







# The utility of a smartphone electronic referral application in facilitating telemedicine in pulmonology

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**Background.** A streamlined referral system for respiratory diseases is essential, and telemedicine offers a viable solution, particularly within the public healthcare sector. There is a paucity of data on the utility of the Vula medical referral application in pulmonology, a field that lends itself to telemedicine.

**Objectives.** To perform a 1-year retrospective observational study to assess the Vula medical referral application utility in a tertiary referral centre in Cape Town, South Africa (SA).

**Methods.** This retrospective study was conducted at a large tertiary-level hospital located in Cape Town, SA. All adult patients referred to the Division of Pulmonology at the institution from January to December 2023 via the Vula virtual referral platform were included. During the study period, all physicians who contacted the pulmonology outpatient department (OPD) or the pulmonologist-on-call were requested to use the Vula virtual referral platform. Emergency referrals (e.g. life-threatening haemoptysis) were discussed in person, but details were still uploaded to Vula. Results were extracted from archived data.

**Results.** During the study period, a total of 2 073 adult patients were referred through Vula. Of these, 1 699 referrals (82%) resulted in a working diagnosis or respiratory syndrome requiring further evaluation, identified by either the referring physician or the pulmonologist. The most common reasons for referral were suspected malignancy ( $n=767$ , 45%) and post-tuberculosis lung disease ( $n=170$ , 10%). Nearly half (868, 42%) of the referrals required only medical advice on further management, or assistance with medical image interpretation. A further 538 patients (26%) were scheduled for diagnostic or therapeutic procedures without an outpatient review. Only 537 patients (26%) were ultimately given an appointment date for further evaluation in the pulmonology OPD.

**Conclusion.** Telemedicine in the form a smartphone electronic referral application significantly improved access to and efficiency of pulmonology services in a resource-constrained environment. Approximately 75% of referrals required either guidance with further medical management, assistance with thoracic imaging interpretation, or diagnostic or therapeutic procedures, significantly reducing the outpatient load.

**Keywords:** smartphone, telemedicine, pulmonology

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Globally, respiratory diseases account for >10% of the total disease burden, impacting >1 billion people with either acute or chronic conditions.<sup>[1]</sup> In South Africa (SA), national mortality data from 2016 revealed that respiratory diseases were the fifth leading cause of death, responsible for 9.4% of all fatalities.<sup>[2]</sup>

In this context, a streamlined referral system for respiratory diseases is essential. Telemedicine refers to the use of technology to facilitate virtual interactions between healthcare providers and patients, enabling remote clinical management.<sup>[1]</sup> It offers an alternative to in-person consultations, and plays a critical role in improving access to healthcare, particularly for individuals facing geographical or logistical barriers to care. In SA, asynchronous telemedicine offers a viable solution, especially within the public healthcare sector, where 85% of the population relies on a primary healthcare model supported by specialists at referral hospitals.<sup>[3]</sup> The advent of telemedicine has shown documented benefits, including expedited urgent referrals, reduced unnecessary clinic visits, improved consistency and quality of care and enhanced infection prevention and control measures.<sup>[4]</sup>

The Vula medical referral application (app) (Vula Mobile Health Care, SA) is an online platform connecting all levels of healthcare

workers, including those at primary level, with specialists across the country.<sup>[5]</sup> Originally developed for ophthalmology, its utility in other medical disciplines quickly became apparent, leading to its broader application. It is now used by >2 700 facilities and 36 000 healthcare workers.<sup>[5]</sup>

Despite this, there is a lack of data on the specific utility of the Vula medical referral app in pulmonology, a field particularly suited for telemedicine. Therefore, we conducted a 1-year retrospective study to assess its effectiveness at a tertiary referral hospital in Cape Town, SA.

## Methods

### Study design and setting

This retrospective observational study was conducted at Tygerberg Hospital, a large tertiary facility with 1 380 beds located in the Cape Town Metropole, serving a population of 3.4 million people. The drainage areas covered include the Eastern and Northern metro subdistricts, Khayelitsha, the West Coast districts, the Cape Winelands and the Overberg rural districts.<sup>[6]</sup> The study received approval from the Stellenbosch University Health Research Ethics Committee (ref. no. S24/03/067), and a waiver of consent was granted due to its retrospective design.

