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A Covid -19 Virtual Ward Model: A Preliminary Retrospective Clinical Evaluation From a UK District General Hospital

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Abstract

Objective: This study aims to evaluate the safety, utilization, ability to reduce length of hospitalization and overall outcomes of a COVID-19 virtual ward providing ongoing treatment at home. **Method:** A retrospective single-center study of patients discharged to the COVID-19 virtual "step down" ward between January 27th 2021 and March 2nd 2021. The referral process, length of hospitalization, length of stay on the virtual ward, readmissions, and ongoing treatment requirements including supplemental oxygen, antibiotics, and/or steroids were all noted. **Results:** A total of 50 patients were referred to the virtual ward. 43 referrals were accepted, 39 of which were from the respiratory ward. Four patients were readmitted, all due to hypoxia. All readmissions occurred within 5 days of discharge. 72% (n = 31) were discharged home with an ongoing oxygen requirement. 14.3% of patients were discharged with antibiotics only, 9.5% with steroids only and 23.8% with both antibiotics and steroids. The mean length of hospital stay for patients discharged to the virtual ward was 10.3 ± 9.7 days and 11.9 ± 11.6 days for all covid positive patients during this time. On average, patients spent 13.7 ± 7.3 days on the virtual ward. The average number of days spent on oxygen on the virtual ward was 11.6 ± 6.0 days. **Conclusion:** The virtual ward model exemplifies the potential benefits of collaborative working between primary and secondary care services, relieving pressure on hospitals whilst providing ongoing treatments at home such as supplemental oxygen. It also facilitates an early supported discharge of clinically stable patients with an improving clinical trajectory by managing them in the community.

Keywords

Covid-19, virtual ward, supported discharge, oxygen therapy at home, virtual monitoring

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Introduction

Whilst not an entirely new concept, there has been a substantial and rapid rise in the use of tele-medicine, virtual clinics, and virtual monitoring throughout the course of the current global Coronavirus-19 (COVID-19) pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Designed to alleviate the burden on secondary care, remote monitoring and virtual wards have been utilized across the globe.[1-3] In the United Kingdom (UK), the National Health Service (NHS) has currently produced two standard operating procedures to encourage widespread implementation.[4,5] Virtual care provides patients with equipment to monitor their condition at home and is designed to detect early signs of deterioration aiming to avoid the need for invasive ventilation and intensive care admission, avoid unnecessary hospital admissions and allow for organized readmissions.[6-10] Covid Oximetry@ Home was a virtual UK initiative set up during the first wave of the pandemic and was directed at early detection of patients suffering from "silent hypoxia."[4] These patients often presented with extremely low oxygen saturations

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without accompanying breathlessness and often required prolonged stays in hospital, invasive treatment and were often associated with poor outcomes.[11] As an initiative it provided supportive care to low complexity patients suffering with COVID-19 at home. In January 2021, NHS England produced a further standard operating procedure that marked an evolution in virtual care designed to further ease the ongoing pressures from the pandemic on the healthcare system.[5] The emphasis was on the introduction of "step down" wards that aimed to facilitate earlier, safe, supported discharge of patients who had received treatment for COVID-19 in hospital. These virtual wards were created to provide hospital level care in the community with the aid of virtual monitoring to not only provide active treatment for higher complexity patients outside the hospital setting but to ultimately reduce the number of bed days for covid admissions and subsequently decrease the ongoing burden on hospital bed space.

Utilizing a collaborative approach between primary and secondary care, the concept of the COVID-19 virtual ward was designed to provide therapies at home including antibiotics, steroids, and supplemental oxygen. Patients were referred by the clinicians in secondary care with advisory parameters for readmission to clinicians in primary care who were then responsible for monitoring and ongoing care of the patients. This aimed to facilitate a reduced length of stay in hospital for medically stable patients who might otherwise remain an in-patient for observation or have delayed discharge until fully weaned off oxygen. As a respiratory virus, a large proportion of patients admitted with COVID-19 require oxygen therapy. This increases the length of hospitalization since patients remain in hospital until they have no further oxygen requirement. Therefore, a virtual model that allows for the provision of treatment at home and allows for even a small reduction in bed days or slightly earlier discharge would be meaningful, particularly considering hospitals are operating well above capacity and will continue to do so even as the direct pandemic pressures rise and fall.

