared to non-HCWs (27).

An Oxford University study of 9 809 hospital staff reported that 11% had COVID-19 infection, with the most likely sources of infection being hospitals and household contacts with COVID-19 (28). The study also found that there was an increased risk among the African (17.1%) and Asian (16.9%) staff members of contracting COVID-19 when compared to Caucasian (9.3%) staff members (28). A study conducted by Sikkema et al. (29) screened 1 796 HCWs for SARS-CoV-2 and found 96 (5%) to be positive. Twenty of these staff members did not have contact with COVID-19 patients. However, six of them had contact with staff members who tested positive for SARS-CoV-2. Genome sequencing was conducted on 50 of these 96 HCWs. Results showed that infections were community-acquired, as opposed to hospital-acquired (29).

PPE has been employed as the primary step in reducing the risk of contracting the virus. PPE is designed to protect HCWs from accidents and illnesses that occur daily during work (24). Appropriate PPE includes N95 masks (or equivalent e.g. FFP 2 mask), goggles, visors, caps, gowns, gloves, and overshoes depending on the given situation (4,6,30). Other measures that need to be considered while in theatre include using disposable materials, plastic covers for anaesthetic monitors and equipment, and disinfecting theatre after the end of the procedure (6). Anaesthetic filters, respiratory circuits, and soda lime should be discarded as well (6). Actions that should be implemented, along with the wearing of PPE, to reduce risk of infection include reducing duration of contact with a person under investigation (PUI) or confirmed COVID-19 patient, social distancing and isolating and quarantining those who are infected or PUIs, respectively (4).

Since the first mass rollout of vaccines in December 2020, there have been over 11 billion vaccine doses administered globally (3). Vaccines for SARS-CoV-2 were developed to reduce severe disease, hospitalisation and death from COVID-19 (31); however, immunity from vaccines varies from person to person, as does the immunity developed from COVID-19 (31). A challenge faced by scientists in developing an effective vaccine has been mutations in SARS-CoV-2 leading to various variants of the virus, with some being more virulent than others (31). As of 12 January 2022, there are nine vaccines approved by the WHO Emergency Use Listing (30). The vaccination program in South Africa against SARS-CoV-2 began

in February 2021, with of over 36 million vaccine doses administered as of 5 June 2022 (5). The Sisonke trial, which administered the Johnson and Johnson vaccine to HCWs across South Africa, found that after one vaccine, 1% of patients had a breakthrough SARS-CoV-2 infection, with 94% of infections being mild, 4% moderate and 2% severe (32). Discovery, a private healthcare medical aid, found that of 1100 members who were hospitalised for COVID-19 treatment, 96% were unvaccinated, while 99% of ventilated patients were also unvaccinated (33). The Centers for Disease Control and Prevention (CDC) reported that fully vaccinated adults of 65 years old and older had a 94% reduction in risk of hospitalisation from SARS-Cov-2 infection (34).

The impact of COVID-19 on anaesthetists has been multifactorial. For example, training programs have been disrupted thus impairing learning (33). Shortages of PPE, postponed examinations, and high-risk exposure to patients, colleagues, or family members have created anxiety and affected the mental health and well-being of anaesthetists (35).

SARS-CoV-2 infection is a complex disease process that is still under investigation. While there are many ongoing research investigations into the disease progression and management, one study, conducted by Morcuende et al. (16), looked at the prevalence and symptoms of SARS-CoV-2 infection in anaesthetists and intensive care workers – the study found that 61 (58%) respondents had work-related exposures to SARS-CoV-2, while only 16 (26%) of these respondents developed symptoms. Costa et al. (36), found that anaesthetists in Brazil had a 5.57 times higher (14.7%) prevalence of SARS-CoV-2 infection than the general population.

1.2 Summary

The COVID-19 global pandemic has rapidly spread across the world. HCWs are exposed to this virus daily. Anaesthetists are frontline workers who perform AGPs in enclosed environments which exposes them to SARS-CoV-2 and increases their risk of contracting SARS-CoV-2 infection. While signs, symptoms and severity may vary from person to person, there is a paucity of data relating to the characteristics of anaesthetists with SARS-CoV-2 infection due to variable host immune response and underlying comorbidities (36). These characteristics may influence the severity of SARS-CoV-2 infection and COVID-19, and identification of risk factors are essential to mitigate severe disease by implementing protective strategies for at-risk HCWs (36). This study describes the prevalence of SARS-CoV-2 infection in the Academic Department of Anaesthesiology of the University of the Witwatersrand (Wits) prior to vaccination.

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Section 2: Author's guidelines

Southern African Journal of Anaesthesia and Analgesia (SAJAA)

Author Guidelines

Submitted manuscripts that are not in the correct format and without the required supporting documentation specified in these guidelines will be returned to the author(s) for correction and will delay publication.

AUTHORSHIP

Named authors must consent to publication **by signing a covering letter** which should be submitted as a supplementary file. Authorship should be based on substantial contribution to:

(i) conception, design, analysis and interpretation of data;

(ii) drafting or critical revision for important intellectual content; and

(iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to **www.icmje.org**); and

(iv) exact contribution of each author must be stated.

DECLARATION OF CONFLICT OF INTEREST

Authors must declare all sources of support for the research and any association with a product or subject that may constitute a conflict of interest. If there is no conflict of interest to declare please include the following statement: The authors declare no conflict of interest.

FUNDING SOURCE

All sources of funding should be declared. Also define the involvement of study sponsors in the study design, collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication. If

the study sponsors had no such involvement, this should be stated as follows: No funding source to be declared.

RESEARCH ETHICS COMMITTEE APPROVAL

The submitting author must provide written confirmation of Research Ethics Committee approval for all studies including case reports. The ethics committee as well as the approval number should be included.

STATISTICAL ANALYSIS

Authors are advised to involve medical statisticians at the protocol stage of their research project: to plan sample size, and the selection of appropriate statistical tests for analysis and presentation.

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Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. The patient should be shown the manuscript to be published. Refer to **www.icmje.org**.

ETHNIC CLASSIFICATION

The rationale for analysis based on racio-ethnic-cultural categorisation should be indicated.

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Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Original articles

Original articles on research relevant to anaesthesia and analgesia should not exceed 3 200 words, no more than 30 references, with up to 6 tables or figures. A structured abstract under the following headings, Background, Methods, Results, and Conclusions is a requirement and should not exceed 300 words.

Clinical Review articles

Review articles relevant to anaesthesia and analgesia should not exceed 2 400 words, with a maximum of 20 references and no more than 6 tables or figures. A summary of 300 words or less is required.

Case reports

Case reports should not exceed 1 800 words with no more than 10 references. Figures are limited to 2 figures and may include images or photographs. The case report should have three headings: Summary (not exceeding 100 words), Case report (with no introduction) and Discussion. Case reports will be published online only. The summary and the URL will appear in the printed version.

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Letters to the editor should be 800 words or less with only one image or table.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - **www.icmje.org**. Manuscripts must be provided in **UK English**.

Qualification, affiliation and contact details

This information must be provided for ALL authors and must be submitted as a supplementary file.

Email addresses of all authors must be provided.

ORCID number of **ALL** authors must be provided - if authors do not have ORCID, please register at https://orcid.org/

Abbreviations

All abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

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Section 3: Draft article

The prevalence of SARS-CoV-2 infection in an Academic Department of Anaesthesiology

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Key words: SARS-CoV-2, COVID-19, anaesthetists, healthcare workers

Abstract

Background

Anaesthetists are frontline workers who perform aerosol-generating procedures (AGPs) in enclosed environments which exposes them to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and increases their risk of contracting SARS-CoV-2 infection and Coronavirus disease 2019 (COVID-19). This study describes the prevalence of SARS-CoV-2 infection in the Academic Department of Anaesthesiology of the University of the Witwatersrand prior to vaccination.

