

The implementation of a virtual Hospital in the Home service for COVID-19 patients in Queensland, Australia: a mixed-method evaluation

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Abstract

Background: Hospital in the Home (HITH) provides home-based care as an alternative to traditional hospitalization. In response to the COVID-19 pandemic, a 350-bed acute care public hospital in the rural Western portion of Southeast Queensland launched a virtual HITH service on December 19, 2021. This service targeted COVID-19-positive patients with additional health concerns, including pregnancy and chronic conditions. Despite accelerated adoption of virtual care modalities within HITH services during the pandemic, evidence for implementing such models for COVID-19 patients remains limited.

Objective: This study evaluated the feasibility, safety, acceptability, and impact of a virtual HITH service for moderate-severity COVID-19 patients in Queensland, Australia, and identified potential improvements for service uptake and sustainability.

Methods: Using the RE-AIM framework, a mixed-method approach was employed to assess individual and system-level outcomes. Quantitative data on service utilization and costs were extracted from electronic health records and financial documentation, while qualitative insights came from interviews with service providers and patients.

Results: As a preventative care initiative, this virtual-enabled HITH model of care successfully provided continuous access to care to the community, while reducing hospital bed occupancy and alleviating system-wide pressures. During the 11-month operational period, the service admitted 3,192 patients. 66 patients were safely discharged early from physical wards to virtual care, while only 12 patients (0.4%) required escalation to in-hospital care. No ICU transfers or deaths occurred. The median length of stay was 5 days (IQR: 4–6), with a 28-day readmission rate of 6.8%. Interviews with 7 staff members and 9 patients revealed high satisfaction levels. Patients valued continuous access to care during limited primary care availability and reported better recovery experiences at home. Staff emphasized the preventative role of the service in identifying high-risk patients and reducing unnecessary hospitalizations, thereby preserving critical hospital resources. Implementation challenges included lack of community awareness, staffing shortages, fluctuating patient volumes, and competition for resources. Despite these barriers, staff demonstrated remarkable adaptability in navigating the rapid evolution of government directives, referral processes, and rapid patients' turnover. The service enhanced workforce skills and strengthened organizational capacity for future virtual care expansions.

Conclusions: This study demonstrates successful implementation of a virtual HITH service that provided safe alternatives to inpatient care during COVID-19 Omicron surges. Findings emphasize the importance of adequate planning to establish the base resources and staffing profile for future pandemic responses, and support expanding this model of care into other clinical domains, given its positive impact on patient outcomes and hospital efficiency.

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Original Manuscript

Original Paper

The implementation of a virtual Hospital in the Home service for COVID-19 patients in Queensland, Australia: a mixed-method evaluation

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Abstract

Background

Hospital in the Home (HITH) provides home-based care as an alternative to traditional hospitalization. In response to the COVID-19 pandemic, a 350-bed acute care public hospital in the rural Western portion of Southeast Queensland launched a virtual HITH service on December 19, 2021. This service targeted COVID-19-positive patients with additional health concerns, including pregnancy and chronic conditions. Despite accelerated adoption of virtual care modalities within HITH services during the pandemic, evidence for implementing such models for COVID-19 patients remains limited.

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This study evaluated the feasibility, safety, acceptability, and impact of a virtual HITH service for moderate-severity COVID-19 patients in Queensland, Australia, and identified potential improvements for service uptake and sustainability.

Methods

Using the RE-AIM framework, a mixed-method approach was employed to assess individual and

system-level outcomes. Quantitative data on service utilization and costs were extracted from electronic health records and financial documentation, while qualitative insights came from interviews with service providers and patients.

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As a preventative care initiative, this virtual-enabled HITH model of care successfully provided continuous access to care to the community, while reducing hospital bed occupancy and alleviating system-wide pressures. During the 11-month operational period, the service admitted 3,192 patients. 66 patients were safely discharged early from physical wards to virtual care, while only 12 patients (0.4%) required escalation to in-hospital care. No ICU transfers or deaths occurred. The median length of stay was 5 days (IQR: 4–6), with a 28-day readmission rate of 6.8%. Interviews with 7 staff members and 9 patients revealed high satisfaction levels. Patients valued continuous access to care during limited primary care availability and reported better recovery experiences at home. Staff emphasized the preventative role of the service in identifying high-risk patients and reducing unnecessary hospitalizations, thereby preserving critical hospital resources. Implementation challenges included lack of community awareness, staffing shortages, fluctuating patient volumes, and competition for resources. Despite these barriers, staff demonstrated remarkable adaptability in navigating rapid evolution of government directives, referral processes, and rapid patients' turnover. The service enhanced workforce skills and strengthened organizational capacity for future virtual care expansions.

Conclusion

This study demonstrates successful implementation of a virtual HITH service that provided safe alternatives to inpatient care during COVID-19 Omicron surges. Findings emphasize the importance of adequate planning to establish the base resources and staffing profile for future pandemic responses, and support expanding this model of care into other clinical domains, given its positive impact on patient outcomes and hospital efficiency.

Keywords

virtual ward, virtual hospital, hospital in the home, hospital at home, home-based care, patient remote monitoring, RE-AIM, implementation outcomes, COVID-19

Introduction

Growing demand for resource-intensive inpatient hospitalization challenges hospital sustainability [1, 2]. Hospital in the Home (HITH) presents an alternative by delivering home-based care to patients who require clinical governance, monitoring, or input that would otherwise need treatment in a traditional inpatient hospital bed [3]. Global evidence demonstrates that HITH can achieve equal or better patient outcomes [3-5], improved quality of life [6, 7], and substantial cost savings [8-10] compared to conventional inpatient care for selected health conditions.

While the concept of shifting certain aspects of care from the hospital to the home has existed for decades, its implementation accelerated significantly following the onset of the COVID-19 pandemic, primarily due to hospital capacity constraints and new reimbursement opportunities [11, 12]. The traditional HITH model of clinicians visiting patients' homes evolved during the pandemic to incorporate remote monitoring [12] and 'virtual wards' [13-15]. These models of care employ virtual care modalities that replicate the systems, staffing, and routines of a traditional hospital ward. This approach allows for acute care delivery to COVID-19 patients deemed lower risk but still requiring monitoring for potential deterioration [3], while facilitating physical distancing to minimize exposure risk [16, 17].

