Factors associated with health information systems that influence continuity of TB care between a District hospital and Primary Healthcare facilities.

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Abstract

Background: South Africa is well known to have a high burden of Tuberculosis (TB) disease. The Western Cape has been identified as having one of the highest numbers of new infections of TB per year in South Africa. TB is the cause of significant mortality and morbidity and has substantial financial implications for patients and the health system. As a result of high levels of HIV, poverty and overcrowding TB has been difficult to eradicate. The significant burden of disease, the caseloads and staff shortages also contribute to challenges to successfully continuing care of TB patients. It has been noted that as much as 24% of TB patients may be lost to follow up (LTFU) in certain districts of the Western Cape.

While previous studies have looked at factors that influence LTFU and continuity of care (COC), no studies have examined how the design and use of Health Information Systems (HIS) may influence these outcomes.

This study aims to describe the current use of HIS in the discharge process of a TB patient at a district hospital in Western Cape and further aims to identify how HIS may facilitate or create barriers to successfully continuing a patient's TB treatment at primary healthcare level after discharge from a district hospital.

Methods: The study was conducted through two phases. Phase 1, secondary data analysis of process maps previously created to understand the TB care pathways and the associated gaps in care within a district hospital and phase 2, a semi-structured interview process. Analysis of both phases involved qualitative thematic analysis attempting to identify and unpack Health Information Systems (HIS) challenges associated with TB care.

Results: Barriers were identified which prevented seamless use of HIS and which did not promote COC. These included poor understanding of TB administrative and referral processes, and what is required to successfully link to TB care and continue care at primary healthcare (PHC) facilities. Further barriers were resources and usability of the HIS, as well as data integrity and fragmented HISs. The only facilitators identified was the availability of clinical information where access was possible and data was complete, as well as an electronic referral platform to TB hospitals.

Conclusion:

Obstacles exist to the effective utilization of HISs in ensuring continuity of TB care between district hospitals and community clinics. To mitigate some of these limitations, we propose that training on SOPs, HISs, and administrative procedures for TB management be intensified. Clarifying ambiguities regarding data, workflows, and HIS prerequisites that support COC could help HCWs better facilitate COC through HIS usage. Additionally, organizations should strive to minimize resource deficiencies hindering HIS utilization. Insights from the TB hospital referral system can be leveraged to enhance care linkage.

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Acronyms

AFBs	Acid Fast Bacilli
CCWs	Community Care Workers
CLINICOM	Clinicom Hospital Information System
COC	Continuity of Care
EC	Emergency Centre
ECCR	Electronic Continuity of Care Record
EDRWeb	Electronic Drug-Resistant TB Register
EMS	Emergency Medical Services
ETR.Net	National Electronic TB Register
GXP	Gene Xpert
HCW	Healthcare Worker
HECTIS	Hospital and Emergency Centre Tracking Information System
HIS	Health Information System(s)
IPC	Infection Prevention and Control
ILTFU	Initial Loss To Follow Up
JAC	JAC Pharmacy dispensing and stock taking system
LTFU	Loss to follow up
MHS/MDHS	Metro (District) Health Services
NHLS	National Health Laboratory Services
NICD	National Institute for Communicable Diseases
NMC	Notification of Medical Conditions
OPD	Outpatient Department
PHC	Primary Healthcare
PHDC	Provincial Health Data Centre
PREHMIS	Patient Record and Health Management Information System
SA	South Africa
SATS	South African Triage Scale
SPV	Single Patient Viewer
Sx	Symptoms
TB	Tuberculosis
TEWS	Triage Early Warning Score
TIER.NET	Three Integrated Electronic Registers
USAID	United States Agency for International Development
WCG:H&W	Western Cape Government Health and Wellness
WC	Western Cape
WHO	World Health Organisation

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Part A: Protocol

Background

Tuberculosis Burden

Prior to the emergence of COVID-19, Tuberculosis (TB) was the foremost cause of death due to infectious diseases globally, claiming almost 1.5 million (18 per 100,000 population) with an estimate of ten million (130 per 100,000) of the global population were infected in 2019 (1). By 2020, due to the COVID-19 pandemic, the slight yearly decline in new TB cases across the world came to a near standstill (2). Notifications of diagnosed TB cases saw an 18% reduction in comparison to 2019 and the number of deaths related to TB increased after 9 years. This was as a result of limited access to health care services and disruptions to basic primary care including TB services. An estimate of 50% of TB cases remained undiagnosed and untreated (2). Subsequent to the COVID-19 pandemic, with the main TB targets of the United Nations and the End TB Strategy having been derailed (3), it is evident that TB persists as a significant threat to global public health and that the COVID-19 pandemic has compromised an already tenuous TB response.

In 2019, approximately 360 000 people had active TB in South Africa (SA) with 209 500 new patients registered with TB. It is estimated that at least 150 000 cases were either undiagnosed or lost to follow up and only 58% treatment coverage was achieved (4). Loss to follow up (LTFU) is considered one of the key challenges to address in the fight against TB. LTFU reflects on those patients, who have been diagnosed with TB but have failed to either start treatment or have had a treatment interruption for a period of two consecutive months or longer (5). According to the World Health Organization (WHO), treatment coverage is described as the proportion of TB cases notified of the total estimated new cases (6). TB treatment coverage in SA did not improve by 2021, instead an unsatisfactory 57% treatment coverage was achieved with an approximated 40% of TB patients not diagnosed in SA (7).

The prevalence of TB LTFU differs considerably between countries, ranging from a low 2.5% in Myanmar to a significant 44.9% in Mozambique (8). In SA, LTFU ranges between 14.9% to 22.5% across provinces (9). The LTFU cohort pose a significant public health risk as they are at increased risk of drug resistant TB as well as freely spread active TB bacilli which may result in new infections (5). Furthermore, LTFU increases relapse rates and hospital admissions, thereby increasing the chance of treatment failure and ultimately death (10).

Investigating the problem of loss to follow up

Previously, intensive focus has been placed on improving TB treatment success rates as a means of achieving improved TB outcomes. TB treatment success rate is defined by the WHO as the proportion of new cases of smear – positive (where an initial examination of a sputum sample shows the presence of acid-fast bacilli (AFB) (11)) TB that has been registered by a national TB programme and that has completed the course of TB treatment in a given year (12). This approach detracts from identifying upstream losses of patients diagnosed with TB but who are not notified or treated and are therefore classified as LTFU. A systematic review by Tola et al. looked at publications between 2008 to 2015 which addressed both non-adherence and LTFU of TB in developing countries (13). The review confirmed that the continuation phase of TB treatment (after initiating treatment and completing the first two months, called the intensive phase) was the most likely phase for patients to disengage from treatment. Factors that influenced non-adherence and LTFU were categorised according to socioeconomic factors, behavioural factors, health system and health service-related factors. Health systems factors include fragmented data systems between laboratories and health facilities or between different health facilities which may affect retention in care (14)**.** Socioeconomic factors (5) vary across a range of domains and include the significant challenges faced by patients such as: unemployment, financial difficulties, lack of food security, housing, poor social support, low education levels, drug abuse, and poor communication between health care workers and patients (5)(15)(16)(17)(13) Health service-related factors included medication side effects, accessibility and relationships between health care providers and patients. These factors have an additive effect and together weave a system of causal pathways that promote treatment disengagement (13). Behavioural factors include amongst others, fear of stigma, smoking and alcohol use, and lack of motivation or self-efficacy. Poor communication between health workers and patients, and patients' knowledge of TB are also considered as behavioural factors contributing to LTFU (13).

An understanding of the continuum of care (also known as the "care cascade") can provide the evidence needed about where to target interventions to reduce LTFU along the pathway to successful treatment. While there is research into health-system related factors that promote disengagement from TB treatment, there remain gaps in understanding the use of health information systems (HIS) and its impact on the problem of TB LTFU and/or Continuity of Care (COC).

Understanding continuity of care in Tuberculosis treatment

The public health system is structured around a DHS which has a strong primary health care (PHC) focus. The PHC platform is the main diagnostic and treatment point for HIV, TB and chronic diseases (4) however, TB care can be provided at any level within the system (4)(18). Notably, it is thought that health services related factors, such as delays in both diagnosis and treatment initiation, are now bigger barriers to reducing TB-associated mortality than behaviour and socio-economic factors (19). In spite of the focused TB service at PHC level, it is estimated that only 50% of TB patients experience COC and successfully complete treatment (14). This emphasises that further actions are needed to improve COC with a focus on identifying gaps in policies and the implementation thereof as well as the improvement of overall TB care rendered.

In South Africa, COC is understood to include the comprehensive discharge and handover of a patient and their health information records from the initial treating facility to another facility to continue treatment. It also encompasses the provision of consistent and appropriate care to the patient for follow up consultations despite being treated by different health workers (15)(16)(17). While there are studies evaluating the processes that contribute to continuity of care once patients are discharged from hospital care to PHC facilities (17)12)(20)(21), no studies were found that look at how the existing HIS platforms facilitate or fail to contribute to communication between district hospital and PHC facilities, and continuity of TB care in SA.

Some studies have specifically examined the experience of TB care in the Western Cape province, South Africa, highlighting some recurring health system challenges for continuity of care (COC) (15)(16)(17)(20)(21):

Inadequate communication and referral mechanisms between healthcare providers and health facilities (15)(16)(17) were seen as significant barrier to COC. *Unclear* documentation and coordination of cases and the lack of electronic database of TB patients led to poor case handovers and notifications. Overall, the studies suggest that collaboration between the hospitals and PHC was lacking and that there were weak feedback systems regarding whether patients treated in hospitals had accessed PHC after discharge or not.

Poor discharge planning and inadequate discharge information (16)(17)(20). Poor discharge planning at inpatient level with weak or no planning processes in place were seen as another barrier to successful COC. Incomplete patient details and insufficient discharge information with outstanding

results were factors thought as affecting down referrals from the hospital to community clinics. As found in our local health system, this study by Kallon et. al. (17) describes hard copies of discharge information given directly to patients. However, these were found to be inadequate and often deficient in important information needed by clinics to appropriately continue care.

Role clarification, poor communication and education of patient (16)(17)(20)(21). Role clarification was highlighted as an important barrier to COC where participants felt that there was a lack of clarity around the roles and responsibilities of staff members within facilities regarding TB COC and that the requirements for COC between facilities were also not clear (16). Further, concerns raised were the lack of education and communication with patients regarding TB care, their specific diagnosis, and the next steps in their care plan, including length of treatment and which facilities to access for their treatment (17)(20)(21).

These studies highlight the breakdown of communication between hospitals and clinics as a major barrier to COC, with unclear referral mechanisms as a pivotal point. From this we can see that linkage between hospitals and PHC TB services must be strengthened to improve COC. This will require a comprehensive overview of TB discharge processes in acute hospitals with the aim to improve the referral process and ensure closed loop feedback of TB patients between hospitals and PHC platforms.

None of these studies considered how the structure or integration of HIS influenced communication and referral processes and how it may ultimately impact COC. Watermeyer et.al. (22) describes successful COC as achieved when communication between the different actors in the care pathway is coordinated, and iterates that without effective communication, systems may be prone to breaking down. If communication has been repeatedly emphasised as a gap in TB care (22) and HIS can be used to improve communication and health outcomes (23), we argue that it only follows that HIS must be interrogated to understand its strengths and/or weaknesses in providing a sound platform for effective communication and subsequent improved COC. However, little is known about how HIS is integrated into the care processes and its influence on COC of TB patients. Care processes encompass all aspects of the patient's journey including administrative and support services not only their clinical management. Most studies of LTFU have focused on patient factors or the social determinants that result in treatment interruption.

At the most, the aforementioned research looking at COC in TB care highlights sustained challenges to TB care delivery. With the paucity of data on the impact of HIS on TB care and following the

literature review on research gaps in routine health information system design (23) where it is noted that HIS barriers may adversely affect clinical care, it will be useful to understand the barriers created by HIS on TB care outcomes and how improving HIS utilisation may eliminate these challenges and contribute to health systems strengthening (HSS).

Following a scoping review (24) that looked at digital health information systems (DHIS) for TB control, 145 articles were reviewed between the period of January 2016 to March 2019. The review emphasised that research looking at health system management and data services must be strengthened to expand the knowledge base, particularly around how these interventions will benefit health care users. Of interest, 30 articles covered monitoring and surveillance, but review of these articles exposed the glaring absence of standardised HIS. Additionally, it revealed that DHIS boasted improved data quality and patient management compared to paper-based systems. This review thus supports the thinking that HIS use in TB care must be evaluated if we are intent on improving TB outcomes.

Health Information Systems and Data Utilisation

A fundamental input to achieving global TB targets by improving the management of TB patients with a reduction in LTFU is an effective surveillance system. Monitoring and evaluation of the burden of TB disease as well as its determinants play a crucial role in implementing functional responses to the TB epidemic. There has been advocacy for the implementation of DHIS in TB care to replace paper-based systems and strengthen surveillance. DHIS can support accurate collection of patient information while simultaneously reducing duplication, inaccuracy, time and effort associated with paper-based systems (17) (25).

Healthcare providers depend on data to provide appropriate care and service delivery. HIS can assist with clinical and administrative functions to improve the care experience and to facilitate successful treatment outcomes. Some important benefits of HIS outlined by Popescu et. al. (26) and by Michel-Verkerke and Hoogeboom (27) include:

Clinical support – where HIS are integrated across facilities and functions to improve diagnoses and treatment of patients through accessibility to broader patient and population data. This enables improved coordination and continuity of care.

Data Collection and Analysis: HIS facilitates data collection and assists in the analysis of health data to improve patient care, population health through aiding health programme planning and cost analysis.

Financial Governance through collaboration, data sharing, and systems controls HIS can effectively assist with cost saving by reducing duplication and waste in the health system, promote time management by reducing time wasting through alleviating laborious and complex tasks and thereby also reducing the probability of human error.

Public Health Management: For successful population health planning, aggregated data is useful to detect epidemiological trends to prevent outbreaks, manage high-risk populations and roll-out effective preventative measures.

However, a systematic review (28) looking at the use of HIS notes that there are many barriers with regards to HIS which may impede operational functionality. The review suggests that an evaluation of the available HIS and its design, as well as its usability and how well it integrates into clinical practice, may assist with resolving some operational problems related to HIS and may help to improve related clinical outcomes. Importantly, such an evaluation will help to ensure that the HIS integrates with clinical workflow as envisioned. This point is echoed by another systematic review (29) which reflects that evaluating these HISs should take into consideration how user friendly they are and whether the HIS integrates into the organisation, with further consideration of social, organizational, political and cultural factors. The evaluation needs to be contextualised for the health system it operates in.

A synthesis report of HIS strengthening measures, by MEASURE Evaluation and the United States Agency for International Development (USAID), aimed to document how strengthening HIS may improve continuity of care for clients across a range of disciplines, including referral strengthening and gender-based violence referral systems as well family health records and child-protection information systems (30). The report highlighted two fundamental prerequisites for a HIS to be effective - it must be user-friendly, facilitate continuity of care, and it must allow for easy data collection that is aggregatable for the purposes of monitoring and evaluation, as well as for decision making. Additional considerations from the report include the amount of information users need to enter for reliable data extraction, the extent of training required, and the support and maintenance that will be needed to successfully roll out and use the HIS. Of note, any inadequacies relating to the above may result in unintentional misuse of the HIS which may include either underutilisation, incorrect use of or outright rejection of the HIS.

An evaluation of patient monitoring systems in a study to scale-up HIS, to improve HIV treatment, found that there was variation and inconsistencies in the use of both paper and electronic systems (31). Study participants expressed their lack of understanding of the electronic systems which impacted on their use of it. An important recommendation from this study was that standards and governance structures need to be put in place for smooth implementation of electronic systems. Another study in Kenya looking at improving referral systems through health information systems strengthening (30), found that there was a gap in data accuracy and quality around the completion of referrals. This was thought to be as a result of poor/no referral monitoring systems, failure to utilise data, poor HIS, and a lack of ownership and accountability for data. This affirmed a previous assessment done in Kenya which indicated that referral documentation was inadequate, no structures were in place for coordination of referrals and that there was wide variability between facilities (30).

Heath Information Systems and Tuberculosis Care

For TB care specifically, information systems can assist with continuity of care and improving case reporting and notification of cases. By augmenting notifications and reporting systems, a standard package of care can be initiated for TB and data collection to enhance treatment programs and epidemic preparedness (32). Unfortunately, efficient information and surveillance systems can be difficult to implement (33). To institute innovative systems supportive environments are required with buy-in from all stakeholders. A baseline situational analysis must be done to determine good and bad processes which can prompt the restructuring and uptake of new systems. As part of understanding the current state, needs and gaps should be identified from the situational analysis with a comprehensive overview of the TB care pathway (25).

Critical points from these evaluations are that a clearly defined, structured referral process will aid in the patients' continuity of care and allow for closing the loop for cases referred, to ensure that appropriate follow-up occurs at the appropriate level of care (30)(31). While this model represents systems for HIV referrals, it is transferrable to other conditions, especially TB as HIV and TB services are often closely linked. Improved treatment outcomes and enhanced continuity of care is possible when there is standardisation of work processes and optimal use of data for informed decision-making (30). No official, standard TB referral guidelines or discharge process with guidance for HIS use or integration could be found either locally by the Western Cape Government Department of Health and Wellness (WCG:H&W) or nationally by the National Department of Health (NDOH).

Poor continuity of care in the Western Cape

In July 2022, a virtual meeting was held by the Standing Committee on Health to review TB programmes across the Western Cape Province and to discuss the formation of a TB ad hoc Committee for the province (34). For the year, July 2021 to June 2022, the province had 46 119 new TB cases with 4156 TB-associated deaths. An estimated 10% of TB diagnosed patients did not return for results or treatment initiation. Innovative ways to strengthen the system and reduce LTFU was considered particularly the use of telemedicine to follow up on those who have disengaged from treatment c. A further stakeholder engagement meeting was held in December 2022 (35). At this meeting the WCG:H&W outlined a response plan to increase awareness and iterate the urgency of TB which has been the leading cause of death in the province for over ten years. The plan includes improving the turnaround time and number of new diagnoses, facilitation of early treatment initiation and to increase treatment completion. There was also a call to incorporate the use of technology as part of the solutions. The four domains of focus for the response plan include prevention, case detection, adherence support and counselling, and linkage to care.