Methods

A cross-sectional, contextual, descriptive research design, using an anonymous, electronic questionnaire, was followed in the study. Consecutive and convenience sampling methods were used. A p-value of <0.05 was considered statistically significant. Descriptive statistics and linear correlations using R 4.0.2 for Windows 1989, 1991 Free Software Foundation, Inc with interface R Studio Version 1.3.959 were used for data analysis.

Results

A total of 147 participants met the inclusion criteria. There were 90 (61.22%) females and 57 (38.78%) males. The mean age was 35.26 years for the 36 participants who tested positive (26.47%) for SARS-CoV-2. Hospital admission was required by 2.78% participants with COVID-19. Male participants had a higher prevalence of having SARS-CoV-2 infection ($p = 0.045$). There were no statistically significant associations between SARS-CoV-2 infection and pregnancy ($p = 0.09$), asthma ($p = 0.11$), autoimmune disease ($p = 0.77$), obesity ($p = 0.9$), diabetes ($p = 0.96$), hypertension ($p = 0.9$) and smoking ($p = 0.69$). Commonly reported COVID-19-like symptoms included fatigue (68.33%), headaches (61.67%) and myalgia (58.33%). Of the participants with a positive SARS-CoV-2 test, 38.46% had reported traveling within 14 days of testing positive ($p <0.001$). Community-exposure to a person with SARS-CoV-2 was associated with participants contracting SARS-CoV-2 infection ($p = 0.001$).

Conclusion

AGPs are not a significant risk factor for anaesthetists in the context of work or community transmission of the virus. There was a statistically significant predisposition for contracting SARS-CoV-2 infection among males, participants who travelled and participants who had community-exposure to a SARS-CoV-2 infected person. HCWs need to be protected through this pandemic and measures need to be institutionalised to maintain the functioning of the healthcare system.

Introduction

On 31 December 2019 the World Health Organization (WHO) was notified of a cluster of viral pneumonias of unknown aetiology, now known to be Coronavirus disease 2019 (COVID-19). COVID-19 is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a novel coronavirus strain.[1] This followed a report of atypical pneumonias in the city of Wuhan, China.[1] A global pandemic was declared on 11 March 2020, where over 114 countries had reported cases of COVID-19.[1] By 5 June 2022, there had been over 532 million confirmed cases and over 6 million deaths due to COVID-19.[2,3]

COVID-19 was first detected in South Africa on 5 March 2020 and has spread rapidly throughout the country.[4] By 5 June 2022, South Africa had experienced over 3.9 million confirmed cases of COVID-19, more than 101 000 deaths, and over 3.8 million recoveries – a 96.7% recovery rate.[5] South Africa ranked 29th in the world in terms of total number of confirmed cases as of 5 June 2022.[2] There have been five waves in South Africa as of 5 June 2022, with the peaks of the respective waves occurring in July 2020, January 2021, July 2021, December 2021 and May 2022.[5] The vaccination programme in South Africa against SARS-CoV-2 began in February 2021, with over 36 million vaccine doses administered as of 5 June 2022.[5]

SARS-CoV-2 is highly contagious and transmitted through droplets.[6-7] Healthcare workers (HCWs) are exposed to this virus daily. Anaesthetists are frontline workers who perform aerosol-generating procedures (AGPs) in enclosed environments which exposes them to SARS-CoV-2 and increases their risk of contracting SARS-CoV-2 infection. While signs, symptoms and severity may vary from person to person due to variable host immune response and underlying comorbidities,[7] there is a paucity of data relating to the characteristics of anaesthetists with SARS-CoV-2 infection. These characteristics may influence the severity of SARS-CoV-2 infection and COVID-19, and identification of risk factors are essential to mitigate severe disease by implementing protective strategies for at-risk HCWs.[7]

This study will describe the prevalence of SARS-CoV-2 infection in the Academic Department of Anaesthesiology of the University of the Witwatersrand (Wits) prior to vaccination. The primary objectives of the study included: determining the prevalence of SARS-CoV-2 infection among anaesthetists between March 2020 and January 2021;

describing the characteristics of anaesthetists with SARS-CoV-2 infection; and describing the risk factors for SARS-CoV-2. Secondary objectives included describing the COVID-19 symptoms experienced; determining the severity of SARS-CoV-2 infection; and determining the most likely environmental source of SARS-CoV-2 infection as to whether it was community or work-related exposure.

Methods

A cross-sectional, contextual, descriptive research design, using an anonymous, electronic questionnaire, was followed in the study. This study was submitted to the Human Research Ethics Committee (Medical), the Graduate Studies Committee, the Wits University Deputy Registrar, as well as other relevant authorities for approval. This study was conducted according to the principles of the Declaration of Helsinki[8] and the South African Guidelines for Good Clinical Practice.[9]

The study population consisted of anaesthetists working in the Department of Anaesthesiology of Wits. Consecutive and convenience sampling was used. The questionnaire was electronically distributed, monthly, to a total of 239 staff members via Google Forms® between June 2021 and September 2021. Completion of the questionnaire was regarded as implied consent. The inclusion criterion for the study was anaesthetists in the Department of Anaesthesiology of Wits who consented to participate in the study. Exclusion criteria included anaesthetist refusal to complete the form and junior doctors, such as interns or community service doctors, in the department. Questionnaires with multiple incomplete sections were excluded from the analysis.

There were 151 questionnaires completed of which 147 questionnaires fulfilled the inclusion criteria. As the analysis was descriptive and exploratory in nature, a formal sample size was not necessary; however, a response rate of 60% was considered acceptable. The actual response rate was 63.18%. Data was collected without identifying information and only the researcher and supervisors had access to raw data.

The questionnaire comprised four sections: 1. Demographics and medical history; 2. Development and duration of COVID-19-like symptoms and COVID-19 testing; 3. Community exposure to COVID-19; and 4. Work-related exposure to COVID-19. Variables studied included the following: age, sex, ethnicity, professional rank,

comorbidities, smoking history, COVID-19-like symptoms, SARS-CoV-2 infection, hospitalisation, travel history, community-related exposure, work-related exposure (AGPs, personal protective equipment (PPE) training and use, person under investigation (PUI) and/or SARS-CoV-2 infected patient management).

The captured data was divided into categorical and continuous variables. Categorical variables were summarised using count (%) and compared using chi-squared tests. Continuous variables were summarised using the mean (standard deviation) or median (interquartile range) and were compared using Student's t-tests. A p-value of <0.05 was considered statistically significant. The statistical software used for analysis of the data was R 4.0.2 for Windows 1989, 1991 Free Software Foundation, Inc with interface R Studio Version 1.3.959.

Results

There were 147 (97.35%) participants that met the inclusion criteria. Four participants were excluded due to incomplete questionnaires. There were 90 (61.22%) females and 57 (38.78%) males. The mean age was 36.15 years (range: 27-66). The participants consisted of 75 (51.02%) registrars, 35 (23.81%) specialist anaesthetists, 31 (21.09%) medical officers and 6 (4.08%) career medical officers. The demographic data is depicted in Table 1.

Out of the 147 participants, 11 had never tested for SARS-CoV-2. The characteristics of participants were compared between those who tested positive and negative for SARS-CoV-2 (Table 2). Of the 136 participants that did test for SARS-CoV-2, 36 (26.47%) participants tested positive. The average age of those who tested positive for SARS-CoV-2 was 35.26 years. The 36 participants comprised of 17 (20%) female and 19 (37.25%) male participants. Of these 36 participants, 34 participants were symptomatic. The study found that being male was statistically significantly associated with having SARS-CoV-2 infection ($p = 0.045$). There was 1 (2.78%) participant who had tested positive for SARS-CoV-2 who required hospital admission to manage COVID-19. No participants reported reinfection for the study period.