## Data collection

All adult patients (aged >18 years) referred to the Division of Pulmonology at Tygerberg Hospital via the Vula virtual referral platform from January to December 2023 were included in this study. Throughout the study period, all physicians contacting the pulmonology outpatient department (OPD) or the pulmonologist-on-call were requested to use the Vula platform. While emergency referrals (e.g. life-threatening haemoptysis) were discussed in person or telephonically, their details were also uploaded to the virtual platform.

Data were extracted from archived records, using folder numbers or other identifiers to prevent duplication before deidentification. Once captured, data were deidentified. General demographic data (age and sex) were collected, along with information on the referral centre, a working diagnosis or respiratory syndrome requiring further evaluation identified by either the referring physician or the pulmonologist. Cases lacking a clear respiratory diagnosis were also documented.

Further data collected included the initial outcomes of the referrals, which were categorised into the following subgroups: (i) medical advice only, including image review; (ii) direct pulmonary intervention (diagnostic or therapeutic); (iii) outpatient appointment; (iv) evaluation for domiciliary oxygen; and (v) admission to Tygerberg Hospital.

## Statistical analysis

Analysis was conducted using Statistical Package for Social Science (SPSS) version 29 (IBM, USA). Continuous variables were expressed as means (standard deviation (SD)) for normally distributed data, and medians (interquartile range (IQR)) for non-normal data. Categorical variables were expressed using frequencies and percentages.

## Results

### Patient demographics and origin

A total of 2 073 adult patients were referred via the Vula referral platform during the 1-year study period. Among these, 1 110 (54%) were male and 963 (46%) were female, with a mean (SD) age of 52.8 (15.0) years. Most referrals external to Tygerberg Hospital came from district hospitals ( $n=790$ , 38%) and primary healthcare centres ( $n=398$ , 19%) (Table 1).

### Diagnosis on referral

A working diagnosis or respiratory symptom requiring further evaluation was identified by the referring physician or the on-call pulmonologist in 1 699/2 073 (82%) of the referrals. Among these, the most common reasons for referral were suspected malignancy ( $n=767$ , 45%) and post-tuberculosis lung disease ( $n=170$ , 10%) (Table 2).

### Outcome of referrals

Of the total referrals, 868 (42%) required only medical advice for further management, or assistance with interpreting thoracic medical imaging (Table 3). Additionally, 538 patients (26%) were scheduled for diagnostic or therapeutic procedures, without the need for an outpatient review at the pulmonology outpatient department (OPD). Ultimately, only 537 patients (26%) required further evaluation by a subspecialist at the pulmonology OPD.

## Discussion

In this 1-year, real-world retrospective study, we showed that >40% of pulmonary medicine referrals were successfully managed through medical advice on further treatment or assistance with medical image interpretation. Additionally, >25% of patients bypassed the OPD

**Table 1. Origin of referrals (N=2 073)**

Origin	n (%)
Tygerberg Hospital	740 (37)
Secondary and district hospitals	790 (38)
Community health centres	398 (19)
Other	85 (4)
Private sector	60 (3)

**Table 2. Working (suspected) diagnosis/reason for referral (N=1 699)**

Diagnosis/reason for referral	n (%)
Suspected lung malignancy	767 (45)
Post-TB lung disease	170 (10)
Other	163 (10)
Pulmonary TB	136 (8)
Interstitial lung disease	131 (8)
Obstructive lung diseases	105 (6)
Haemoptysis	55 (3)
Pleural effusion	34 (2)
Hydatid disease	33 (2)
Aspergilloma	29 (2)
Sarcoidosis	25 (1)
Pneumothorax	20 (1)
Pulmonary hypertension	18 (1)
CTEPH and/or pulmonary embolism	13 (1)

TB = tuberculosis; CTEPH = chronic thromboembolic pulmonary hypertension.

**Table 3. Outcome of initial referral (N=2 073)**

Outcome	n (%)
Medical advice and image review	868 (42)
Direct intervention*	538 (26)
Outpatient review	537 (26)
Assessment for domiciliary oxygen	78 (4)
Admission/transferral to tertiary hospital	52 (3)

\*Without prior outpatient review.

and were directly offered diagnostic or therapeutic interventions. Only one-quarter of patients required in-person consultations at the pulmonology OPD. Prior to the rigorous implementation of telemedicine, most referrals – excluding emergency cases – would have been managed in person, underscoring the significant impact telemedicine has had on enhancing efficiency in a resource-constrained tertiary care setting.

Through remote guidance, >800 patients were effectively managed at their primary facilities, avoiding the need for transfer to the tertiary hospital for inpatient or outpatient care. This undoubtedly resulted in cost savings, such as reduced patient transport expenses, enhanced patient convenience and minimised delays in initiating appropriate treatment.