Despite an increasing evidence base, widespread adoption and scaling of HITH services has been limited in practice [18]. Implementation barriers identified in the literature include compelling

evidence of safety [13], lack of perceived need [19], lack of culturally safe and equitable care access [20], and misaligned or lack of financial incentives for implementing such a complex intervention [21-23]. In addition, while the pandemic accelerated technology deployment in HITH services, there is a paucity of evidence for its safety and effectiveness in the management of patients with COVID-19 [18].

This study presents a pragmatic, mixed methods evaluation of a virtual-care enabled HITH service for treating COVID-19 patients with moderate symptoms in Queensland, Australia. We aimed to: 1) assess the feasibility, safety, acceptability, and impact of this model of care; and 2) identify adaptations that would improve its uptake and sustainability. Findings from this study may support iterative developments and guide potential expansion of this model of care into other clinical areas, to meet rising healthcare demand and increase inpatient care capacity.

Method

Setting

This study was conducted at a large 350-bed acute care public hospital serving the rural western region of Southeast Queensland, Australia. The region faces unsustainably high demand for hospital services due to having the fastest growing community in the state, which is projected to nearly double by 2036. It is also a culturally and economically diverse area with a 39% higher obesity rate and 28% higher rate of daily smokers compared to the Queensland state average [24].

The virtual Hospital in the Home service

The re-opening of Queensland's borders in December 2021 following an extended period of interstate restrictions resulted in a surge of COVID-19 cases. The most predominant strain during this period was Omicron (sub-lineage B.1.1.529/BA.1) [25]. In response to the increased demand, a virtual COVID-19 HITH service was rolled out on 19 December 2021. This dedicated service stream aimed to reduce hospital presentations by supporting COVID-19 positive patients with additional health concerns such as pregnancy or chronic conditions. The service adopted a 'whole family' approach, incorporating paediatricians and midwives to enable coordinated care for parents and children through a single point of contact. Following declining COVID-19 referrals, the service was then decommissioned on 28 November 2022. Additional details on the operational aspects of the service are provided in **Appendix 1**.

Service referrals came from various internal and external sources, with patients able to self-refer via online eligibility checkers. Admission criteria were based on state-level policy guidelines [26], which required patients to be medically stable and safely self-isolate at home, have an appropriate residence for home-based care, and have access to a telephone. Referred patients were assessed against these admission criteria and triaged as mild, moderate, or high risk using established definitions. Admitted patients were contacted via phone or videoconference by a team of doctors and nurses to discuss their symptoms and care plan. Devices such as oximeters and thermometers were provided to patients as needed, with sphygmomanometers only provided to the maternity cohort. Patients were asked to upload their observations into an online coordinator system, which were reviewed daily by a nurse for any signs of deterioration. If an in-person review was necessary, patients were transferred to a physical ward at the hospital.

Study design

A mixed-method study was designed to evaluate the implementation of the virtual COVID-19 HITH service. The data collection and analysis approach were guided by the RE-AIM framework [27, 28], which focuses on five dimensions of individual- and setting-level outcomes essential to healthcare interventions' impact and sustainability: Reach, Effectiveness, Adoption, Implementation, and Maintenance (Table 1). This framework was well-suited for this study as it facilitates the identification of both effective components and areas needing adaptation in care delivery models, promoting sustainable adoption and implementation of evidence-based interventions [27, 29]. Additionally, it balances internal and external validity, enhancing generalizability to other settings and populations.

Quantitative and qualitative data were simultaneously collected, then analysed separately and triangulated to guard against researcher bias [30]. By integrating quantitative and qualitative investigations, the study provides a more comprehensive picture of not only what occurred, but also why and how both intended and unintended outcomes emerged [31].

The study received ethical clearance from the West Moreton Human Research Ethics Committee (HREC/2023/QWMS/91529). We followed the "Consolidated criteria for reporting qualitative research" (COREQ) checklist [32] for reporting.

Table 1: RE-AIM evaluation dimensions of the virtual COVID-19 Hospital in the Home service

RE-AIM Dimension	Key question guiding the analysis	Metrics/ Measures/ Outcomes	Data sources
Reach	Who were the patients accessing the virtual COVID-19 HITH service?	• Total number of patients admitted • Demographic characteristics • Factors contributing to participation/ non-participation • Referral source	Routinely collected electronic databases, patient and staff interviews
Effectiveness	How did the virtual COVID-19 HITH service impact continuity and quality of care?	• Safety (whether the HITH care model led to adverse outcomes, e.g., higher mortality, hospital transfer or readmission rates) • Service acceptability (e.g., patients' overall satisfaction, perceived timelines of care, recommendation)	Routinely collected electronic databases, PREMS, patient interviews
Adoption	What factors contributed to staff willingness to adopt the virtual COVID-19 HITH model of care?	• Staffing profile • Staff engagement • Barriers to adoption	Staff interviews, program documents
Implementation	How and why was the virtual COVID-19 HITH service	• Motivation • Facilitators and barriers to implementation	Patients and staff interviews,

	established and adapted over time?	• Service feasibility (whether patients and health providers could interact with the model of care) and fidelity (whether service was delivered as intended) • Cost associated with the establishment and implementation	program documents
Maintenance	To what extent has the virtual COVID-19 HITH service become part of routine practice?	• Degree of service institutionalization • Impact on hospital efficiency (e.g., inpatient bed days saved) • Areas for service extension and improvement	Staff interviews
HITH – Hospital in the Home, PREMS – Patient reported experiences measures			

Recruitment and data collection

Quantitative data on health service use and cost were retrospectively extracted from routinely collected electronic health record databases and finance documentation. Data on patients' experiences were extracted from inpatient Patient Reported Experience Measures (PREMS) from January 2022 to October 2022 (**Appendix 2**). The PREMS was a standardised statewide online survey sent to patients' mobile phone number two days after hospital discharge.

Qualitative data were obtained through one-on-one interviews with both service providers and consumers. Invitations were sent to all 49 staff members previously involved in the service's development, delivery, and management, as well as to 200 English-speaking former patients. The 200 patients were randomly selected, yet a balanced representation of sex, Indigenous status, residential suburb, and marital status was ensured. Service providers were approached via email, while former patients were mailed a study pack with participation details. Participants were informed that the interviewer had no prior involvement with the virtual COVID-19 HITH service and was independent from it. All participants were given time to review the information letter and provide written consent before data collection commenced.