The study found that pregnancy ($p = 0.09$), asthmatics ($p = 0.11$), autoimmune disease ($p = 0.77$), obesity ($p = 0.9$), diabetes ($p = 0.96$), hypertension ($p = 0.9$) and smoking ($p = 0.69$) were not statistically significantly associated with SARS-CoV-2 infection.

Table 1: Demographic Data

Characteristic	Total (n = 147)
Age, mean ± SD (years)	36.15 ± 7.70
Sex, n (%)	
Female	90 (61.22)
Male	57 (38.78)
Ethnicity, n (%)	
Asian	28 (19.05)
African	42 (28.57)
Caucasian	73 (49.66)
Other	4 (2.72)
Rank, n (%)	
Career medical officer	6 (4.08)
Medical officer	31 (21.09)
Registrar	75 (51.02)
Specialist anaesthetist	35 (23.81)
Smoker, n (%)	
Yes	11 (7.48)
No	136 (92.52)
Comorbidities, n (%)	
None	102 (69.39)
1	39 (26.53)
>1	6 (4.08)
Comorbidities, n (%)	
Asthma	18 (12.24)
Autoimmune disease	11 (7.48)
Obesity	11 (7.48)
Hypertension	5 (3.40)
Pregnancy	4 (2.72)
Diabetes	3 (2.04)
SD: Standard Deviation	

Table 2: Associations

	SARS-CoV-2 positive (n=36)	SARS-CoV-2 negative (n=100)	p-value
Sex, n (%)			
Female	17 (20)	68 (80)	
Male	19 (37.25)	32 (62.75)	0.045
Ethnicity, n (%)			
Asian	8 (34.78)	15 (65.22)	
Black	13 (31.71)	28 (68.29)	
Other	1 (25)	3 (75)	
White	14 (20.59)	54 (79.41)	0.46
Rank, n (%)			
Career medical officer	2 (33.33)	4 (66.67)	
Medical officer	9 (32.14)	19 (67.86)	
Registrar	20 (28.17)	51 (71.83)	
Specialist anaesthetist	5 (16.13)	26 (83.87)	0.49
Comorbidities, n (%)			
None	27 (29.35)	65 (70.65)	
1	7 (17.95)	32 (82.05)	
≥2	2 (40)	3 (60)	0.31
Pregnancy, n (%)			
Yes	3 (75)	1 (25)	
No	33 (25)	99 (75)	0.09
Asthma, n (%)			
Yes	2 (11.11)	16 (88.89)	
No	34 (28.81)	84 (71.19)	0.11
Autoimmune Disease, n (%)			
Yes	2 (18.18)	9 (81.82)	
No	34 (27.20)	91 (72.80)	0.77
Obesity, n (%)			
Yes	3 (30)	7 (70)	
No	33 (26.19)	93 (73.81)	0.9
Diabetes, n (%)			
Yes	0 (0)	2 (100)	
No	36 (26.87)	98 (73.13)	0.96
Hypertension, n (%)			
Yes	1 (25)	3 (75)	
No	35 (26.52)	97 (73.48)	0.9
Smoker, n (%)			
Yes	3 (27.27)	8 (72.73)	
No	33 (26.40)	92 (73.60)	0.69

The participants reported testing positive for SARS-CoV-2 in the following months: May 2020 (3), June 2020 (8), July 2020 (9), November 2020 (1), December 2020 (7) and January 2021 (8).

There were 60 participants (40.81%) who had symptoms of COVID-19; however, only 34 (56.67%) of these participants tested positive for SARS-CoV-2, while 26 participants (43.37%) tested negative for SARS-CoV-2 at the time of symptoms. The commonest reported symptoms included fatigue (68.33%), headaches (61.67%) and myalgia (58.33%). Refer to Table 3 for a full list of symptoms reported.

Table 3: Symptoms

Symptom	**Participants (n=60)**	
	Yes	**No**
Fatigue, n (%)	41 (68.33)	19 (31.67)
Headaches, n (%)	37 (61.67)	23 (38.33)
Myalgia, n (%)	35 (58.33)	25 (41.67)
Cough, n (%)	33 (55)	27 (45)
Sore Throat, n (%)	29 (48.33)	31 (51.67)
Fever, n (%)	26 (43.33)	34 (56.67)
Chills, n (%)	25 (41.67)	35 (58.33)
Shortness of Breath, n (%)	18 (30)	42 (70)
Anosmia, n (%)	16 (26.67)	44 (73.33)
Dysgeusia, n (%)	12 (20)	48 (80)

The characteristics of participants who had reported a community-related exposure were compared between those who tested positive and negative for SARS-CoV-2 (Table 4). There were 5 (38.46%) participants that tested positive for SARS-CoV-2 that had travelled, either locally or internationally, within 14 days of onset of symptoms, which was statistically significant ($p < 0.001$). Our study found 9 (22.50%) participants who contracted SARS-CoV-2 infection after a community-exposure to a person with SARS-CoV-2 which was statistically significant ($p = 0.001$).

Table 4: Community-related exposure

	SARS-CoV-2 positive	SARS-CoV-2 negative	p-value
Travel, n (%)			
Yes	5 (38.46)	8 (61.54)	
No	8 (7.69)	96 (92.31)	<0.001
Public transport, n (%)			
Yes	3 (7.14)	39 (92.86)	
No	10 (9.52)	95 (90.48)	0.89
PPE use, n (%)			
Yes	9 (11.25)	71 (88.75)	
No	2 (9.52)	19 (90.48)	0.42
Contact with known SARS-CoV-2 positive person, n (%)			
Yes	9 (22.50)	31 (77.50)	
No	4 (3.74)	103 (97.26)	0.001

The characteristics of participants who had reported a work-related exposure were compared between those who tested positive and negative for SARS-CoV-2 (Table 5). However, there is not enough evidence of a statistically significant association between work-related exposure and contracting SARS-CoV-2 infection.

Table 5: Work-related exposure

	SARS-CoV-2 positive	SARS-CoV-2 negative	p-value
AGP involvement, n (%)			
Yes	23 (16.08)	120 (83.92)	
No	0 (0)	4 (100)	0.86
Appropriate PPE not used during AGPs, n (%)			
Yes	9 (14.75)	52 (85.25)	
No	14 (17.28)	67 (82.72)	0.57
Trained to don and doff PPE, n (%)			
Yes	22 (15.71)	118 (84.29)	
No	1 (14.29)	6 (85.71)	0.9
Practice correct donning and doffing, n (%)			
Yes	16 (15.09)	90 (84.91)	
No	7 (17.07)	34 (82.93)	0.97
SARS-CoV-2 positive and/or PUI involvement, n (%)			
Yes	23 (16.43)	117 (83.57)	
No	0 (0)	7 (100)	0.59

Discussion

To the best of our knowledge, this study is the first in South Africa to determine the prevalence of SARS-CoV-2 infection in an academic Department of Anaesthesiology, albeit a small sample size when compared to studies conducted globally.[7,10] The majority of the participants in our study were anaesthetic registrars (51.02%).

Anaesthetists perform AGPs daily due to their airway management expertise and are therefore exposed to SARS-CoV-2. The cumulative prevalence of SARS-CoV-2 infection among anaesthetists in our study was found to be 26.47% between March 2020 and January 2021. Costa et al.[7] found a prevalence rate of 14.7% among anaesthetists between June and July 2020, which was 5.57 times higher than the prevalence among the general population of Brazil at the time. In our study, July 2020 recorded the highest number of infections, with a prevalence of 6.12%, followed by January 2021, with a prevalence of 5.44%. These findings coincided with the peak infections in South Africa during the first and second waves,[11] which had prevalence rates of 0.02% and 0.04%, respectively. This suggests a higher risk of SARS-CoV-2 infection among anaesthetists.

