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RESEARCH

An evaluation of a virtual COVID-19 ward to accelerate the supported discharge of patients from an acute hospital setting:

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Abstract

Background/Aims In response to high numbers of hospital admissions as a result of COVID-19, a virtual ward was implemented to achieve accelerated discharge from hospital without compromising patient safety. This study assessed the impact of this virtual ward for patients admitted to the acute hospital setting with COVID-19.

Methods A community-based intervention using digital technology and a multi-disciplinary team of specialist clinicians to monitor patients at home was established. An analysis was carried out within the service investigating the safety, health outcomes and resource use of the first 65 patients discharged from hospital into the virtual respiratory ward.

Results Red days, where an urgent response was required, decreased from 33.8% of patients in their first 3 days at the virtual ward to 10.8% in their final 3 days (P=0.002). Four patients were readmitted to hospital, all for clotting disorders. There was one death, which was deemed unrelated to COVID-19. Length of stay was also reduced by 40.3% (P<0.001) and estimated overall savings were £68 052 (£1047 per patient).

Conclusions The virtual ward appeared to assist with earlier discharges, had a low rate of clinically necessary re-admissions, and seemed to reduce costs without compromising patient safety. The authors believe that this intervention could be applied across other NHS trusts facing similar capacity issues as a result of COVID-19.

Key words: COVID-19, Digital technology, Length of stay, Patient discharge

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Introduction

During the first 'wave' of the COVID-19 pandemic there was concern that health systems could be overwhelmed. The surges of COVID-19 infections and hospital admissions caused unprecedented issues with the provision of hospital-based care in Leicester, Leicestershire and Rutland, as well as in the UK as a whole. Between May and June in 2020, a digital pathway for assisted discharge for patients with COVID-19 was devised by clinicians from University Hospitals Leicester NHS Trust, the community specialist respiratory team of Leicestershire Partnership Trust and Spirit Digital (Spirit Health Group, Leicester, UK). The clinical algorithms used in the COVID-19 digital platform were devised and reviewed by two independent respiratory consultants.

It was expected that this change to a virtual model of care would relieve pressure on the acute setting, among other potential benefits to patients and healthcare professionals. The digital platform was deployed in November 2020, when Leicester, Leicestershire and Rutland experienced the second wave of the pandemic. Its onset accompanied the capacity issues experienced by acute hospitals during winter, creating severe challenges in the delivery of acute care within the region. The increased demand for acute beds was exacerbated by the impact of COVID-19 on the workforce, with many clinicians either having contracted COVID-19 themselves and self-isolating, or shielding from direct patient contact.

At the outset of the pandemic, digital technology was considered potentially useful for surveillance, screening, triage, diagnosis, monitoring and contact tracing (Wariri et al, 2021). The UK has been at the forefront of the centralised use of digital technology in surveillance, diagnostic testing and contact tracing at a national level. The use of digital technology to support remote triage and consultations across many clinical disciplines has been widespread (Price et al, 2020; Han et al, 2021). The Royal College of General Practitioners (2021) has suggested that a mix of remote and face-to-face consultations should continue even after the COVID-19 pandemic.

CliniTouch Vie (Spirit Digital, Spirit Health Group, Leicester, UK), the digital app, was already in use in the clinical commissioning groups of Leicester, Leicestershire and Rutland to support the management of patients with respiratory disease before the pandemic. This was not the first virtual ward set up to contend with the COVID-19 pandemic, with similar interventions leading to reduced acute bed days (Thornton, 2020). During the first wave of the pandemic, it was recognised locally that patients typically bifurcated into two separate cohorts: those likely to recover quickly and those expected to deteriorate further, which gave a plausible hypothesis to the former cohort being eligible for an early supported discharge intervention. After the first wave of the pandemic, information flowed quickly on the early use of virtual wards in the UK (Thornton, 2020). In March 2020, virtual wards were established. Manchester University Foundation Trust developed the first assisted discharge service in the UK, in which patients were managed through regular phone calls. Of the first 200 patients, 10% were readmitted (Thornton, 2020). In West Hertfordshire NHS Trust, patients were discharged from the emergency department into a virtual ward, rather than being admitted. From mid-March to 11 May, 1042 patients with COVID-19 were admitted to the virtual ward. They estimated that of the first 400 patients, 300 bed days were saved in the hospital over 3 weeks (Thornton, 2020). There seemed to be early evidence regarding the effectiveness of virtual wards in enhancing hospital capacity, with no evidence of patient safety being compromised.