Despite previous research into the benefits of remote home monitoring models for other conditions prior to the pandemic and their widespread use during the current pandemic, studies on implementation and impact is still a growing area. Facilitation to discharge complex patients home from hospital with ongoing treatment requirements such as oxygen whilst providing adequate and safe monitoring is an area that is particularly rare within the literature on virtual ward models. This study aims to look at the safety, utilization, possible future use, and to evaluate the virtual ward outcomes against the current literature on various virtual ward models.

Methods

A retrospective single-center study of patients discharged to the COVID-19 Virtual Ward from a district general hospital (District General Hospital, defined as hospitals that provide secondary and occasionally tertiary level care predominantly to a local area) in the United Kingdom from 21st January to 2nd March, 2021.

Virtual Care

The virtual ward evolved to have 4 possible pathways for patients to be referred to: mild, moderate, severe, and palliative. The pathways were designed to indicate the level of remote monitoring required for the patient based on their ongoing requirements. Initially, this was determined by agreement between the referring clinician and the virtual ward clinician based on basic pre agreed criteria that eventually evolved into the suggested referral pathways provided to the referring wards (Figure 1). On discharge, patients were given a home monitoring set provided by DOCCLA (DOCCLA—Swedish Medtech company working in partnership with various NHS trusts including Hertfordshire community NHS trust to provide equipment and monitoring interface for the virtual ward). Each pack contained equipment to measure temperature, heart rate, oxygen saturations, and blood pressure, as well as a mobile monitoring device on which to enter their recordings. Prior to leaving the hospital, each patient received appropriate training on how to use each piece of equipment and instructions on how to set up the mobile monitoring device at home. All equipment required at home came in a pre-set box that was allocated specifically to the patient. Training was provided by staff familiar with the equipment and consisted of one session at the bedside involving an explanation and demonstration of each piece of equipment given to the patient. Patients were then asked to demonstrate their understanding of what they had been told and consent to being discharged to the virtual ward. They were also provided with appropriate helpline numbers should they develop any issues with any of the devices, as well as a contact number to a medical professional hub should they become concerned about their wellbeing. Once discharged from the ward all equipment was returned.

The eventual capacity of the Virtual Ward was a maximum of 30 patients at any one time. Clinicians in primary care reviewed the observations entered onto the system 3 to 4 times per day and daily decisions regarding patients ongoing management was decided by a team of doctors and nurses on a daily board/ward round. Frequency and method of contact either phone call/face to face or video consult was determined first by the pathway the patients were discharged on to and subsequently the observations and the discretion of the clinicians on the virtual ward. If required, patients were referred back to hospital via the medical registrar on-call. Advice could also be sought from a respiratory consultant if deemed necessary.

For those patients with ongoing oxygen requirements, patients were weaned to a maximum rate of 4 L/min prior to