There were 60 (40.81%) participants who were symptomatic for COVID-19; however, only 34 (56.67%) of these 60 participants tested positive for SARS-CoV-2. Morcuende et al.[10] found that 26.2% of participants, who were intensivists and anaesthetists, had postexposure symptoms while only 12.1% of the participants tested positive for SARS-CoV-2. El-Boghdadly et al.[12] reported that 184 (10.7%) participants who were involved with tracheal intubations either tested positive for SARS-CoV-2 or developed symptoms consistent with COVID-19. There were two possible reasons for these findings. The first is that the positivity rate of SARS-CoV-2 tests is lower than the symptom prevalence as either participants did not have the virus, or their tests were inaccurate. The second reason is that symptoms experienced from COVID-19 overlaps with other diseases people may have.

Among our study participants, there were no reported reinfections with SARS-CoV-2 for the period of the study. This compared to a reinfection rate of 0.5% found in a study conducted by Costa et al.; however, this study's data collection period was between June and July 2020.[7]

The population of the study was skewed as there were 90 female and 57 male participants. Pregnancy was not associated with having SARS-CoV-2 infection ($p = 0.09$); however, there were only four pregnant participants in the study. Our study found that male sex was a significant risk factor for SARS-CoV-2 infection ($p = 0.045$). No other sociodemographic independent risk factors for SARS-CoV-2 infection and severity of disease were identified in our study. This is supported by various other studies which showed no correlation between age and ethnicity and an increased risk of SARS-CoV-2 infection.[7,13-14] However, older age, male sex, hypertension, diabetes, immunosuppression, chronic respiratory, cardiac and kidney disease are risk factors for infection and severe COVID-19.[15-18] Liver disease and obesity were also found to be risk factors.[18] The most likely reason we did not elicit other risk factors in our study was due to a small sample size and a younger median age.

Symptoms of COVID-19 reported in this study included fatigue, headaches, myalgia, cough, sore throat, fever, chills, shortness of breath, anosmia and dysgeusia. These findings are in keeping with symptoms reported in various other studies.[10,13] It is of concern that only 43.33% of SARS-CoV-2 positive participants reported fever, as temperature screening has been observed as the most often used screening tool.[19]

Our study found 1 (2.78%) participant who had tested positive for SARS-CoV-2 required hospital admission. This participant, who reported no comorbidities, only required nasal cannula as part of management for COVID-19. Morcuende et al.[10] found that anaesthetists who donned PPE appropriately and were prepared for managing SARS-CoV-2 were not at risk for severe COVID-19 illness.

There were 5 (38.46%) participants that tested positive for SARS-CoV-2 that had travelled, either locally or internationally, within 14 days of onset of symptoms. Traveling participants were more likely to have contracted SARS-CoV-2 infection when compared to those who did not travel ($p < 0.001$). This suggests that travel restrictions mitigated transmission of the virus prior to vaccinations.

Schmid et al.[13] reported that 40.4% of anaesthetists had community-related exposure to confirmed SARS-CoV-2 positive cases, compared to 26.24% in our study. Our study found that 9 (22.50%) participants who had community-related exposure tested positive for SARS-CoV-2, which was statistically significant (p = 0.001). Sikkema et al.[20] found that SARS-CoV-2 infections were more likely community-acquired, as opposed to hospital-acquired, as was found in our study. This supports the implementation of isolation and quarantine, after infection from, and exposure to, SARS-CoV-2, respectively.

Schmid et al.[13] found that 70.3% of anaesthetists had contact with at least one SARS-CoV-2 positive patient in hospital, compared to 95.24% from our study. There were 117 (83.57%) participants that tested negative for SARS-CoV-2, while 23 (16.43%) participants reported a positive SARS-CoV-2 test, after participating in procedures involving SARS-CoV-2 positive patients or PUIs (p = 0.59). Our study found no association between AGPs involvement and having SARS-CoV-2 (p = 0.86), as well as inappropriate PPE donned and having SARS-CoV-2 (p = 0.57), in keeping with results found by Costa et al.[7] and Schmid et al.[13] There is not enough evidence of a statistically significant association between work-related exposure and contracting SARS-CoV-2 infection. These findings suggest that while many SARS-CoV-2 infections occurred in the work environment, few occur while managing SARS-CoV-2 positive patients or PUIs. This could be due to precautions not being observed during social interactions at work, or due to variables not assessed in our study.

Limitations of the study were multifactorial. The study is contextual as it is only representative of anaesthetists in the Department of Anaesthesiology of Wits. It does not include other departments or hospitals, which may have different exposure risks and staff complements. Thus, the study is not fully representative of South African HCWs. However, it did provide some insight into a group of South African HCWs at a higher risk of SARS-CoV-2 exposure. The study is cross-sectional and may not accurately represent what the future may hold as the disease process is continuously evolving. The study looked at data prior to vaccinations which may affect transmission of the virus as well as severity profile of the disease. The study is based on the memory recall of participants' experience of SARS-CoV-2 infection and symptoms. We also relied on self-reported SARS-CoV-2 testing. We cannot comment accurately on the prevalence of SARS-CoV-2 infection as 11

(7.48%) of participants did not test for the virus. The results of the study are descriptive and exploratory in nature.

Conclusion

Anaesthetists in the Department of Anaesthesiology of Wits have had extensive exposure to SARS-CoV-2. AGPs are not a significant risk factor for anaesthetists in the context of work or community transmission of the virus. There was a statistically significant predisposition for contracting SARS-CoV-2 infection among males, participants who travelled and participants who had community-exposure to a SARS-CoV-2 infected person. Further studies are required for a more accurate representation of the pandemic. We have identified the prevalence, characteristics, potential risk factors, symptomatology and sources of infection which could help guide future protocols and resource allocation. HCWs need to be protected through this pandemic and measures need to be institutionalised to maintain the functioning of the healthcare system.

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Conflict of interest

The authors declare no conflict of interest.

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Ethics declaration

The study was submitted to the Human Research Ethics Committee (Medical). Approval number M210333.

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Section 4: Proposal

The prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology

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4.1 Introduction

On 31 December 2019 the World Health Organisation (WHO) was notified of a cluster of viral pneumonias of unknown aetiology, now known to be Coronavirus disease 2019 (COVID-19) - a disease caused by a novel strain of coronavirus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (1). This followed a report of atypical pneumonias in the city of Wuhan, China (1). A global pandemic was declared on 11 March 2020, where over 114 countries had reported cases of COVID-19 (1). By 6 February 2021, there had been over 100 million confirmed cases and over 2 million deaths due to COVID-19 (2,3).

COVID-19 was first detected in South Africa on 5 March 2020 (4) and has spread rapidly throughout the country. By 6 February 2021, South Africa had experienced over 1.4 million confirmed cases of COVID-19, more than 46 thousand deaths, and over 1.3 million recoveries (5). South Africa ranked 15th in the world in terms of total number of confirmed cases as of 6 February 2021 (2). There have been two waves as of 6 February 2021, with the peak of the first wave experienced in July 2020, and the beginning of the second wave in December 2020 (5).

COVID-19 is epidemiologically related to transmission from animals to humans, and subsequently humans-to-humans (6–9). The incubation period of SARS-CoV-2 is reported to be four to seven days (6). The reproductive number is estimated to be 2.2 from a study done by Li et al. (8). Viral shedding and transmission occur during the first week of illness (8). However, symptomatic patients are thought to be infectious from two to three days prior to symptom onset, to 14 days after symptom onset (4). The SARS-CoV-2 virus is spread by aerosolization of respiratory secretions, through contact, droplet, or airborne routes (4). Transmission risk is dependent on proximity and duration of contact to a patient with COVID-19 (10). Unpublished data from a study by Nishiura et al. (11) estimates an 18.7-fold higher risk of transmission indoors than outdoors. Public transportation and hospitals, where patient-staff, staff-staff, and staff-patient transmission may occur, are considered high-risk environments (10).