The objective of the digital platform established at University Hospitals Leicester NHS Trust was to improve patient flow by enabling the safe discharge of patients at the early stages of recovery from COVID-19 infection. It was recognised that this required a system-wide approach, with acute hospital services working closely with community providers to ensure that patients were monitored following their discharge. A flexible model was required to respond to further surges in cases of COVID-19, while also taking into account the impact that annual winter pressures would have on local capacity.

This study reports on the deployment and early clinical and economic outcomes of the digital pathway at University Hospitals Leicester NHS Trust. The aim of the intervention was to create capacity in secondary care, while maintaining patient safety. This is an early evaluation to share a description of the service and early outcomes, as healthcare systems around the world face ongoing challenges.

Methods

This was an observational evaluation of a novel service, rather than a clinical trial; there was no active comparator group, randomisation or blinding. The data reported are of the first 65 participants that accessed the intervention. The analysis is primarily narrative in nature and describes the early results of the implementation of the virtual ward programme. While statistical methods have been employed to determine the validity of the initial findings, many endpoints were not pre-specified, no estimate of effects were pre-determined and no power calculations were made. The intervention was delivered consistently to the patients reported on in this analysis, with no variation in how care was organised or delivered. The Standards for Quality Improvement Reporting Excellence guidelines were used to structure the paper (Ogrinc et al, 2015). In a systematic review of virtual wards, Vindrola-Padros et al (2021) stated that no conclusions could be drawn regarding patient safety and the identification of early deterioration because of missing data and a lack of standardised reporting. Moreover, in-depth economic analyses were not reported in the majority of models analysed in this review, making the financial impact of virtual wards difficult to gauge. However, the methods employed in the present study aimed to address these issues as much as possible, despite the limitations associated with service evaluations.

Intervention

The virtual ward was facilitated using CliniTouch Vie, a digital platform that comprises both a patient and clinical portal. Clinical data are entered by the patient and uploaded to a clinical dashboard, which prioritises patients depending on their responses to clinical questions and observations. The platform also allows patients and clinicians to connect via message or by embedded video consulting features. The platform can be accessed via any smartphone, tablet (Android or IOS) or computer (Windows- or Apple-operating systems).

The specialist respiratory department at University Hospitals Leicester NHS Trust is located within Glenfield Hospital. Patients were identified for the service following senior medical review at the hospital. The virtual service provided care for patients in Leicester, Leicestershire and Rutland, in a partnership between University Hospitals Leicester NHS Trust, Leicestershire Partnership Trust and Spirit Digital. The preference was for patients to use their own devices to access the platform but, if patients did not have access to a suitable device, a smartphone was provided free of charge by Spirit Digital.

The virtual ward service provided remote support and follow up for patients with respiratory symptoms admitted to hospital with a clinical diagnosis of COVID-19 and at risk of deterioration after discharge. At the time of implementation, because of the lack of a validated deterioration risk scoring tool for patients with COVID-19, a clinical decision aid was formulated by the respiratory team at University Hospitals Leicester NHS Trust to assess patients' suitability for discharge. To meet the clinical referral criteria for the virtual ward, patient needed to be:

- Medically fit for supported discharge, as decided by their designated consultant
- Able to cope at home
- Willing to engage in full active treatment
- In possession of a smartphone, tablet or laptop.

They also needed to have two or more risk factors for increased safety netting from the list below:

- <10 days since onset of symptoms
- Respiratory rate of 20–22 breaths per minute
- Oxygen saturations of 92–94%
- Living alone
- Belonging to a clinically extremely vulnerable group.