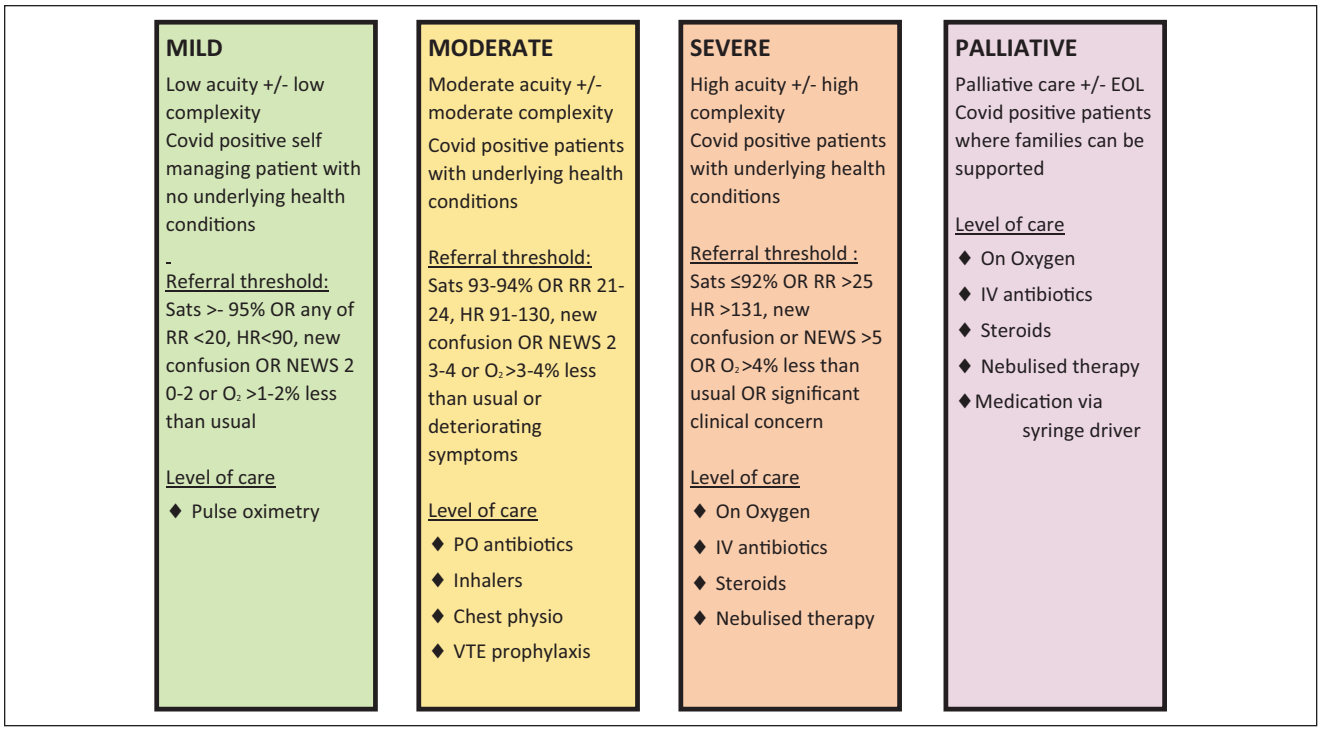

Figure 1. Suggested referral pathways and criteria for Covid Virtual Ward.

discharge. Clinicians on the virtual ward aimed to wean oxygen by 1 L every 24 to 48 h provided that the patients were not breathless, saturations were above 94% (provided they had no underlying lung conditions) and they were able to undertake their normal activities of daily living without any symptoms. Patients were not discharged from the ward until they were 24 h off oxygen and had stable saturations >94% or at baseline.

Population Studied

All patients admitted to the virtual ward during this time period were included in the study. Rejected referrals were acknowledged but not included. All patients admitted to the virtual ward had been admitted to hospital for treatment of COVID-19 as their primary diagnosis with a laboratory confirmed positive COVID-19 polymerase chain reaction PCR test for SARS-CoV-2 following a nasopharyngeal swab. Suitable patients were identified by secondary care physicians predominantly from the respiratory ward and referred to primary care physicians responsible for the COVID-19 virtual ward via phone call. Suitable patients were selected based the NHS standard operating procedure for a virtual ward and could be broadly defined as any independent patient with an improving clinical trajectory who could consent and adequately prove that they were able to correctly utilize the equipment provided. A paper referral was also filled in by the secondary care physician outlining the parameters for escalation back to secondary care including target oxygen saturations, heart rate, temperature, and blood pressure. A suitable pathway to determine the ongoing level of monitoring required was also identified on the referral. Patient referrals were rejected if they were deemed to be potentially unsafe to be managed within the community on the virtual ward and included patients not being independent with their activities of daily living, requiring high levels of social input, an inability to report their symptoms reliably or levels of cognitive impairment that would mean they were unable to escalate their condition appropriately should it deteriorate and being deemed unable to utilize the remote monitoring equipment sufficiently. Patients were also rejected if their main ongoing treatment requirements were not COVID-19 related or if the patient themselves chose to reject referral to the virtual ward if they felt that it was not something they could manage (Table 1).

