Rapid Evaluation of Croydon Virtual Ward

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Health Innovation Network South London

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Overview

This rapid evaluation aims to give quick and early messages around the impact of a technology-enabled virtual ward. It looks at patients that were admitted to the Croydon Health Services virtual ward which used the Current Health hub to continuously monitor the health of patients that were acutely unwell and identify any health deterioration.

The evaluation explores a series of questions:

1. Who are the patients being admitted to the virtual ward?
2. What factors are essential to make the model effective?
3. Did patients find using the technology acceptable?
4. What is the patient experience of the service?
5. How did the service impact on healthcare utilisation?
6. Did the service deliver any cost savings?
7. What were the patient outcomes?

In order to answer these evaluation questions a mixed methods approach was used, looking at a range of pre-existing quantitative data provided by Croydon Health Services and Current Health based on a cohort of 250 patients that had been admitted to the virtual ward, as well as three qualitative interviews with patients, and a staff survey that was completed by three members of staff involved in the virtual ward. Where appropriate data from virtual ward patients was also compared to a control group of 33 patients that received care from Croydon's Rapid Response team prior to the virtual ward being implemented. These patients would otherwise have been appropriate for admission to the virtual ward.

Key findings

Key insights related to each of the evaluation questions have been outlined below:

Who are the patients being admitted to the virtual ward?

- Virtual ward patients tended to be older, with 60% aged 60 or over and 25% over the age of 80. The most common reason for admission was COVID-19, as opposed to long term conditions (LTC) or emergency episodes.
- On average, virtual ward patients had 4 comorbidities and were on 6 medications.
- Patients spent an average of 9 days on the virtual ward.

What factors are essential to make the model effective?

- Staff raised the following as key factors for success: The ward being run by community (not acute) services, pathways in place to ensure emergency treatment is accessed when needed, upskilling staff on continuous monitoring and knowing when to use continuous versus spot monitoring, and having a cross-system multi-disciplinary team, among others.

Did patients find using the technology acceptable?

- Over half of patients (56%) were generating readings from their Current Health kit for over 75% of the time they were being monitored by the virtual ward, with 17% having readings for 50-75% of the time, while 28% of patients had readings for 50% or less of their time on the ward.
- Feedback survey scores were largely very positive, with over 87% of patients giving positive agreement with each statement given in the questionnaire. The areas patients were most positive about was the ease of

learning to use the kit (89%) and the fact it was simple and easy to understand (89%).
- Most (96%) virtual ward patients proceeded to use the Current Health kit with 4% declining it or requesting it be removed.

What is the patient experience of the service?
- Patient experience scores were very high with a net promoter score of 55, which is classed as 'excellent', this means that most patients that completed the questionnaire would recommend the Current Health devices to family and friends.
- Patients reported that the service gave them peace of mind and was easy and simple to use.
- Patients felt they were being kept out of hospital whilst receiving the same standard of care as they would in a hospital environment. Patients reported having their needs met above and beyond what they had anticipated, which in some instances exceeded their experience of being treated in hospital in terms of feeling safe.

How did the service impact on healthcare utilisation?
- Mean number of telephone contacts per virtual ward patient per day was 1.27, which was much higher than the control group, while home visits were lower in the virtual ward patients.
- A&E attendances and admissions were similar across virtual ward and control patient groups.
- The median number of physiological alarms per patient per day was 2.5, with the majority (80%) of patients having 4 or fewer.
- Monthly referrals to the rapid response team increased by 51% in the 12 months after the virtual ward became fully operational, compared to the previous 12 months. This increased demand of both rapid response and the virtual ward remote monitoring required an increase of staff to monitor the virtual ward, including 22.5 hours of a telehealth project manager (who was split between virtual ward and being a rapid response matron), and GPs that worked between 8am – 8pm 7 days a week. This resource does not equate to a 51% rise in staffing of the team. This also resulted in additional wards not needing to be opened in the acute hospital for COVID-19 wave 2 as had been the case for wave 1.

Did the service deliver any cost savings?
- The estimated cost saving per patient in terms of the shift to telephone contacts instead of home visits was £522.12, and bed days was £220.32, leading to a total estimated cost saving per virtual ward patient of £742.44 compared to the rapid responses control group.

What was the patient outcome?
- Of the 250 patients being monitored via the virtual ward, 65% remained at home on monitoring for the duration of their care, 20% had an admission to hospital during their time on the virtual ward, for a further 10% it was realised that telehealth was not appropriate and they were discharged early and referred on to more appropriate services for their needs, 4% of patients declined the monitoring devices or asked for them to be removed, and 1% of patients died during their time on the virtual ward.
- Of the 20% admitted to hospital, 84% were discharged back home.
- Readmissions and hospital admissions post-discharge from the virtual ward were relatively low, at 12% and 9% respectively.
- Telehealth monitoring found significant pathology that was detected earlier or would otherwise not have been detected with possible fatal outcomes if not treated. This includes five patients with new pulmonary embolism, 2 with heart arrhythmias, 2 patients with obstructive sleep apnoea, and one patient with persistent tachycardia who was diagnosed with an incidental atrial myxoma.
- Patient interviews indicated that there had been a significant improvement to patients' quality of life since being cared for under the virtual ward team.

Conclusion

- Whilst some of this data is small in number and hard to definitively prove, it is clear that Croydon virtual ward was able to:
    - appropriately deliver care in patients' homes for 65% of virtual ward patients (all of which were acutely unwell)
    - manage a cohort of up to 30 patients at one time using only a small team of clinicians
    - deliver a service that patients were largely satisfied with
- More data would need to be obtained on a larger control group and including COVID-19 and long-term conditions patients to truly understand whether the differences in outcomes and utilisation are significant.

Recommendations

- The service continues to monitor acutely unwell patients and to gather more data on patient outcomes
- More evaluation is needed particularly to explore the benefits of continuous versus spot monitoring amongst long-term condition patients
- Trust systems need to be developed to enable structured collection of data and integration with Current Health observations data.

1. Background

Croydon implemented their technology-enabled virtual ward model in July 2020 taking the initial few patients onto the ward (27 patients over the first 3 months), followed by a full opening in September 2020 when it ramped up to monitoring a maximum of 30 patients on the ward at a time.

The virtual ward sits within Croydon Health Services NHS Trust in the Community Services arm of the Trust within their Rapid Response team. The Rapid Response team, in order to extend managing the virtual ward recruited a band 7 telehealth project lead working 22.5 hours per week in a dual role also as a Rapid Response matron/telehealth project lead, and a Rapid Response GP working from 8am-8pm, 7 days a week in a dual role across Rapid Response and the virtual ward. Each day one to two members of the team are allocated to monitor the virtual ward. The patients are actively monitored between 8am-8pm; any patient concern is handed over to the out of hours Rapid Response service. During the hours 8pm and 8am patients are not being actively monitored and are told to call 999 or 111 if their health deteriorates during this time. Monitoring devices are still worn overnight, and this data is then reviewed by the monitoring team when they start their monitoring again at 8am. As well as these two additional roles that have been brought into the team to manage the virtual ward the wider Rapid Response team were all trained in how to use remote monitoring equipment and data and the virtual ward was integrated into their existing roles. Additional tasks included making home visits to virtual ward patients and using remote monitoring data to inform and manage patient care. This wider team includes 4.2 whole time equivalent band 7, 1.52 band 6, and 1 band 4 Rapid Response nurses. This team are a two-hour community response team seeing new referrals within 2 hours at home. The virtual ward is supported by 2 consultant physicians with Geriatrics specialism and a respiratory consultant who provides clinical support for cases and for the weekly multidisciplinary patient round.