Once a patient had been identified as clinically suitable and the risk had been estimated, the referring team ensured that a decision on escalation had been made and documented before discharge on the referral form. A structured discharge process was then initiated by staff, in which patients were introduced to the service and confirmed their willingness to take part. On the last day before discharge from hospital, patients were registered on the virtual platform, provided with a thermometer and pulse oximeter, and taught how to use them. On the day of discharge from hospital, patients were assisted in accessing the patient portal and completed the first question set, as well as the questions on informed consent and data sharing. Staff ensured that patients were confident in using the platform and confirmed that patients had the contact details for the respiratory team and the Spirit Digital (the providers of the CliniTouch Vie platform) helpline.

Key outcomes

The following were considered the most important endpoints to be evaluated:

- The overall safety of the virtual ward, ie the number and percentage of re-admissions and the number and distribution of red days in the virtual ward (a priori)
- The length of hospital stay of those who accessed the virtual ward (a priori) and, to establish whether bed days were reduced following the introduction of the virtual ward (post hoc)
- The costs associated with the virtual ward (a priori), and the estimated impact on overall resource use (post hoc).

Every patient accessing the virtual ward had their daily risk and health status rating recorded using the codes red, amber and green (RAG). The number of patients in the virtual ward and their RAG status were explored over time. Student's *t*-tests (paired and two-tailed) were conducted to compare patients' scores on their first day, first 3 days, last day, last 3 days in the virtual ward. These data were extracted from the CliniTouch database and analysed using the Microsoft Excel 365 Data Analysis pack. All re-admissions were reported, with the cause of re-admission identified and the case explored by senior clinicians.

Treatment regimes in the first and second wave of the COVID-19 pandemic altered as clinical knowledge improved. Patients accessing the virtual ward were compared to the entire cohort of patients who did not require either oxygen or intensive monitoring (ie broadly comparable patients and treatments) before the introduction of the virtual ward in November 2020.

Information regarding the use of clinical resources on the virtual COVID-19 ward was provided by Leicestershire Partnership Trust and the costs of clinician time attached to the intervention were sourced from the University of Kent's Personal Social Services Research Unit dataset (Curtis and Burns, 2020). The number of interventions was accessed from the CliniTouch Vie database. The cost of 1 bed day in the Glenfield Hospital respiratory wards, individual lengths of stay for patients admitted into the virtual ward, and the mean plus confidence interval for similar patients (no intensive or high dependency care or oxygen administration) admitted and discharged throughout the month of November and immediately before the introduction of the virtual ward in Glenfield Hospital were sourced from the business team within the University Hospitals Leicester NHS Trust Finance Directorate in cooperation with the clinical commissioning groups for Leicester, Leicestershire and Rutland. All analyses were based on these datasets.

All patients gave informed consent for their anonymised data to be used for research purposes. The evaluation proposal was submitted to the local institutional review board, but the need for full ethical approval was waived because the study was a service evaluation.

Results

A total of 66 patients were admitted to the Leicestershire Partnership Trust virtual ward from when it opened in November 2020 up to 31 January 2021. Their ages ranged from 21.5–87.4 years, with a mean and median age of 56 and 58 years respectively. Data regarding patients' ethnicities were not retained, but 39% of the patients were recorded as female. Of the 66 patients, data were available for only 65 individuals, as one patient was re-admitted before inputting any data. This admission and the associated costs are included in the narrative, but the denominator has been kept as 65 to maintain consistency.

The mean and median length of stay in the virtual ward were 13.2 days and 14 days respectively, with only one patient staying for 20 days. Patients were discharged from the virtual ward at the discretion of the clinicians and as per hospital protocol. Figure 1 shows