Data Collected

Information was collected on patient age, gender, number of days between recorded positive COVID-19 PCR test and admission to hospital, length of hospital stay prior to referral, the Virtual Ward pathway referred to, oxygen requirement on discharge and whether they were discharged home with any steroids, antibiotics, or both. Length of hospital admission of patients admitted to the virtual ward and all covid patients in the hospital over the same time period was recorded. Length of stay on the virtual ward, the number of

Table 1. Summary of Inclusion and Exclusion Criteria for Referral to the Covid Virtual Ward.

Inclusion criteria	Exclusion criteria
>18 years old	<18 years old
Improving clinical trajectory (bloods, CXR)	Clinical signs of deterioration
Ongoing dexamethasone and/or antibiotic requirement	Antibiotic or steroid requirement not related to COVID-19
Oxygen requirement ≤4 L/min	Oxygen requirement >4 L/min
Oxygen saturations ≥94% or >92%, not symptomatic and with PE excluded or at baseline, +/− Oxygen	Oxygen saturations <94% or >92% with PE not excluded and/or symptomatic or >3% off baseline
Afebrile ≤37.8 for minimum of 48 h	Documented fever ≥37.8 in last 48h
Overall NEWS2 score <3	Overall NEWS2 score >3
Heart rate <90	Heart rate >90
Able to use a telephone/videoconference and demonstrate ability to utilize monitoring equipment	Unable to demonstrate the ability to use a telephone/video conference and/or monitoring equipment
Adequate social support, self-caring, able to isolate	High social requirements, unable to self care, high levels of cognitive impairment

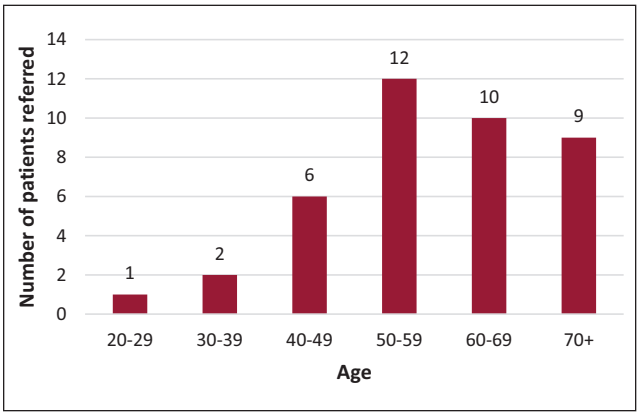

Figure 2. Number of patients referred to the virtual ward in each age group.

days spent on oxygen whilst on the virtual ward, the need for readmission and the clinical indication was also evaluated. Standard deviation, mean average, and 95% confidence interval was calculated as appropriate. Data was collected without patient identifiable information from a combination of the electronic medical systems NERVECENTRE and ICE as well as paper medical documentation.

Results

A total of 50 referrals were made to the covid virtual ward between its first admission 21st January 2021 and last admission 2nd March 2021. The average age of patients admitted to the virtual ward was 58.7 ± 12.9 years, range (27-89). The majority of patients referred were in the age group of 50 to 59 years (n = 12) with the second most common age group 60 to 69 years (n = 10) (Figure 2). 67.5% of patients referred were male and 32.5% were female. There was an average of 8.1 days between a covid positive PCR-test and admission to hospital for those admitted to the covid virtual ward.

Forty-three referrals were accepted, of which 39 referrals were made from the respiratory ward. Patients were discharged to the following virtual ward pathways: 2 (4.7%) mild, 17 (39.5%) moderate, 6 (14.0%) severe, 16 (37.2%) not stated on the referral form, no patients referred to the palliative pathway and 2 patients were excluded as the referral forms were not located in the notes. Of the patients referred for a second time, 2 were discharged onto the severe pathway and 1 patient did not have the pathway specified on the referral form (Figure 3). Referrals were rejected due to ongoing requirements not being COVID-19 related, patients were deemed not to be on an improving clinical trajectory and patient choice.