The risk of SARS-CoV-2 infection can be broken down into four types: risk of infection with SARS-CoV-2 due to environmental or individual factors; risk of hospitalisation or critical illness from COVID-19; and risk of death from critical illness due to COVID-19 (10).

A person under investigation (PUI) is any person with acute signs (less than 14 days), symptoms, or critical illness compatible with SARS-CoV-2 infection; or an asymptomatic person who has had close contact with a confirmed SARS-CoV-2 positive patient (4). A close contact is considered as either face-to-face contact (less than 1 metre) or being in a closed space with a COVID-19 infected patient for at least 15 minutes without appropriate personal protective equipment (PPE) being donned (4). Close contacts should be placed in quarantine for self-monitoring for a minimum of 10 days from the time of the last COVID-19 exposure, and SARS-CoV-2 testing should only be done if symptoms develop (4,12). COVID-19 infection is considered a confirmed case once laboratory testing has reported a positive SARS-CoV-2 result, regardless of patient symptomatology (4). A confirmed patient with COVID-19 should be placed in isolation for a minimum of 10 days after symptom onset (12).

COVID-19 can manifest as a spectrum of clinical signs and symptoms (4). While some patients may be asymptomatic, others experience severe respiratory failure and fatal sequelae. Symptoms may last from a few days up to months post infection. El-Boghdadly et al. (13) have described that out of 184 participants, 111 (60%) experienced fatigue, 102 (55%) had a cough, 100 (54%) had a sore throat and 35 (19%) had shortness of breath at a mean follow up of 32 days. A cohort study by Huang et al. (14) comprising 1 733 patients, has shown that at six months post discharge from hospital, fatigue or muscle weakness (63%), sleep difficulties (26%) and anxiety or depression (23%) were the most common symptoms experienced. Seventy six percent of these patients experienced at least one symptom after six months (14). Other risk factors noted for persistent psychological symptoms in this study were being female and having experienced severe disease (14).

A study by Xiong et al. (15), which followed up on 538 patients at three months post discharge from hospital, showed that fatigue, post activity tachypnoea, and alopecia were more common in women than in men. The study also described that 49.6% of patients experienced at least one symptom at the three months follow up (15).

A cohort study of 105 healthcare workers (HCWs) conducted in New York City by Morcuende et al. (16) found that 61 (58%) of participants had a work-related exposure of which 16 (26.2%), comprising anaesthetists and intensive care providers, had symptoms. The most frequently reported symptoms from this cohort study were myalgia, fever, sore throat, and diarrhoea (16).

Individual factors which may increase risk of SARS-CoV-2 infection or increase severity of COVID-19 include: older age, male sex, ethnicity, obesity, hypertension, diabetes, immunosuppression, chronic respiratory, cardiac, or kidney disease (17–20). A population cohort study conducted by the Western Cape Department of Health in South Africa found that patients who had a higher risk of severe disease and mortality were associated with male sex, HIV, hypertension, diabetes, tuberculosis, and chronic kidney disease (21). Mortality may be multifactorial in nature as socioeconomic status may influence occupation, use of public transport, multigenerational housing, and overcrowding (10,16). An unpublished study by International Severe Acute Respiratory and emerging Infection Consortium (ISARIC) found that 21-24% of non-White patients required intensive care admission when compared to White patients, where 13% required admission (22). The average case-fatality rate (CFR) among 44 672 patients in China was 2.3% (17). The CFR was higher in certain categories: 5.6% in patients with cancer, 6% in patients with hypertension, 6.3% in chronic respiratory disease patients, 7.3% in diabetic patients, 8% in those aged 70-79 years old, 10.5% in patients with cardiovascular disease, and 14.8% in those 80 years and older (17).

SARS-CoV-2 is transmitted through droplets (6). HCWs, particularly those who perform aerosol-generating procedures (AGPs), have a higher risk of exposure for contracting COVID-19 (16,23).

AGPs include tracheal intubation and extubation, tracheal suction, bronchoscopy, cardiopulmonary resuscitation, high-flow nasal cannula, continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP), and disconnecting from mechanical ventilators (6,24). Anaesthetists fall into this high-risk group of HCWs who perform AGPs daily in enclosed environments.

The American Society of Regional Anaesthesia and Pain Medicine (ASRA) and the European Society of Regional Anaesthesia and Pain Therapy (ESRA) have recommended that, wherever feasible, regional techniques should be conducted over general anaesthesia to avoid AGPs (25). The intubateCOVID registry, used in a study by El-Boghdadly et al. (13), reported 184 (10.7%) of participants involved with tracheal intubations either tested positive for SARS-CoV-2 antigen or developed symptoms consistent with COVID-19 over a mean follow period of 32 days. In contrast, a study by Morcuende et al. (16), which surveyed anaesthetists and intensive care providers, suggested that community exposure, rather than exposure at work, contributed to SARS-CoV-2 infection. The study also found that anaesthetists were not at significant risk for severe COVID-19 illness in the setting of appropriate PPE and preparedness (16).

While procedures performed by anaesthetists may be considered high-risk exposure, areas within a hospital may be high-risk exposure areas too. These include, but are not limited to, areas with high foot traffic, enclosed areas, areas where infection control precautions are inadequate, or areas where AGPs are performed, such as operating rooms (10). The proximity and duration of contact of HCWs in these environments put them at high risk of exposure of SARS-CoV-2. Furthermore, not only are HCWs exposed to these environments, and to patients admitted with COVID-19, they are also exposed to asymptomatic colleagues in the workspace. A study conducted by Treibel et al. (26) screened 400 HCWs for SARS-CoV-2 using nasal swabs. Forty-four HCWs tested positive, of which 12 (27%) were asymptomatic. A report by Chinese Centre for Disease Control of 72 314 case records (17) showed that 3.8% of individuals infected with SARS-CoV-2 were HCWs. England reported a four to six-fold higher infection rate in HCWs when compared to non-HCWs (27).

An unpublished Oxford University study of 9 809 hospital staff reported that 11% had COVID-19 infection, with the most likely sources of infection being hospitals and household contacts with COVID-19 (28). The study also found that there was an increased risk among the Black (17.1%) and Asian (16.9%) staff members of contracting COVID-19 when compared to White (9.3%) staff members (28). A study conducted by Sikkema et al. (29) screened 1 796 HCWs for SARS-CoV-2 and found 96 (5%) to be positive. Twenty of these staff members did not have contact with COVID-19 patients. However, six of them had contact with staff members who tested positive for SARS-CoV-2. Genome sequencing was conducted on 50 of these 96 HCWs. Results showed that infections were community-acquired, as opposed to hospital-acquired (29).

PPE has been employed as the primary step in reducing the risk of contracting the virus. PPE is designed to protect HCWs from accidents and illnesses that occur daily during work (24). Appropriate PPE includes N95 masks (or equivalent e.g. FFP 2 mask), goggles, visors, caps, gowns, gloves, and overshoes depending on the given situation (4,6,30). Other measures that need to be considered while in theatre include using disposable materials, plastic covers for anaesthetic monitors and equipment, and disinfecting theatre after the end of the procedure (6). Anaesthetic filters, respiratory circuits, and soda lime should be discarded as well (6). Actions that should be implemented, along with the wearing of PPE, to reduce risk of infection include reducing duration of contact with a person under investigation (PUI) or confirmed COVID-19 patient, social distancing, and quarantining those who are infected or PUIs (4).

The impact of COVID-19 on anaesthetists has been multifactorial. For example, training programs have been disrupted thus impairing learning (31). Shortages of PPE, postponed examinations, and high-risk exposure to patients, colleagues, or family members have created anxiety and affected the mental health and well-being of anaesthetists (31). A review on the impact of COVID-19 on anaesthetists by Sneyd et al. (31) suggests that a shortage of PPE has “precipitated poor practice” and “training in full PPE challenges communication between trainee and trainer”. Social distancing has resulted in a loss of personal support systems, which has further heightened anxiety among anaesthetists (31).