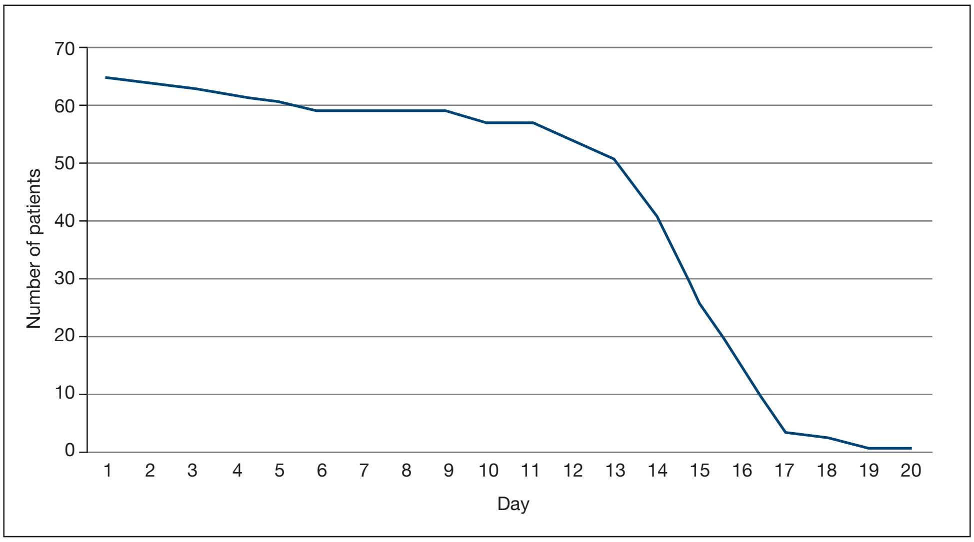

Figure 1. Day of discharge from the virtual ward for patients admitted between November 2020 and January 2021 (n=65).

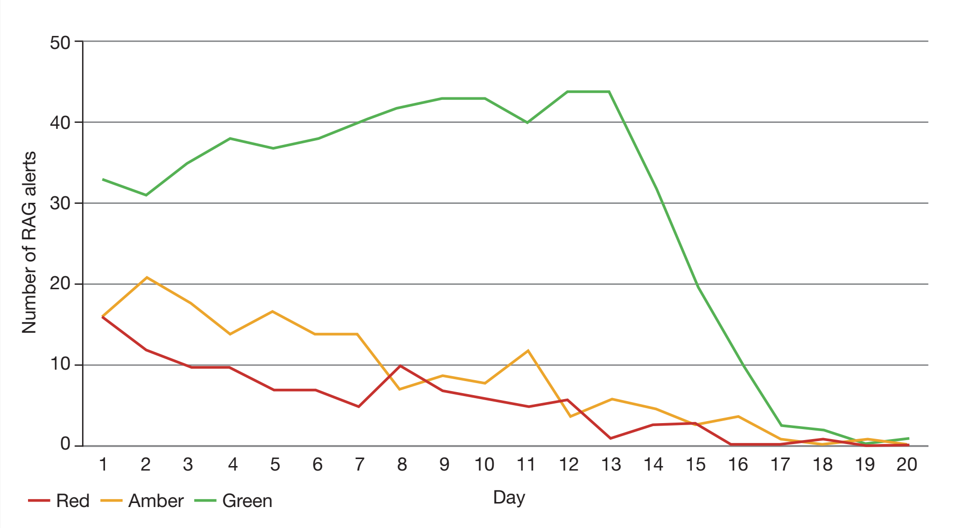

Figure 2. Red, amber, green (RAG) ratings of 65 patients in the virtual ward over 20 days (mean length of stay=13.2 days).

the daily number of patients in the ward, with 91% of patients remaining in the virtual ward for 9 days or more.

The number of patients who were re-admitted to the hospital from the virtual ward was four (6.2%), and included the patient for whom there was no data. The number of patient red alerts on their first day on the virtual ward was 16 (24.6%), with 22 (33.8%) in the first 3 days after admission. The number of patients with a red alert on their final day on the virtual ward was five (7.7%), with seven (10.8%) in their last 3 days on the virtual ward. This represents a relative reduction of 56.3% (P=0.049) in red days from the first day to the last day, and 68.2% (P=0.002) from the first three days to the last three days on the virtual ward. The absolute number of RAG rating scores over time for the 65 participants is shown in Figure 2.

There was no significant correlation between patient length of stay at the Glenfield respiratory wards and length of stay at the virtual ward. The average length of stay in the hospital wards before the introduction of the virtual ward in November 2020 was 5.5 (±1.3) days, while the mean length of stay for those discharged into the virtual ward was 3.3 (±0.4) days.