The virtual ward was set-up rapidly following the first wave of COVID-19 to undertake remote monitoring of appropriate acutely unwell patients to provide early assistance when signs of health deterioration were picked up and to allow these patients to be managed in their own homes for as long as it was appropriate. The ward monitored a range of patients, including those with COVID-19 as well as a range of long-term conditions or following an emergency episode (more details of the key reason for being admitted onto the virtual ward can be seen in section 2.1). Patients began being admitted to the ward at the start of the second wave of COVID-19 and

was later rolled out to patients with other long-term conditions from March 2021. Whilst the main aim of the virtual ward was to care for patients having an acute episode as an alternative to being cared for in hospital, there were also two outpatient departments that were using remote monitoring to trial manage a small number of patients that were being seen in a hypertension (7 patients), or stroke clinic (2 patients). Clinicians working in these outpatient departments had direct access to remote monitoring data only for the patients under their care, and the role of the virtual ward for these patients was to set up patients with remote monitoring and ensure their data was uploaded to their patient record for outpatient clinicians to review. This had a direct impact on the waiting time which saw hypertension clinic patients wait for blood pressure monitoring reduce from 6 weeks to 1 week. Other outpatient departments, such as Heart Failure Team have be looking into how to utilise the remote patient monitoring device to benefit their cohort of patients.

Remote monitoring kits were procured from Current Health. The kit consisted of a wearable that provided continuous, clinical grade measures of oxygen saturation, respiratory rate, pulse, motion, and skin temperature. The wearable integrated with a tablet for video visits, and for patients to report symptoms. An integrated blood pressure cuff was supplied for those suffering from hypertension or an infection (including COVID-19). An integrated weighing scale was also supplied for heart failure patients. The kit also included a 'home hub' which connected the wearable to the cloud via the home internet connection, or 3G cellular network for those without home internet. The wearable was attached to a patient's arm and was worn at all times except when patients were washing. When the wearable was away from the home hub (for example, if they left the house), vital signs were still collected for up to eight hours and stored on the wearable. These were then uploaded when the patient returned within range.

The patients' vital signs were displayed for the Croydon telehealth team and Rapid Response GP on a web dashboard, accessible via a desktop or mobile phone. The dashboard showed aggregated vital signs, similar to a hospital observation chart. Alarms were set, so that when patients' vital signs exceeded a pre-set threshold, alerts would be sent to the team via push notifications, and also displayed on the web dashboard. The patient cohort's progress could also be tracked longer term via aggregated reports, downloadable from the web dashboard. The patients themselves are not able to see data on their vital signs and when an alert has been activated as this was not available from the Current Health device at the time. Those that have a blood pressure cuff can see their pulse rate and blood pressure readings.

Clinical staff working on the virtual ward called the patient either via phone or video call, from within the web dashboard to the supplied tablet, to discuss any health change or concern and to decide on the most appropriate course of action. This might have included a home visit or asking the patient to come into hospital if necessary (information on healthcare utilisation whilst on the ward can be seen in section 2.5). Robust pathways are available for Rapid Response to use for further investigations if needed without attending the emergency department.

There were a number of criteria for referral to the virtual ward;
Patients needed to be:

- living in Croydon borough or registered with a Croydon GP,
- aged 18 or over,
- living in their own home, (including a care home or sheltered accommodation)
- deemed suitable/ to gain benefit from home monitoring by clinicians working on the virtual ward.

Patients were excluded/ not deemed appropriate under the following conditions:

- under end-of-life care,
- in distress,
- risk of lymphoedema
- heavy tattooing on both upper arms (this can lead to inaccurate results due to the wearable using transmission photoplethysmograph sensors which reflect light from the skin to measure pulse and spo2. This type of sensor is not unique to Current Health kits)
- acute psychosis/mental health

Whilst the above lists the key inclusion and exclusion criteria for the virtual ward there were not strict criteria over the types of emergency episodes or conditions that could be monitored by the virtual ward. The triage process used for accepting patients onto the ward has evolved over time as the knowledge and experience of staff members has improved regarding the types of patients that are most suitable for the virtual ward. The criteria itself remains quite fluid with a lot of room for clinical judgement.

Referrals were opened up to a range of teams and healthcare professionals, the full breakdown can be seen in section 2.

Patients were given an estimated date of discharge when they were admitted to the virtual ward based on their primary reason for admission. As patients approached this estimated date of discharge, a decision was made regarding whether their readings were within acceptable limits for discharge. The clinician then phoned or video called the patient to check on them and ensure that any referrals to other services were complete. Following this, data were downloaded from the Current Health device and attached to the patient's electronic record, and a discharge letter was generated to the patient's GP. Finally, collection of the device was arranged and a patient feedback form was completed to understand the patient's experience of using the device.

The overall objectives of the services were to:

- Reduce the burden on the emergency department by keeping people at home or using other pathways
- Enable patients that were acutely unwell to receive care at home rather than in hospital
- Relieve pressure on acute hospital services by supporting early discharge
- Enable the Rapid Response team to manage an increased caseload with only a limited increase in staff
- Reduce COVID- 19 exposure for staff and patients
- Provide at-home hospital-level care for those refusing admission
- Provide equal access to all residents

1.1 Evaluation purpose and design

1.1.1 Purpose

This is a rapid evaluation which aims to give quick and early messages around the impact of a technology-enabled virtual ward. More specifically, it aims to answer the following evaluation questions:

- Who are the patients being admitted to the virtual ward?
- What factors are essential to make model effective?
- What is the patient experience of the service?
- Do patients find using the technology acceptable?
- How did the service impact on healthcare utilisation?
- Did the service deliver any cost savings?
- What were the patient outcomes?

1.1.2 Scope

Patients that have been admitted to Croydon Health Services virtual ward and used the Current Health hub to monitor their health and identify any health deterioration.

1.1.3 Design/ methodology

A mixed-methods approach was used to conduct this evaluation using a range of quantitative data provided by Croydon Health Services and Current Health, as well as a small number (3) of qualitative interviews with patients. Due to the speed at which this evaluation was conducted it was not possible to design a bespoke data collection

exercise so data that already existed within Croydon Health Services systems (both community services and acute) and was already being obtained by Current Health was used to answer these evaluation questions.

Data collected from Croydon Health Services was based on 250 patient episodes that had been under the care of the virtual ward between July 2020 and June 2021 and had not opted out of their data being used for secondary purposes. The data collected was available within their systems but did not exist in a structured coded format. Data collection, therefore, involved clinical staff working within the virtual ward reading through case notes across systems held within community services as well as a separate acute trust system to extract relevant data on healthcare utilisation and patient outcomes. The evaluation team at the Health Innovation Network then applied a process called quantitizing, whereby this narrative/text information is turned into structured coded data for analysis.

In order to understand whether utilisation and outcomes of patients changed as a result of the intervention, data on a control group was obtained. This involved clinical staff working in the virtual ward reviewing patients seen by the Rapid Response team prior to virtual ward being implemented. These staff identified those patients that would've been suitable for the virtual ward had it been an option and obtained their data on healthcare utilisation and outcomes. The period of time reviewed May and June 2020 in order to be as close to the time of the ward being implemented so that COVID-19 patients would feature in the data. Unfortunately, once the data was reviewed it was clear that COVID-19 testing was not yet being done in community services during that time period. Whilst it is likely that some patients within the control group did have COVID-19, it is not possible to know this definitively. More about this can be found in section 4 on the evaluation limitations.

Control patients that were seen by the Rapid Response team received a see, treat and discharge service from the team. The Rapid Response team sees patients within 2 hours of a referral and sets out to make a treatment plan, which includes conducting some observations and tests and making referrals onto outpatient teams and to district nurses. The service aims to have addressed the acute needs of the patient within 72 hours but those who are more complex or awaiting equipment may remain under the team for longer as necessitated by their clinical needs.