The interviews followed a semi-structured format guided by the study objectives (**Appendix 3**). In general, the interviewer sought to cover patients' overall experiences with the virtual COVID-19 HITH service, including its usability, positive and negative aspects, areas for improvement, and whether they would recommend it to others in similar situations. Health staff were asked about factors facilitating and challenging service delivery during rapid deployment, perceptions of patient safety, and areas needing improvement. Participants were free to comment in other areas. The selection of follow-up questions, question order, and phrasing varied according to each participant's narrative to enable the emergence of participant-led insights, reflecting their varied histories, modes of expression, and foci of experience.

Invited participants were interviewed once. Participants had no prior knowledge of, or relationship with, the interviewer. Semi-structured interviews were conducted via MS Teams for staff members and by phone for patients, in line with their preferred communication methods. The same interviewer (LKV) conducted all interviews to ensure consistency. Interviews were audio-recorded, supplemented with handwritten field notes, transcribed verbatim, de-identified, and quality

checked. Participants were encouraged to speak freely until they indicated they had nothing further to add. Demographic information was collected at the end of each session with participants' consent.

Analyses

Descriptive statistics were used to summarise all quantitative data in RStudio 4.3.1 [33]. Categorical variables are presented as frequencies and percentages. Length of stay is presented as median with interquartile range. All costs were inflated to 2024 dollars using an index of hospital price inflation [34].

The qualitative data collection and analysis process followed an iterative approach that involved data familiarisation and researcher reflexivity, allowing for the adaptation of the semi-structured interview guide questions as new insights emerged. Initial codes were generated using inductive thematic analysis [35], which were subsequently revised and reorganized multiple times before being collated into potential themes. The candidate themes were then refined in accordance with the five RE-AIM dimensions to ensure that they highlighted important patterns across the dataset. An essentialist approach was applied in the thematic analysis, reporting experiences, meanings, and reality as perceived by participants. The analysis was primarily conducted by two members of the research team (LKV and MA) using NVivo 14 [36]. LKV is a PhD candidate in health services research with mixed-method training and MA is an experienced qualitative researcher specializing in implementation science. Coding was compared between analysts for consistency, and the coherence of interpretations was interrogated through discussions with the broader study team.

Results

Interview participant characteristics

Seven staff members and nine patients were interviewed between February to August 2024. The response rate was 14% for service providers and 6% for patients. All interviewed staff members were female, including one doctor, one divisional leader, one nurse unit manager, one clinical nurse consultant, and three registered nurses, with specialties in geriatrics, oncology, and paediatrics. Patient participants were predominantly of English or Australian descent, with one identifying as Fijian - Indian. Six of the nine patients were female, five over 60 years old, with the exception of a younger woman from the maternity cohort who shared experiences related to both herself and her admitted child. Two invited patients did not participate in interviews but submitted letters expressing their views, which were also included in the analysis.

Reach

Patient demographics and characteristics

During 11-month operational period, a total of 3,909 COVID-19 patients were admitted to the HITH unit. Of these, 622 patients with severe symptoms received only in-person treatments either at their residence or a hospital clinic. 95 patients had missing or unknown data, and 3192 patients were admitted to a virtual HITH ward. Within the virtual cohort, 2417 were adult patients (75.7%), 495 were paediatric patients (15.5%) and 280 were maternity patients (8.8%). A total of 44 patients had multiple admissions to the service, resulting in 3,240 overall admissions. The number of daily

admissions to the virtual HITH ward fluctuated from 2 in early January 2022 to 43 in mid-July 2022. At the peak of each Omicron wave, the team managed up to 120 patients simultaneously. The demographic characteristics of the virtual cohort are described in Table 2.

Table 2: Demographic characteristics of the virtual COVID-19 Hospital in the Home patients

Baseline characteristics	n = 3192	(%)
Female	2027	(63.5%)
Age		
<5 years old	252	(7.9%)
5 - 19 years old	295	(9.3%)
20 - 24 years old	122	(3.8%)
25 - 39 years old	771	(24.2%)
40 - 64 years old	1094	(34.3%)
65+	651	(20.4%)
Unknown	7	
Aboriginal and Torres Strait Islander	233	(7.3%)
Speaking English only	3140	(98.4%)
Marital status		
Never married	1069	(33.5%)
De facto/ Married	1612	(50.5%)
Separated/ Widowed	321	(10.1%)
Unknown	190	
Having private health fund cover	1416	(44.4%)
SEIFA - IRSAD quintile		
1 (most disadvantaged)	1879	(58.9%)
2	107	(3.4%)
3	675	(21.2%)
4	504	(15.8%)
5 (most advantaged)	11	(0.3%)
Unknown	16	

SEIFA Socio-Economic Indexes for Areas, IRSAD Index of Relative Socio-economic Advantage and Disadvantage

Service demand

The demand for the service increased following the reopening of Queensland's border, coinciding with a spike in COVID-19 cases. Many patients emphasized the need for professional support, driven by fear and uncertainties during this challenging period.

"All you heard was the horror stories about how ill some people were, and I was concerned what would happen with me living alone in almost the countryside" (patient 6)

"There was a lot of unknown at that time, there were constantly new directives being put out. So yeah, just to discuss those things that pop up through your head, you know, in the middle of the night when you're not too sure." (patient 8)

The majority of interviewed patients had comorbidities or health concerns requiring additional support. This included chronic conditions needing regular medication and monitoring, recent surgery, breathing issues related to asthma, scarring from previous pulmonary embolisms, and pregnancy complicated by caring for young children. As one pregnant participant described:

"At the time, I was into my second trimester. I was just really sick. I had a toddler and an older

child. The older child tested positive and had some mild symptoms. The toddler, we couldn't test obviously because he was too young. My toddler was quite sick as well..." (patient 7)

As COVID-19 cases began to decline, the demand for service decreased significantly towards the end of the operational period.

Challenges in service access

Despite substantial demand, most patients were generally unaware of the existence of this virtual COVID-19 HITH service or what it entailed, even after being admitted.

"I wasn't aware that it actually existed, basically. And it wasn't explained to me what it was. So I didn't actually know why people were ringing me to start with... Having COVID, you just don't know what's going on, and it was a bit scary. I wasn't even aware that they were from the hospital. So, I was like, why are they ringing?" (patient 8)

Most patients interviewed were referred while engaging with other health services. Patients highlighted the need for more transparent community information on accessing the service.