Additionally, a recent situational analysis was undertaken by the WCG:H&W (36). Its basis is the understanding that Health Information is a crucial component to any health system and investing in and appropriately using data is fundamental to HSS. Since the inception of the Provincial Health Data Centre (PHDC), the WCG:H&W is thought of as a data rich department. The PHDC merges and/or synchronises patient-level information, drawing data from multiple health information systems to produce a single patient record which can be accessed through the Single Patient Viewer (SPV) platform. It is also able to generate disease specific reports and collate data from laboratory results, pharmacy systems, clinical records and registers across hospital or primary care platforms (4). According to the situational analysis, the availability of data has not translated into improved patient outcomes. Reasons for this include accessibility of information systems, lack of IT infrastructure particularly at facility level, usability of data reports, awareness of data resources, lack of data interpretation skills, organisational culture of utilising data for decision-making and continuous improvement.

At another stakeholder engagement meeting, the WCG:H&W presented feedback on the Provincial TB Response Plan where it was indicated that 91% of clients with confirmed TB were initiated on treatment with 69% of those successfully completing treatment and 26% of clients were LTFU between 2021 to 2023 (37). From these reports it is clear that continuity of TB care of confirmed clients is a serious concern in the WC, highlighting the need to address the challenge of continuity of care

(34)(35)(36)(37).

Research question, study objectives and substantive relevance

Research question

Given this review of relevant literature and experience, this study will address the following research question:

What are the facilitators and barriers to using health information systems to strengthen continuity of TB care between a district hospital and primary healthcare centres?

Study Objectives

For this study, we aim to understand how the current use of HIS may facilitate or detract from continuity of care for patients discharged from hospital with TB. We aim to:

1. Describe the current HIS process for TB patients discharged from a district hospital.
2. Explore the HIS barriers (or facilitators) that clinicians experience, which may impact continuity of care at PHC level.

Substantive relevance

As discussed earlier, TB care and TB LTFU are critical priorities for the Western Cape province and South Africa as a whole. Some qualitative studies have previously indicated health system barriers as critical factors in reducing LTFU, as reported earlier. However, these studies have not fully considered the critical operational details that may explain why patients are LTFU or not linked to care. Subbaraman et. al. (2020) suggests that detailed interrogation of why patients are dropping from the TB COC and understanding barriers to successfully engaging patients in TB care may assist with developing more robust TB programs (38).

In the Western Cape, moreover, Kallon and Colvin (2022) found that systemic weaknesses in health care delivery promoted LTFU, including procedural problems like unclear referral and discharge pathways (17). However, root cause analysis of these systemic problems has not yet been undertaken. At the same time, the report by MEASURE Evaluation and the USAID, examining how to improve continuity of care found that investing in, and strengthening HIS by improving tools like electronic health records (EHR), can improve continuity of care (30). Better understanding the role of HIS in limiting or promoting LTFU is then important to improving TB care. Further, quality improvement

initiatives and interventions to improve outcomes may subsequently be founded on these studies (38).

Study Setting

A district hospital in Western Cape Province was identified to be the focus of this study. District hospitals were envisioned to provide support to the PHC platform and to ensure good clinical standards within their defined district. District hospitals receive referrals from PHC and may refer patients back to the community for continuation of care. The District Hospital commands a critical position in the district, with consequences for population health outcomes, because of its allocation of specialist human and technical resources. It should provide outreach and clinical support to healthcare workers at primary care facilities as well as public health expertise. Further important functions of the district hospital include skills transfer through clinical training, sharing of resources and utilising PHC data around mortality and morbidity for the planning of clinical services and health systems strengthening (39)(40)**.**

Victoria Hospital Wynberg (VHW) is a large Metro District Services Hospital in Wynberg, in the southern suburbs of Cape Town. It falls under the governance of the Southern Sub-district which serves the geographical areas stretching from Wynberg and Kenilworth in the north, to the southern areas of Masiphumulele and Simonstown; across to Phillipi and Lavender Hill, and Imizamo Yethu and Hout Bay, east and west respectively. It has 203 inpatient beds and treats approximately 100 000 patients, annually. It serves a large drainage area with a population close to 1 million people (41). Roughly 80% of this population is uninsured and reliant on public services and social grants (42). VHW offers specialist care across a range of disciplines and is the hub to which 20 primary care facilities and one small district hospital refers to. It also serves self-referred patients and patients referred from private facilities such as general practitioners (GPs) and private hospitals.

The hospital is 132 years old and was initially built as a Cottage Hospital with only 14 beds in 1889. Over the years, extensions have been built on to the original building, but space has always been and continues to be constrained. The layout of the building has not been designed to accommodate the increasing amounts of infectious diseases seen as iterated by the VHW Infection Prevention and Control Committee (IPCC) (43)(VHW IPC Committee, 2021).

Looking at data for Victoria Hospital Wynberg (VHW), the district hospital serving the Southern

Subdistrict, a few noteworthy values are seen from the TB Cascade Outcomes for 2021 (***Error! Reference source not found.***). Of a total of 435 cases diagnosed at VHW in 2021, 88% of cases were started on treatment at VHW. 11% of TB diagnosed patients only received treatment on admission with no primary health care treatment thereafter. This translates to 48 people with untreated TB, with the potential to infect a further 480 to 720 people over the subsequent year. A low 38% total were captured as having successfully completed their TB treatment. This is a significant gap from the Global End TB Strategy which aims for 90% of TB treatment coverage with 90% of those treated achieving successful treatment completion. These values warrant a closer look at the processes meant to link patients to care but seem to be falling drastically short.

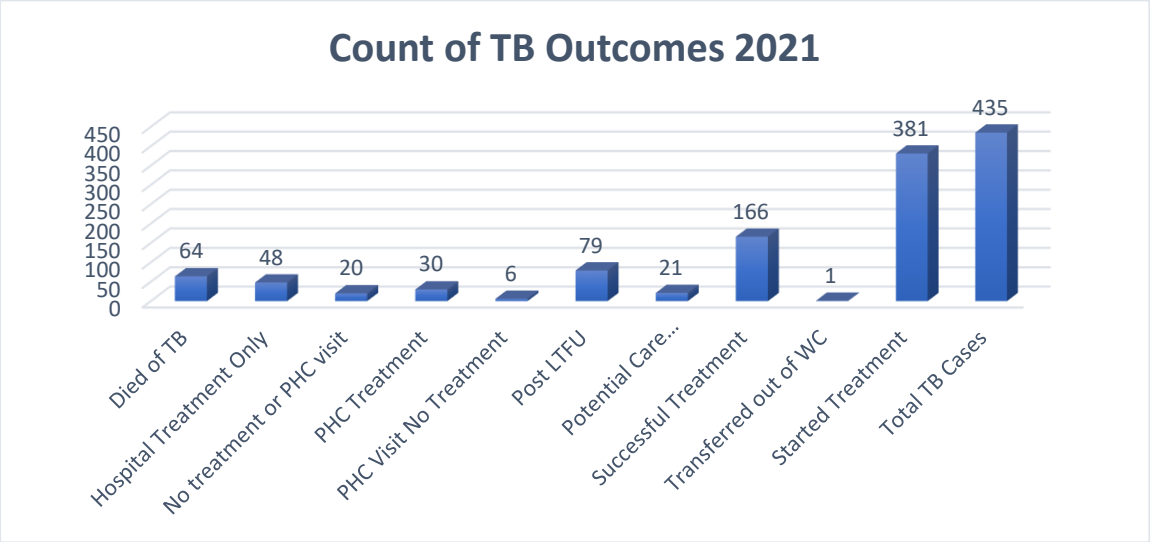

Figure 1: Graphical Representation of TB Outcomes for VHW 2021

Source: SPV TTAL report for VHW 2021

Research Purpose and Conceptual Paradigm

Study purpose

This research will seek to describe the current HIS, - explore how it is used and the barriers to using the HIS to support the TB patient discharge from a district hospital and downward referral to primary health care level. Exploratory research endeavours to obtain insight into and clarify poorly understood situations (45). This study will be used to understand the current HIS processes and challenges experienced between clinicians and hospital clinical departments, and how this may impact the intended patient care envisioned by the Department of Health (DOH), provincially and nationally. It will further attempt to understand whether there are any deficiencies in the HIS, or its use, which may impact on follow-up, continuation of TB treatment and overall linkage to TB care at PHC. Consideration

of how these factors may influence the expected outcomes or why these factors exist will be considered for future research. Where possible, evidence-based recommendations about discharge processes from hospital and linkage to primary health care will be offered as well as considerations for policy and implementation.

Conceptual Paradigm

This research will be broadly rooted in the paradigm of relativism. Through a relativist epistemology we aim to understand how the function of HIS impacts TB continuity of care at a district level hospital and which factors, contextual or other, may facilitate its usefulness. From this perspective, it is understood that health systems are complex and are constructed by the actors within the system and shaped by their behaviours based on experience and/or interpretation of their work or the system (46).

This paradigm highlights the importance of engaging actors' views and experiences better to understand the complexity of health care processes and interactions between healthcare providers, healthcare users and health information systems (45).

Research Design and Study Strategy

This research will adopt a flexible approach and is an exploratory cross-sectional study, that seeks to understand the HIS processes and utilisation of HIS in relation to TB care and discharges at a district hospital in Western Cape.

Two phases are envisioned for the research as depicted in *Appendix A*, with qualitative data being used to evaluate HIS facilitators and barriers to linking TB clients to community care. The first phase will involve analysis of secondary data, previously collected as part of a process mapping undertaken to understand the steps in TB management from admission to discharge. HIS barriers and facilitators to discharge and linkage to care will be identified. This information will then be used in the second phase of research, to guide the content of semi-structured interviews with purposively selected respondents.

Research Phase 1: Secondary data analysis

Data to be analysed

To understand the current processes around TB care, the patient journey, processes and information flow was mapped through a process of value stream mapping for Victoria Hospital. Interviews were conducted with key stakeholders to inform the mapping process. These stakeholders are key in the operational and clinical management of TB patients and included administrative clerks, junior and senior clinicians, managers, and different categories of nurses at Victoria Hospital.

Value stream mapping, more specifically, is a "*visual representation of the flow of people, material and information in a complex system"* (47). A value stream map is a tool derived from the LEAN philosophy, a methodology that optimises human resources, effort, input and other resources in an organisation to create the best value for clients (47)(48). Value stream mapping is a variation of process mapping, which not only analyses each step in a process but also considers work that may not add value to a process or outcome(48). In-depth process mapping provides the basis on which process improvements can be built and systems efficiency can be enriched (49).
In broad terms, process mapping attempts to determine every step and decision and influencing factors of a process. This can assist in the identification of opportunities for improvement so that efficiency can be increased. Importantly, it shows the fundamental interrelationships and interdependence between the different steps in a process.

The data avilable from the process mapping considers the following processes (TB patient refers to confirmed or suspected TB case) (see **Appendix F**):

1. TB patient presentation to the Emergency Centre (EC)
2. TB patient flow through the EC
3. TB patient discharge from the EC
4. TB patient admitted to ward from the EC
5. TB patient flow and discharge from the ward
6. TB patient flow through and discharge from Outpatients departments
7. Infection Prevention and Control (IPC) team information process

Notes from discussions and/or meetings with different roleplayers informed the development of preliminary process maps. These notes will be reviewed and further analysed. The notes are drawn specifically from 3 meetings/group discussions with members of the hospital infection prevention and control team and members of senior management; walkthroughs of outpatients department (OPD), wards and EC (more spefically Gemba walks (50), which are adopted in the LEAN methodology, with the intention of observing employees going about their daily workplace processes or tasks, understanding what they do and what barriers or facilitators they experience in doing these tasks) that entailed detailed discussions with critical staff in each area (the clinical head of EC, the triage nurses in EC, the acting operational manager of EC, 2 senior registered nurses in the medical wards, the operational manager of OPD, doctors in the internal medicine team); and 2 meetings with staff from 2 PHCs.

Data access was afforded to me by the Scaling Data Grant team, as I am the information lead on TB care at Victoria Hospital. Information on the hospital processes ultimately belongs to Victoria Hospital and authorisation for use of process data was granted by the hospital's chief executive officer and clinical manager.

Data Analysis

For this study, the further analysis of the process mapping data will follow the Value-Stream Improvement Method (48), also rooted in LEAN methodology. The preliminary process maps will be reviewed. Notes and audio recordings from the meetings, discussions and walkthroughs will be compared to them. Once the process maps, notes and audios are corroborated the next step will be to determine which steps in the process add value by successfully progressing the patient or the process to the next step toward the outcome, understanding which steps do not add value and should be eliminated and which steps are necessary but do not add value to the patient (51). Further process map analysis includes understanding the timing of processes, any duplication of work and what delays or bottlenecks exist. Of importance is to understand of any challenges employees may experience in following these processes. The steps from the process maps will be categorised according to Value (value-added activity) – essential inputs because the add value, quality, and result in the desired outcome for the patient; Unnecessary Waste (non-value added activity) – input that is not essential to the patient but is required to facilitate value-added tasks; and Necessary Waste (essential non-value add activities) – processes or inputs that are not essential to delivering the service (51)(52)(53). From these, we will look for the disconnects in the process which will inform us of the gaps, duplication

and redundancy of work, recurring difficulties in the processes, unclear work requirements and objectives as well as complicated steps or conflicting objectives.

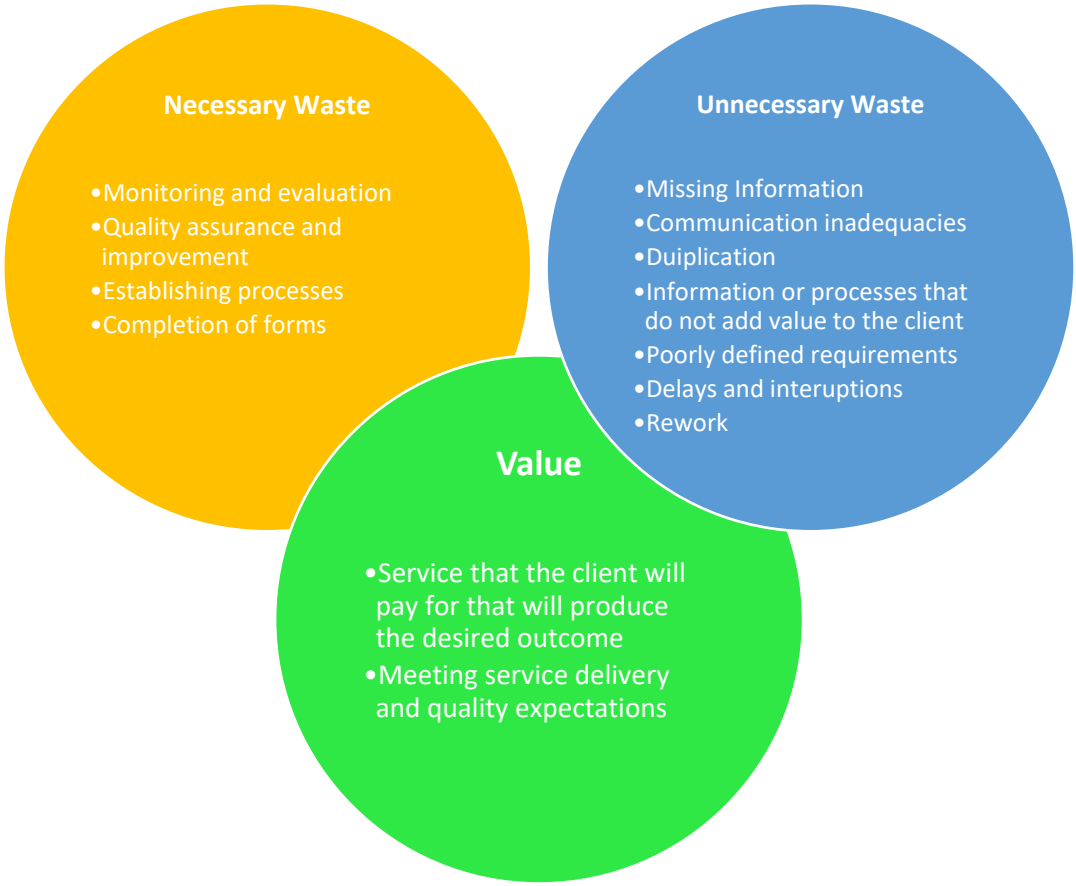

Figure 2: Defining Value and Waste

Source: Adapted from RA Boss Process Mapping Analysis. How Sure Are You That Your Processes Stand Up To The Test Of Bringing Real Value To Your Customer(52)

Overall, the information from the process maps can be used to identify potential problem areas in the TB care pathway. For the purpose of this dissertation, HIS challenges will be the focus of analysis. The identified HIS challenges will then be used as discussion points in semi-structured interviews in Phase 2 of the study.

Research Phase 2: Semi-structured interviews

Semi-structured interviews

Semi-structured interviews will be conducted by the researcher and will be guided by a flexible interview protocol, itself informed by the findings of Phase 1. Semi-structured interviews are a

useful, qualitative research tool that allows researchers to "*understand the thoughts, belief and experiences of individuals*" (54). The benefit of this method is that it allows for the exploration of the process of discharging TB patients through discussing thoughts and ideas, as well as the feelings and beliefs of the interviewees.

Individual interviews will be conducted face-to-face, with audio recording of the interview. Interviews will be conducted at Victoria Hospital, in a private office. All interviews will be conducted in English. Only staff members will be interviewed therefore there is no expectation that an interpreter will be required because all staff are proficient in English. However, should the anyone prefer conversing their home language, an interpreter will be sourced for Xhosa. Informed consent forms will be available in participants preferred language.