SARS-CoV-2 infection is a complex disease process that is still under investigation. While there are many ongoing research investigations into the disease progression and management, only one study, conducted by Morcuende et al. (16), was found in the literature review which looked at the prevalence and symptoms of SARS-CoV-2 infection in anaesthetists and intensive care workers – the study found that 61 (58%) respondents had work-related exposures to SARS-CoV-2, while only 16 (26%) of these respondents developed symptoms.

4.2 Problem statement

The COVID-19 global pandemic has rapidly spread across the world. HCWs are exposed to this virus daily. Anaesthetists are frontline workers who perform AGPs in enclosed environments which exposes them to SARS-CoV-2 and increases their risk of contracting SARS-CoV-2 infection. While signs, symptoms and severity may vary from person to person, there is a paucity of data relating to the characteristics of anaesthetists with SARS-CoV-2 infection. The study will describe the prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology of the University of the Witwatersrand (Wits).

4.3.1 Aim

The aim of this study is to describe the prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology of Wits.

4.3.2 Objectives

Primary objective

The primary objectives are:

- To determine the prevalence of SARS-CoV-2 infection among anaesthetists between March 2020 and January 2021.
- To describe the characteristics of anaesthetists with SARS-CoV-2 infection.
- To describe the risk factors for SARS-CoV-2 infection.

Secondary objectives

The secondary objectives are:

- To describe the COVID-19 symptoms experienced.
- To determine the severity of SARS-CoV-2 infection.
- To determine the most likely environmental source of SARS-CoV-2 infection – community vs work-related exposure.

4.4. Research assumptions

The following definitions will be used in the study**:**

COVID-19: Coronavirus Disease 2019 caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).

COVID-19 Exposure: Close contact with someone who has COVID-19 infection.

Close contact: Either face-to-face contact (less than 1 metre) or being in a closed space with a COVID-19 infected patient for at least 15 minutes without appropriate PPE being donned (4).

Person under investigation (PUI): any person with acute (less than 14 days) signs, symptoms or critical illness compatible with COVID-19 infection, or an asymptomatic person who has had close contact with a confirmed SARS-CoV-2 positive patient (4).

COVID-19 Infection (confirmed case): A confirmed positive laboratory test for SARS-CoV-2 with, or without, signs and symptoms (4).

Anaesthetist: Any qualified doctor working in the Department of Anaesthesiology including consultants, registrars, and medical officers.

Consultant: A specialist anaesthetist or career medical officer.

Registrar: A qualified medical doctor who is registered with the Health Professional Council of South Africa as a trainee anaesthetist.

Medical officer: A qualified medical doctor working in the department of anaesthesiology under specialist supervision. Medical officers with more than 10 years of experience in the Department of Anaesthesiology are career medical officers and regarded as consultants.

4.5. Demarcation of study field

The study will be conducted among anaesthetists within the Department of Anaesthesiology, affiliated to the Faculty of Health Sciences of Wits. The staff complement of the department is 90 consultants, 109 registrars, and 40 medical officers – a total of 239 staff members.

4.6. Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of Wits.

Approval to conduct the study will be obtained from Dr Motshabi, the Academic Head of the Department of Anaesthesiology of Wits (Appendix A).

Implied consent:

- Participants will be emailed an online questionnaire which will include an information letter and questionnaire (Appendix B and C).
- No identifying data will be obtained from the questionnaire.
- Completion of the questionnaire will be regarded as implied consent.

Anonymity and confidentiality:

- Data will be collected without identifying information.
- Only the researcher and supervisors will have access to raw data.

Data will be stored securely electronically on a password protected database for six years after completion of the study.

The study will be conducted according to the principles of the Declaration of Helsinki (32) and the South African Guidelines for Good Clinical Practice (33).

4.7. Research Methodology

4.7.1.1 Research design

A cross-sectional, contextual, descriptive research design using a questionnaire will be followed in the study.

A cross-sectional study is a study where data are collected, and analysis done at a specific point in time (34). This study is cross-sectional because the prevalence of SARS-CoV-2 infection in anaesthetists is evaluated at a specified point in time.

A contextual study is a study that evaluates participants in their own environment, or in context (34). This study is contextual as it evaluates anaesthetists in the Department of Anaesthesiology in the University of the Witwatersrand.

A descriptive study is a study that describes a phenomenon, or phenomena, without determining the relationship between variables (34). This study will describe the prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology of Wits.

4.7.2 Study population

The study population consists of all anaesthetists working in the Department of Anaesthesiology of Wits.

4.7.3 Study sample

Sample size

The sample size was determined in consultation with a biostatistician. The department consists of 90 consultants, 109 registrars and 40 medical officers – a total of 239 staff members. Questionnaires will be sent out via email to all anaesthetists in the department. As the analysis will be descriptive and exploratory in nature, a formal sample size was not necessary; however, a response rate of 60% (144 respondents) is considered as acceptable.

Sampling method

The study will use a consecutive and convenience sampling method.

Consecutive sampling is the inclusion of every subject that meets the inclusion criteria (34).

Convenience sampling includes readily available participants in the study (34).

4.7.4 Inclusion and exclusion criteria

Inclusion criteria

The inclusion criterion for the study is:

- Anaesthetists in the Department of Anaesthesiology of Wits who consent to participate in the study.

Exclusion criteria

- Questionnaires with multiple incomplete sections.
- Anaesthetist refusal to complete the form.
- Junior doctors such as interns or community service doctors in the department.

4.7.5 Data collection

Questionnaire development

A questionnaire has been developed (Appendix C) using four sections. The sections are adopted from various pre-existing questionnaires found in the literature review for content validity (4,14,16). The sections include: demographics and medical history, development and duration of COVID-19-like symptoms and COVID-19 testing, community exposure to COVID-19, and work-related exposure to COVID-19. The questionnaire has been reviewed by three members of staff from the Department of Anaesthesiology for face validity.

The online questionnaire using Google Forms® will be sent out via email to all anaesthetists within the Department of Anaesthetics for completion. Data collection will take place over a period of two weeks to allow participants to complete the questionnaire at their leisure.

Raw data will subsequently be captured from Google Forms® using a Microsoft Office Excel® spreadsheet. Only the researcher and supervisors will have access to raw data captured.

4.7.6 Data analysis

Data will be summarised from the four sections of the questionnaire and will be analysed from the Microsoft Office Excel® spreadsheet with the assistance of a biostatistician.

The captured data will be summarised in tables and graphs, as appropriate. Categorical data will be summarised using count (%) and continuous data using the mean (standard deviation) or median (interquartile range), based on information from sections 1 and 2. Chi-squared tests or Fisher exact tests will be used for examining association between categorical variables. Wilcoxon rank-sum tests or t-tests will be used for continuous variables. Logistic regression will be used for the appropriate data to determine relationships between variables and independent factors for possible risk factors.

4.8 Significance of the study

COVID-19 has affected millions of people throughout the world. HCWs have a higher risk exposure to the disease and its variants than the general population as they experience both community and work-related exposure. There is no data available for HCWs in the Department of Anaesthesiology of Wits regarding the prevalence of SARS-CoV-2 infection, signs and symptoms experienced with COVID-19, and risk factors for developing severe disease. Data captured may be used to inform planning, decision-making, and delivery of safe services by HCWs.

The study will evaluate the characteristics of anaesthetists who had SARS-CoV-2 infection, determine their most likely source of infection, describe the symptoms

experienced, as well as identify potential risk factors associated with severe disease.

4.9 Validity and reliability of the study

Validity refers to the accuracy of results i.e. how accurately a method measures what it is intended to measure (34). Reliability refers to the consistency, or reproducibility, of results (34).