"It would be good to have more information of availability of service, types of service, how to access this service, eligibility criteria, cost if any." (patient 2)

The shifting and unclear referral process created barriers to service access. Staff expressed concerns about delays with the online self-referral platforms, as patients' information often arrived 3-4 days after their positive tests, by which time they may have begun recovering. A few staff further emphasized that the eligibility criteria listed through those platforms occasionally led to oversights, with some patients registered but not referred to the service.

"Sometimes I would call an at-risk family that was classed through the website and they would ask me to call their family, their cousin, their neighbour, because they also had COVID." (staff 3)

Concerns were also raised about patients with limited health literacy or cognitive impairments who may not recognize when they need care. Technological barriers further complicated access for patients without mobile phones or those unable to answer calls at unscheduled times.

"There are people out there who are not educated to know that their health is deteriorating. We would have to give them all that advice. It wasn't just normal everyday people like you and me, we're talking about people that have cognitive deficits, or people that are elderly." (staff 5)

"For elderly people who don't have a mobile phone, it was hard for them to get to the phone when we ring, because there wasn't any set kind of time." (staff 4)

Effectiveness

Patient outcomes

The virtual COVID-19 HITH service enabled both early discharge support ("step-down") and hospital admission avoidance ("step-up"). Of the 3192 patients, 66 successfully "stepped down" from hospital wards to virtual HITH ward and safely went home sooner, while only 12 patients (0.4%) initially admitted to the virtual HITH required "step-up". No patients were escalated to the intensive care unit and there were no deaths either in the virtual HITH ward or in the physical ward after escalation. The median length of stay for all virtual COVID-19 HITH admissions was 5 days (IQR 4-6). The 28-day readmission rate following the index admission was 6.8% (n=217). Of these, 16 patients were re-admitted to the virtual COVID-19 HITH ward and recovered, while 201 patients were

readmitted into other hospital physical wards with 1 death following these re-admissions.

Table 3: Patient outcomes of the virtual COVID-19 Hospital in the Home service

Admission characteristics	n = 3192	(%)
Length of stay, median (IQR)	5 (4 – 6)	
Early discharge from physical wards to the virtual HITH ward	66	(2.1%)
Escalate from the virtual HITH ward to physical wards	5	(0.2%)
Escalate from the virtual HITH ward and transfer to other hospitals ^a	7	(0.2%)
Discharge home	3180	(99.6%)
Death	0	(0%)
Readmission	217	(6.8%)

IQR interquartile range

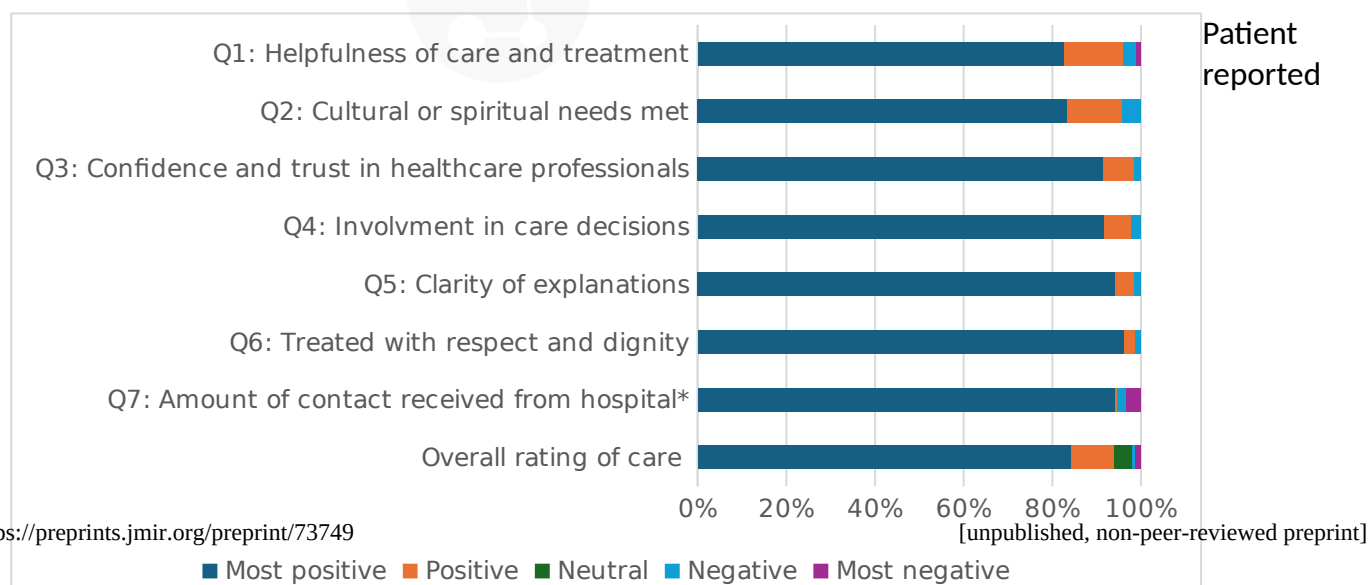
^a These admissions were transferred outside of the operating health service so their discharge outcomes could not be determined.

Interviews further confirmed that the virtual COVID-19 HITH service was safe and effective for managing COVID-19 symptoms at home. All interviewed patients, with their length of stay ranging from two to 21 days, agreed on its efficacy. Four patients received remote monitoring devices delivered directly to their homes, and three had medication prescriptions sent to local pharmacies for pickup. No interviewed participants reported worsening symptoms or health deterioration during their care.

Staff participants appreciated the availability of a doctor on-site, ensuring rapid responses to queries and immediate prescription of medications, further safeguarding patient health in the virtual COVID-19 HITH service. As a consultant-led care model, it achieved quicker patient turnover compared to nursing-led services in nearby hospitals. Other staff participants also highlighted the preventative nature of this service, emphasizing its role in identifying high-risk patients within the community and preventing unnecessary hospitalizations.

"I would say it probably is even more safe that they're on the service at home rather than no service because, you know, it's the safety net. If they're having shortness of breath and if they're not on the service, by the time they eventually can't breathe and present to ED and are very sick, you know, you can safety net that and potentially get something prescribed to prevent that happening." (staff 4)

Service acceptability



experiences of using the virtual COVID-19 HITH service are shown in Figure 1. Predominantly responses were “most positive” across all categories, indicating a high level of patient satisfaction in

seven domains of quality of care.