Resource use in the virtual ward

The total number of virtual consultations conducted in response to a patient giving a 'red' rating in the virtual ward was 109, 30.1% of which were in the first 3 days of admission (Table 1). Each red rating led to two video-consultations, with a mean total duration of 27.5 minutes. These contacts were conducted by band 7 specialist nurses or physiotherapists. Patients with amber ratings in the first week were also contacted, resulting in 114 consultations in total. Ten patients with a green rating who had not been contacted before were also contacted in the second week as part of the discharge process. The total consultation costs for the 65 patients over the 20 days they spent in the virtual ward were estimated and are shown in Table 1.

The cost of virtual ward contact per patient was estimated at £93.52. The total cost of virtual monitoring via CliniTouch Vie was £2583 (£39.74 per patient) and the total cost of monitoring and contacting patients was £8662 (£133.26 per patient). The mean rate of readmission to hospital from the virtual ward was 6.2%, with readmission costs totalling at £11 704 (£180.06 per patient).

A common adverse outcome of COVID-19 is venous clotting, which has been found in 20% of patients hospitalised for the virus (The Royal College of General Practitioners, 2021). In this cohort, two of the patients who were re-admitted to hospital from the virtual ward on day one would likely have had their clotting event while in hospital under usual care, while the other two patients had a clotting event on days four and five, at which point, without the virtual ward, they likely would have been discharged from hospital and then readmitted.

Table 1. Number of clinician contacts and associated costs by patient red, amber, green (RAG) rating over 20 days at the virtual ward		
Patient RAG rating	***n***	**Cost (£)**
Red	109	2844
Amber (week one only)	114	2974
Green (week two only)	10	261
Total contacts	233	6079

Source: Curtis and Burns (2020).

Table 2. Summary of resource savings from reductions in average length of stay at Glenfield Hospital following the introduction of the virtual ward	
Resources	**Savings**
Average length of stay before intervention	5.5 days
Average length of stay post intervention	3.3 days
Bed days	
Number of patients seen in virtual ward	65
Bed days saved	144.2 days
Reduction in bed days	40.3%
Costs (£)	
Bed days costs averted	£76 714
Costs of intervention	£8662
Total resources saved	£68 052
Resources saved per patient	£1047

Early discharge and bed days potentially released

The average length of stay before the introduction of the virtual ward was 5.5 days, decreasing to 3.3 days after the virtual ward was implemented, representing a 40% reduction in bed days (P<0.001). The mean local estimate of the cost of a bed day in a respiratory ward in the Glenfield Hospital in the month of November 2020 was £532. The implications for resource savings produced by the virtual ward are summarised in Table 2.

Discussion

These results suggest that the primary goal of increasing acute capacity was achieved through the introduction of the virtual COVID-19 ward. Overall, 25% of patients had red alerts on their first day in the virtual ward, indicating a reduced health status. If these patients had been retained in the hospital for an additional day, which would have been likely in usual circumstances, this would have cost a total of £8512, representing 98% of the costs of the virtual ward.

For the virtual ward to be cost-neutral, it would need to have reduced bed days by one for every four patients referred into it. In actuality, it reduced bed days by 2.2 per patient admitted for COVID-19 or related complications. The estimated savings incurred by introducing the virtual ward (compared to maintaining the previous discharge protocol) were 8.9 times greater than would have been required to make the ward cost-neutral. If the costs of all four re-admissions from the virtual ward to the hospital are included, this figure decreases, but still represents savings 6.5 times greater than would have been required to make the ward cost-neutral.

However, this intervention was not only about saving resources. On 15 January 2021, 48% of patients in Glenfield Hospital had been admitted with COVID-19-related disease. Creating additional capacity by minimising lengths of stay, while maintaining patient safety, was crucial. The direct costs of the virtual ward were relatively low at around £133.26 per patient, which made it a sustainable intervention, particularly if patients' average length of stay in hospital was reduced. The results align with initial analyses conducted in other hospitals regarding the safe reduction of hospital bed days (Thornton, 2020). The estimated savings from the virtual ward of over £1000 per patient were substantial, and the readmission rate of 6% was relatively low.