Validity and reliability of the study will be ensured through the following:

- The use of an appropriate study design – a cross-sectional, descriptive research design using a questionnaire will be followed in the study.
- The questionnaire will be derived from pre-existing validated questionnaires.
- Data will be safely captured and stored electronically by a single researcher.
- Data will have no identifying information captured.
- Data will be analysed and interpretated in consultation with a biostatistician.

4.10 Potential limitations of the study

The study is contextual as it is only representative of anaesthetists in the Department of Anaesthesiology of Wits. It does not include junior doctors, such as interns and community service doctors, as they rotate between other clinical disciplines every two to six months, respectively.

It does not include other departments or hospitals, which may have different exposure risks and staff complements. Thus, the study is not fully representative of South African HCWs. However, it will provide some insight into a group of South African HCWs at a higher risk of SARS-CoV-2 infection.

The study is based on memory recall of participants' experience of SARS-CoV-2 infection and symptoms. The results may not be accurate due to memory lapse.

COVID-19 is an evolving and ongoing disease. The study is cross-sectional and may not accurately represent what is yet to come.

4.11 Project outline

4.11.1 Time frame

Year	2021										
Month	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Proposal											
Ethics approval											
Postgraduate approval											
Data collection											
Data analysis											
Submission											

4.11.2 Financial plan

The University of the Witwatersrand Department of Anaesthesiology will bear the cost of the printing and paper for the research proposal, research report, and binding of final research report.

Description	Price per item	Number of items	Total
Printing proposal	R1	300	R300
Printing research report	R1	600	R600
Binding final research report	R20	1	R20
Total			R920

4.12 References

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4.13 Appendices

Appendix A: Permission from the Head of Anaesthesiology

Dear Dr Motshabi,

My name is Bhavin Daya and I am a registrar in the Department of Anaesthesiology of the University of the Witwatersrand. I would hereby like to request permission to conduct my research study across all staff members (consultants, registrars and medical officers) in the Department of Anaesthesiology of the University of the Witwatersrand.

My research study is entitled “The prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology”. By understanding the characteristics of anaesthetists with SARS-CoV-2 infection, it will allow the Department of Anaesthesiology to risk-stratify allocation of staff members to high-risk COVID-19 environments.

The study will take place in the form of anonymous, online questionnaires using Google Forms. The questionnaire will be voluntary, and completion of the questionnaire will imply consent. This research report will be submitted to the Faculty of Health Sciences to fulfil the requirements for my MMed degree. A copy of the final report, should you request it, will be made available to you.

Yours sincerely

Dr Bhavin Daya

071 134 3179

Bhavin.daya@gmail.com

Date: 03/03/2021

Applicant's Signature: 

Bhavin Daya

WHO WILL SUPERVISE THE PROJECT? (Where applicable)

Name Dr Sujai Mohanadasan
Dr Kylesh Pegu

Department: Anaesthesiology

Telephone No: 0724460673
0820411855

Email: iajus24@gmail.com
kyleshpegu@yahoo.com

Signature: 

Date: 03/03/2021

HEAD / RESEARCH COORDINATOR OF DEPARTMENT / ENTITY IN WHICH STUDY WILL BE CONDUCTED (Where applicable) (Wits Students Academic HOD must sign)

Name: Dr Palesa Motshabi

Department / Entity HOD Department of Anaesthesiology

Tel No: 0114884344
0834321994

Email: Palesa.Motshabi@wits.ac.za

Signature: 

Date: 07/03/2021

Appendix B: Information leaflet

Dear colleague,

My name is Bhavin Daya. I am a registrar in the Department of Anaesthesiology at the University of the Witwatersrand. I would like to invite you to participate in my research study entitled “The prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology”. By understanding the characteristics of anaesthetists with SARS-CoV-2 infection, it will allow the Department of Anaesthesiology to risk-stratify allocation of staff members to high-risk COVID-19 environments. This research report will be submitted to the Faculty of Health Sciences to fulfil the requirements for my MMed degree.

I would like you to participate by completing the following questionnaire. The questionnaire has four sections. The questionnaire is completely anonymous, and all responses will be kept secure and confidential. No identifying data will be requested or captured. Only myself and my supervisors will have access to raw data. If at any point you feel uncomfortable answering any of the questions, you are free to withdraw from the study. Participation in the study is voluntary and consent will be implied by the completion of the questionnaire. The questionnaire will take no more than 10 minutes to complete. No incentives will be provided for completion of the questionnaire.

If you have any questions regarding the study, kindly contact me, Dr Bhavin Daya (071 134 3179), or either of my supervisors, Dr Sujai Mohanadasan (072 446 0673) or Dr Kylesh Pegu (082 041 1855).

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand. This committee protects the dignity and rights of all research participants. If you have any concerns about the way this study has been conducted, please contact the chairperson of the Human Research Ethics Committee, Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by email on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretaries are 011 717 2700/1234 and the email addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za.

Thank you for your time.

Kind regards

Dr Bhavin Daya

071 134 3179

bhavin.daya@gmail.com

Appendix C: Questionnaire

Section 1: Demographics and medical history

1. Age

    - In years

2. Sex

    - Male
    - Female

3. Ethnicity

    - Asian
    - Black
    - Coloured
    - White
    - Other

4. Professional rank

    - Medical officer
    - Registrar
    - Career medical officer
    - Specialist anaesthetist

5. How many years of anaesthetic experience do you have?

    - < 5
    - 5 – 9
    - 10 – 14
    - ≥ 15

6. Do you have any of the following medical conditions? You may select more than one answer.

- Asthma
- Autoimmune disease
- Cancer
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Diabetes
- HIV
- Hypertension
- Obesity
- Pregnancy
- None

7. Do you smoke any tobacco/marijuana/vape products?

- Yes
- No

Section 2: Development and duration of Coronavirus disease 2019-like symptoms and COVID-19 testing between March 2020 and January 2021

1. Did you ever develop symptoms for COVID-19 between March 2020 and January 2021?

- Yes
- No

2. When did you develop symptoms for COVID-19? Provide month and year.

- Month and year
- Not applicable

3. Please indicate which symptoms of COVID-19 you experienced, if any, between March 2020 and January 2021.

- Fever (≥ 38°C)
- Chills
- Cough
- Sore throat
- Shortness of breath
- Myalgia
- Fatigue
- Headaches
- Diarrhoea
- Anosmia (loss of sense of smell)
- Dysgeusia (altered sense of taste)
- Other (please specify)

4. How long did your symptoms last?

- < 7 days
- 7 – 14 days
- 15 - 21 days
- ≥ 22 days

5. Did you test for COVID-19 between March 2020 and January 2021?

- Yes
- No

6. How many times did you test?

- 0
- 1
- 2
- 3
- 4
- ≥ 5

7. Did you ever test positive for SARS-CoV-2 between March 2020 and January 2021?

- Yes
- No

8. When did you test positive for SARS-CoV-2? Provide month and year.

- Month and year
- Not applicable

9. Did you require hospital admission for COVID-19?

- Yes
- No
- Not applicable

10. Did you require any of the following to manage COVID-19?

- Nasal prongs
- High-flow nasal cannula
- Non-invasive ventilation
- Mechanical ventilation
- None of the above

Section 3: Community exposure to COVID-19

1. Did you travel, either domestically (interprovincial) or internationally, within 14 days prior to developing COVID-19 symptoms?

- Yes
- No
- Not applicable

2. Did you use any form of public transport (taxi, train, bus or aeroplane) during the COVID-19 pandemic?

- Yes
- No

3. Were you wearing basic personal protective equipment (i.e. facemask) at the time of traveling or using public transport?

- Yes
- No
- Not applicable

4. Close contact refers to either face-to-face contact (less than 1 metre) or being in a closed space with a COVID-19 infected patient for at least 15 minutes without appropriate PPE donned.