Due to the exploratory nature of the research, the interviews will be used to understand specific events and processes and how they were experienced by the respondents. Interview questions will be open-ended and flexible and will probe perceived contextual and systemic challenges regarding the discharge process of TB patients to community care. Broadly, we are interested in understanding, amongst other things *(see Appendix E)*:

- Are staff aware of what is expected of them?
- Have they received training?
- Do they know what paperwork/electronic work is required?
- How do HIS facilitate or create barriers to the expected work?
- Are SOPs and guidelines available for the use of and purpose of the HIS?
- How are HIS used in reality?
- What are the challenges in the processes?

Sampling

Non-random, purposive sampling will be employed to select participants. Participants will specifically be chosen for their knowledge or involvement of TB care provision in VHW, ensuring their functional relevance to this research and support in-depth inquiry.

Participants will be chosen predominantly from among VHW doctors, junior and senior, because they are primarily responsible for initiating and managing the discharge process of TB patients, and they interact with the HIS used for discharges. However, relevant managers, nursing, and pharmacy staff,

as well as administrative clerks will also be interviewed to gauge whether there is general knowledge of the HIS processes.

Junior doctors such as interns will be a specific group of focus as they are expected to execute the discharge processes within the hospital. Understanding their experience will assist in gaining insight around the knowledge base transferred as part of their training, given their knowledge of VHW, specifically, is limited.

Purposive sampling and a flexible study design means that a set number of participants is not exclusively prescribed but rather participants are sampled based on what information is needed and how many participants are available – information that will become more apparent as the research progresses. Ensuring variability among participants – in age, experience, job profile – will also support in-depth assessment (55)(56).

Data Analysis

Data analysis will be undertaken concurrently with data collection. Reflective memos and notes will be taken throughout interviews. Analysis will entail transcribing interviews, and then analysing them thematically by applying descriptive codes, based on the data themselves (55)(57). These inductively generated codes will then be categorised to reveal patterns &/or themes. The categories will be derived both from the data analysed as well as from consideration of existing literature about the barriers to using electronic medical records (58).

Ultimately, a written report of the findings will be developed. This will include a future-state value stream map (48); a revised mapping process that exclude steps in the process that are unnecessary and will include steps that will add value or improve the process outcome. Ideally, this will envision the model way of how TB patients should be discharged and linked to community care to meet the desired outcome of improved continuity of care.

Rigour, Privacy and Ethical Considerations

Conducting interviews and collecting useful information from them, requires establishing trust and rapport between the interviewer and the participants (54). Sensitive data is shared and if participants do not trust the research or the interviewer, valuable information and insights may be lost. It is, therefore, important to clearly explain why the research is needed and how their contribution will be

meaningful. During the interviews, active questioning and clarification of information shared will add to rigour (45).

To further enhance research rigour, analysis will entail triangulation across the different data sources which include the interviews, process map findings, and literature review. The use of existing literature as one source of codes also represents theoretical triangulation (59)(60).

Ethics clearance will be sought from the University of Cape Town. Ethical guidelines for research will be adhered to ensure that no harm will be done to participants and system functionality (45). Informed consent will be taken for all participants. Staff have full autonomy and may opt not to participate without repercussion. Participants will be made aware that the research is an evaluation of the systems rather than assessment of their work ability. *(See Appendix D for the Information sheet and consent form)*

All interview transcripts will be anonymised, and participants will be assured about the confidentiality of information. Interviews, audio recordings and analysis will be stored electronically in a password protected folder on a password protected device. No other staff has access to this device. The device will not be stored on the hospital's premises.

Positionality

It is important to acknowledge my own position at Victoria Hospital. I am a senior doctor with 10 years of work in the hospital, and I am associated with the management team for quality improvement work.

In this position I already have trust and rapport with most staff members, and I have knowledge and awareness of both contextual and cultural factors at play in the hospital. However, my seniority may impact trust and ease of interviewees, particularly that of junior staff members. I need to be fully cognisant of my own positionality (61)(62) and how it may influence the research process – as I conduct and analyse interviews; and in terms of protecting the confidentiality of my interviewees. I will maintain a researcher diary to record observations and thoughts around my positionality and will discuss these issues with my supervisors, as sounding boards, during the research process.

Limitations

This research, as a result of its cross-sectional design, has potential limitations. Collecting too much data, time constraints and the snapshot overview may impact the depth of the research. There are concerns that this design may lack scientific rigour, but this will be addressed through the trust gained by the working relationships I have with colleagues who will be the interviewees. To further strengthen the rigour, I will ensure research transparency by making the research methods, data collection and data analysis as well as results freely available.

Research bias may also readily present itself in different forms through this design. The main possible forms of bias include sampling bias and interviewer bias. However, as discussed, the purposive sampling approach is appropriate for this exploratory study and awareness of my own positionality will be constantly considered through engagement with my supervisors during the study.

The research seeks purely to understand current factors that may impact the successful use of HIS to link TB patients to community care in Victoria Hospital. This means that the outcomes may not be transferable to other settings. However, there is opportunity for learning of relevance to other settings, and insights into future research that may be undertaken.

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Part B: Journal Manuscript

Factors associated with health information systems that influence continuity of TB care between a District hospital and Primary Healthcare facilities.

Targeted Journal: BMC Health Services

Abstract

Background: Tuberculosis (TB) care and TB loss to follow-up (LTFU) are priorities for the Western Cape (WC) province and South African health systems. In 2023, WC reported a TB LTFU rate of 26%, compared to national averages of 14,9%-22,5% for South Africa and between 2,5%-44,9% in other countries. Previous South African studies have indicated health system barriers as critical to LTFU. Such barriers include procedural problems like unclear referral and discharge pathways. Global studies have found that strengthening health information systems (HIS) can improve continuity of TB care. As part of the WC Government's efforts to tackle the provincial TB burden, better understanding of the role of HIS in limiting or promoting LTFU is important.

Methods: A two-phase qualitative study was undertaken in one WC district hospital. This hospital is the referral hub for primary healthcare facilities (PHC) in a subdistrict with 24% TB LTFU. Phase 1 involved secondary data analysis of process maps previously developed within the hospital and identified challenges to successful continuity of TB care between the hospital and PHC level. This analysis informed the content of subsequent semi-structured interviews with 20 hospital staff members, purposively selected to offer insights from different departments and staff groupings. Thematic analysis across data sets identified the main HIS barriers and facilitators to continuity of TB care.

Results:

Barriers to using HIS for TB care included lack of training around TB administrative processes, with poor understanding of information requirements for successful referral of TB care, and the absence of standard operating procedures for using HIS. Challenges with the HIS platforms included incomplete data and fragmented information systems which are not accessible to all PHC facilities.

Facilitators for continuity of care included the availability of clinical information, while a model could be adopted from the electronic referral system to specialist TB hospitals with direct communication between clinicians.

Conclusion:

The effective use of HIS to enable continuity of TB care between a district hospital and PHC could be enhanced by training around standard operating procedures and improving administrative pathways for HIS use. Further research is also important.

Keywords: Health Information Systems, Continuity of Care, Tuberculosis, Loss to Follow Up

Background

Tuberculosis remains a significant global health challenge and South Africa (SA) has one of the world's highest incidence rates (1)(2). Despite efforts to improve diagnosis and treatment, loss to follow-up (LTFU) remains a persistent issue which poses a challenge to effective TB management, both in South Africa and globally (3). In the context of TB management, "loss to follow-up" (LTFU) and "initial loss to follow-up" (ILTFU) refer to different stages in the patient care process where individuals are lost to the healthcare system. From previous World Health Organisation (WHO) definitions, LTFU referred to TB confirmed clients who start treatment but do not complete it, while ILTFU referred to clients who are diagnosed with TB but do not register for or initiate treatment (4). From the WHO 2021 TB treatment outcome definitions, LTFU is defined as "*A patient who did not start treatment or whose treatment was interrupted for 2 consecutive months or more*" (5).

Various factors contribute to LTFU including socio-economic challenges, stigma associated with TB, inadequate healthcare access, and the migration of clients (3)(6)(7)(8)(9). Additionally, the complexity and duration of TB treatment often result in poor adherence, leading to LTFU, and also compromises individual client outcomes and public health objectives. Problems experienced include treatment failure, disease progression, and the development of drug-resistant strains, posing a significant threat to global TB control efforts (3)(10). Interrupting treatment also increases the likelihood of transmission within communities, perpetuating the cycle of TB incidence and exacerbating the burden on healthcare systems (3)(10). These factors have an additive effect and together weave a system of causal pathways that promote treatment disengagement (11).

Continuity of care is crucial (COC) in addressing TB LTFU. In South Africa, continuity of care is considered as comprising the provision of consistent and appropriate care to the client, including follow-up care, regardless of being treated by different health workers (6)(7)(8). Key COC components include early detection, timely initiation of treatment, regular monitoring of treatment adherence and response, provision of client education and support, and seamless transitions between different levels of care (6)(7)(8). COC is enabled by the handover of a client's health information records from one healthcare worker (HCW) to another to support continued treatment.

Health Information Systems (HIS), thus, play a crucial role in addressing TB LTFU and ensuring COC through facilitating the collection, management, and analysis of client data, enabling healthcare providers to track clients' progress, monitor treatment adherence, and identify those at risk of LTFU (12). By integrating TB-related data into health information systems, healthcare providers can better coordinate TB care, identify gaps in services, and tailor interventions to meet clients' needs (12).

A report of HIS strengthening (HISS) measures, by MEASURE Evaluation and the United States Agency for International Development (USAID), documented how HISS may improve COC across a range of disciplines, including by referral strengthening. The report emphasised that an effective HIS must be user-friendly, facilitate continuity of care, and enable easy data collection for monitoring and evaluation, and informed decision making (13). The report also considers the amount of information users need to enter for reliable data extraction, the extent of training required, and the support and maintenance that will be needed to successfully roll out and use the HIS. Any problems meeting these considerations may result in unintentional misuse of the HIS which may include either underutilisation, incorrect use of or outright rejection of the HIS (13).

Unfortunately, efficient information and surveillance systems can be difficult to implement (14). Globally, and especially in LMICs, there is difficulty providing quality health care in the face of reduced resources, the high complexity of health care and the increasing burden of disease (15)(16)(17). It has been seen that challenges with the safety and quality of health services are often due to operational and systems failures (15)(18)(19) relating to information, equipment and material defects (19). Health information system inefficiencies in South Africa have specifically been considered by Wright et. al (20), who considered the role and focus of the country's various electronic HIS. They reported that manual HIS may impact the quality and continuity of care (COC) as a result of, amongst others, errors in data capturing as well as duplicated or misplaced client files (20). The review of electronic HIS further suggests that the efficiency of clinical work may be impacted when such HIS do not seamlessly fit with work processes (20).

Globally, it is recognised that efforts to strengthen health information systems must prioritize interoperability, data security, and privacy to ensure the seamless exchange of information while safeguarding client confidentiality (21)(22)(13). Investing in robust health information infrastructure and capacity-building initiatives can, meanwhile, empower healthcare systems to effectively address TB LTFU and promote continuity of care, ultimately contributing to improved TB control and prevention efforts on a global scale (12)(23).

Improved treatment outcomes and enhanced continuity of care is possible when there is standardisation of work processes and optimal use of data for informed decision-making (13). If HIS can improve data outputs and subsequently, communication and health outcomes (24), then it follows that in every setting HIS must be interrogated to understand their strengths and/or weaknesses in providing a sound platform for effective communication and subsequent improved COC in TB care.

This study probed the HIS processes and utilisation of HIS in relation to TB care and discharges at a district hospital in the Western Cape province of South Africa, and sought to address the question: '*What are the facilitators and barriers to using health information systems to strengthen continuity of TB care between a district hospital and primary healthcare centres?*'

It is important to note that this research considers newly diagnosed TB clients, those with presumed TB as well as those previously diagnosed and already on TB treatment, therefore considering clients lost to follow up both initially and at later stages of the treatment process.

Methods

Study design and setting

This research study was an exploratory cross-sectional study, that included two phases. The first phase entailed analysis of secondary qualitative data, previously collected through a process mapping exercise, to identify critical problems impacting on TB case finding and the continuation of TB care. Phase 1 findings were then also used to guide the content of the semi-structured interviews conducted in phase 2. These interviews sought to understand in more detail the experience of participants in interacting with HISs and working through TB administrative processes. Together the findings answered the research question.

The Western Cape province, one of nine South African provinces, was the setting for this study because it has one of the highest TB incidence rates nationally with an estimated incidence rate of 681 per 100,000 population, which is higher than the national average of 468 per 100,000 population and a provincial LTFU rate of 21%-26% (25)(2)(26)(27). In addition, since 2021 the Western Cape Government Health and Wellness (WCG:H&W) department has actively sought to strengthen TB care and address TB LTFU within the City of Cape Town, through improving HIS access and data use. This work is supported by the Scaling Data project implemented within the WCG:H&W Metro District Health Services, covering the City of Cape Town (28).

Within the South African health system, district hospitals provide clinical support to PHC facilities and down refer clients to continue TB treatment at PHC. More broadly, they hold a pivotal role in any district, with impacts on population health outcomes due to their specialist human and technical resources. Further important functions of the district hospital include skills transfer through clinical training, sharing of resources and utilising PHC data around mortality and morbidity for the planning of clinical services and health systems strengthening (29)(30).

The hospital purposively selected as the study site is located within Cape Town and is the referral centre for 20 PHC facilities and one other small district hospital, and falls within a subdistrict that has particularly high TB LTFU rates (31).

Research Phase 1: Analysis of secondary data

As part of the wider Scaling Data project, data about TB care pathways and factors influencing them were collected between April 2022 and March 2023 through different modalities within an overall exercise of process mapping conducted within the study hospital.

Process mapping is considered a fundamental principle of quality improvement approaches in healthcare(32)(33). Process maps are visual representations of the series' of actions necessary to achieve an outcome in a process (32)(33). The mapping process requires key role players to engage with each other in an effort to have a common understanding of the process or system that is under review. Through the mapping they develop comprehensive knowledge of existing practices and what may be required to improve the processes of focus (15).

For this study, the annotated process maps from the study hospital were examined and each annotation indicating a process gap was categorised by cause. Further analysis entailed listing the identified process gap themes in an excel worksheet and quantifying them, to identify the range of problem areas experienced, and frequency of their identification. This analysis (**Figure 3**) clearly showed that information systems were judged by those involving in the process mapping to be the biggest problem in the TB care pathways. Further analysis of the gap data from the process maps, undertaken specifically for this study, then explored the particular nature of these information system problems, and phase 2 of the study allowed more detailed exploration of them.

Research Phase 2: Semi-structured interviews

Data collection

In Phase 2 of the study, semi-structured interviews allowed more detailed exploration of the challenges experienced with the study hospital's TB information systems, as initially identified in phase 1. Non-random, purposive sampling was employed to select interview participants, based on their knowledge of or involvement in TB care within the study hospital – so ensuring their functional relevance to this research and supporting in-depth inquiry. The variation among participants – in experience and job profile – also supported in-depth assessment (34)(35). Three departments were first elected as most relevant to the provision of TB care in the hospital, and then participants were purposively selected within each department (and at hospital level) to offer different insights of relevance to TB HIS and care. **Table 1** summarises the departments and groups of staff within these departments that were selected for interview and presents the rationale for their selection. For each department, it was intended to sample all of the staff in each group but in practice, due to time limitations

for the study and work commitments for staff within each group, a sub-set of participants in each group were selected for interview on the basis of their availability.

Participants were approached by TE to request participation and schedule a suitable day and time for the interview. No selected interviewees refused to participate. Interviews were conducted in person in December 2023. Consent to be interviewed and audio recorded was requested and obtained from each participant; and information was relayed regarding voluntary participation. The duration of interviews was between 24 to 60 minutes. Recordings were transcribed using TurboScribe software. Transcripts were anonymised with each participant allocated a unique identifier to maintain confidentiality. All transcripts were reviewed to ensure accuracy and supplemented with the notes made during the interview, where applicable. The audio files and transcripts were kept on a password-protected device.

The characteristics of the 20 participants interviewed are represented in **Table 2**. They had a total of 251 years' experience between them (not all in the study hospital), ranging from 1 to 45 years. Two participants were not directly involved in clinical TB care and two indicated administrative involvement. 15 participants were primarily trained as medical doctors, with various job roles including senior doctors in management positions as well as junior doctors with one year's experience. Three participants were trained professional nurses with clinical and management experience and two were senior administrative clerks with 16- and 30-years' experience, respectively.

Table 1: Choice of areas and staff to interview

Departments	Justification	Staff	Rationale
Emergency Centre	First point of contact for acutely unwell patients. Department where many TB suspects who are discharged back to the community for follow up are seen.	**Consultant**	Understand practices within the department.
			Sets the expectation and standard of care for the department.
			Oversee teaching and service provision, so may impact on other health care workers.
Internal Medicine	Majority of TB patients requiring admission are referred to and admitted to Internal Medicine.	**Medical interns**	Of junior doctors, they see the most TB cases.
			Required to do most of the administrative work, such as managing discharges.
			Most likely to interact with paperwork and health information system.
		Permanent Medical Officers	Most likely to know practices and expectations within the hospital.
			Train and oversee junior staff such as interns, so maybe impact on their practices.
		Registrars	Rotate through different healthcare facilities, have potential to reflect on experience in study hospital compared to other facilities.
			Can feedback what expectations have been expressed when starting at the hospital, and what orientation includes.
			Expected to teach and oversee junior staff, so maybe impact on their practices.
		Consultants	Understand practices within the department.
			Sets the expectation and standard of care for the department.
			Oversee teaching and service provision, so may impact on other health care workers.
Surgery	Department which regularly consults on TB cases.	**Surgical intern**	Understanding of processes in the surgical department such as TB discharges and referrals as they would be required to facilitate and complete them.
		Consultants	Understand practices within the department.
			Sets the expectation and standard of care for the department.
			Oversee teaching and service provision, so may impact on other health care workers.
Hospital Level	Various staff within the hospital including hospital managers to explore experiences and understanding of these particular individuals within the organisation.	**Operational Manager**	Sets the standard of care within a ward for the nursing staff.
			Provide in-service training for nursing staff within their wards.
		Information Management Clerk	Understanding of TB HIS and data reporting requirements for the hospital.
		Senior Administrative Clerk	Coordinate paperwork and processes for TB patients, such as appointments etc.
		Clinical Manager	Oversees all clinicians and provision of clinical services
			Sets the standards for clinical care and governance
		Nursing Manager	Oversees all nursing functions and nurse-led programs and services within hospital such as Infection Prevention and Control.
			Ensures nursing training and standards of care.
		Infection Prevention and Control Coordinator	Manages the Infection Prevention and Control programme for the
			Monitoring and surveillance of TB cases within the hospital.
			Previously tried to link each TB case to a PHC facility.