Table 1 sets out the range of methods used and data obtained to answer each of the evaluation questions above.

Table 1: Evaluation framework

	Evaluation question/ objectives	Measure(s)/metrics	Data source/ collection method	Control
1.	Who are the patients being admitted to the virtual ward?	Patient demographics e.g. age bands, comorbidities, primary complaint	Croydon Health Services	
2.	What factors are essential to make model effective?	• Feedback from staff members • Feedback from patients	Unstructured survey 3x Patient interviews	
3.	What is the patient experience of the service?	Net promoter score Patient feedback	Collected via Current Health patient experience questionnaire 3x Patient interviews	
4.	Do patients find using the technology acceptable?	• % of time wearing the device vs time on platform • Patient feedback on using the tech • No. of patients requesting removal of devices	Current Health Current Health patient survey Croydon Health services	

	Evaluation question/ objectives	Measure(s)/metrics	Data source/ collection method	Control
5.	How did the service impact on healthcare utilisation	• Admission and readmission rates • Length of stay in hospital (ICU and ward) • Outpatient attendances • Community Services home visits • Telehealth calls • Patient referrals to Rapid Response • Alarming rates	Croydon Health Services Current Health	Rapid Response data from May and June 2020 screened by clinician as being suitable for the virtual ward
6.	Did the service deliver any cost savings?	• Applying unit costs to activity at objective 3 • Applying average bed day costs to average length of stay data obtained as a comparator	PSSRU/ NHS tariff.	
7.	What was the patient outcome?	• Overall outcome (stayed at home, hospital admission, discharged early etc.) • No of patients admitted to hospital and destination (ICU vs ward) • Discharge destination of admitted patients (home, care home, mortuary) • No of patients on home oxygen therapy • Readmissions and deaths at 7 and 28 days post discharge • 3x case studies	Croydon Health Services data 3x Patient interviews and virtual ward staff input	Rapid Response data from May and June 2020 screened by clinician as being suitable for the virtual ward

2. Findings

The Croydon virtual ward started receiving patients in July 2020, with a small number of patients being referred in July and August 2020 followed by a ward of 20-30 patients being monitored from September 2020. Data of patient pathways being admitted to the ward was collected from 7 July 2020, when the first patient referral was accepted onto the ward, up until 28 of June 2021. Over this period, 250 patient episodes were completed i.e. patients that had been admitted onto the ward and discharged within this period. In order to ensure patient confidentiality, the data obtained was pseudonymised (given a unique identifier that does not link back to other NHS datasets) at a patient episode level and therefore it was not possible to understand how many unique patients these 250 patient episodes related to. Five patients had more than one virtual ward admission. The rest of this report will detail a range of analysis all of which relate to these 250 patient episodes.

The virtual ward was set up by staff within Croydon's Rapid Response team and, therefore, worked closely with staff within this team, who referred 31% of the patient episodes seen by the ward. A quarter of referrals (26%) came via various inpatient and outpatient specialties within the acute hospital, with just under a quarter of referrals coming from the Emergency Department (ED) (23%). Smaller proportions came through community services teams (7%), primary care staff (5%), London Ambulance Service (4%), through self-referrals (3%) and via care home staff (1%). The full breakdown can be seen in table 2 below.

Table 2: Source of referrals to Croydon virtual ward.

Referral source	No. of referrals	% of referrals
Rapid Response	78	31%
Acute hospital	66	26%
ED	58	23%
Community	17	7%
Primary Care	13	5%
London Ambulance Service	9	4%
Self	7	3%
Care home	2	1%
Total	**250**	

The average (mean) stay on the virtual ward was nine days, with the longest stay at 49 days for a patient referred for early supported discharge from hospital for covid 19 oxygen wean at home.

Fourteen patients (6%) stayed on the ward for less than a day after establishing that telehealth was not appropriate for them (10 patients, 4%) or that they required admission to an in-patient bed (4 patients, 2%). There were also 10 patients (4%) with long stays of 29 or more days on the virtual ward (with 5 of these patients being on the ward due to a long-term condition of which 1 was for hypertension, 3 patients for an emergency episode and 2 being seen due to COVID-19).

Table 3 below gives a sense of the spread in length of stays on the virtual ward.

Table 3: Duration of time (in days) spent on the virtual ward.

Duration on virtual ward	No. of patient episodes	% of patient episodes
0 days	14	6%
1-2 days	30	12%
3-7 days	89	36%
8-14 days	78	31%
15-21 days	20	8%
22-28	9	4%
29+ days	10	4%
Total	**250**	

2.1 Who are the patients being admitted to the virtual ward?

Between July 2020 and May 2021 a total of 263 patients were admitted to Croydon Virtual Ward for monitoring. Of these, 250 patients consented for their data being used for the purpose of service evaluations and, therefore, these patients are included in the analysis within this report. A further 13 patients chose to opt-out from their data being used for anything other than direct care and have been excluded from this evaluation.

Prior to the virtual ward being set up (May and June 2020), 33 patients were identified who were seen by the Rapid Response team but could have been managed via telehealth. These patients have been used as a control group.

Patient age was recorded for 248 virtual ward patients. A quarter of patients were aged 80 or over, 35% were aged 60-80, and 40% aged under 60. The breakdown of patients by ten-year age band can be seen in table 4 below.

When split by reason for admission, there were more younger patients in the COVID-19 group than the LTC/emergency episode group, with only 17% of COVID-19 patients being 80 or older, while 40% of LTC/emergency episode patients were 80 or older.

Compared to the control group, there was a far higher proportion of patients under the age of 70 (59% of virtual ward patients versus 6% of the control group).

Table 4: Age band of virtual ward and control patients.

Age band	Virtual ward patients		VW Covid-19 patients		VW LTC/emergency episode patients		Control patients	
	n	%	n	%	n	%	n	%
20-29	8	3%	5	3%	3	3%	0	0%
30-39	9	4%	8	5%	1	1%	0	0%
40-49	27	11%	24	15%	3	3%	0	0%
50-59	54	22%	41	25%	13	15%	1	3%
60-69	46	19%	34	21%	12	14%	1	3%
70-79	42	17%	22	14%	20	23%	9	27%
80+	62	25%	27	17%	35	40%	22	67%
Total	**248**		**161**		**87**		**33**	

Ethnicity data was incomplete in 200 patients (80%), in keeping with recognised challenges in general NHS ethnicity recording. Whilst the remaining 50 patients suggested the Croydon virtual ward population was ethnically diverse the lack of data makes it difficult to understand whether this sample is representative of all virtual ward patients so has not been included in this report.

There were a variety of reasons for patients being admitted and monitored via the Croydon virtual ward, these included people being monitored as they had COVID-19 symptoms, or following a COVID-19 admission, being monitored for a long-term health condition such as heart failure, hypertension or asthma or being monitored due to an emergency episode or decline in health such as an infection or pulmonary embolism. In comparison, all the patients in the control group were being seen by Rapid Response for long-term conditions.

Table 5: Reason for admission to the virtual ward/Rapid Response team (control).

Reason for admission	Virtual ward patients		Control patients	
	N	%	N	%
Covid-19	161	64%		
Long term conditions	65	26%	33	100%
Emergency episode	24	10%		
Total	**250**	**100**	**33**	

Of the 161 patients admitted due to Covid-19, the majority (84%) had a positive diagnosis, and in a further 8% Covid-19 was suspected but not confirmed. The ward also admitted 14 patients who had been discharged from hospital following a Covid-19 admission and were being monitored via the ward back at home.