9.3% (n = 4) patients were readmitted to hospital after deterioration was identified. Of these 4 patients, 3 were re-referred to the virtual ward on second discharge. All readmissions were due to hypoxia and 3 had been discharged on supplemental oxygen. No readmitted patient died whilst in hospital, required admission to the Intensive Care Unit (ITU) nor required increased ventilatory support such as non-invasive ventilation (NIV) or intubation. All readmissions were identified by the clinicians on the virtual ward and no-one re-presented to hospital of their own accord. All 4 readmissions occurred within the first 5 days of discharge to the virtual ward and the average length of the second admissions was 4.5 days (range 2-6 days). The average length of initial hospital stay for those who were readmitted was 2 days (range 1-3 days).

The mean length of hospital stay for patients discharged to the virtual ward was 10.3 ± SD 9.7 days, (95% CI 7.4-13.2) and 11.9 ± SD 11.6 days, (95% CI 11.0-12.8) for all covid positive patients during this time. The average length of stay on the covid virtual ward for all patients was 13.7 ± SD 7.3 days (95% CI 11.4-16.0). Average length of stay for those discharged with an oxygen requirement was 15.1 ± SD 6.5 days (95% CI 12.7-17.5). Mean length of stay on the virtual ward for those without an oxygen requirement was shorter at 7.9 ± SD 5.5 days (95% CI

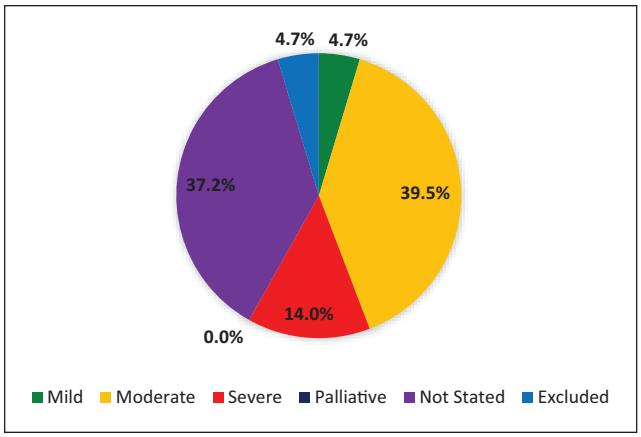

Figure 3. Percentage of referrals to each pathway on the Covid Virtual Ward (n = 43).

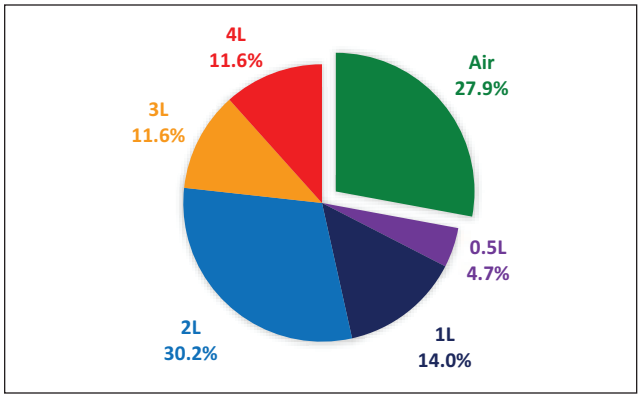

Figure 4. Oxygen requirements on discharge to virtual ward (n = 43).

4.5-11.3). The average number of days spent on oxygen was 11.6± SD 6.0 days (95% CI 9.4-13.8) excluding those that had no oxygen requirement on discharge and those that went on to have long term oxygen at home. There was no significant difference based on gender for those with an ongoing oxygen requirement. Males required oxygen on the virtual ward for an average of 11.6 ± SD 6.2 days (95% CI 9.0-14.3) and females an average of 11.5± SD 5.2 days (95% CI 7.9-15.1).

Thirty-one (72%) patients were discharged home on oxygen, with the majority discharged home on a starting rate of 2 L/min oxygen. Oxygen requirements prior to leaving hospital were 4.7% (n = 2) on 0.5 L, 14% (n = 6) on 1 L, 30.2% (n = 13) on 2 L, 11.6% (n = 5) on 3 L and 11.6% (n = 5) on 4 L. 27.9% (n = 12) were on air (Figure 4).