Table 2: Participant Demographics

Participant	Gender	Profession	Total Years of Experience	Direct interaction with TB patients	Frequency	Capacity
P1	Female	Medical Doctor	1	Yes	Daily	Clinical
P2	Female	Medical Doctor	1	yes	Daily	Clinical
P3	Male	Medical Doctor	18	Yes	Daily	Clinical
P4	Female	Medical Doctor	6	Yes	Daily	Clinical
P5	Male	Medical Doctor	20	Yes	Daily	Clinical
P6	Male	Medical Doctor	1	Yes	Daily	Clinical
P7	Female	Medical Doctor	1	Yes	Daily	Clinical
P8	Male	Medical Doctor	13	Yes	Daily	Clinical
P9	Female	Registered Professional Nurse	14	Yes	Daily	Clinical
P10	Male	Administrative Clerk	30	Yes	Frequently	Administrative
P11	Female	Medical Doctor	15	Yes	Frequently	Clinical
P12	Female	Registered Prof Nurse	24	Yes	Occassionaly	Clinical
P13	Male	Medical Doctor	21	No	Not applicable	Not applicable
P14	Male	Administrative Clerk	16	No	Not applicable	Not applicable
P15	Female	Medical Doctor	1	Yes	Frequently	Clinical
P16	Female	Registered Professional Nurse	45	Yes	Occassionaly	Administrative
P17	Female	Medical Doctor	1	Yes	Daily	Clinical
P18	Female	Medical Doctor	7	Yes	Daily	Clinical
P19	Female	Medical Doctor	6	Yes	Daily	Clinical
P20	Male	Medical Doctor	10	Yes	Daily	Clinical

The interview questions focused on:

- *Training and orientation* on TB administrative processes, standard operating procedures (SOPs) and the use of HIS.
- *Legislative requirements* of providing TB care to clients and discharging them into the community and what HIS processes are required for this.
- *Referrals pathways and platforms used:* Training on the TB referral processes including referral facilities and communication, and HIS used to achieve this.
- *Availability and use of HIS:* The experiences, challenges, and positives of the available HISs and related processes.

Data Analysis

Interview transcripts were corroborated with the interviewee notes taken during interviews. They were then analysed using Nvivo software version 14, using the thematic analysis approach (36). The analyst (TE) read all transcripts to familiarise herself with the content. Meaning units were then extracted from the transcripts and coded. The initially coding was deductive based on the groups of information barriers identified in the phase 1 analysis; within each group, subcodes were then inductively generated as the transcripts were analysed.

Data were triangulated across interviews, comparing responses between groups of participants (including across departments) and individuals, and interviewee responses were also compared to the findings on information and HIS barriers from the process map analysis. The challenges highlighted through the process mapping were clarified through the interviews. Finally, as presented in the discussion, data from interviews was compared to existing literature around HIS barriers in healthcare (37)(38) and barriers to COC (6)(7)(8).

Positionality

It is important to acknowledge that the researcher (TE) is a senior clinician working at the study hospital. This could have introduced bias in responses, although no respondent refused to be interviewed when reminded that participation was voluntary. All expressed comfort about being interviewed, suggesting a level of trust and rapport with the researcher. The researcher's own knowledge of the hospital could also have introduced bias in interviews and analysis. To limit this risk, the researcher initially documented her thoughts and judgements about the possible challenges of HIS in relation to TB care. This refers to a methodological approach called Bracketing (39)(40), which seeks to enhance the researcher's own awareness of preconceived ideas, allowing participants to express their own thoughts and reducing bias in the identification and interpretation of themes. These initial ideas did, however, assist in contextualising interpreting the data collected in this study.

Results

The initial mapping process identified the overall set of TB care pathways (or flows) in the hospital (see **Table 3**) and also illuminated how these flows may connect (see **Figure 1**), what HIS are being used (see **Table 4**), and how information is transferred between the flows and PHC clinics. It also, finally, generated an initial indication of what barriers there are to using the HIS (see **Figure 3**).

Table 3: Different flows for TB care and information.

Flow	Description
1	TB patient presents to the EC
2	TB patient flow through the EC
3	TB patient discharge from EC
4	TB patient admitted to ward from EC
5	TB patient flow and discharge from the ward
6	TB patient flow through and discharge from outpatient departments
7	Infection prevention and control team information process

From Figure 4 the general flow through the hospital can be seen, with entry into the hospital care at either Flow 1 or Flow 6. Flow 1, a client presenting acutely to the EC, is the commonest route of admission. From either Flow 1 or 6, persons with TB, confirmed or presumed, are most likely to be admitted to the Internal Medicine Department as noted from EC and Internal Medicine departments through their statistics from the Hospital and Emergency Tracking Information System (HECTIS), which is a web-based data collection system for clients attending emergency centres across the Western Cape (41). A small number of persons with TB may be admitted to Surgery, with fewer to other departments, supporting the purposive sampling approach applied in phase 2.

The flows end with a referral for the continuation of TB care at a PHC facility; or at Flow 5, a TB hospital referral can also be done. Ward discharges are all done via the Electronic Continuity of Care Record system (ECCR) which is a web-based application used by hospitals to prepare discharge summaries for inpatients (40). Flow 3 and Flow 6 do not ordinarily utilise an electronic health record and referrals are often only paper-based. Where ECCR is use for electronic discharges, clients are usually given a paper copy of the ECCR summary to present to their nearest clinic within a few days of discharge. Flow 7 is an adjunct to the other flows and supports infection prevention and control systems within the hospital by ensuring surveillance and monitoring of confirmed TB cases within the hospital as well as striving to ensure PHC awareness of community TB cases.

Table 4: List of commonly identified HIS

CLINICOM	**Clinicom Hospital Information System** A single client administration system, accessible for all clients from any hospital or healthcare facility (20).
ECCR	**Electronic Continuity of Care Record** A web-based application that is accessible and used by all hospitals to prepare discharge summaries for inpatients. The application is also available to PHC facilities to access the discharge information and medication prescriptions (42)
HECTIS	**Hospital and Emergency Centre Tracking Information System** HECTIS is a web-based data collection system for clients attending emergency centres across the Western Cape (41).
NHLS	**National Health Laboratory Services (Trakcare Application)** Standardised, web-based laboratory information and results for each client (20).
NMC	**Notification of Medical Conditions** Notification of notifiable medical conditions via NMC app (or via email). This is for detection, surveillance, public health response and outbreak management of particular diseases (43).
SPV	**Single Patient Viewer** A universal electronic health record that integrates data from all HIS for a comprehensive record of individual client clinical data (44).

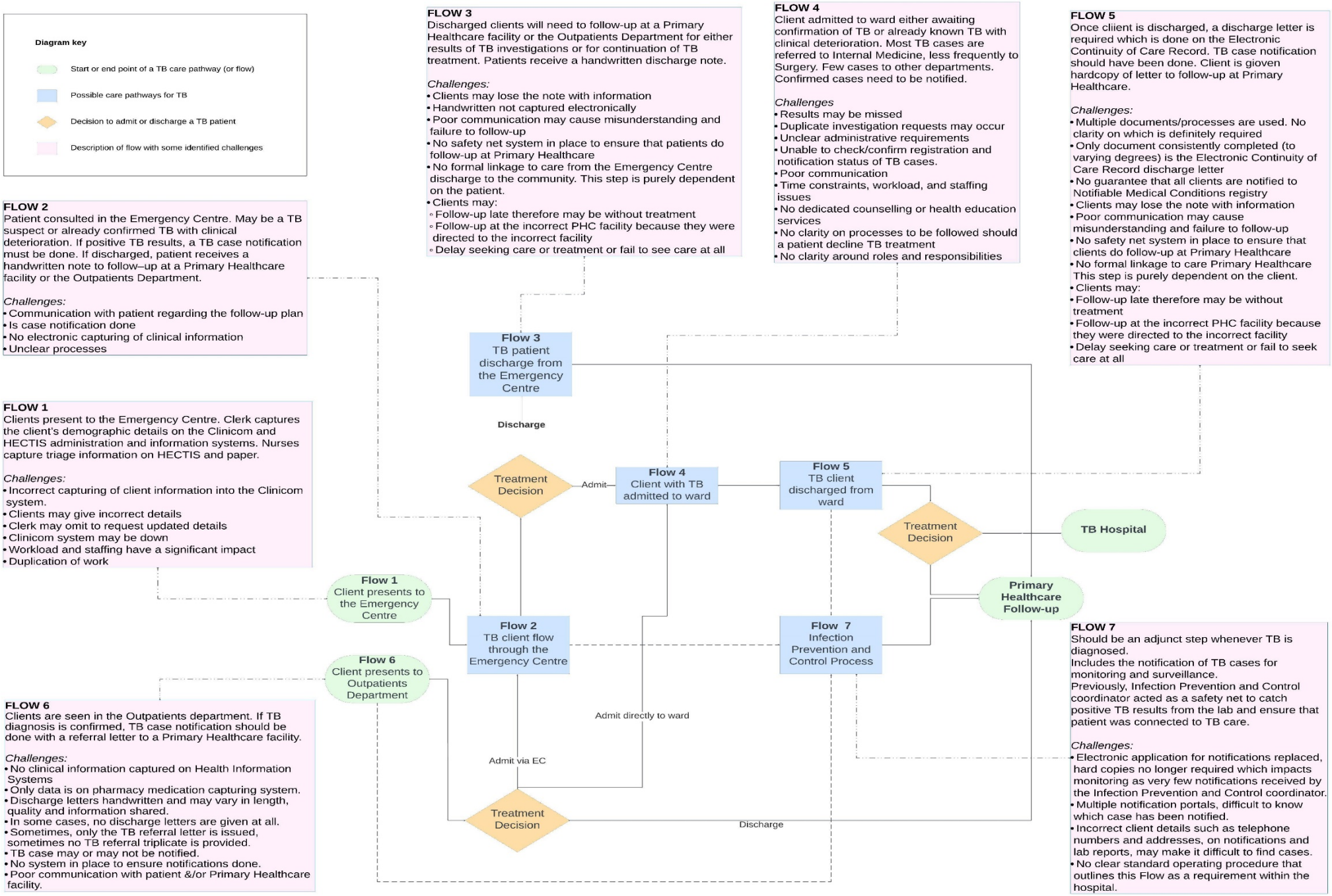

Figure 1: Overall TB Care Pathways and HIS flows at Study Hospital

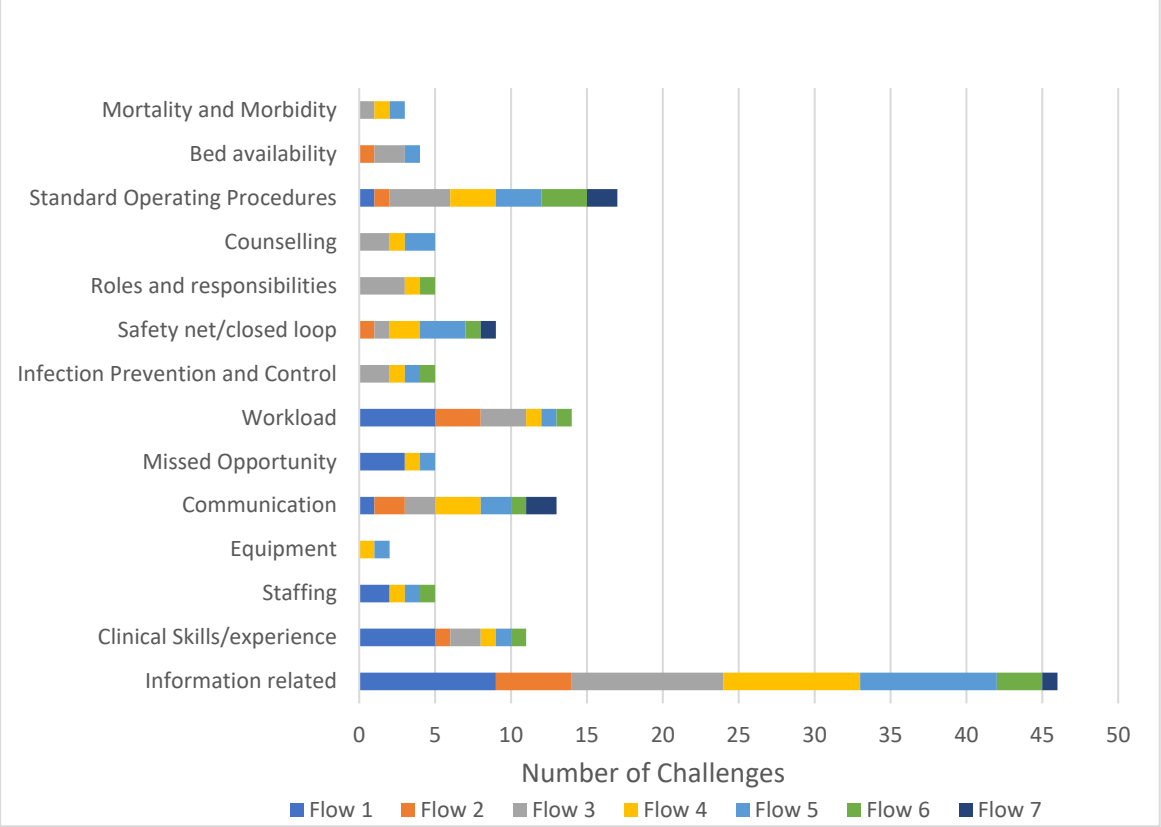

Figure 2: Count of Challenges identified in all the care pathways (flows) identified through the mapping process.

Further analysis of the data about HIS challenges drawn from the process maps indicated that the main groups of problems, as summarised in (**Figure 2),** included:

- *Process challenges* including functionality and usability of the HIS, transferability of information between systems and multiple input platform and data integrity issues such as incorrect data captured, back capturing difficulties, duplication, or incomplete data.

- *Capacity challenges* such as knowledge, skills and training with digital literacy and advocacy for HIS use, clear guidance on standard operating procedures and communication.
- *Infrastructure issues* such as insufficient desktop computers, poor network connectivity, failure to utilise more efficient information technology (IT) solutions and lack of IT support.

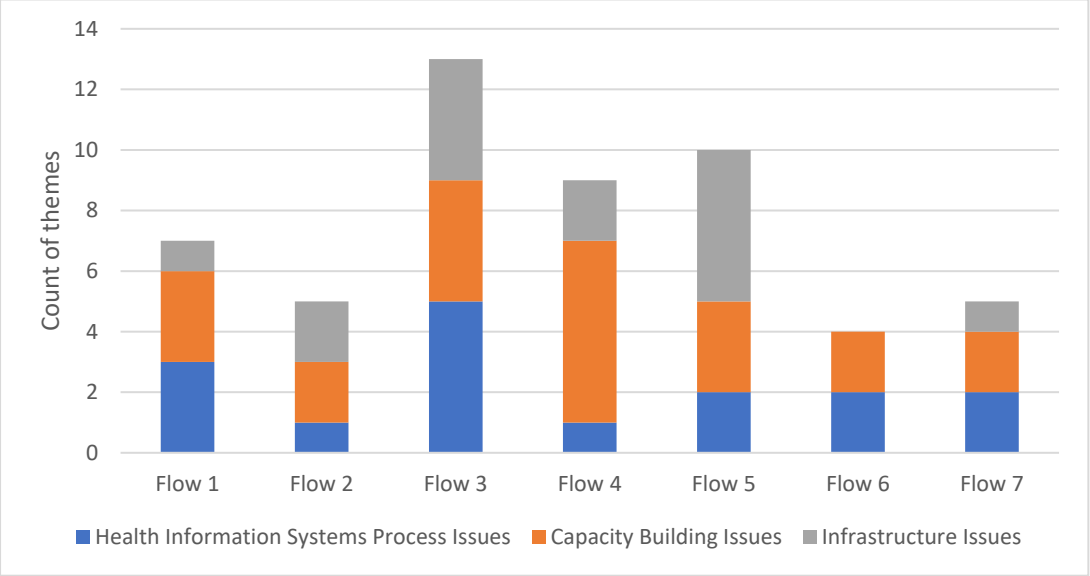

Figure 3: Count of information related barriers by patient care pathway (Flow) in study hospital (identified from process maps).

The HIS issues that were extracted from the thematic analysis of phase 1 informed the main barrier themes considered also when analysing phase 2 data, while the subthemes were derived from analysis of the phase 2 data. Facilitators identified focused on TB COC and were drawn only from phase 2 data. The final list of themes and subthemes are displayed in **Table 5**.

Triangulation of data drawn from phase 1 and phase 2 of the study showed some differences which are highlighted in the text below. In contrast, although respondents were purposively selected to draw on a range of experiences and positions, analysis of interview data showed that there were very few significant differences in responses among respondents. However, the presentation of findings below does highlight differences of experience between staff groups where identified.

Table 5: Themes and subthemes extracted from process map analysis and semi-structured interviews.