Figure 1: Patients' reported experiences of using the virtual COVID-19 Hospital in the Home service (n = 599)
Data were extracted from state-wide online survey inpatient Patient Reported Experience Measures (PREMs) from January 2022 to October 2022.

*Q7 had a 3-point scale which has been converted: most positive – the right amount, negative – too much and most negative – not enough.

Most interviewed patients valued the consistent daily communication, typically involving one or two phone calls per day. Videoconferences were also arranged when visual assessments were required.

“I really appreciated that they actually sent the package, I didn't have an oximeter ... and I really appreciated that there was contact every day as well.” (patient 9)

Although staff interviews indicated that some patients initially felt uncertain or sceptical about virtual care, which made them hesitant to participate, all patients interviewed expressed a strong desire for more of this type of service in the community. They also showed a willingness to receive more healthcare at home as long as their symptoms remained stable.

Patient participants confirmed that the virtual COVID-19 HITH service was user-friendly, with all participants expressing that they would highly recommend it to others in similar situations. Patients were particularly impressed by the quick response times and the respectful attitude of the medical staff during admission.

“The morning we registered, that afternoon we spoke to somebody... Yep, and the next day we had the medication.” (patient 2&3)

“Whenever I rang, someone always answered. I didn't get an answer machine. And I didn't have to wait for someone to ring me back. Somebody answered the phone every time.” (patient 9)

“I know what doctors and nurses are like, but they were actually very caring. They asked if I wanted more phone calls towards the end when I was feeling quite well. They always asked if I was happy with what I had, or would I like them to do more couple of days?” (patient 8)

Most patients interviewed agreed the greatest value of the virtual COVID-19 HITH service was the peace of mind it provided during a period of uncertainty and anxiety.

“I was doing that myself, but the medical help was there, it was a phone call away. It was really reassuring, really comforting. Knowing I had the strength of that backs me up.” (patient 5)

Many patients interviewed also noted that receiving care at home contributed to a better recovery experience compared to hospitalization. One patient, who had experienced COVID-19 treatment both in a physical hospital ward and through the virtual HITH service, reflected:

“I actually had COVID twice and got into the hospital with it as well... Home thing is a lot better. You know, I felt a lot more restful, and I felt that I recovered quicker at home because I don't have the continual noise that goes on at a hospital” (patient 5)

For many, the ability to stay home meant more than just physical comfort. Patients emphasized the importance of being close to loved ones and the emotional and mental health benefits of receiving care in a familiar environment.

“I wouldn't have coped locked up in hospital. I suffer post-traumatic stress. I don't like being locked up.” (patient 1)

“I live with my adult children and I'm the carer for my two sons and my daughter. They all have mental health issues. I was worried, like, if I would have to leave the kids or what was going to

happen." (patient 9)

Adoption

Staffing profile

The virtual COVID-19 HITH service was staffed by a multidisciplinary team with flexible staffing levels to accommodate varying patient demand. Medical oversight was provided by an adult and a paediatric Consultant at 1.0 full time equivalent (FTE). The nursing workforce comprised Clinical Nurse Consultants (2.0 FTE), Clinical Nurses and Clinical Midwives (4.8 FTE), and Registered Nurses (2.1 - 11.76 FTE). Supporting roles included Administration Officers (1.4 - 2.8 FTE), a dedicated Pharmacist (1.0 FTE), and Operational Officers (2.8 FTE).

Staff experiences and challenges in service adoption

Overall, staff were supportive of the virtual HITH model of care for managing COVID-19 patients. All staff participants recognized the value of the service during this critical time and were deeply committed to delivering high-quality care.

"My staff worked so hard over that Christmas. My staff were like 110%. We all got together and everybody just did what they needed to do to respond. The teamwork was amazing."
(staff 1)

However, frontline staff often felt overwhelmed and exhausted, a sentiment that was not unique to the HITH team but reflected the broader strain on healthcare workers during the pandemic. Despite strong support and advocacy from their manager, which many appreciated, it wasn't enough to fully address the difficulties they faced.

"There was a lot of emotion, I would say. I've never seen the HITH nurses feeling that overwhelmed. And really, I think not one of us didn't cry going home because it was so hard. It was something none of us want to go through again because there were so many facets to it."
(staff 5)

Many staff participants highlighted the challenges of insufficient preparation and staffing, particularly in the early stages of the service. Many staff who transitioned from other wards had limited experiences with running a virtual ward and had to rely heavily on their past experiences, while quickly being trained by the core HITH staff to navigate their new roles.

"We had to learn the system very fast, logging into a platform and finding the templates. And then it became just second nature. You just come in, you did your job." (staff 5)

"It did require me to learn how to assess patients in a different way... I've always been in ward environments, where I could visually assess my patients. So having to assess them without seeing them, that was difficult at the start, but I learned to change my approach to trying to get as much information from what the patient could describe to me over the phone." (staff 2)

Fluctuating patient volumes and rapid patient turnover posed another challenge, making it difficult for staff to prepare adequately and maintain a balanced workload. This was compounded by evolving referral processes, as well as the constantly changing recommendations around isolation, quarantine, and actions following a positive COVID-19 test during this time.

"On one day, you might have a bunch of discharges and no referrals or minimal referrals. One nurse might only have to call five patients, which isn't much... but on other days, you might have to call 30 patients, and it's just hectic." (staff 4)

Implementation

Motivation and early planning

The motivation to establish a new dedicated virtual COVID-19 HITH service was driven by widespread concern across the state as COVID-19 cases were expected to surge. The announcement of Queensland's border reopening was a key trigger, prompting immediate actions. Information was gathered from various sources and adapted to develop the services' clinical criteria and structure. This included internal insights from a nurse navigator-led model implemented during earlier COVID-19 waves, and some other virtual care models previously employed for managing patients with chronic conditions. Lessons were also drawn from programs developed in response to cruise ship outbreaks and early cases at another major metropolitan tertiary hospital. Protocols for administering antiviral drugs were developed based on interviews with clinicians from another state, where these treatments had already been implemented locally.

Barriers to implementation

Standard HITH services, which provide acute-level care including rehabilitation, IV antibiotics, and infusions, were already in place within the hospital. The introduction of the virtual COVID-19 HITH service led to a temporary hold on other standard HITH services. This decision was made to allow the entire HITH team to focus on the COVID-19 response, as initial staffing was insufficient to manage the massive influx of patients.