Only about a quarter of VULA referrals led to appointments at the pulmonology OPD. Prior to the implementation of telemedicine, which facilitated rapid two-way communication, most non-emergency referrals would have required in-person consultations to gather additional information.

Our findings are in keeping with a report by Morkel *et al.*,<sup>[6]</sup> who showed the benefits of the Vula app in orthopaedics, illustrating its effectiveness as an alternative to traditional paper-based referral methods. In their study, referrals managed solely by advice accounted

for 33% of 1 985 cases ( $n=647$ ), suggesting that Vula alleviates pressure on overburdened trauma services. Similarly, in our overburdened and sometimes understaffed pulmonology department, we were able to manage 42% of referred cases remotely.

Mzamo *et al.*<sup>[7]</sup> conducted a study at a trauma centre focusing on orthopaedic cases, and found that Vula improved the transfer of information and documentation for initial management of open fractures at the referring institution. They reported a marginal improvement in the time from referral at the primary facility to assessment by the orthopaedic team at the tertiary facility. In comparison, our study indicated that Vula minimised the overall number of cases transferred as inpatients to 3% ( $n=54$ ), reinforcing our findings of improved documentation and information transfer. These studies and our own clearly demonstrate that telemedicine has significantly improved efficiency in a resource-limited tertiary care setting.

Dreyer *et al.*<sup>[8]</sup> demonstrated that accurate index diagnoses in conditions such as chronic obstructive pulmonary disease can lead to reduced hospital admissions in pulmonology. Vula enhances the accuracy of initial diagnoses by enabling subspecialist expertise to be disseminated to other levels of care, and reduces the need for personal contact with tertiary services.

Despite the clear benefits of the Vula app, it is essential to address potential barriers to its adoption, particularly physician acceptance. A systematic review by Garavand *et al.*<sup>[9]</sup> identified several factors influencing physician acceptance, including government policies, perceived behavioural control, perceived usefulness and attitudes toward technology in medicine.

While ethics are crucial for any healthcare technology, they have also impeded the adoption of digital health initiatives due to concerns about confidentiality and consent, as highlighted by Deji *et al.*<sup>[10]</sup>

Despite existing barriers, telemedicine is not a new concept in SA. The COVID-19 pandemic highlighted its significance in healthcare systems, demonstrating effective public health response strategies for timely outbreak control, as noted by Verhagen *et al.*<sup>[11]</sup> Telemedicine facilitated information sharing among healthcare professionals, disease surveillance and communication with patients and communities. Additionally, den Hollander *et al.*<sup>[12]</sup> emphasise that the Vula service provides a centralised database for recording and analysing referrals and referral patterns, data that were previously unavailable in healthcare systems.

Importantly, the accessibility of this service via smartphones aligns with findings from a study by Xu *et al.*<sup>[13]</sup> where most doctors (69.2%) reported that mobile devices improved their personal performance, and 79% felt that they enhanced patient care. This suggests a strong endorsement of a mobile app's role in improving healthcare delivery among physicians.

Future research should further explore Vula's role in strengthening the public health system, particularly in high-volume referral areas, and in upskilling referring health workers.

A major strength of this study is its large sample size, allowing for a robust assessment of telemedicine in a resource-constrained setting. However, a limitation is the retrospective nature of the study, and the inability to identify a diagnosis or relevant respiratory syndrome in all cases. It should also be pointed out that the Western Cape Province has an advanced linked picture archiving and communication system

(PACS), which may limit the generalisability of the findings of this study to other resource-constrained settings. Additional limitations include the absence of clinical outcome data, particularly for patients managed remotely, as well as a lack of robust evidence regarding qualitative measures such as user satisfaction and clinician-reported barriers.

## Conclusion

We have demonstrated that telemedicine in the form of a smartphone electronic referral application significantly improved the access to and efficiency of pulmonology services in a resource-constrained environment. Approximately 75% of referrals required either guidance with further medical management, assistance with thoracic imaging interpretation, or diagnostic or therapeutic procedures, significantly reducing the outpatient load.

**Data availability.** The data used for this study are available from the authors on request.

**Declaration.** This study was the research assignment for WG's MMed (Int) degree at Stellenbosch University.

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**Author contributions.** WG and CFNK contributed to the design and data analysis. WG and MSM collected the study data. WG and CFNK composed the first draft of the manuscript, which was reviewed and edited by all co-authors.

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**Conflicts of interest.** None.

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