Table 6: Covid-19 status of patients admitted to virtual ward due to Covid-19.

Reason for admission	n	%
Covid-19 detected	135	83.9%
Post Covid-19	14	8.7%
Covid-19 suspected	12	7.5%
Total	**161**	100

Of the 65 patients being monitored due to a long-term condition, 35% were being monitored for hypertension, 25% for heart failure, 23% for COPD or an oxygen assessment, 9% for unspecified chronic disease management, 5% for asthma, 3% for stroke management and one patient for bronchiectasis. One patient had two different conditions that were the primary reasons for admission to the ward, so numbers do not add up to 65 within the below table.

There were a small number of patients with long term conditions that were trialling the remote monitoring kits in order to monitor patients within outpatient departments, this included 7 patients that were being monitored by Croydon hypertension clinic in order to reduce down the waiting times for blood pressure monitoring, this enabled wait times to drop from 6 weeks down to 1 week. For these patients staff in the hypertension clinic had direct access to remote monitoring data for the patients under their care. The remaining 16 hypertension patients were under the care of the virtual ward team due to an acute exacerbation of their condition. Some of these patients were declining going into hospital for a number of different reasons so were being given medication and being monitored at home.

In addition to the 7 hypertension patients the Croydon stroke service were also monitoring 2 stroke patients (1 of which was also being monitored by the hypertension clinic) in order to trial the use of remote monitoring for stroke patients to understand if this would be a helpful tool for managing patients with strokes in future.

In total there were 8 patients (3%) that were being monitored by outpatient services rather than being referred to the virtual ward due to an acute episode.

Table 7: Long-term conditions being monitored via virtual ward.

Long-term conditions	n	%
Hypertension	23	35.4%
Acute exacerbation of hypertension	16	24.6%
Outpatient blood pressure monitoring	7	10.8%
Heart failure	16	24.6%
COPD/oxygen assessment	15	23.1%
Chronic disease management	6	9.2%
Asthma	3	4.6%
Stroke management	2	3.1%
Bronchiectasis	1	1.5%
Total	65	

Of the 24 patients being monitored due to an emergency episode the majority of these patients had an infection (19 patients), with smaller numbers being monitored due to other types of episodes such as a pulmonary embolism, the full breakdown can be seen in table 8 below.

Table 8: Types of emergency episode that led to need for monitoring.

Emergency episode	n	%
Infection	19	79.2%
Pulmonary embolism	2	8.3%
Tachycardia	1	4.2%
Medication overdose	1	4.2%
Pneumothorax	1	4.2%
Total	24	

Data for the control group were collected differently and recorded the reason for referral to the Rapid Response team, as displayed in table 9 below. The most common reason for referral was UTI at 21%, followed by chest infection, oedema and shortness of breath at 9% each.

Table 9: Reason for referral for control patients.

Reason for referral	n	%
UTI	7	21%
Chest infection	3	9%
Oedema	3	9%
Shortness of breath	3	9%
Diarrhoea/nausea/vomiting	2	6%
Discharge follow up	2	6%
Falls	2	6%
Heart failure	2	6%
Other	2	6%
Allergic reaction	1	3%
Carer stress	1	3%
Constipation	1	3%
Cough	1	3%
Dizziness	1	3%
Pain	1	3%
Skin problem	1	3%
Total	33	

The average number of comorbidities within the virtual ward patient group was 4, and patients ranged from having no comorbidities to 13 comorbidities. Most patients had quite a number of comorbidities, with only 7% having no comorbidities and 25% having 1 or 2 comorbidities. Larger proportions had between 3 and 5 comorbidities (42%) with 26% of this patient group having 6 or more comorbidities.

When split by reason for admission, COVID-19 patients had an average of 3 comorbidities while the average for LTC and emergency episode patients was higher at 5 comorbidities per patient.

In comparison, the average number of comorbidities in the control group was similar to LTC/emergency episode patients at 5, with no patients having 0 comorbidities, and only 9% having less than 3. Most control patients (64%) had 3 to 5 comorbidities.

Table 10: Number of comorbidities of virtual ward and control patients.

No. of comorbidities	Virtual ward patients		VW Covid-19 patients		VW LTC/emergency episode patients		Control patients	
	n	%	n	%	n	%	n	%
0	17	7%	17	11%	0	0%	0	0%
1-2	62	25%	44	27%	18	20%	3	9%
3-5	105	42%	72	45%	33	37%	21	64%
6+	66	26%	28	17%	38	43%	9	27%
Total	**250**		**161**		**89**		**33**	

In the virtual ward, the average number of medications used by patients was 6, ranging from 0 to 19. When split by reason for admission, Covid-19 patients had a slightly lower average number of medications, at 5, while LTC/emergency episode patients had a higher number at 8. Average number of medications in the control group was similar to the LTC/emergency episode group at an average of 8 medications per patient, ranging from 1 to 24.

Table 11: Number of medications of virtual ward and control patients.

No. of medications	Virtual ward patients		VW Covid-19 patients		VW LTC/emergency episode patients		Control patients	
	n	%	n	%	n	%	n	%
0	36	15%	35	22%	1	1%	0	0%
1-3	57	23%	46	29%	11	13%	4	13%
4-6	45	19%	30	19%	15	18%	10	31%
7-9	53	22%	25	16%	28	33%	5	16%
10+	52	21%	22	14%	30	35%	13	41%
Total	**243**		**158**		**85**		**32**	

2.2 What factors are essential to make the model effective?

In order to understand the factors essential to making a virtual ward model effective, information was gained from staff working on Croydon's virtual ward and wider Rapid Response team via a short unstructured staff survey, as well as discussions between the evaluation team and the key staff involved, to get their views on how to make the ward work effectively. It should be noted that the virtual ward was set up at pace in response to the first wave of COVID-19 with little time for planning and no project manager involved in the implementation.

Ward run by community services
Key themes arising from discussions with staff highlighted the importance of the virtual ward sitting within community services as opposed to within an acute setting. The team felt that by having the service set up within a community team they could be very responsive when needed and ensure that home visits could be offered instead of admission.

"I think hosting it within a team that already does Community work is quite unusual and quite different to how other people have done it, but it's meant that we've been able to do something when someone's unwell, rather than just sending them straight in, we've been able to go and see them in person, and I think that's something that I think works well for this."

Effective pathways to emergency treatment
Within Croydon borough both their community health provider and acute hospital are run by Croydon Health Services NHS Trust. By having a common footprint for both services, delivered by an integrated acute and community trust, the relationships between the community services and acute teams were strong and enabled staff within community services to get appropriate acute care for the virtual ward patients when needed; including getting their patients admitted when needed, as well as getting tests and outpatient appointments with the necessary level of urgency. The team themselves have worked hard on building these effective relationships and developing a network of services that understand the work of the virtual ward and can help the pathways into treatment for virtual ward patients run smoothly.

Staff are used to managing risk
Another key theme that arose from discussions with the team is the need for staff to understand how risk can be mitigated and managed in people's own home. The patients being admitted to the virtual ward were acutely unwell and many would have been in hospital if the virtual ward had not been in place. Managing such an acutely unwell cohort of patients within the community requires risk to be managed by the team and the ability to proactively manage and mitigate risks to ensure that patients get timely and appropriate care for their needs. The team felt this ability to manage risk lent itself better to the attitudes of community services staff, as opposed to acute staff, as they had confidence in the ability of the team to manage people at home.

"It's very interesting, so when I work in the hospital when I'm acute and go into the hospital I become more and more risk averse the longer I stay in and I when go back out to the community I'm like, oh it's all fine we'll keep that person who's quite unwell at home, it'll be fine with x support, so that's what they want and support them with XY and Z, but the moment I go back into hospital immediately my appetite for risk goes down again."