"... we had not enough staff [initially]. We had 300 to 400 patients, and our team had not increased by a single staff member" (staff 1)

"It's very quickly became that HITH was running virtual COVID and nothing else. In an ideal world, if we had had a team prepped, ready to go, that would have been really beneficial. Instead, we found ourselves rapidly pulling from outpatient departments that had been temporarily closed to start staffing the model as quickly as we could to reduce the impact on other HITH services, because that was also important to keep running at the time." (staff 7)

Recruitment of additional staff began approximately one month after the service rollout. The onboarding of new staff provided much needed relief, allowing the new virtual COVID-19 HITH service to be operated simultaneously alongside other standard HITH services under the same HITH unit. Paediatric and maternity staff were not involved in the initial phase but joined the team later. The service operated without a purpose-built workspace and sufficient equipment. This was further complicated by physical distancing and personal protective equipment requirements for health services during the pandemic. The team was initially assigned a temporary cabin outside the hospital, followed by a small clinic space within the hospital.

"It was so hot ... our nurses had to gown up in COVID clothes and [...]. You had to sit there for hours, [...]. You had to leave and doff off to get a drink." (staff 5)

"We were in an old dialysis urology, just a little section downstairs on 5G that we were using as a little clinic space. A lot of areas in the hospital had closed down with people working from home, and we had to go to different levels and spread out. There wasn't a real dedicated place for us. We had to find our own space to make all the phone calls and then were kicked out and then had to find another place." (staff 5)

"We had to go and borrow from endoscopy computers because we didn't have enough computers to use on." (staff 1)

Concerns were also raised about the level of support available during the service's establishment. Some frontline staff expressed frustration with delays in securing the resources necessary to deliver

the service and the late inclusion of key personnel in the early planning stages. It was recognized that creating a business case for committing resources and allocating staff was particularly challenging due to uncertainty around the requirements of the new model of care, and competing priorities across the health service. As one manager said:

"It's very hard for a health service to provide budget and staffing around a model that is unknown. So as much as it may have seemed like we weren't listening, there's also a budgetary concern about committing FTE and resources to something unknown. We didn't know what we were going to need. On reflection of that and on probably lessons learned, it's looking at the base resources that you need to prepare the model efficiently, with a dedicated plan in place for what resources you will use when the model needs to be implemented." (staff 6)

Need for real-time adaptations

Staff participants reported that the virtual HITH service was launched rapidly. While some early preparations were in place, the team had to adapt and make adjustments in real-time due to the rapid evolution of government directives for COVID-19, referral processes, and recommendations around isolation.

"Two days after the borders opened, [staff was informed that] a patient is stepped down to our virtual care ... [staff had to] set up a model within 24 hours." (staff 1)

"It was a lot of early preparing. However, when the time actually came, there was a lot of planning happening on the fly as things were unfolding." (staff 7)

Staff participants demonstrated remarkable adaptability in navigating practical challenges. For example. If patients couldn't be reached by phone, text messages were sent as a follow-up. Staff also routinely checked that patients' environments were safe for self-isolation, ensuring they had access to essential support and could maintain overall wellbeing. In extreme cases, as one staff member explained:

"Sometimes you couldn't get on to people. They wouldn't answer their phones, and, you know, I think a few times we did have to do welfare checks on people who lived alone. If you just couldn't get on to them all day and then the next day, then we would have to call the police and ask them to do a welfare check." (staff 4)

Remote monitoring protocols were also adapted to accommodate varying levels of digital literacy. Technologically proficient patients uploaded measurements directly to an online platform, while others reported their observations through phone consultations. The monitoring approach was also customized based on length of stay and clinical severity.

"We provided remote patient monitoring equipment to many patients, but often gathered results over the phone because the online platform couldn't handle the quick turnover of numbers we were managing. If we knew we had someone for longer, or we were very concerned and needed to monitor them very closely, we would onboard them to the online platform." (Staff 7)

Another key aspect was the rapid adaptation of medical governance and clinical criteria across varying patient demands. The initial service design was modelled after existing chronic disease management programs, anticipating the volume of patients needing active home monitoring would be large. However, as the service progressed, it turned out that the majority of patients presented with low-acuity symptoms. Additional challenges emerged when incorporating paediatric and maternity patients due to their distinctly different clinical parameters and risk profiles. The service was eventually transitioned from predominantly equipment-based remote patient monitoring to

self-reported symptoms over the phone.

"Admitting all of them like we did from the beginning, every single patient notified were admitted, we then had to go back and cancel all of these admissions after we assessed them because we realised, they didn't need us, or they didn't need that level." (staff 6)

This level of adaptation affected the service fidelity, in that it was delivered differently than initially intended. However, this was necessary to accommodate the contextual flux and changing service demands. Staff participants noted that having clearer admission criteria would have improved resource planning and reduced logistical and administrative burdens. As one manager reflected:

"The amount of administrative resources required to run a service like this were significantly underestimated. There's a big difference between aiming to avoid hospital presentations for low-acuity, COVID-positive patients and substituting hospital care for those who are acutely unwell with COVID. This distinction is where the administrative workload comes in. We had to quickly create outpatient encounters for all screened patients and then admit only those who required higher-level care." (Staff 7)

Cost

The total cost for the service operating period was \$5.4 million, translating to \$439 per patient bed day and \$2,255 per admission. Labour costs accounted for 93% of total expenditure (\$5.0 million). Additional costs included general clinical and domestic supplies, computer-related services and equipment, and pathology. Further details on the costing process and a modelled cost-effectiveness analysis are available in a separate publication [37].

Maintenance

Service integration into business as usual

The virtual COVID-19 HITH service was decommissioned and absorbed into the regular workflows of the standard HITH team on 28th November 2022 due to declining COVID-19 referrals after peak periods. COVID-19 patients meeting clinical criteria continue to receive home-based care, consistent with other HITH patients, but with appropriate isolation requirements. Virtual, face-to-face, or a hybrid approach is now applied universally to all HITH patients, regardless of diagnosis. The virtual platform enables stable patients to continue their treatment at home and helps staff optimize their workflow, while in-person visits remain essential for assessing environmental and behavioural factors, such as dietary habits or home setup, which may impact patient outcomes.