Barriers
Capacity Challenges
Training
Workload
Standardisation
Standard operating procedures
Follow-up process
Communication
Process Challenges
Access
Usability
TB Case Notification and Registration system
Data Integrity
Duplication
Data issues
Infrastructure
Resources
Facilitators
Information availability
TB hospital referrals

Barriers

1. Capacity Challenges

Capacity challenges relating to TB administration and HIS use for TB COC can be understood as those factors that limit staff from appropriately using the available HIS to access, enter or share TB related health information to assist with COC at PHC. Capacity building, meanwhile, is considered as *"the development and strengthening of human and institutional resources"* by the WHO (45). Four capacity factors were identified.

Training concerns was the most referenced subtheme in interviews, with all 20 participants agreeing that very little to no training existed for TB administrative processes nor for the various HIS that HCWs are expected to use. The training theme was not extracted from the mapping data analysis.

P4: No, no formal systems training. I think it's very much on the job experience. Kind of being told that these are the patients you must notify and then very much not how to create formal follow up plans or registration with facilities.

P13: When it gets rolled out, there's a bit of training that happens, but there's no, unless there are departments that are doing it that I'm not aware of, there's no ongoing training… And then you get someone with limited understanding and you handover the little bit of understanding to the next person...

Administrative processes broadly refer to non-clinical management processes that support a client to move to the next step of care or to a necessary function such as surveillance of TB. Examples include referral processes, documentation and information required for successful handover and COC at the next facility, TB case notification and case registration. Training should also clarify roles and responsibilities for the different staff members involved in TB care. Training is important because some HIS are not easy to use or may have functions that are not obvious, or requirements that are not clear. Without appropriate training the intended use and even the intended outcomes for healthcare may not be achieved. Most participants agreed that learning took place on-the-job and often colleagues would informally orientate them, even though such colleagues were themselves rarely formally trained. Sometimes senior staff would take guidance from junior staff who may have been more exposed to particular systems and processes elsewhere.

In the process maps, workload was identified by staff as a significant factor influencing the clinicians' ability to provide comprehensive discharge plans and accurately capture this information on the HIS. Interviewees noted that this gap subsequently impacted on the quality of the long-term care plans and communication to the clients who are discharged (and the problems may be compounded by staffing challenges, or limited availability of computers and network connectivity).

P4: … the interns, get dumped with like 10 discharges with a very quick or very short period of time to do them. So, you either do a few good discharges or you do all of your discharges, which I don't like. And I really do think that discharges should be quite thorough. But your time and kind of other commitments probably do impact on it.

P6: … I need to do five discharges and you can't sit down and really process and tick all the boxes all of the time. I think it will be inevitably something that slips through.

There are also not clearly established and well understood SOPs to guide how clients should be discharged to the PHC or to outpatients for follow up. Doctors discharge clients based on their existing knowledge of processes or based on what they have been told. These processes and information may

differ amongst clinicians depending on whether they are permanent staff or locums etc. Challenges included HCWs not having clarity on what is needed for follow-up, where clients should be followed up, not being able to give a specific follow-up date at an identified PHC clinic and not understanding the importance and difference between TB case notification and TB case registration although they are two distinctly different processes, with different purposes. All but two respondents including senior managers, assumed that registration relates to case notification. The consequences of incorrect case notification and registration could include underreporting of cases, impede case finding and poor monitoring and surveillance of TB.

P19: the difference between registration and notification... I don't know what registration is… I know it's not the same, but I don't know what it is.

P6: …SOP wise, I'm sure there is one. But not that I've used or that's been supplied to us or that we've been alerted to.

P8: …something as basic as interns' understanding how much of TB treatment a patient goes home with, or the insights into when they should follow up before the medication runs out, or notification protocols. I don't think we have an SOP...

This was a common finding from both process maps and the interviews. For example, in the inpatient care pathway, significant challenges with determining the required standard of work were identified and no SOPs were available to guide the processes of care for TB clients (see **Figure 5**). This could be seen in the gaps in the TB notification (NMC) process as well as the lack of guidelines around the discharge process, how to link a client to the appropriate PHC clinic and what information is required at the clinic level. The most common process is to provide a client with a discharge letter which is usually, but not always, captured electronically. A notification of medical condition is meant to be done upon diagnosis, but this is often delayed, sometimes even omitted. Clients are issued with a varying supply of TB medication, between 5 days to 1 month's supply. TB case registration is not done at the hospital and no treatment card is issued. Clients who are discharged to a primary care clinic are then required to present themselves at the clinic with the discharge paper in hand, within a few days. Clients are not directed to a specific clinic. Most respondents were not clear where clients should go for follow-up, nor whether all clinics provided TB care. A few participants indicated that they try to look on the internet (using Google) to identify the correct referral facility, but this method is not successful.

P17:…We always just say follow-up with local clinic. We never even check which clinic it is. We just give them a discharge summary…. Some of the sisters look at the discharge summary and then write a card out. But we haven't been giving cards because it takes so much extra time to find the cards… then write a date, find out which clinic the patient goes to. Then they don't know which clinic they go to…

Barriers to communication were also emphasised as a problem in the process mapping and repeated in the interviewees. There is no standard verbal communication practice nor printed information such as a TB leaflet given to clients; only the discharge letter is given, and it may not be explained to the clients. There is also no direct communication with PHC clinics to inform them of the clients that they should expect, and there is no safety net for those clients who do not present to PHC.

P4: I definitely think that there are times that we maybe haven't explained to the patients… they get given a discharge letter and a month of treatment... I don't know if we formally tell them about connecting with the clinic…

P5: There's actually no direct interaction with the facility, where you're phoning them or you're emailing them saying… patient X with TB is coming to start or continue his TB treatment at your facility

P19: …We've tried to get the direct dates because… It hasn't worked well… No one's answered the phones… to make specific appointments. So, what we've been doing now is just giving specific dates that are not booked on the other side, which is creating resentment amongst our primary healthcare colleagues because they say that we don't have the authority to do that and we're not following their systems.

2. Process Challenges

Process challenges related to implementation difficulties, technical challenges, and information-related issues such as data integrity and duplication.

HIS integration between the hospital and primary care clinics was specifically raised by interviewees in phase 2 as a problem. Not all clinics are able to access the same HIS and not all of those who do have access capture the relevant information. If clients lose their hospital discharge letters, HCWs at clinics may not have access to that information. Similarly, if a client requires hospital admission, vital information may be missed if not captured on the electronic HIS platforms at primary care facility

level. Additionally, none of the current HIS indicate where in a client's TB treatment course they are, what their adherence is like or whether they have successfully completed treatment.

P2: …not all clinics put the information on single patient viewer. If they come from a city clinic, we can't follow those patients up… we never know if patients actually complete treatment. None of the systems will tell us if it's a successful completion…

P17: …that clinics don't use ECCR is also frustrating. Yes, we can look at SPV when there were clinic visits, but we can't see what happened, like what the situation was, what they thought happened there…

Respondents noted that access to certain HIS was difficult with applying for logins being particularly cumbersome. One particular HIS, SPV, was described as most helpful because it has comprehensive longitudinal client information across all WCG:H&W facilities, however it was also the one most difficult to access as it requires a government email address linked to an employee's staff number - which locum and short-term contract staff may not have. Another challenge with logging into some of the HIS is that access is facility-specific, which causes problems for the large numbers of staff who rotate through different facilities.

P5: …it's taken me almost a year to get my own access, access to SPV, access to ECCR. For years, it's just been an absolute nightmare to actually get access… this year, my new staff, medical officers, interns, struggle to even get just an email account, which then slows down the fact that you can't get SPV access, you can't get certain accesses.

P18: …most ECCRs are only per facility… but the problem is that sometimes when you add on, they get rid of the other ones… it's like they're block you out from seeing the information.

P19: SPV, would be great if there were any doctors in this whole hospital that had access to it… I applied… six times over the course of two years...

HIS usability problems were raised in both the interviews and process maps. They resulted from multiple HISs with varying access requirements – as discussed – as well as technical difficulties with the function of certain applications, and no feedback mechanisms to easily determine whether certain

processes have been completed. Many participants raised specific concerns about the challenges with capturing TB ICD-10 codes as well as, as noted, difficulties with the case notification application - with at least 5 possible ways of submitting a TB case notification across the various HIS. With the ICD-10 codes, finding the correct ICD-10 was challenging and participants often resorted to an internet search to assist. This, they felt, was a waste of their time.

P20: …the biggest concern is it doesn't integrate further on our platforms. It should be more integrated in terms of automatically linking result versions, PACS, reporting, and I think the actual platform itself could be a little bit more user-friendly in terms of showing patients' flow through the system…

P5: … interact with multiple systems, you have to interact with ECCR… now you've got HECTIS, ECCR, NHLS, you've got to check x-rays on Xero viewer, then you on PACS…

P5: And I don't know exactly what to say to my staff… because now we get told that we can use the NMC paper-based or the NMC app…

Sometimes, the electronic HIS were unavailable due to technical issues such as network updates and power cuts. In these instances, back capturing of information is required but may be omitted due to workloads or no backup processes in place. Subsequently, the information may not be transferred to the appropriate HIS. This was also evident through both process maps and interviews.

P3: …when the server is down… you can't order the x-ray, you can't do the x-ray, you can't look at the x-ray, and you can't get the labs… our backup system is not mature enough to allow us to do offline work.

P14: Obviously you do have connectivity issues… it can become frustrating to a user, where they can't actually do their job.

In both phases of the study data integrity was identified as a problem for continuing TB care at PHC. The lack of data standardisation impacted on the way in which HIS are utilised for TB information. Across departments, there seemed to be different expectations about what TB information is required to be entered into the HIS and this may differ depending on what information is relevant to the department, not necessarily what is relevant to enable COC when the client is discharged to primary care level. Data standardisation within departments is also not consistent. TB data captured in the HIS

varies depending on staff experience, staffing capacity, as well as workload and lack of information and training, as previously indicated.

P1: The thing is though is that it's not standardized… you can get a summary that's really great…'it's so detailed and then you can also get one where it's three lines.

P11: The problem would be information for whose eyes? I wouldn't read the whole paragraph … I would skip to what is pertinent to me. So, when the interns come through to me… we help them very quickly to deconstruct the discharges so that it is relevant for the surgically minded person…

A problem noted in phase 1 was the capturing of client information which was often inaccurate as updated details were not captured or clients relayed incorrect information. It was often found that updated client details were handwritten on the client's file but not updated on Clinicom **(Table 3)**. This was also noted in the interviews.

P16: And the address is not always correct…. Sometimes it will indicate 3 Suikerbossie, sometimes no apartment number, sometimes no street name or suburb...

Lost client folders or misfiling of folders also contributed to information challenges noted on the process maps. However, one respondent suggested that misfiling did not happen frequently at the study hospital.

P8: We have a particularly good folder service, and we can generally rely on the fact that if somebody has been in our facility in the last 5 years, there will be a folder provided and we can review it.

Duplication of data was a concern raised in phase 1 and phase 2, resulting from the use of HIS for some steps in a process and the simultaneous use of a paper-based model for the same process. Such practices were thought to result from limited staff confidence in using a newer HIS system and greater familiarity and trust of the old, paper-based system. Duplication creates more work, reduces efficiency, and increases costs. Respondents also indicated that sometimes they work around the required TB data capturing on the HIS to avoid technical difficulties, as well as what they perceive as duplication of work.

P19: I think people feel like they're giving the same information a few times… I don't think they understand that there's a value to having that information captured formally…also people don't know what some of the parts of that form mean.

P5: …didn't replace the paper-based system... What it did do is it really was an add-on to the current system... why are we duplicating so much work?

3. Infrastructure Challenges

A lack of the resources required to interact with, use or produce an end product related to HIS for TB, such as discharge plans and letters, were also shown to impact on the use of HIS to provide comprehensive information and complete processes for TB care. The most frequent shortage was computers with 50% of participants expressing that access to computers affected their work. This was also reflected in Flow 5 and 6 (see **Figure 3**).

P11. Computers are a problem. There aren't enough computers if we need to do discharges.

The lack of computers is compounded by the demand for them. In one area, the few available computers must be shared between different departments and staff e.g., administrative clerks, nursing as well as two or three clinical departments.

P3: We've got the most PCs per area, in the hospital, and it's still a struggle, when inpatient teams and the nursing teams needs to use the PCs. There's still scope for more, especially, if we are going to look at electronic discharge formats.

Other limiting factors were insufficient printers, network points, and simple hardware challenges such as keyboards and electrical plugs.

P19: …the hardware itself is also a problem.... of the interns have bought their own keyboards because the ones they were using to type was too awful…

Facilitators

Although not raised in the process mapping data, two factors facilitating TB COC through the use of HIS were identified in interviews, with agreement across respondents.

1. Information Availability

Despite the many challenges described there was concurrence that the HIS were helpful to the continuity of TB care where they were accessible. They provide an electronic record of clients' clinical histories, medication and an overall idea of attendance and adherence to TB treatment. Even in cases where comprehensive information may not be available, there is usually enough to gather an idea of a client's TB investigations, diagnoses, and treatment regimens. The HIS in the Western Cape province were noted to be an invaluable part of providing quality TB care, in comparison to the systems some respondents had used elsewhere in South Africa, particularly with the use of a single unique patient identifier.

P4: … Western Cape is miles ahead... having consistent folder numbers and having ECCR and SPV makes a huge difference in finding out previous drug sensitive or resistant TB. It helps a lot just having that context because patients don't often give reliable histories.

P7: …I think they're pretty effective, helpful systems. Especially coming from… where nothing was online.

P20: I think it's invaluable... you can make a very quick assessment of someone's story… I think that goes without saying, it's been a massive success for us. Because I've worked elsewhere that don't have that feedback system. And it's a disaster.

2. Referrals to specialist TB Hospital Complexes

While this is not specifically a facilitator to COC between the hospital and PHC clinics, lessons in the use of this system could be used to facilitate TB COC at PHC. The VULA referral platform electronic application is used to refer clients to specialist TB hospitals and was seen positively by respondents. Vula was originally created with the aim to assist HCWs at PHC level to refer to and seek advice from specialists. While it serves as a referral method, it also stores health information regarding clients

which may be accessed if results, x-rays etc. are required, which is helpful if the facilities do not have access to the same wider HIS - as discussed above, in relation to the integration of HIS issues. The direct interaction with a clinician at the receiving facility, giving the opportunity to clarify uncertainties regarding client care is another useful feature. This process also allows the receiving facility to allocate a receiving date. The availability of a guide on which clients to refer to which TB hospital also improves the efficiency of the HCWs doing the referrals. These experiences are quite different from those around referral to PHC clinics, as discussed earlier.

P15: …there's an orientation book that we got for the interns which briefly describes the criteria for DP Marais, Brooklyn Chest...

P5: If we are discharging the patient to a TB hospital, then there needs to be a referral to the TB hospital, giving them information about the patient, and allowing them the ability to ascertain whether that's an appropriate referral to their care.

P8: VULAs… There's a digital accountability. I think particularly for TB hospitals, I think it works pretty well.

Discussion

This study intended to determine the HIS-related barriers and facilitators to successful COC for TB clients, between the district hospital and primary care level. In the discussion we compare experience from the study hospital with wider literature, to consider how widespread the challenges identified may be and what the study adds to the existing knowledge base.

The main barriers to using HIS for TB administration to promote continuity of TB care included process challenges, capacity challenges and infrastructure deficits. Noticeably, fewer concerns related to the usability and functionality of the HIS itself were raised compared to factors that support the intended use of the HIS for TB care, and how these factors then impact the eventual COC of a TB client.

Usability (a process challenge) of the HIS was impacted by multiple HIS needing different access credentials, the time required to use the HIS and technical difficulties with the functionality of certain HIS applications. Where functions were unclear or troublesome, participants may simply avoid using the HIS altogether. Accessibility (also a process challenge) was the key reason certain HIS were not used and related to the inability to gain login credentials for some systems. This included the inability to access some HISs such as SPV because a WCG:H&W email address is required which many staff do

not have especially locums and sessionists. Additionally, the multitude of systems means that multiple passwords need to be remembered; and with frequent password changes and forgotten passwords, it becomes cumbersome to request access repeatedly. Those without access may either avoid using the HIS or borrow access credentials, resulting in reduced efficiency of workflow and data recording (37).

Participants felt that fragmented HIS (another process challenge) between laboratories and health facilities or between different health facilities, also had a negative effect on COC. This has also previously been reported for TB care in South Africa (46). The structure of the Cape Town PHC system, with two parallel health service providers (local and provincial government), meanwhile, means that available facilities do not all have universal access across all the existing HIS e.g., WCG:H&W HCWs do not have access to the Patient Record and Health Management Information System (PREHMIS) used in primary care clinics operated by the City of Cape Town. The aim of PREHMIS is to record basic patient information and the various services provided, enabling the generation of automated reports. (20). It mainly focuses on management information, which means not all clinical details are stored in the system. HISs in the WC may also not be accessible to other provinces in South Africa (44). Internal migration of South African health care users is a known phenomenon (47), and migration in itself may disrupt TB COC and the usefulness of HISs, and promote the spread of infectious diseases such as TB (9).

Nationally, there are two TB registers that are used: the national electronic TB register (ETR.Net) for drug-sensitive TB data, and the electronic drug-resistant TB register (EDRWeb) for drug-resistant B data. Additionally, the Three Integrated Electronic Registers (TIER.NET) is a national software system for monitoring and evaluating, capturing standardized data of patients on antiretroviral and TB treatment (48). Apart from using TIER.Net for capturing ARV data, these systems are not used within the study hospital and participants were not aware of these systems, which minimises its overall usefulness. With the integration of TB and HIV program data, the TB module for TIER.Net replaced the paper-based TB register at facility level. This provides immediate and easy access to both individual and aggregated TB data (49). One setback for this system however, are the cases that are not registered (50).

These findings suggest that an integrated system should be implemented in future, with one interface for all aspects of the various HIS including investigations, attendances, medications, imaging, and clinical records. Such a HIS must accommodate simple user registration requests with responsive IT support. The WC's SPV HIS is a universal electronic health record that integrates data from all HIS for a comprehensive record of individual client clinical data. It's strength is that it attempts to have single

unique identifier for each client and makes an effort to merge information where the system identifies the same demographic information (such as national identification numbers) for clients with multiple patient identification numbers (44). However, from this study we have seen that it is difficult to gain access to SPV. Additional concerns include the lack of comprehensive clinical information on SPV where accessing another HIS is then required for clinical details of hospital admissions etc.