Of those discharged with medication, 14.3% (n = 6) received antibiotics only (1 patient excluded as receiving antibiotics for cellulitis not COVID-19), 9.5% (n = 4) received steroids only, 23.8% (n = 10) received both antibiotics and steroids and 52.4% (n = 22) were discharged on neither (Figure 5).

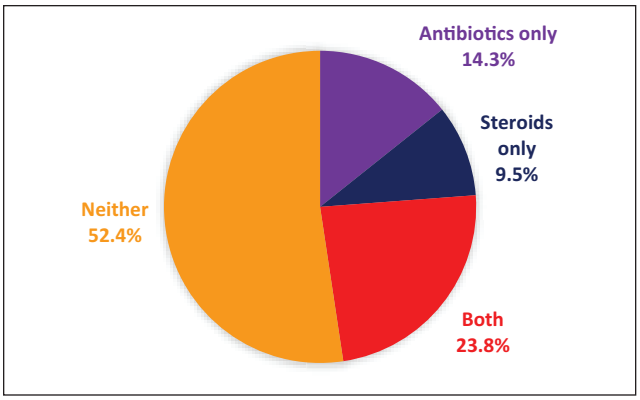

Figure 5. Medication requirements on discharge to virtual ward (n = 42).

Discussion

Our results suggest that a virtual ward model providing ongoing treatment at home to patients of high acuity/complexity who have been treated in hospital for COVID-19 is safe, effective and has the potential to ease the burden on hospital bed space by reducing length of hospitalisation. It provides an environment to give patients the confidence to be discharged and allow patients who are in hospital weaning off oxygen to have this done at home.

Discharging patients home with ongoing oxygen requirements to the virtual ward allows adequate detection of deterioration even after a short hospital admission. Of the 9.3% (n = 4) of patients requiring readmission to hospital, 3 were discharged on oxygen. Even with both admissions combined, the length of stay was shorter than the average covid patient. Therefore, despite the requirement for readmission, the overall benefit of a reduced length of stay in hospital remains. Though it is not always possible to predict which patients may require escalation of care and that acute desaturation can occur very insidiously, discharge to a virtual ward provides an effective way to continue monitoring patients after a short admission.[8,9,12] Our results show that this still applies to patients treated for severe COVID-19 and discharged with an ongoing oxygen requirement.

There is a paucity of data with which to directly compare our findings as the vast majority of literature does not cover virtual models that provide ongoing treatment at home. A study of the implementation of a similar model in the Netherlands also reports that early discharge from hospital is possible in cases of severe COVID-19 and reports the greatest reduction in the duration of hospitalization is seen in patients in need of home oxygen therapy.[7] Whilst the range of days spent on our virtual ward was highly variable, there was a noticeably longer length of stay for those requiring oxygen, 15.1 days compared to 7.9 days. The variation may have been due to several factors and that it was a completely new scheme. The majority of referrals were from the respiratory ward and therefore many patients had been

treated for severe COVID-19 with NIV or ITU admission or had underlying lung conditions. Consequently, they were predisposed to a long wean from oxygen or longer recovery. Additionally, community weaning of oxygen is a slower regime than hospital. Unlike Grutters et al[7] who calculated an estimated total number of bed days saved, it is not possible in our study to determine a number of bed days saved. The weaning regime in the community varied quite substantially from that of the regime in hospital and therefore was not a direct equivalent. In our evaluation, it is likely that the actual number of bed days saved would be smaller than the 11.6 day average spent on oxygen but that there would be a significant saving regardless, as they had an oxygen requirement on discharge. The study is limited in some ways by its small sample size and further studies utilizing a larger sample would help better evaluate its benefits.