"We still have a lot of patients on our books that have COVID. They will still come to us if they need and we've just included that group of patients into the standard way of how we deliver care." (staff 7)

"We still have the virtual platforms and all that equipment. But that's used for not just COVID-19, but it's also used for a lot of other patients who we might want to monitor their weight daily or their blood pressure." (staff 5)

Impact on hospital efficiency

From its launch to decommissioning, the virtual COVID-19 HITH service saved a total of 16,651 inpatient bed days. As a preventative care initiative, the service successfully provided continuous access to care to the community, while reduced hospital bed occupancy and alleviated system-wide pressures. As one manager observed:

"From a system wide perspective, I've seen the significant pressure on beds and staffing. And we know that patients will present to a hospital if they're concerned. Given there were significant challenges with patients accessing their general practitioners at that time, I think the fact that they had us to call provided peace of mind if nothing else. And I think we really did achieve what we set out to achieve in preventing multiple anxious patients with COVID rocking up to the hospital because they're very concerned. Since I've been here, it opens my eyes to much more of the potential in this space to help relieve the bed pressures in the system." (staff 7)

The initiative has also left a lasting impact through workforce development. While most staff have remained within the HITH unit, others have leveraged their experience to pioneer new virtual care services:

"I'm currently now starting a tele-chemo service. So I guess that the experience working in the COVID here, virtual, has really helped in the setup of this new service. I think the time that was spent there was very valuable for me to give another perspective on how treatment can be delivered to patients without them being in here, paying up space in the hospital for other more acute patients." (staff 4)

Beyond individual skill development, the service strengthened organizational capacity to respond to future healthcare challenges:

"It was a big learning curve. So that if ever faced with that again, we would go, right, we know what to do. Yeah. I think that's been the best thing that's come out of that." (staff 2)

"I've learned so many lessons as a leader, as a service manager, as a strategic, project quality improvement, like so much has come out of that, which is really good, even though it was challenging." (staff 7)

Areas for service extension and improvement

The HITH unit' continues to expand beyond its original catchment area, with plans underway to address a gap in service delivery in paediatric care.

"We have a fair few kids that sit on a waitlist for 12 months to get a bowel washout for chronic constipation, which could be done at home ... Our diabetes services is getting bigger, but it's still a combined paediatrics adult service. And so they don't have the resources to be able to check on those kids at home" (staff 3)

A recurring theme among staff participants is the desire for greater organizational recognition and voice. This acknowledgment is seen as crucial for securing additional funding to meet growing demand, acquire necessary equipment, and develop skills in virtual care delivery.

"HITH is very forgotten about sometimes. Maybe people above me need to have a better understanding of what HITH can do. Because at the end of the day, it is cost-saving. It gets people out of hospital. And you know, one of our values is care closer to home." (staff 3)

"I think a lot of the work that HITH does generally is really unseen. And because our patients are at home, it's almost like out of sight, out of mind. Thinking that how much work goes into keeping these patients out of hospital, and the resourcing that's required to maintain and support a model like that, I don't think our team got the right kind of acknowledgement." (staff 7)

Staff have also identified several key areas for service improvement. Stronger inter-departmental collaboration is needed to ensure HITH patients who aren't physically present in the hospital but are in admitted care at home receive equitable access to care compared to patients in a physical ward, including timely access to medical imaging and specialist consultations. Addressing virtual care

scepticism through staff and patient education is also key. As one staff member suggested, staff onboarding should include a brief virtual care introduction, and patients could be supported during their first consultation to build confidence.

“When people hear about telehealth, there is a fear of the unknown ... Once people realise how easy it is, a lot of that scepticism will be overcome.” (staff 4)

Discussion

Principal results

This study evaluated the implementation of a virtual HITH service for COVID-19 patients using the RE-AIM framework. Findings from this study indicated that this virtual-enabled HITH model of care was both feasible and safe with positive patient outcomes. Patients highly valued this model as a reliable way to access timely and continuous care during a chaotic period of rapidly changing health information and limited primary care access. Health providers also saw the service as an effective preventative model that helped reduce hospital admissions for high-risk patients, thereby preserving critical hospital resources. However, challenges emerged including adapting to evolving government directives, managing complex referral processes, handling fluctuating patient volumes, inadequate staff training, and balancing competing priorities for resources. Nonetheless, the study highlights clinicians' ability to adapt to real-world needs and pivot from traditional home visits to a virtual care model, which was key to the service's successful implementation.

The study also highlighted the operational complexities of implementing a large-scale, consultant-led virtual HITH service. Findings from this study emphasized the importance of adequate planning to establish the base resources and staffing profile for future pandemic responses. Future services should incorporate a robust data aggregation system and clear admission criteria to improve patient selection that could help to reduce administrative burdens. The development of a shared decision-making application may support this process, a strategy that has been demonstrated effectiveness in a similar context [47]. Additionally, our findings support the adoption of a flexible, blended care model that combines virtual and in-person visits, tailored to patients' unique circumstances. This approach, consistent with previous research [48-51], enables comprehensive patient assessment, optimizes staff workflow, and improves access to care.

Comparison with prior work

Findings from this study is consistent with studies on the implementation of virtual HITH services in other Queensland hospitals during concurrent [38] and previous waves [39, 40] of the COVID-19 pandemic. It contributes to the growing literature on “virtual wards” by demonstrating the success of an approach that supported all adults, paediatrics, and maternity patients. The study also reveals substantial bed-day savings through this model of care and highlights staff willingness to expand virtual home-based care to other health conditions. This aligns with current healthcare trends toward shifting more care closer to home as systems face rising demand and budget constraints [1, 41, 42]. While HITH has traditionally served adult populations [43-46], our findings suggest potential for expansion into multidisciplinary care, including paediatric and maternity services.

This study leverages the strength of multiple data collection methods to capture quantitative outcomes from a large number of patients, while gaining deeper insights through individual interviews. By using postal recruitment rather than online methods, we were able to include voices from elderly people with low digital literacy and avoid inherent bias, offering a more inclusive view

of patient experiences. Staff interviews featured perspectives from nearly all frontline roles, as well as service managers who were instrumental in the service's setup. This provided valuable insights into the rationale and operational choices behind the service's establishment. Although conducted within a single hospital, this site is the largest tertiary facility in the region, covering a large catchment area spanning urban and rural locations, which enhances the generalizability of our findings to more settings.