Were you in close contact with anyone outside of the work environment, who was SARS-CoV-2 positive at the time of close contact or subsequently tested positive after close contact?

- Yes
- No

5. Were you ever placed in quarantine due to a community-related COVID-19 exposure?

- Yes
- No

6. Did you test positive for SARS-CoV-2 following a community-related exposure?

- Yes
- No

7. Do you think you most likely contracted COVID-19 outside of work?

- Yes
- No
- Maybe
- Not applicable

Section 4: Work-related exposure to COVID-19

1. Aerosol-generating procedures (AGPs) include tracheal intubation and extubation, tracheal suction, bronchoscopy, cardiopulmonary resuscitation, continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP) and disconnecting from mechanical ventilators.

Have you been part of any AGPs between March 2020 and January 2021?

- Yes
- No

2. Were you at any point not wearing appropriate PPE during AGPs?

- Yes
- No
- Not applicable

3. Were you trained to correctly don and doff PPE?

- Yes
- No

4. Did you always follow the correct procedures during donning and doffing of PPE?

- Yes
- No

5. Were you in close contact with any staff member, or patient, who was SARS-CoV-2 positive at the time of close contact or subsequently tested positive after close contact?

- Yes
- No

6. Were you part of any procedures involving COVID-19 patients or persons under investigation (PUIs)?

- Yes
- No

7. Where did these procedures take place? You may select more than one answer.

- Theatre
- ICU
- Emergency department
- Ward
- Radiology (MRI or CT scan)

8. Were you ever placed in quarantine due to a work-related COVID-19 exposure?

- Yes
- No

9. Did you test positive for SARS-CoV-2 following a work-related exposure?

- Yes
- No

10. Do you think you most likely contracted COVID-19 at work?

- Yes
- No
- Maybe
- Not applicable

Section 5: Annexures

Section 5.1 Ethics approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R49 Dr B Daya

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M210333

NAME: (Principal Investigator)	Dr B Daya
DEPARTMENT:	School of Clinical Medicine Department of Anaesthesia Medical School University
PROJECT TITLE:	*The prevalence of SARS-COV-2 infection in an academic department of anaesthesiology*
DATE CONSIDERED:	2021/03/26
DECISION:	Approved conditionally
CONDITIONS:	The approval of the Registrar is required to include any participants who are registered students of the University <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Drs S Mohanadasan and K Pegu
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2021/05/20

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **March** and therefore reports and re-certification will be due in the month of **March** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator _____ Date _____

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

31 May 2021

Bhavin Daya
Student number (452070)
MMed (Anaesthesia)
Wits Department of Anaesthesia

TO WHOM IT MAY CONCERN

"The prevalence of SARS-COV-2 infection in an academic department of anaesthesiology"

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

Ethical clearance has been obtained. Protocol number: **(M210333)**

Research commencement: (As per consent obtained from HOD)

Nicoleen Potgieter
University Deputy Registrar

Private Bag 3, WITS, 2050, South Africa | T +27 11 717 12043 | E nicoleen.potgieter@wits.ac.za | www.wits.ac.za

5.2 Graduate studies approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

08 April 2021
Person No: 452070
PAG

Dr B Daya
Unit 3, Pebble Brooke Estate
Houghton Drive
Houghton
2198
South Africa

Dear Dr Bhavin Daya

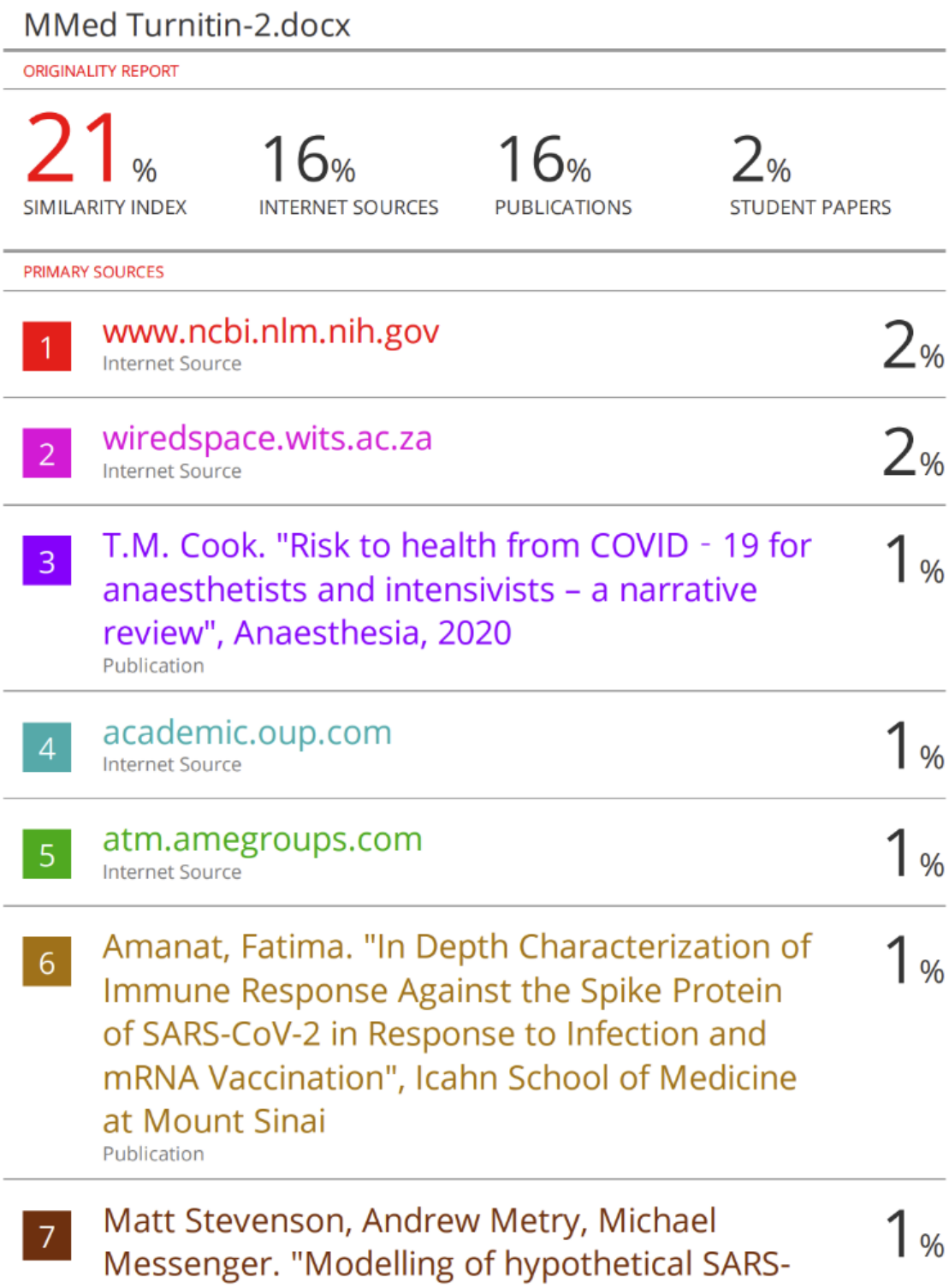
Master of Medicine in Anaesthesia: Approval of Title

We have pleasure in advising that your proposal entitled *The prevalence of SARS-CoV-2 infection in an academic department of anaesthesiology*. has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.3 Turnitin report



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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | FACULTY OF HEALTH SCIENCES

29th June 2022

The Chairperson
Graduate Studies Committee
Faculty of Health Sciences
University of the Witwatersrand

Dear Sir/Madam
Re: MMed: The prevalence of SARS-CoV-2 infection in an Academic Department of Anaesthesiology

Dr Bhavin Daya, student number: 452070, has submitted his research report to Turnitin which revealed a similarity index of 21%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of research.

Yours sincerely

Kylesh Pegu
Supervisor