Understanding when to use continuous monitoring vs spot monitoring
Whilst the virtual ward initially set out to monitor COVID-19 patients during the second wave, it started to take on patients with long-term conditions that would benefit from the virtual ward once the second wave had calmed down. The team felt that having technology that offered continuous monitoring worked really well for those that were acutely unwell, but they were unsure whether the same level of monitoring was needed for patients being managed for a longer term.

"Continuous monitoring has its definite advantages and the prediction of deterioration is brilliant, but for some patients that's not the right technology and we now have a gap in coverage and we don't have the kind of spot monitoring which might be better for other teams like respiratory and the stroke team and the heart failure team that haven't really adopted Current Health, because they're too worried about having all the alarms. So there is something about getting the right technology for the right patients, and at the moment I love continuous monitoring for our sick ones, but I'm not sure we've got it right for our lower level, longer term patients."

Staff training on continuous monitoring
The shift between spot monitoring and continuous monitoring required staff training as the staff running the ward

were used to taking more traditional spot observations on patients, and the change in the way that observation data was used required a shift in thinking and was highlighted as a training need.

"So we had to do extra training and the reason why it's a challenge is for most of us we do a set of observations and if those observations are ok, we think they're fine. The difference with continuous monitoring is you get that increase in heart rate or my favourite was a lady who used to hoover - every time she hoovered heart rate went up but then what you see on continuous is it then very quickly settles back to normal and it's all fine. So learning not to panic at or get worried or concerned about where things have changed, but is the trend over time stable? This was a really big challenge to get through for the clinicians."

Logistics
One of the key learnings from setting up the virtual ward was getting the logistics around the dropping off and collection of the Current Health kits right to ensure that as many patients as possible could benefit from the kits. The team started off by using the Croydon equipment service to deliver, pick up and clean the equipment; however, it was found that the team was not able to be responsive enough to the service's needs. This resulted in some changes being made, whereby the Rapid Response team took responsibility for the logistics aspects by delivering the kits themselves when they set up patients on monitoring and using a local taxi service to collect the devices and drop them back with the team who were then responsible for cleaning. They found that by deploying the kits themselves they could be more responsive and have more kits in circulation, and that the taxi company was more efficient than the equipment service.

Simple referral process
The simplicity of the referral process and ensuring referrals could be made 24/7 was a key factor to ensuring that the virtual ward was a success. They rolled out referrals to all staff across the system, from acute, community services, primary care, and the ambulance service. This was really important in order to get access to the right patient cohort, the process was very straightforward and could be done by staff working any shift pattern.

Cross system multi-disciplinary team
Having a cross-system multi-disciplinary team meeting weekly for the virtual ward patients has been key to its success. The team includes members of staff from acute, community services and primary care.

Future improvements re IT and systems
Although not currently in place, the team are planning to work with Current Health to get the observations data to integrate into EMIS (the patient record system used within Croydon Community Services) so it can easily be attached to the patient's electronic record. At present, staff are downloading the data when they discharge patients from the ward and then uploading it to a patient's record.

Equally, the team did not have time to set up key data fields on their patient information system (EMIS) prior to implementing the digitally enabled virtual ward. This has led to data for this evaluation being obtained manually by clinical staff trawling through patient case notes to pull out key data on healthcare utilisation and patient outcomes, and this data has not been coded or recorded in any uniform format. The team would like to set up some forms to obtain this type of information in a more structured format to make the future monitoring of patients' longer-term outcomes more accurate and readily available.

Whilst the virtual ward is run by Croydon Community Services Rapid Response Team there are a number of occasions when the transfer of observation data between the rapid response team and acute services has been useful including when patients being monitored are admitted to hospital as well as for those that were referred on to outpatient services for future management of their care. As the acute trust use a different system from community services, in these cases, the team have uploaded the relevant data into the acute trust system so that the appropriate departments then have access to the data within the patient record. In future it would be useful to have integrated patient records that can be accessed across community services, acute services, and primary care.

As well as feedback from staff working on the ward a number of factors were flagged through interviews with 3 patients as having been important from a patient perspective, these have been summarised below:

Set up of virtual ward, information, and consent

Two of the patients interviewed had similar experiences regarding consenting to and gaining information about the virtual ward. Both patients were told about the service during their time in hospital and were followed up with contact by the Rapid Response team directly, who conducted a home and suitability visit before arranging the virtual ward set-up in their homes. These patients engaged in the decision to be admitted to the virtual ward and reported feeling fully informed to make this decision.

"The nurse who was leading it explained it to me, and the doctor who came to visit me never stepped away and explained to me what was going on and what they were doing to me… they told me how it would work… that they could actually monitor me from where they were and I would be able to see when I did my blood pressure what my readings were. And if something was wrong, they could actually monitor away from me and tell me what it is…. I knew when something was wrong; I could feel it myself… they were always quick on the phone to say 'you could do this, or we could do that'"

Patient describing the first time the virtual ward service was offered to them.

"During the home visit, a nurse did a check of vitals, blood pressure that sort of thing. At that point I really wasn't very comfortable. She or her colleague explained it and what best course of action would be… and I would be an appropriate candidate for the service, so yeah…. A second lady came with the monitor and went through it very, very thoroughly, to explain to me how it works, how to use it and so on…. I had no problems using it …. set up was very smooth."

Patient describing how the virtual ward service was offered to them.

For another patient who was being cared for by a family member, both patient and carer were informed about the virtual ward prior to discharging the patient from hospital, due to the patient's severe condition, both patient and carer signed consent papers to use the service and reported feeling adequately informed to do so.

"In hospital they told me I needed to stay with family or friends, or I might be put into a home because I was so sick [from COVID]… I found somewhere to stay with [next of kin]…the team went round to check it over [next of kin's house] whilst I was still in hospital. The day I got there [next of kin's house], two hours later a nurse came round and set up equipment…. I can't remember…. I think they told me I was going to be monitored at home and I said yes that's fine… at least it kept me out of hospital."

Patient describing their experience of receiving information about the virtual ward.

The family carer/ next of kin was also pleased with the information they were given about how to set up and use the kit. Having been quite scared about the patient being discharged to their home after being so ill and being responsible for them, they were put at ease.

"The doctors and nurses made me aware [patient] was not in a good way and they thoroughly explained about them being linked to the monitor….it was amazing, I would have been really scared without it and it really helped a few times when they [patient] got really bad. It was a truly Rapid Response…they [nurse] told me everything I needed to know and anything else they were just on the other end of the laptop… and not just a voice, you can see and speak to them on video."

Family carer describing the experience of setting up the virtual ward at home.

Initial intensive support from the clinical team

All patients spoken to described regular contact with the nurses and virtual ward team during the first week of monitoring to ensure the patient and/or carer were confident and understood the messaging coming from the

system itself. This was reassuring and provided a sense of security to all. Throughout the admission period, the patients reported feeling more confident in using the equipment to take readings in addition to reporting these readings via the tablet or laptops provided.

Discharge process
Patients reported the process of being discharged from the virtual ward was smooth and did not feel rushed, which included one or more follow-ups to ensure the patient was managing well.

"They discharged me when I improved and explained 'we will take you off the monitor'. They told me they'd do it at the end of the week if I had continued improvement… They came and saw me and arranged for it to be picked up. They followed up after about four days and popped in to see if I was ok and see how I was and if I needed anything and did my bloods for me then. Same smooth service on all occasions."
Patient describing when they were discharged from the virtual ward

Quick acting on technical issues
There were no issues reported with the overall care model or particular aspects which should be improved. Signal failures related to Wi-Fi connection or the technical devices (monitors, screens) malfunctioning were experienced by all three patients that were interviewed; however, it was emphasised that these issues were quickly resolved by the appropriate party when they did occur.