It is worth noting that none of the 66 patients withdrew from the virtual ward because of system failures or faults. If patient care is to rely more heavily on digitally-supported services in the future, systems must be reliable enough to be able to support clinical care. The software used for the virtual ward had a 100% success rate in daily sharing of patients' data with clinicians. One patient withdrew at their own discretion on day two and had been rated green the previous day. All other patients left the virtual ward with the agreement of clinical staff.

The virtual ward allowed patients to be treated at home, reducing their likelihood of contracting a hospital-acquired infection or of infecting staff with COVID-19 which, amid a workforce crisis, is paramount. Patients' symptoms were monitored daily through the virtual ward, and the ability to communicate with clinicians via text and video conferencing meant that any decline in symptoms could be rapidly identified. Over time, patients' wellbeing broadly improved, as can be seen in the reductions in red and amber days shown in Figure 1. This suggests that the virtual ward was successful in reducing length of stay without compromising patient safety.

However, as noted by Malas et al (2020), COVID-19 has caused a significant increase in adverse blood-clotting outcomes; this was the reason behind the four re-admissions to hospital from the virtual ward, resulting in the death of one patient. Two of these four patients had their clotting event on the first day after hospital discharge, which potentially delayed access to optimised care. All re-admissions were clinically reviewed by senior clinical colleagues within University Hospitals Leicester NHS Trust and Leicestershire Partnership Trust, and the inference that COVID-19-related disease was the primary attributable factor for the readmission could not be ascertained. All patients were on thromboprophylaxis while in the hospital, and were mobile on discharge. At the time of the study, the admission criteria for the virtual ward excluded patients discharged on oxygen. However, the service has since been extended to include these patients, with the aim of weaning them off oxygen as part of their recovery from COVID-19. The service intends to report on this cohort of patients at a later date.

The COVID-19 pandemic has accelerated a worldwide digital health revolution. The unprecedented public health challenge of providing safe care for patients and clinicians, while also enabling increased capacity within the healthcare system, would be difficult and expensive to sustain within traditional working methods. Digital solutions do not replace the key role that clinicians play in the care of their patients, but they can provide them with more specific, systematic and prioritised clinical data to enable them to make high-quality clinical decisions. A recent paper reported a 3.5-fold increase in re-admissions and a 7.7-fold increase in mortality at 140 days for patients discharged from hospital

Key points

- The virtual COVID-19 ward seemed to reduce bed days by 40% and increase bed availability in the hospital.
- The virtual ward accelerated the discharge of patients safely, with a relatively low re-admission rate.
- The introduction of the virtual was cost-effective and led to considerable cost savings.
- Access to digital systems can be expanded rapidly to help with future surges in infections and has a potential role in expanding into other non-COVID-19-related hospital discharges.

following admission for COVID-19-related disease (Ayoubkhani et al, 2021). The digital component of the virtual ward service was easily scaled up, and most UK localities have specialist community respiratory teams. Therefore, this model of care could be rapidly introduced in other localities or expanded into additional 'at risk' cohorts of patients to improve outcomes post discharge from hospital.

Limitations

The results were open to bias and confounding, which reflected the environment within which the virtual ward was introduced, as a pre-planned emergency response to circumstances. There are also inevitable limitations associated with real-world data. The costs of implementing the virtual ward intervention were more certain than the potential costs of not implementing the virtual ward, making comparison difficult.

Conclusions

The COVID-19 virtual ward seemed to achieve its objective of increasing hospital capacity, with a low rate of re-admission. The software used was also reliable in sharing data with clinicians. The cost per patient was low and the savings appeared relatively high, making the service cost-efficient. The technology is accessible and specialist community respiratory teams are commonplace in the UK. Therefore, this service could be reproduced across other NHS trusts facing similar capacity pressures as a result of COVID-19, although additional and higher-quality data is needed to help inform future practice in this area.

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Conflicts of interest

Jim Swift, Noel O'Kelly and Chris Barker are employed by Spirit Health Group, which owns the intellectual property associated with CliniTouch Vie. The remaining authors have no conflicts of interest to declare. The intervention was supported financially by funding from Ageing Well. The views and opinions expressed in this article are those of the authors and do not necessarily reflect the views of Spirit Health Group, Leicestershire Partnership NHS Trust or Leicester School of Allied Health Sciences, De Montford University.

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