Data integrity concerns (a process challenge) were raised by most participants and include not only the accuracy of reporting and the amount of clinical data captured, but also the understanding of what TB data to report and how to report it using the HIS. Concerns around the accuracy of client demographic details as well as completeness of discharge summaries were raised. Mlotshwa et al. (51) previously described challenges with the recording and reporting of TB cases in a district in the Western Cape province, which led to under-representation of TB cases. Under-reporting or reporting errors were also found in other South African provinces; and a systematic review of paediatric and adolescent TB cases reported that under-reporting TB disease is a significant, general problem in low-middle income countries (52)(53)(54). In this study, most participants thought TB case registration data on the discharge HIS was related to case notification and so incorrectly indicated on the HIS that the case had been registered. The consequence of incorrectly stating that cases have been registered is not fully clear. However, such inaccuracies can result in underreporting of TB cases, poor planning of public health responses, and gaps in case finding (46)(37).

Further data integrity concerns revolved around the frequent duplication of data due to the simultaneous use of a HIS for certain steps in a process while still relying on a paper-based model for the same process. This was thought to stem from limited staff confidence in using the newer HIS and a greater familiarity and trust in the traditional paper-based system. Such duplication leads to increased workload, reduced efficiency, and higher costs.

We found that a shortage of computers and other equipment (an infrastructure challenge) significantly impacted clinicians' ability to engage with HIS. Inconsistent network connectivity was also a recurrent challenge. Similar barriers were described in other South African studies of broader public health challenges and barriers to implementing electronic health records (55)(56). The lack of resources limited participants ability to provide comprehensive TB information or to construct a methodical follow-up plan for continued TB care at PHC. Insufficient administrative equipment has also been found to affect quality of care and health services provision globally (57).

Additionally, the electronic HIS were sometimes unavailable due to technical issues like network updates and power outages. During these instances, back capturing of information is necessary but may be overlooked due to high workloads or the absence of backup procedures. As a result, the information might not be transferred to the appropriate HIS. South Africa faces unique challenges that create significant barriers to implementing electronic HIS, particularly load shedding, is a major obstacle, hindering the country's ability to adopt and effectively use new digital technologies (58). These challenges include limited connectivity, frequent load shedding, and restricted access to technology. Addressing these barriers is crucial, requiring policymakers to ensure that selected HIS platforms are supported by offline functionality and alternative backup power to guarantee continuous workflow.

The most evident concerns among capacity issues, from both study phases, included the lack of training and lack of awareness of SOPs to guide HCWs both with the administrative and HIS procedures required for TB care and with how to optimise the data and use of the HIS to promote COC. Interviews also revealed that minimal training regarding these processes was offered at any level of clinicians' training or at the start of a new job. It is clear that the approach within the hospital and the broader academic system is focused on clinical teaching and limited attention is given to the supplementary processes which are also intended to facilitate TB care. Yet these supplementary processes are themselves critical in mitigating disease spread and impact.

A search of the published TB literature across SA and globally revealed that reporting systems were described by WHO (59) for national TB programmes and by Podewils (52) for TB reporting in SA, but this study shows that these approaches are not followed at the study hospital. No circulars, SOPs, or guidelines relating to such processes could be found for the Western Cape province nor for the wider national department of health. There would appear to be no comprehensive guide on appropriate referrals pathways, nor on what clients can be comfortably managed at PHC level, nor on what information is required at PHC level to integrate the client into TB care within the WC. Except for National Institute for Communicable Diseases (NICD) information on South African notification processes (60), which details the approach to NMC, there is also no guidance on the difference between TB case notification compared to case registration, nor when this should be done. An earlier study exploring barriers and facilitators to the implementation of general electronic health records in SA considered early training a capacity factor which could impact implementation of EHR (56). Marais et. al. considered TB education a critical factor for improving TB COC from hospital discharge in WC,

however, this education suggestion was aimed at client education (7). No studies specifically consider training weaknesses in the administration component of TB care as a factor impacting TB COC.

TB administration and TB referral systems also seemed to be an area of vague knowledge amongst the study participants. The exception was the referral process to specialist TB hospitals, which was seen as a facilitator for TB COC, though not specifically at PHC level. It was supported by clear referral guidelines and an HIS application that involves direct communication to a clinician at the TB hospital and through which a date for admission or follow-up plan is communicated. Down referrals to PHC, however, typically involve a client receiving a hardcopy of the electronic discharge summary, itself of varying quality. The client is then instructed to present to their closest PHC facility with the summary to continue their TB care. But Kallon et. al. found that hard copies of discharge information from hospitals in WC are inadequate, missing important information needed by clinics to appropriately continue TB care (8). Although advanced HIS are available in WC, they do not seamlessly link TB clients to care at PHC, and given, also, the lack of clarity regarding follow-up processes, do not promote COC. Clients may lose their letter, the PHC facility is not aware of who to expect and there is no clear process of ensuring that all confirmed or presumed TB clients actually reach their PHC facility for follow-up. Previous studies in WC similarly found poor communication and inadequate referral systems, together with weak feedback systems about successful or failed follow-ups, to be a significant barrier to TB COC (6)(7).

Increased workloads, resulting from high client numbers and limited staff capacity was another capacity challenge identified. This was judged to reduce the amount of time that clinicians could spend interacting with HIS and the amount of information they would enter in to the HIS. This also impacted referrals to PHC facilities. A review of challenges in improving quality of healthcare in South Africa (17) affirmed that a shortage of human resources adversely impacted client care and staff performance. This was echoed by a literature review that considered factors which affect working conditions in public hospitals, globally (57). The impact of this challenge on TB HIS and administrative processes could potentially be minimised if sufficient training and support structures are put in place to clarify the requirements for these processes and improve the usability of HIS.

Finally, a lack of standardisation of HIS (a capacity challenge), as well as work processes such as discharges, notifications, and referral pathways result, moreover, in confusion about required work among staff, inconsistent follow-up plans for clients, and ultimately, poor communication and increased chances of failing to connect to TB care. The multiple HIS platforms in the WC (46) vary

significantly depending on facility type, and do not all speak to each other – so one facility may miss out on client information from another facility.

These findings suggest that efforts to ensure that HCWs are trained on the use of HIS and its functions, particularly relating to TB care, and the provision of clear SOPs for the requirements of TB data, the mechanisms of reporting this data, the transfer of data and the TB referral pathways and receiving PHC facilities, may improve the health systems' attempt at improving COC for TB clients, thereby improving TB outcomes. Use of the Vula referral platform may be valuable as a down referral tool from hospitals to PHC facilities though it was initially created for PHC HCWs to refer to specialists. This may increase awareness at the PHC of specific clients who should be expected and can also improve the active finding and follow-up of these clients, ultimately reducing LTFU.

Training and SOPs will serve as tools to improve TB COC through attention to the finer details such as case notifications and registrations, provision of correct clinical information and direct linkage to care, which are factors seemingly overlooked in the study hospital. This may have implications for broader TB programmes, and to understand how the design of the HIS and training and SOPs of their HIS and TB response may ultimately impact TB COC.

Ultimately, to improve public health response planning and HIS integration into TB care, particularly to facilitate TB COC and improve overall TB outcomes, these issues must be addressed in developing an integrated HIS platform that easily allows for information entry into the system, automation of functions, and access to all information across all facilities. Primary dependence on clients to initiate contact with PHC for follow-up should be eliminated to rather have a HIS alert to PHC facilities to expect these clients with follow-up appointments already issued through the discharge process at district hospital level.

South Africa is currently embarking on the implementation of the National Health Insurance (NHI) scheme. The NHI aims to enhance access to quality health care services for all South African citizens. To achieve this goal, an electronic health record (EHR) system will need to be developed to register and track patients who visit various health care providers (56)(61). Timeously, lessons for a national EHR can be taken from these findings which should include the use of a single unique patient identifier number which is functional across all provinces and facilities, a reduction in isolated HIS use with improved interoperability between systems, focused training on the use of the EHR and easy usability for optimum user experience and improve data collection and COC. Importantly, acquiring access to the EHR should be simple with quick access to responsive IT support. Lastly, clients medical and

demographic data should be updated in real time to ensure up-to-date information to support clinical decision making for the best health outcomes.

Study limitations

The limitations of this study include the inclusion of only one healthcare facility and the purposive sampling of participants that could have introduced selection bias. However, this was mitigated through the inclusion of participants with the relevant knowledge, experience, and involvement with TB care. Also, the hospital selected can be regarded as a fairly typical urban district hospital, whose experience is unlikely to be considerably different from others in the City of Cape Town. In addition, the study entailed an in-depth description of processes and interactions with health information systems, drawing on in-depth interviews which explored the practical experience and perspectives of the participants. The respondents were, moreover, selected to represent the different groups involved in TB care in this hospital and so offer a comprehensive assessment of relevant experience. As the interviews were conducted by the same researcher, consistency was maintained in interview style and the data collection process. Although the researcher is also a senior clinician in the hospital, clear steps were taken to offset the biases in data collection and analysis that this might have introduced. Research rigour was also enhanced by the triangulation of findings across different data sources, included process maps, interviews and wider literature.

Conclusion

This study suggests that HCWs find HIS useful for supporting continuity of TB care where they have easy access to such systems and sufficient information has been entered into them. However, a range of barriers were identified as undermining the effective use of HIS in relation to continuity of care between a district hospital and community clinics. These barriers in themselves suggest some possible solutions. Tackling TB loss to follow up may require improved training around SOPs for care, the information systems themselves, and administration process for TB. Further, organisations should tackle the resource gaps that inhibit the use of HIS. Lessons can also be drawn from the TB hospital referral platform to improve linkage to primary care. While the Vula referral platform was initially created for PHC HCWs to refer to specialists, it may be valuable as a down referral tool from hospitals to PHC facilities. Improving the functionality of the various systems through their integration and allowing easier access to them at all levels of healthcare, as well as establishing automated

appointment systems with a named follow-up facility may facilitate continuity of TB care. Further research should consider whether the challenges identified in this study are more widespread within the Western Cape and South African health system, as well as further explore some of the possible strategies for strengthening information systems role in supporting continuity of care for TB services.

Declarations

Ethics approval and consent to participate

The study procedures were reviewed and approved by the Human Research Ethics Committee at the University of Cape Town ref: *749/2023* and the Western Cape Provincial Health Research Committee ref: *WC_202311_028.*

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

TE analyzed and interpreted the process maps and the interviews. LG and TA reviewed the themes and subthemes. All authors read and approved the final manuscript.

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Part C: Appendices

Appendix A: Research Flow Diagram

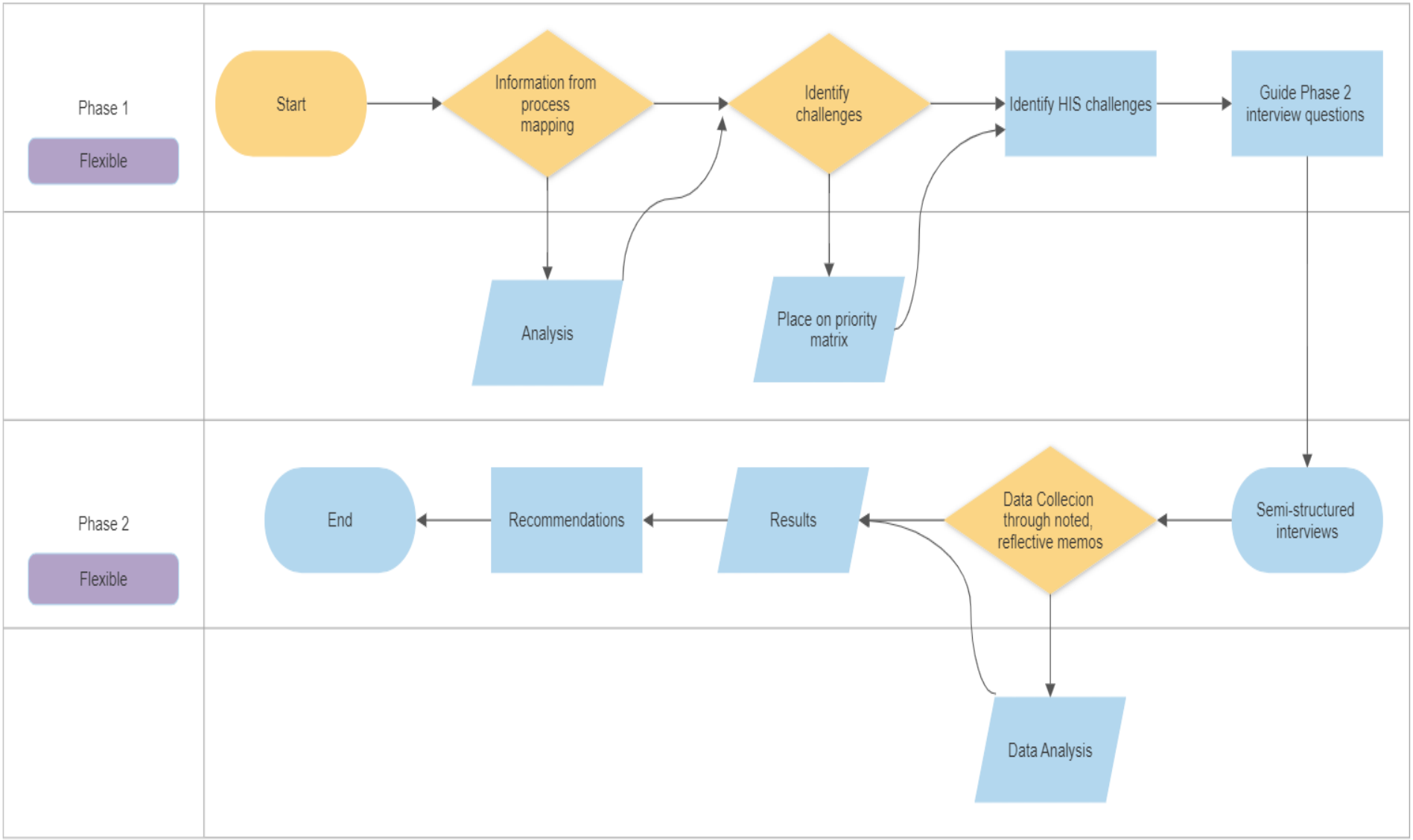

Figure 1 Research flow diagram

Appendix B: Ethics Authorisation

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room 45 E-52-E-Floor- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-submissions@uct.ac.za
Website: www.health.uct.ac.za/home/human-research-ethics

15 November 2023

HREC REF: 749/2023

Prof L Gilson
Health Policy Systems
Public Health & Family Medicine
Email: lucy.gilson@uct.ac.za
Student: Tasneem.Esack@westerncape.gov.za

Dear Prof Gilson

PROJECT TITLE: FACTORS ASSOCIATED WITH HEALTH INFORMATION SYSTEMS THAT INFLUENCE CONTINUITY OF TB CARE BETWEEN A DISTRICT HOSPITAL AND PRIMARY HEALTHCARE FACILITIES-
(MPH CANDIDATE-DR TASNEEM ESACK)

Thank you for your response letter dated 30 October 2023, addressing the issues raised by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 November 2024.

Please submit a progress form, using the standardised Annual Report Form (FHS016) or FHS017 if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Dr Tasneem Esack will also be involved in this study.

Please quote HREC REF 749/2023 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

Signed by candidate

PROFESSOR M BLOĆKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research

Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Appendix C: Western Cape Government Approval

Western Cape Government

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 0866; fax: +27 21 483 6058
24th Floor, 4 Dorp Street, Cape Town, 8001

REFERENCE: WC_202311_028
ENQUIRIES: Dr Sabela Petros

University of Cape Town
Anzio Road
Observatory
Cape Town
7925

For attention: Prof Lucy Gilson, Dr Tasneem Essack

Re: Health Information Systems' barriers and facilitators that impact continuity of TB care between a District hospital and Primary Healthcare facilities.

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.
Please contact the following people to assist you with any further enquiries in accessing the following sites:

Victoria Hospital	**Dr Graeme Dunbar**	**021 799 1211**

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, provided that normal activities at requested facilities are not interrupted and staff are not put under pressure to comply with the research activities.
2. Researchers must provide the department with an electronic copy of a Final Report using the Annexure 9 template within six months of completion of research. This can be submitted to Health.Research@westerncape.gov.za. Future research will not be allowed on the health platform if a Final Report is not submitted.
3. In the event where the research project goes beyond the *estimated completion* date which was submitted, or the final date of the ethics clearance letter, researchers are expected to complete and submit a progress report (**Annexure 8**) and an updated ethics clearance letter to Health.Research@westerncape.gov.za. Failure to do so will render this approval letter void.
4. The reference number above should be quoted in all future correspondence.

Yours sincerely

Signed by candidate

DR M MOODLEY
DIRECTOR: HEALTH INTELLIGENCE
DATE: 10 December 2024
CC

Appendix D: Informed Consent Form

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

This informed consent form is for healthcare workers who may be involved with the discharge process of TB clients at Victoria Hospital, Wynberg. We are requesting the following categories of staff to participate in in this research project, Information Management Officers, junior and Senior Doctors, Nurses, Clerks, Allied Health, and Senior Managers. The research project is titled, "Health Information Systems Facilitators and Barriers to Continuation of TB Care Between a District Hospital and Community Health Centers."