"Even that one issue where something wasn't right with the connection… it wasn't recording what I was doing so they couldn't monitor me… it was [resolved] very, very quickly."
Patient describing technical issues with their monitor.

"Couple of times where we couldn't get a signal…. and it [blood pressure monitor] was falling down but the nurse called me a couple of times to find out what was going on…she said you need to tighten it up and [carer] did it and all was well."
Patient describing an incident with the BP monitor.

2.3 Did patients find using the technology acceptable?

Wearable adherence is one proxy indication of whether patients found the technology acceptable. Wearable adherence was calculated by dividing the hours monitored by the total hours between device activation and discharge from the current health service per patient. The only circumstances whereby patients are asked to remove their device is when washing or attending outpatient appointments or the emergency department, however this time is not considered when calculating adherence rates as it is only possible to know the proportion of time that patients are being monitored for, not the reason they are not being monitored for a period of time. In addition, for some patients there would be a time gap between when they are told they can stop wearing devices, as they have been discharged from the virtual ward, and the devices being collected, and both these cases are likely to make adherence look lower than it is in reality. Patient episodes missing an activation date were excluded from this analysis. In total, wearable adherence data was available for 178 patient episodes.

A breakdown of wearable adherence can be found in table 12 below. Mean wearable adherence was 68%. Over half of patients (56%) achieved a wearable adherence of over 75%, while only 28% of patients had an adherence of 50% or less.

Table 12: Breakdown of wearable adherence per patient episode.

Wearable adherence	n	%
Did not wear device (0%)	3	2%
Greater than 0%, but less than or equal to 25%	22	12%
Great than 25%, but less than or equal to 50%	24	13%
Greater than 50%, but less than or equal to 75%	30	17%
Greater than 75%, but less than or equal to 100%	99	56%
Total	**178**	

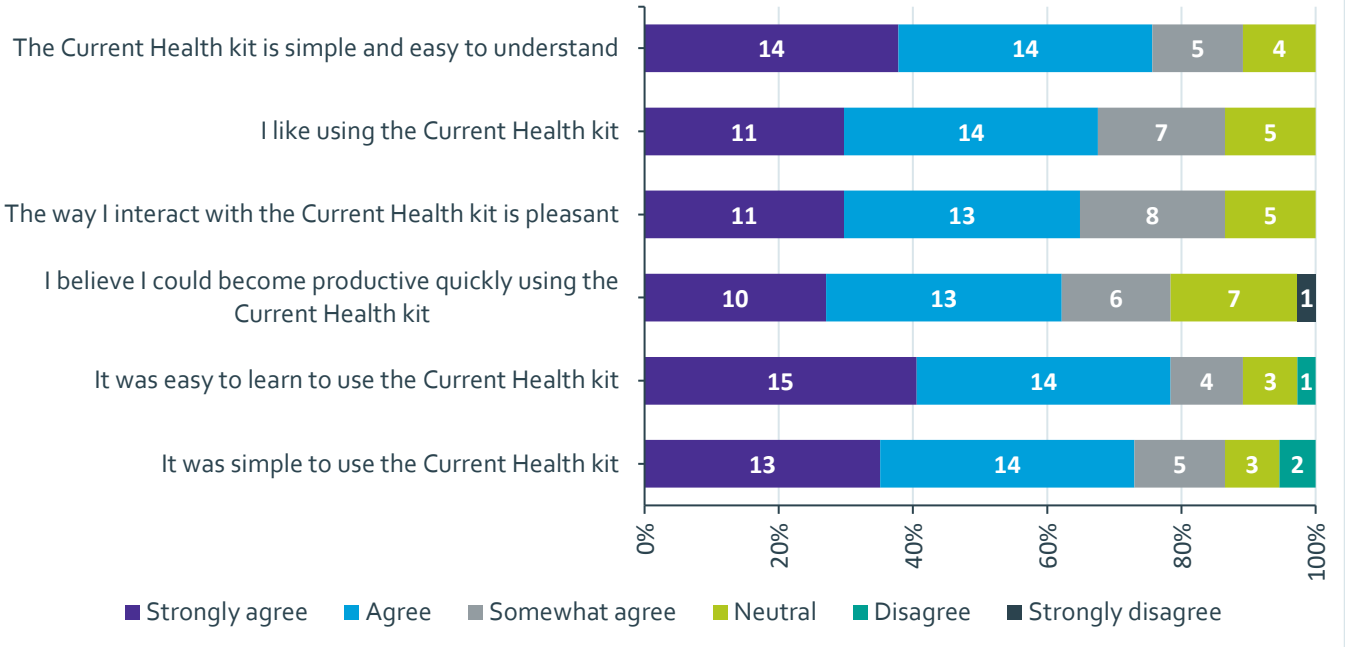
The 'Ease of Use' subscale of the validated Telehealth Usability Questionnaire (Parmanto et al. 2016) was also sent to patients via Current Health. A total of 37 patients completed the survey. Patients were asked to score six statements about their experience of using the Current Health kit, each statement was scored on a 7-point scale from 'Strongly agree' (7) to 'strongly disagree' (1). Scores were largely very positive, with over three-quarters of patients giving positive agreement with each statement given in the questionnaire.

The areas patients were most positive about was the ease of learning to use the kit (89%) and the fact it was simple and easy to understand (89%). A slightly lower proportion (87%) agreed that it was simple to use the Current Health kit, it was pleasant to interact with the kit and that they liked using the kit.

An overall score of 5.3 or more is considered "high" (Serwe, 2018). The overall Ease of Use score for the Virtual Ward was 5.9 (SD 1.1) out of 7.

The full breakdown of responses to each of the 6 agreement statements is presented in chart 1 below.

Chart 1: Patient views of Current Health



A small number of patients left some comments about the kit including one patient who felt that if they were capable of using it anyone should be:

"It's so easy am not computer literate so if I can do it anyone can and the nurse that showed me was great, thank you"

Feedback from the three patient interviews suggested that the technology was acceptable, although it was noted that perhaps eligible patients would need to have a minimum level of digital literacy in order to be a good candidate for the programme. This was mainly related to the management of the notifications from the tablet or laptop and being responsive to these when needed. Small adjustments were reported in order to make the experience more comfortable for the patients. For one patient this included setting up the monitoring system in the bedroom instead of the living room closer to the internet connection as they were severely ill and could not easily get up and down the stairs throughout the course of the day. For another patient, their blood pressure monitor failed to give correct readings and it was decided to allow them to use their own monitor and for the patient to upload the readings manually as they felt confident to do so.

Amongst the 250 patient episodes, there were a number of patients that had a shorter length of stay than anticipated, including 25 (10%) patient episodes where it was decided that telehealth was not appropriate. Amongst these patients, there was one patient where it was not possible to connect within their house, nine patients were referred onto more appropriate services and for six patients the ambulance service was called as they were too unwell to stay at home. As referrals to the virtual ward come via various services that do not use remote monitoring, the understanding of what patients are appropriate for remote monitoring was not always well understood by referrers, e.g. patients having the necessary dexterity, or for those that could not manage the equipment themselves that they did not have regular carers that the team could train to use the equipment. A triage with the rapid response team is conducted over the phone, but it is not always possible to determine whether a patient is appropriate until seeing them in person to fit the devices. At this point it may be decided that a patient is not appropriate for remote monitoring or the patient may be asked to try the device but it is clear very early on that they are not capable so the device is then removed.