Limitations

The study has some limitations. First, comorbidity information was not recorded in the routinely collected electronic hospital database, limiting our ability to assess how comorbidities and different health conditions might impact patients' access to and safety within the service. Second, as with all patient-reported data, there may be some self-selection and recall bias. Our sample was not very diverse in language and ethnicity, and recalling experiences from two years ago may have posed challenges for some participants. Lastly, while patients generally accepted this care model, we couldn't determine how uptake might differ if they had a choice between virtual and in-person HITH care, as this service was introduced out of necessity in response to a health crisis. Although most patients reported better recovery experiences at home, some staff noted that certain patients initially felt sceptical about virtual care, making them hesitant to participate. Unfortunately, we were unable to recruit those who held these reservations. We recommend further investigation into factors influencing HITH service rejection in contexts similar to our study, building upon existing US-based research [52]. Future research should also focus on developing better understanding of patient preferences to inform the development of more inclusive virtual HITH services. Critical areas for investigation include evidence-based decisions regarding which modalities to offer, for which populations, and in what circumstances. Particular attention should also be paid to equity considerations, especially in serving culturally and linguistically diverse communities and elderly patients who may face challenges with digital healthcare system.

Conclusions

Recent advancements in remote monitoring technology, coupled with the pressure on health systems caused by the COVID-19 pandemic, have motivated many countries to prioritise HITH services. This study demonstrates the successful implementation of a virtual HITH service in Queensland, Australia, which offered a safe alternative to inpatient care for diverse cohorts of COVID-19 patients during peak Omicron variant surges. Although competing priorities for resources and staffing posed operational challenges, our findings support the potential for expanding this model of care beyond the pandemic and into other clinical domains given its substantial positive impact on patient outcomes and hospital efficiency. Well-defined care pathways, skilled and sufficiently staffed teams, and clearly determined resource requirements are essential for facilitating widespread adoption and scaling of virtual HITH from an emergency response measure into routine care delivery.

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Conflicts of Interest

None declared.

Abbreviations

HITH – Hospital in the Home

COVID-19 – Coronavirus disease caused by the SARS-CoV-2 virus

FTE – Full-time equivalent

Appendices

Appendix 1: West Moreton Health virtual COVID-19 Hospital in the Home service planning report

Appendix 2: PREMS questionnaire

Appendix 3: Semi-structured interview guide

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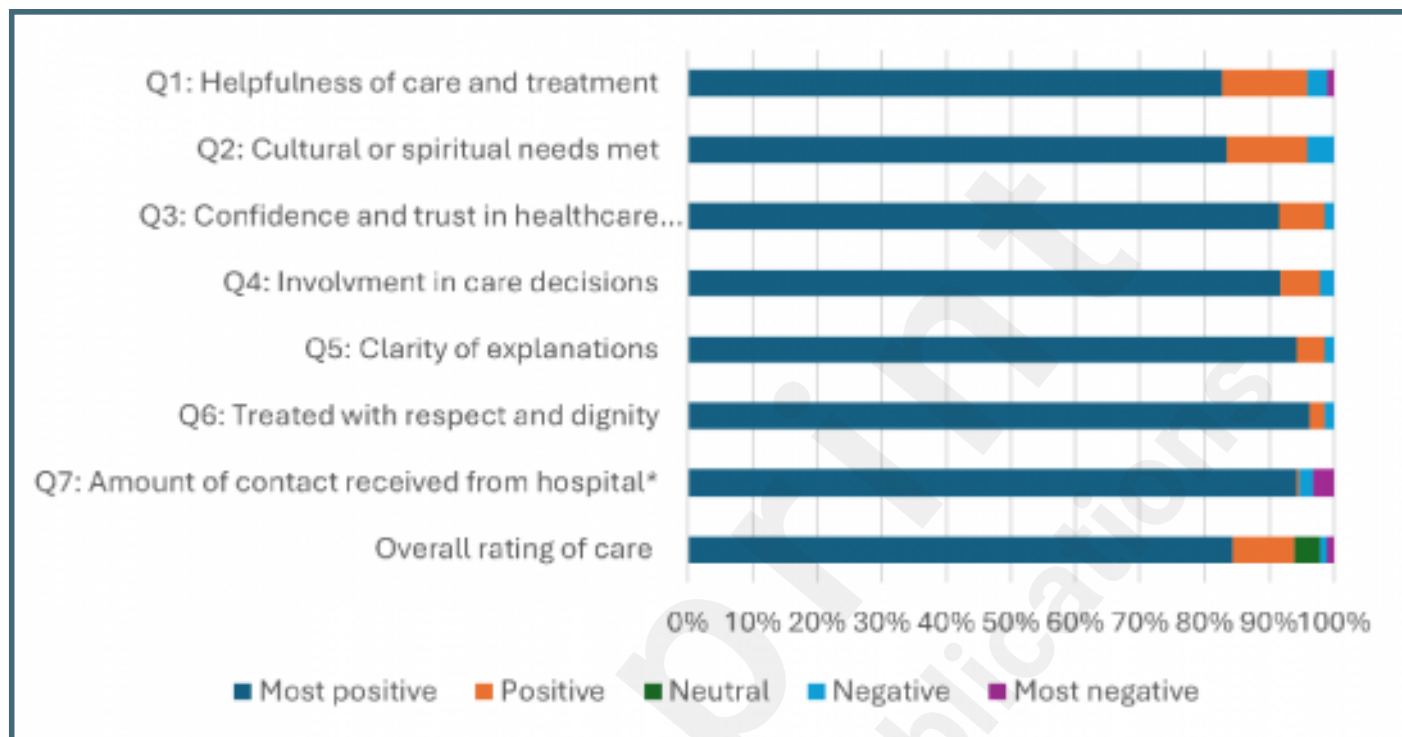
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Supplementary Files

Figures

Patients' reported experiences of using the virtual COVID-19 Hospital in the Home service (n = 599). Data were extracted from state-wide online survey inpatient Patient Reported Experience Measures (PREMS) from January 2022 to October 2022. *Q7 had a 3-point scale which has been converted: most positive – the right amount, negative – too much and most negative – not enough.



Multimedia Appendixes

Virtual HITH Service Planning Report.

URL: <http://asset.jmir.pub/assets/2c9ec95fe15a973f69544b5c9f48352e.docx>

Patient Reported Experience and Outcome Measures (PREMS) Information Sheet (for inpatient and hospital care).

URL: <http://asset.jmir.pub/assets/64c992caba0d9e280cb8aee73d8004e3.docx>

Semi-guided interview guide.

URL: <http://asset.jmir.pub/assets/5eea267a2465dcd4bde9ea3ca7ada11f.docx>