Principal Investigator: *Lucy Gilson*

Sub-investigator: *Tasneem Esack*

Organization: *University of Cape Town*

Project: *Health Information Systems Facilitators and Barriers to Continuation of Tuberculosis Care*

Version: *1*

This Informed Consent Form has two parts:

• Information Sheet (to share information about the study with you)

• Certificate of Consent (for signatures if you choose to participate)

You will be given a copy of the full Informed Consent Form

Part I: Information Sheet

Introduction

I am Tasneem Esack, a medical doctor working at Victoria Hospital Wynberg and a student at the University of Cape Town, doing research toward a Master's degree in Public Health. I am doing research on Tuberculosis, and the Health Information Systems factors that may help TB patients to continue their TB treatment at their Community Health Centers. I would like to provide you with some information and invite you to participate in this research. You do not have to decide immediately whether you want to participate or not. You are also welcome to speak to me or a manager about the research and your participation if you feel it necessary. If there are any words or concepts that are not clear within this form, please ask me to clarify so that you can have a better understanding of the research and your participation in it.

Appendix D: Informed Consent Form

Purpose of the research

Our communities have high rates of Tuberculosis and many patients do not continue with TB treatment once they are discharged from hospital care. We want to understand how Health Information systems create barriers to care or help improve continuation of TB care in communities. Your input will help us understand more about this. This knowledge may help us improve the systems' barriers for patients and healthcare worker.

Type of Research Intervention

This research will involve your participation in a one-on-one interview that be will approximately 30 minutes long.

Participant Selection

You are being invited to take part in this research because we feel that your experience as a healthcare worker involved in the care and discharge processes of TB patients can contribute to our understanding and knowledge of how the health information systems we use, assist in the continuation of TB care.

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate the choice that you make will have no bearing on your job or on any work-related evaluations or reports. You may change your mind later and stop participating even if you agreed earlier.

Procedures

a. We want to learn more about how the Health Information Systems used in our health facilities contribute to TB care. In the interviews you will be asked about your understanding and use of the Health Information Systems and how it impacts TB care and discharges.

b. You will participate in an interview with myself. The interview will be conducted in a private, comfortable space. If you do not wish to answer any of the questions asked during the interview, you may say so and we will move on to the next question. No one else will be present unless you would like someone else to be there. The information collected will be kept confidential, and no one else except the researchers will access the information from your interview. The entire interview will be recorded, and notes will be made, but no-one will be identified by name on the recordings or notes. The recordings and notes will be kept in a password-locked electronic file on a password protected personal device that is not kept in the hospital.

Appendix D: Informed Consent Form

Duration

The research takes place over a month in total. During that time, we will interview you once and the interview will last for approximately 30 minutes.

Risks and Right to Refuse or Withdraw

During the interview you will not be expected to divulge any personal information, you will only be asked to explain processes that are followed to discharge TB patients from the hospital. You may however feel uncomfortable discussing work practices. Be assured that the information you share will not impact your job or position in any way. You do not have to answer any questions that you do not feel comfortable with, and you do not need to provide reasons for not responding. You will be afforded the opportunity to review your input and you may change or remove your responses if you so wish, or if you feel the notes do not reflect your answers.

Benefits

By participating in this research there will be no direct benefit to you, but your participation may help us to find out more about how Health Information systems can improve continuity of TB care.

Reimbursements

You will not be provided any incentive to take part in the research.

Confidentiality

Research participants and the data collected from them will be treated with respect and confidentiality. Informed consent will be obtained from each participant before further information is gathered from them. Personal identifiers will be removed from the study materials. A unique study number will be assigned to each participant to serve as an identifier. Only the researchers will know what numbers have been allocated to participants, and this information will be stored in a password encrypted file.

Sharing the Results

The knowledge that we get from this research will be shared with you and other participants before it is made widely available to the public. A summary of the results will be provided to each participant. Following this, we may publish the results so that others who are interested in TB care may learn from the research.

Appendix D: Informed Consent Form

Who to Contact

If you have any further questions, please feel free to ask them at any time. If you have questions later, please contact me:

Tasneem Esack

Email: esack.smart@gmail.com

Address:

Victoria Hospital Wynberg,

Alphen Hill Rd,

Wynberg, 7800

Telephone Number:

021 799 1163

082 673 8978

Alternatively, you may contact the research supervisors:

Lucy Gilson

Email: lucy.gilson@uct.ac.za

Tumelo Assegaai

Email: tumelo.assegaai@uct.ac.za

The study procedures were reviewed and approved by the Human Research Ethics Committee at the University of Cape Town ref: *749/2023* and the Western Cape Provincial Health Research Committee ref: *WC_202311_028.*

Appendix D: Informed Consent Form

Part II: Certificate of Consent

a. Participant Statement

I have been invited to participate in research about Tuberculosis and Health Information Systems. I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Name of Participant: _____

Signature of Participant: _____

Date: _____

Day/month/year

b. Researcher's Statement

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the following:

1. Participation is voluntary and participants may refuse or withdraw from the interviews at any time.
2. All information shared will be kept confidential.
3. That there will be no direct benefit or reimbursement to the participant.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Name of Researcher: _____

Signature of Researcher: _____

Date: _____

Day/month/year

Appendix E: Interview Questionnaire

Guide for conducting semi-structured interviews with healthcare workers at a district hospital

The purpose of this interview is to map characteristics of health information systems (HIS) used at a district hospital in the care process of TB patients. The purpose is to understand the current condition and use of HIS and how it contributes to the continuity of care of TB patients. This understanding will be drawn from HCWs' knowledge of the HIS and how HIS factors may facilitate or hinder continuation of TB treatment in the community after discharge from a district hospital. Ultimately, this research may identify potential HIS strengthening interventions that may improve quality of TB care as well as successful linkage to community care with improved treatment outcomes.

Introduction

Greet and thank the participant for their time. Introduce myself, position, and reason for the research. Provide the participant with the information sheet on the study. Re-iterate points on confidentiality and risk and the introduce the consent form. Ask for consent to utilise an audio recorder as well as consent to take written notes on each response.

Interview

Start with general questions including demographics.

Profession	
Years of experience	
Years at this facility	
Role at facility	
Does the HCW work at other facilities?	
Do they interact with TB patients? How often? Clinically/administratively/other capacity.	

Depending on the issues that arise during these introductory questions, the focus of inquiry can be shifted to any of the themes identified from the mapping and prioritisation process. Ensure that all the prioritised themes are covered in the interview. New themes raised during the interview must be accommodated and explored if applicable.

1. Capacity

Appendix E: Interview Questionnaire

1.1. Did you or any of your team members undergo any specific training/courses on TB administration and discharge process? If yes, provide details.

1.1.1. Are you aware of the clinical and legislative requirements of providing TB care to patients and discharging them into the community?

1.2. What Health Information Systems do you interact with for your TB patients?

1.2.1. What has your experience been like with these systems?

1.2.2. Have you had formal training on these systems?

1.2.3. Are you aware of any SOPs for using these systems particularly for TB patients?

1.3. Do you receive TB patients via referrals? Do you refer TB patients to others?

1.3.1. Have you received training/education on the TB referral processes?

1.4. What factors determine choice of referral facility?

1.4.1. Which patients are referred where?

1.4.2. Can you describe how this referral process work?

1.4.3. How do you refer to TB facilities?

1.4.4. How is information shared between the different facilities &/or healthcare providers

1.5. Do you know what is expected of you when discharging TB patients? *What HIS/forms/admin? Where to send?*

2. Process and Infrasructures

2.1. Describe the data you collect/enter into HIS regarding TB patients? *(Notifications/registration/medication regimens)*

2.1.1. What challenges do you have with collecting or entering data?

2.1.2. How does this data help you/the patient/the facility/the system?

2.2. Have you experienced any challenges or positives with the HIS? (*resources, equipment, skill, time, usability etc)*

2.3. Do the health information systems serve as barriers or facilitators of continuity of care?

2.3.1. What are the facilitating factors?

2.3.2. What are the barriers?

Appendix E: Interview Questionnaire

3. Improvement Suggestions

3.1. What adjustments can be made by healthcare providers &/or the health system with regard to HIS that can improve continuity of TB care?

3.2. Do you have any suggestions for improvements to the health information systems?

Try to elicit specific examples of practice improvement. For each example, probe further to understand factors that can facilitate or hinder implementation of change in practice.

Closing

Thank the participant for their time and input. Ask if there is any additional questions or feedback. Assure confidentiality and the sharing of the study results with the participant. Request permission to get back to the participant for any clarifications or additional further information.