As well as patients for whom telehealth was not appropriate, there were also ten patients (4%) that declined the device or requested it be removed. These patients declined the devices as they were not confident about using the technology and were more frequently elderly patients that lived alone. Most of these patients were admitted to the virtual ward soon after implementation and staff familiarity with the system may have been a factor. As staff working on the ward became more confident in explaining the benefits of remote monitoring and helping patients grow confidence in using the technology, they gained experience of working with this patient group.

2.4 What is the patient experience of the service?

Patients were asked to give a Net Promotor Score (akin to the NHS Friends and Family Test), rating how likely they were to recommend Current Health to family and friends on a scale of 0-10. The Net Promotor Score is calculated by classifying respondents as 'Promotors' (score 9-10), 'Passives' (7-8) and 'Detractors' (0-6). The overall score is derived by subtracting the percentage of Detractors from the percentage of Promotors. There is no universal standard for NPS, but the score's authors Bain & Co. consider an NPS above 0 as "good", above 20 "favourable" and above 50 as "excellent". The NPS score for the Virtual Ward was 55.

The majority of reflections on the scoring were positive, with patients saying the service 'gives them peace of mind' and is 'easy' and 'simple' to use. One patient reflected on the fact it also saves clinician time:

"I know I am being monitored. It saves having to go to hospital or having a doctor keep visiting me. As they can check my vitals all online"

Others reflected that they felt looked after by the staff:

"Excellent service and feel very confident that I'm being looked after. Dr's and nurses are lovely"

Only one patient scored the service lower than 5, scoring it a '0', this patient found the amount of input needed by the patient problematic, including the inflexibility of tasks which are messages that come through to tell a patient to take their blood pressure or temperature and the fact that they found messages coming through to ask them to charge their device for 15 minutes too frequent as well as not understanding that they would be taking temperature readings themselves:

"The daily tasks are a bit inflexible, the wearable recharge tasks are too frequent, the communication between the blood pressure unit and the tablet is a bit unreliable, we were not informed that we would need to take our own temperature readings"

In terms of the three patient interviews, all reported an overwhelmingly positive experience being treated under the care of the virtual ward team overall. Three themes were repeated among all three patients which described (1) the convenience, ease, and comfort of treatment in one's own home, and equally out of hospital, (2) the personalised care and specialist support received by the virtual ward team and wider hospital teams during this time and (3) feeling safe under care at home.

Patients felt they were being kept out of hospital whilst feeling like they were receiving the same standard of care as they would in a hospital environment. Patients reported having their needs met above and beyond what they had anticipated, which in some instances, exceeded their experience of being treated in hospital in terms of feeling safe.

"I think it was better [than hospital treatment], it was a personal touch… you got to know nurses so well. It was like having a named nurse to yourself. That's the way I saw it…. In hospital, there's a ward full of patients and one nurse responsible for everyone, at home, I was alone and had the nurse to myself … that's the way I saw it."
Patient describing care in their home

2.5 How did the service impact on healthcare utilisation?

In order to look at healthcare utilisation, data was obtained on the number of telephone contacts, home visits, outpatient appointments, ED attendances and admissions for each virtual ward and control patient. As expected, the mean number of telephone contacts per patient per day was significantly higher in virtual ward patients at 1.27, compared to the control group at 0.47. The model the team used of a ward round meant that every patient had a telephone call per day as part of the virtual ward round even if no alerts were triggered and if an alert was triggered additional contact would be made.

When comparing by reason for admission to the virtual ward, patients admitted for emergency episodes had the highest rate of telephone contacts per patient per day at 1.38, followed by COVID-19 at 1.27, and LTCs was lowest at 1.23.

This data, including means and medians per day for all patients that were on the ward for a day or more, can be found in table 13 below. A further breakdown of this data in virtual ward patients by reason for admission can be found in table 14. Mann-Whitney U tests were carried out between the virtual ward patient groups and the control group to determine whether there were any statistically significant differences at the 95% confidence level. 14 patients were excluded from this analysis as they had a duration on the virtual ward of less than a day. Of these, 4 were admitted to hospital and 10 were deemed inappropriate for telehealth.

The mean number of home visits per day was lower in virtual ward patients compared to the control group, with 0.32 home visits per virtual ward patient per day, and 0.93 home visits per control patient per day. The mean number of home visits per day was similar across all reasons for admission.

The mean number of outpatient appointments per patient per day was lower in virtual ward patients than the control group (p=0.17), and this difference was seen across all reasons for admission. However none of these differences were significant at the 95% confidence level (p=0.09, p=0.48 and p=0.65) for COVID-19, LTC and emergency episode patients respectively, compared to the control group).

The mean number of ED attendances per patient per day (0.07) and admissions (0.06) was similar in virtual ward patients across all reasons for admission, with no significant differences compared to the control group (p=0.81 for ED attendance; p=0.98 for admission).

Table 133: Healthcare utilisation of virtual ward and control patients.

	Virtual ward patients (n=250)			Control patients (n=33)		
	Total	Mean	Median	Total	Mean	Median
No. of telephone contacts	2,680	1.27*	1.14	45	0.47	0.50
No. of home visits	404	0.32*	0.17	84	0.93	0.75
No. of outpatient appointments	21	0.01	0.00	7	0.08	0.00
No. of ED attendances	61	0.07	0.00	8	0.09	0.00
No. of admissions	44	0.06	0.00	6	0.06	0.00

**statistically significant difference compared to control group at 95% confidence level.*

Table 14: Healthcare utilisation of virtual ward patients, split by reason for admission.

	Covid-19 (n=161)			LTC (n=65)			Emergency episode (n=24)		
	Total	Mean	Median	Total	Mean	Median	Total	Mean	Median
No. of telephone contacts	1,401	1.27*	1.17	970	1.23*	1.14	309	1.38*	1.29
No. of home visits	242	0.31*	0.20	117	0.33*	0.14	45	0.35*	0.20
No. of outpatient appointments	5	0.00	0.00	12	0.01	0.00	4	0.02	0.00
No. of ED attendances	39	0.08	0.00	16	0.05	0.00	6	0.06	0.00
No. of admissions	31	0.07	0.00	9	0.05	0.00	4	0.05	0.00

**statistically significant difference compared to control group at 95% confidence level.*

A number of physiological alarms were available for use in Croydon virtual ward patients to alert clinicians to wearable/device readings outside of normal limits that may require clinical action. Table 15 below breaks down the number of alarms per patient per day, in patients that were monitored for longer than 24 hours. Please note that the number of alarms may also depend on clinician activity, as if an alarm wasn't silenced within a certain time period it would repeat.

The median number of physiological alarms per patient per day was 2.5, with the majority (80%) of patients having 4 or fewer. Only 4% of patients had an average of 10 or more alarms per day.

Table 15: Breakdown of number of physiological alarms per patient per day, for patients that were monitored for longer than 24 hours.

Number of alarms per patient per day	n	%
0-4	139	80%
5-9	28	16%
10-14	5	3%
15-19	1	1%
Total	**173**	

Of the 51 virtual ward patients that were admitted to hospital during their time in the virtual ward, length of stay data was available for 46 of them. Mean length of stay in hospital for virtual ward patients was 11.5 days, with a median of 6. This ranged between 2 and 55 days. The long stay being for a COVID-19 patient that was transferred to ITU with multiple Covid related complications. Length of stay in hospital data was available for the 5 control patients that were admitted to hospital. Mean length of stay in the control patients was higher than the virtual ward patients at 14.2 days, with a median of 8 days. Ranging between 6 and 29 days.