Whilst research shows that virtual ward models designed to follow up patients after a short admission or assessment in the Emergency Department (ED) is not unsafe,[8,12] our model differs in its design as it provides for patients with ongoing treatment requirements. 72% of patients required ongoing oxygen support and in comparison to other models the virtual ward provided a higher level of home monitoring including sphygmomanometry, heart rate and temperature monitoring alongside the commonly used pulse oximetry. A readmission rate of 9.3% is equal to the readmission rate of approximately 9% in a comparable study but is noticeably lower than the 18% reported as requiring hospital reassessment in the same study.[7] It is also comparable to many other studies that report a similar percentage of patients requiring either ED re-assessment or hospital admission.[1,2]

Of the patients referred to the virtual ward, only 9 patients (20.9%) were over the age of 70. Considering how the burden of disease adversely affects older more vulnerable patients[13] the low referral rate of those in the aging population is likely due to limitations based on higher levels of impaired cognition, lack of technological literacy and social support requirements. One model even limited the age of patients eligible for referral to 65.[14] Further studies exploring the effectiveness of the Virtual Ward in more elderly patients including additional support that they may require would be beneficial for assessing its longer term value.

Future Research

Telemonitoring positively contributes to patient satisfaction by enabling them to recover in their home environment.[7,8] Further analysis of patient experience and engagement is important as literature suggests that higher levels of engagement with remote monitoring is associated with better patient outcomes.[15] Studies have documented models that integrate support between social and medical services upon discharge[16,17] and there is a need to avoid inadvertently discriminating against certain sectors of the population based on differing access requirements.

The rise in the use of telemedicine does present both ethical and medico-legal issues such as liability and the protection of patient data. In the event of an incorrect diagnosis there may be difficulty differentiating the exact cause of the error such as erroneous use of equipment, poor quality of image, or incorrect reading of the report. There is also a dual issue regarding liability: one with the physician performing the consultation and one related to the suitability of the equipment.[18,19] In a virtual ward setting some of these issues can be potentially reduced by ensuring that the patient is able to demonstrate adequate use of the equipment prior to leaving hospital, had no severe cognitive impairment and the virtual observations that are being used to monitor the patient's clinical condition are able to replicate the majority of the elements of the NEWS2 score which is the same system utilized in hospital to monitor deterioration. The quality of the equipment provided was deemed safe for use by the hospital and was checked to be of equivalence to hospital grade before distribution. Telemedicine is still very much a developing field in the area of legislation and legality and to ensure patient safety with telemedicine this will be an area of focus for the future.

Our study does not assess the economic viability and cost effectiveness of this particular ward model. It requires further research for future application and expansion to include other respiratory diseases. When first introduced, remote home monitoring for COVID-19 patients was expected to have a positive economic impact mainly due to savings in staff time, PPE utilization and reduced hospitalization. With future implementation of a potentially wider remit for remote monitoring, issues such as resource allocation and funding, particularly with the return of normal workloads, may well be a concern in providing sufficient staff and enough resources.[20] Only 8.6% of all patients with COVID-19 in the hospital were discharged to the Virtual Ward. Additional numbers of referrals were not possible due to a limitation in Virtual Ward capacity, primarily because of staff available to safely manage and follow up referred patients. To significantly reduce the length of hospital admissions, the ability of the Virtual Ward to take on more patients would be of benefit. This could be achieved by both increasing the service provision and earlier discharge from virtual ward to increase patient flow. Given that no patient monitored beyond 5 days required readmission, it may be possible to safely discharge certain patients from the virtual ward earlier with safety netting advice such as actions to take should their condition worsen, fail to improve, change in some manner or if they have further concerns regarding their health. Since oxygen requirement was the main contributing factor to increased length of stay on the virtual ward, development of a standard operating procedure for the weaning of oxygen may well expedite this process and would also provide guidance for referrals from

other wards within the hospital and would likely reduce any potential increase in the percentage of readmissions. Studies indicate that remote monitoring contributes to increased efficacy in the use of resources based on a reduction in the length of hospital stay and subsequent increase in bed availability without compromising the level of patient care.[21]

Authors' Note

DOCCLA is an independent Swedish company that has been selected to work alongside several NHS trusts including East and North Hertfordshire NHS Trust to provide virtual wards but had no involvement in the research and all authors have no direct affiliation with the company.

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Declaration of Conflicting Interests

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