Appendix F: TB Care Pathways (Flows) in Study Hospital

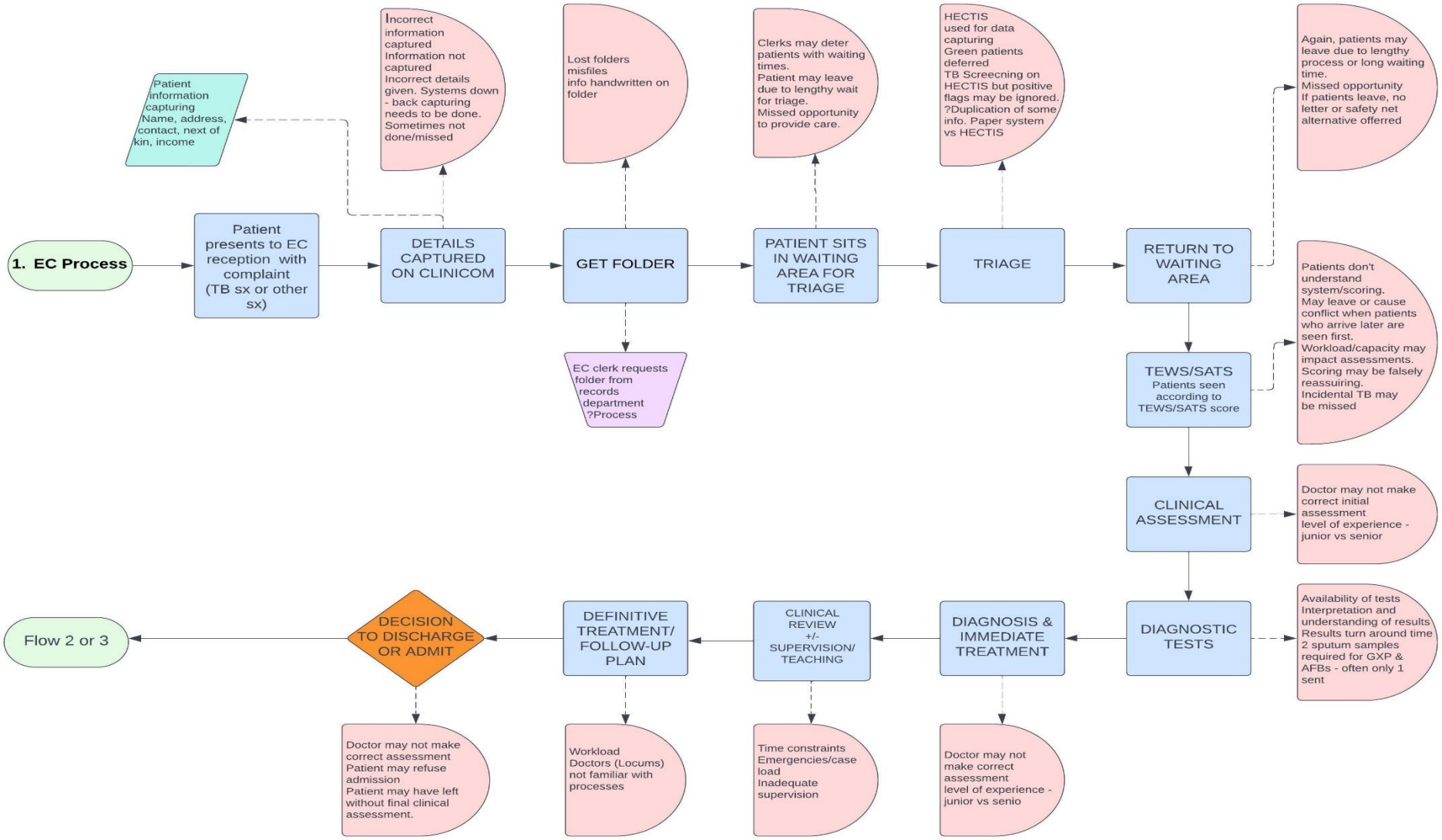

Figure 2: Flow of EC process

Appendix F: TB Care Pathways (Flows) in Study Hospital

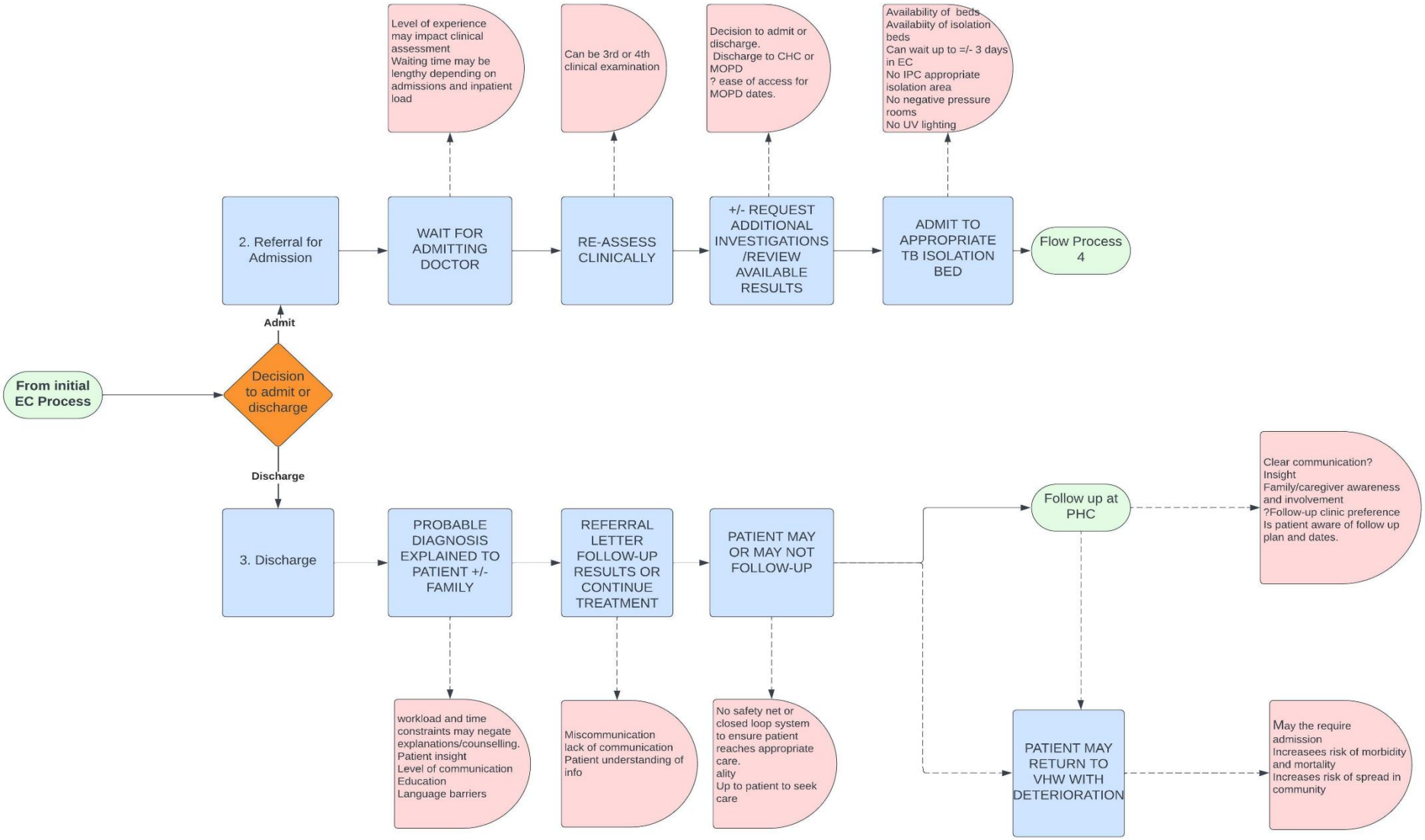

Figure 3: EC decision to admit or discharge process

Appendix F: TB Care Pathways (Flows) in Study Hospital

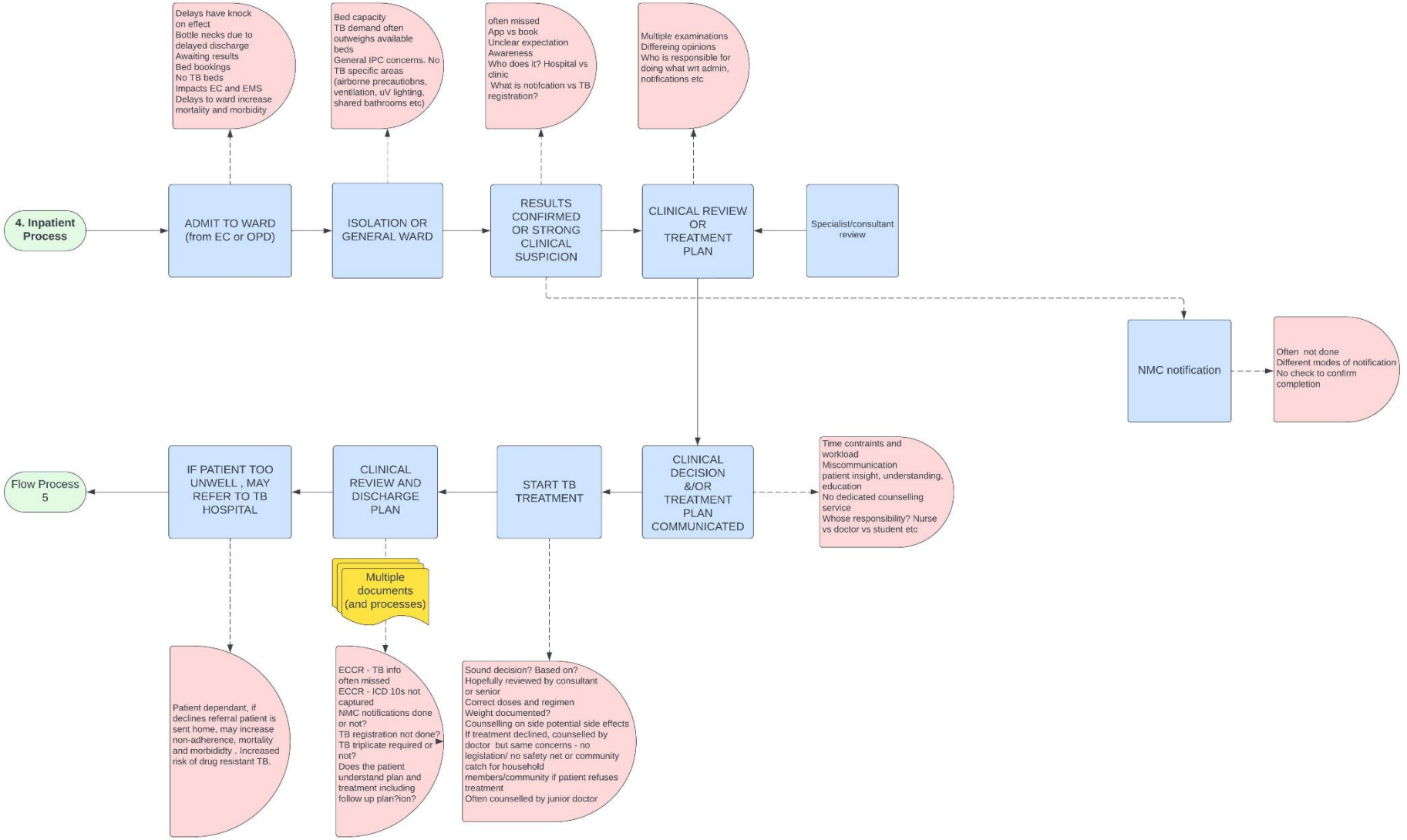

Figure 4: Flow of Inpatient process

Appendix F: TB Care Pathways (Flows) in Study Hospital

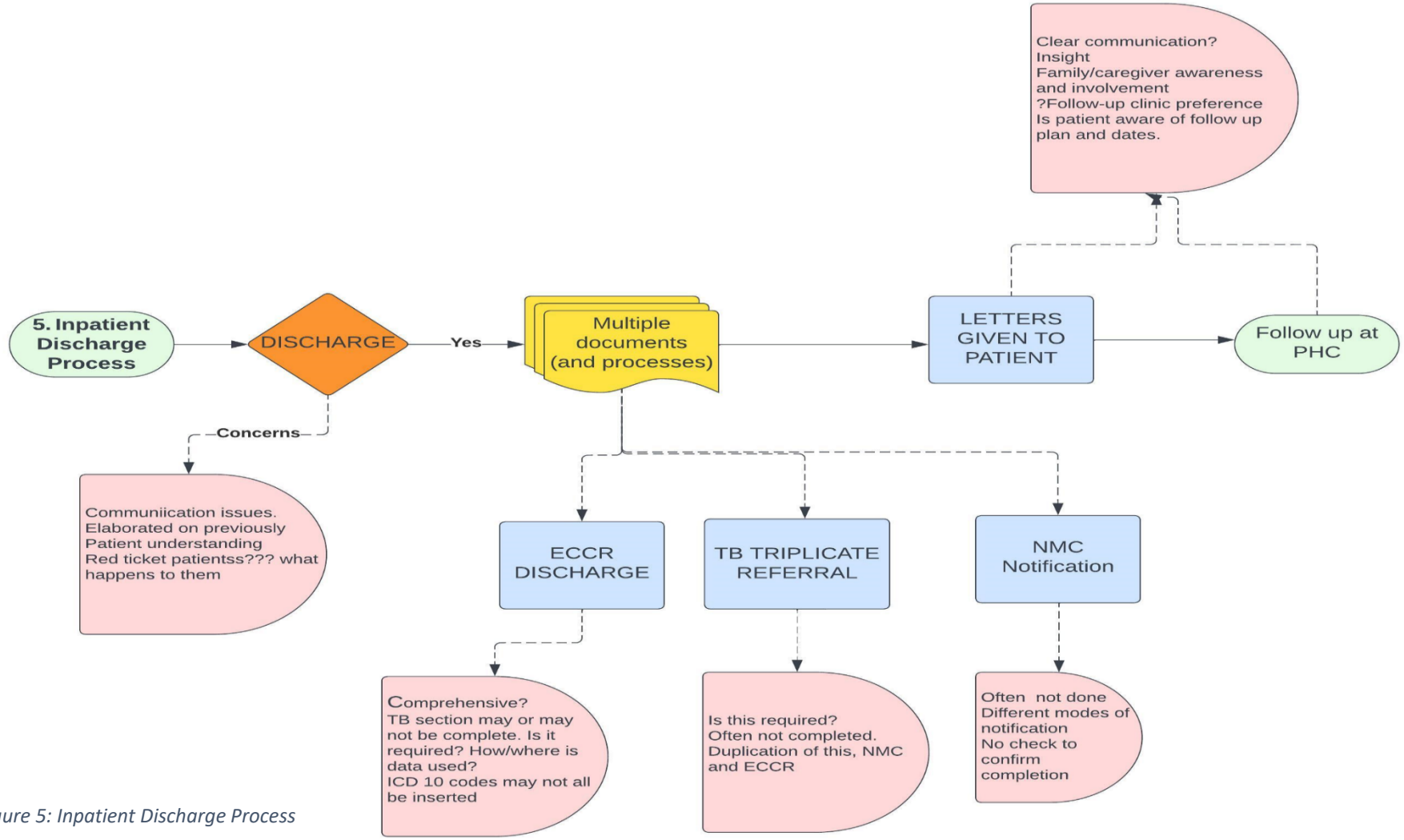

Figure 5: Inpatient Discharge Process

Appendix F: TB Care Pathways (Flows) in Study Hospital

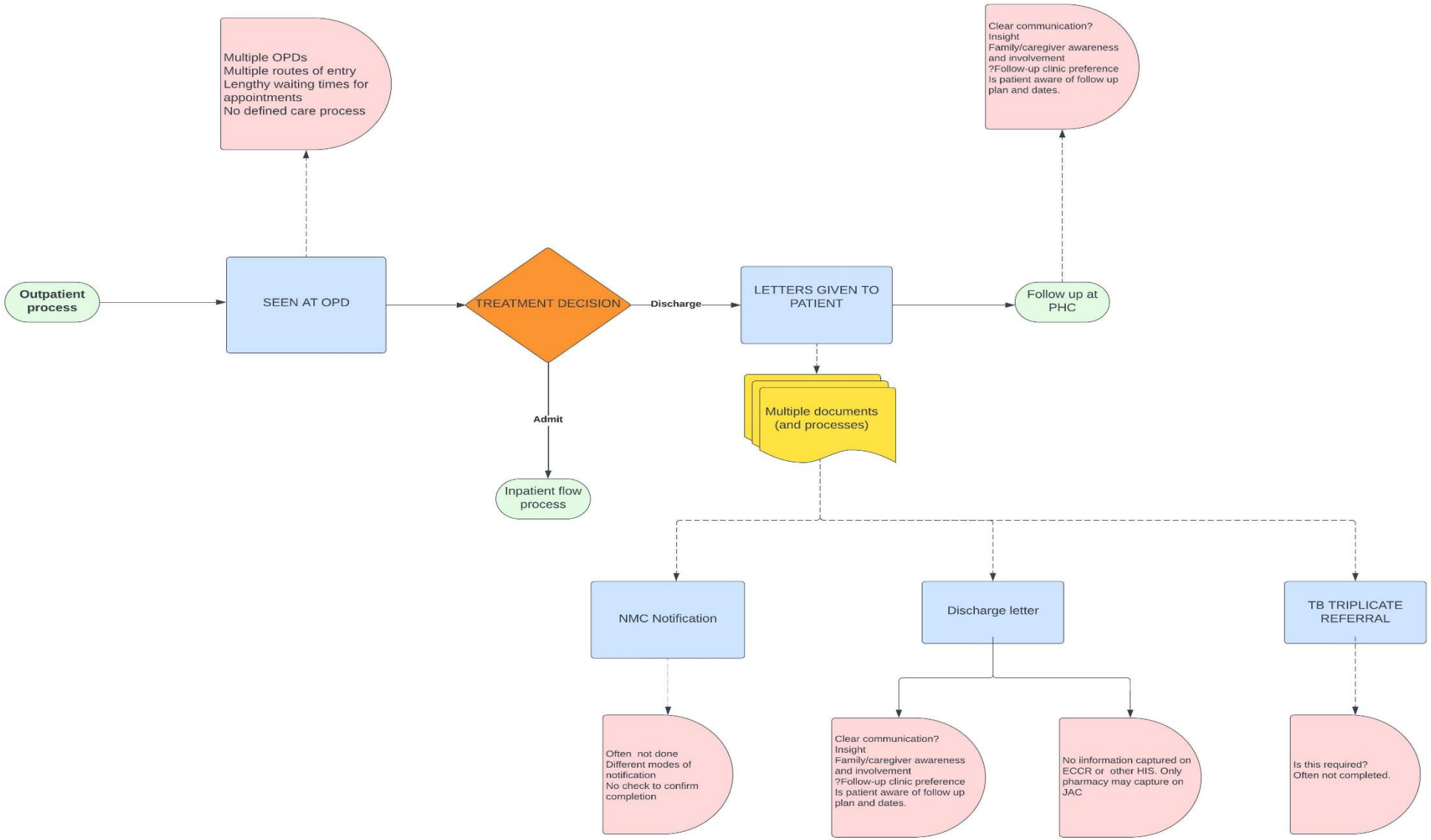

Figure 6: OPD Process

Appendix F: TB Care Pathways (Flows) in Study Hospital

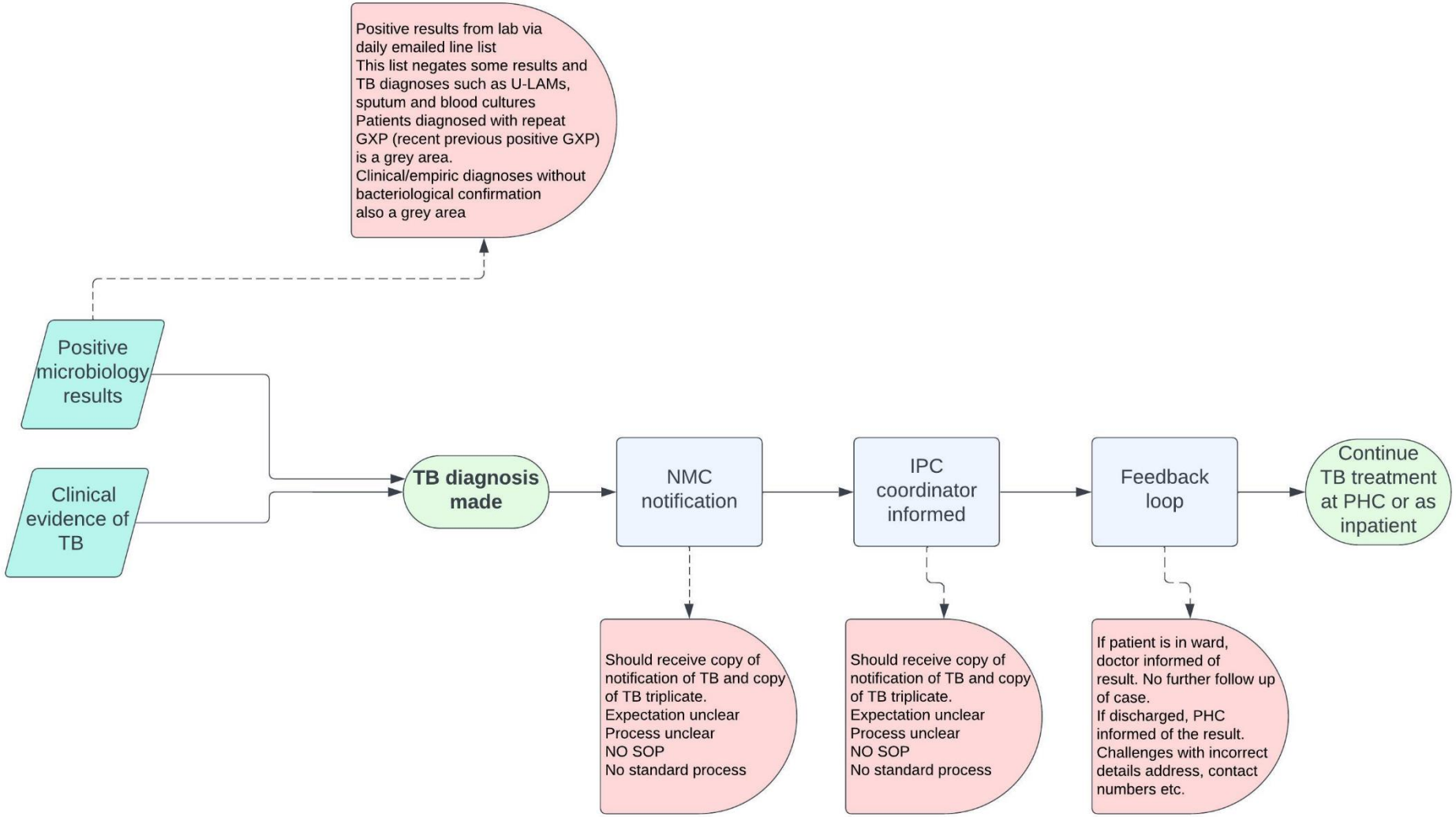

Figure 7: IPC Process

Appendix G: Journal Style Guide

Research article

Criteria

Research articles should report on original primary research, or present a new experimental or computational method, test or procedure. Manuscripts reporting results of a clinical trial must conform to CONSORT 2010 guidelines. Authors of randomized controlled trials should submit a completed CONSORT checklist alongside their manuscript, available at www.consort-statement.org. Research articles may also report on systematic reviews of published research provided they adhere to the appropriate reporting guidelines which are detailed in our editorial policies. Please note that non-commissioned pooled analyses of selected published research and bibliometric analyses will not be considered. Studies reporting descriptive results from a single institution or region will only be considered if analogous data have not been previously published in a peer reviewed journal and the conclusions provide distinct insights that are of relevance to a regional or international audience.
Please note that the journal does not consider research focused on:

- Clinical research
- The clinical knowledge, decision-making, and practice of healthcare professionals
- Increasing for-profit healthcare revenue. For example, monetizing healthcare or personal health data, or marketing for-profit healthcare, including health and insurance products

Data sharing
BMC Health Services Research strongly supports open research, including transparency and openness in reporting. Further details of our Data availability policy can be found on the journal's About page.

BMC Health Services Research strongly encourages that all datasets on which the conclusions of the paper rely should be available to readers. We encourage authors to ensure that their datasets are either deposited in publicly available repositories (where available and appropriate) or presented in the main manuscript or additional supporting files whenever possible. Please see Springer Nature's data repository guidance. Where a widely established research community expectation for data archiving in public repositories exists, submission to a community-endorsed, public repository is mandatory. A list of data where deposition is required, with the appropriate repositories, can be found on the Editorial Policies Page.

Professionally produced Visual Abstracts
BMC Health Services Research will consider visual abstracts. As an author submitting to the journal, you may wish to make use of services provided at Springer Nature for high quality and affordable visual abstracts where you are entitled to a 20% discount. Click here to find out more about the service, and your discount will be automatically be applied when using this link.

Preparing your manuscript

The information below details the section headings that you should include in your manuscript and what information should be within each section.

Please note that your manuscript must include a 'Declarations' section including all of the subheadings (please see below for more information).

Appendix G: Journal Style Guide

Title page

The title page should:

- present a title that includes, if appropriate, the study design e.g.:
    - "A versus B in the treatment of C: a randomized controlled trial", "X is a risk factor for Y: a case control study", "What is the impact of factor X on subject Y: A systematic review"
    - or for non-clinical or non-research studies a description of what the article reports
- list the full names and institutional addresses for all authors
    - if a collaboration group should be listed as an author, please list the Group name as an author. If you would like the names of the individual members of the Group to be searchable through their individual PubMed records, please include this information in the “Acknowledgements” section in accordance with the instructions below
    - Large Language Models (LLMs), such as ChatGPT, do not currently satisfy our authorship criteria. Notably an attribution of authorship carries with it accountability for the work, which cannot be effectively applied to LLMs. Use of an LLM should be properly documented in the Methods section (and if a Methods section is not available, in a suitable alternative part) of the manuscript.
- indicate the corresponding author

Abstract

The Abstract should not exceed 350 words. Please minimize the use of abbreviations and do not cite references in the abstract. Reports of randomized controlled trials should follow the CONSORT extension for abstracts. The abstract must include the following separate sections:

- **Background:** the context and purpose of the study
- **Methods:** how the study was performed and statistical tests used
- **Results:** the main findings
- **Conclusions:** brief summary and potential implications
- **Trial registration:** If your article reports the results of a health care intervention on human participants, it must be registered in an appropriate registry and the registration number and date of registration should be stated in this section. If it was not registered prospectively (before enrollment of the first participant), you should include the words 'retrospectively registered'. See our editorial policies for more information on trial registration

Keywords

Three to ten keywords representing the main content of the article.

Background

The Background section should explain the background to the study, its aims, a summary of the existing literature and why this study was necessary or its contribution to the field.

Methods

The methods section should include:

Appendix G: Journal Style Guide

- the aim, design and setting of the study
- the characteristics of participants or description of materials
- a clear description of all processes, interventions and comparisons. Generic drug names should generally be used. When proprietary brands are used in research, include the brand names in parentheses
- the type of statistical analysis used, including a power calculation if appropriate

Results

This should include the findings of the study including, if appropriate, results of statistical analysis which must be included either in the text or as tables and figures.

Discussion

This section should discuss the implications of the findings in context of existing research and highlight limitations of the study.

Conclusions

This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study reported.

List of abbreviations

If abbreviations are used in the text they should be defined in the text at first use, and a list of abbreviations should be provided.

Declarations

All manuscripts must contain the following sections under the heading 'Declarations':

- Ethics approval and consent to participate
- Consent for publication
- Availability of data and materials
- Competing interests
- Funding
- Authors' contributions
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