Table 16: Average Length of Stay of patients that were admitted to hospital

	Virtual ward patients	VW Covid-19 patients	VW LTC/emergency episode patients	Control patients
# Patients with data	46	32	14	5
Mean LOS	11.5	11.7	11.1	14.2
Median LOS	6	6	6	8

Chart 2 below displays the number of referrals to the Rapid Response team per month for time periods leading up to, during, and after establishing the virtual ward. The number of referrals was relatively constant from April 2019 to June 2020, and then increased rapidly between July and December 2020, before remaining constant at an elevated level until August 2021. The increase in referrals coincided with 2 events; firstly the start of on-boarding of patients on the virtual ward in July and secondly increased system demand from August 2020.

The increase in referrals to Rapid Response corresponds to the increased health need seen across the system with more patients accessing and requiring healthcare. In wave one, the Trust utilised private medical beds to reduce demand on the acute hospital, which were closed in June 2020. Promotion of Rapid Response across the emergency department, the ambulance service and primary care increased awareness of both virtual ward and home assessment, which resulted in a significant increase in referrals to the Rapid Response team. No additional beds were opened.

Chart 2: Number of referrals to Rapid Response team time series.

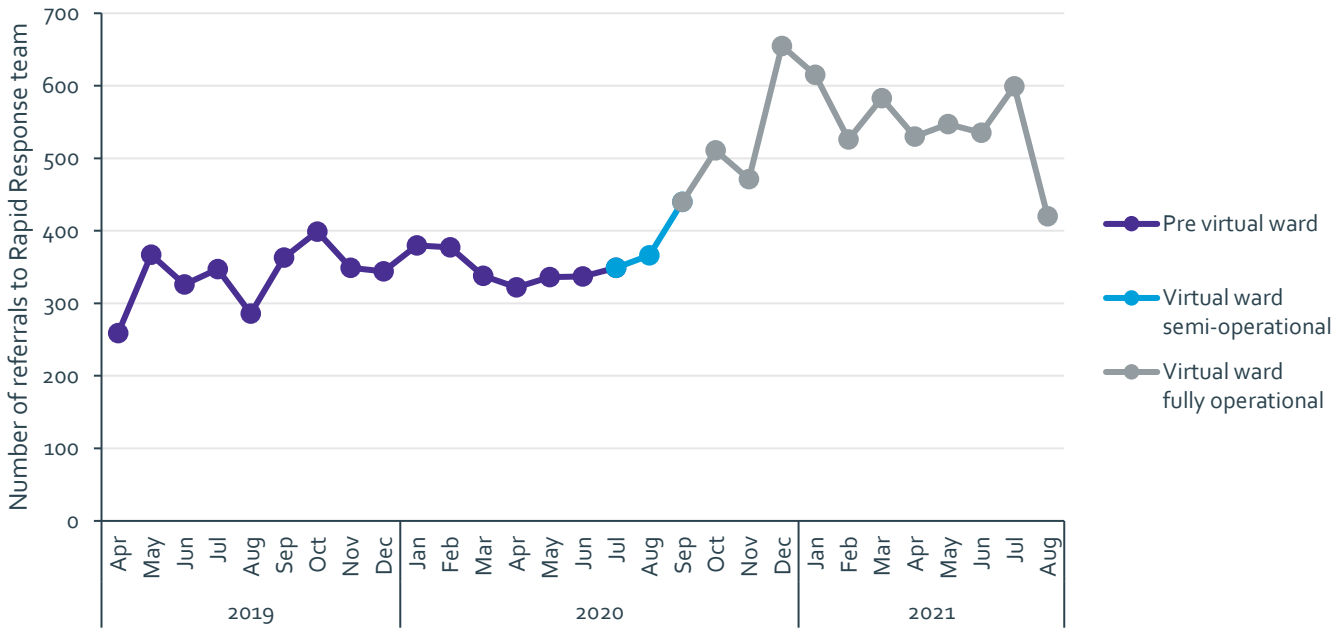


Chart 3 displays the number of referrals in the 12-month period before the virtual ward was fully operational (September 2019 – August 2020) alongside the 12-month period after the virtual ward became fully operational (September 2020 – August 2021). This shows on average, the number of referrals was over 50% higher after the virtual ward became fully operational (see table 17 below for full monthly breakdown). The increase in referrals to Rapid Response coincides with COVID-19 wave 2 which saw an increase in ambulance calls and hospital admissions. The increased referrals are for a cohort of patients that would otherwise have needed care from acute hospital services, so this activity has most likely been shifted from Croydon acute hospital, rather than added capacity to see additional patients. It is difficult to fully understand the shift in activity between the acute hospital and the Rapid Response team and whether the virtual ward directly led to a reduced pressure on inpatient beds, as hospital admission rates were also very high at the time of the virtual ward being opened.

Chart 3: Monthly number of referrals to Rapid Response team pre and post virtual ward.

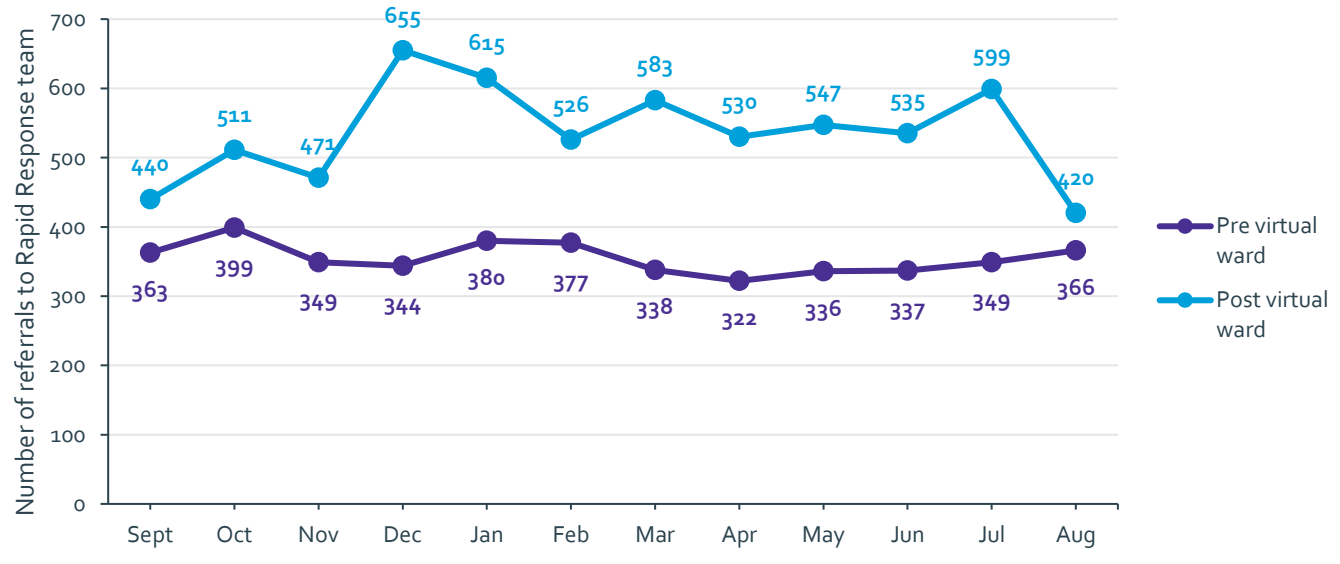


Table 14: Percentage change in number of referrals to Rapid Response team before and after virtual ward was fully operational.

Month	No. referrals to Rapid Response team		% change
	Pre virtual ward	Post virtual ward	
September	363	440	21%
October	399	511	28%
November	349	471	35%
December	344	655	90%
January	380	615	62%
February	377	526	40%
March	338	583	72%
April	322	530	65%
May	336	547	63%
June	337	535	59%
July	349	599	72%
August	366	420	15%
Total	**4,260**	**6,432**	**51%**
Mean	**355**	**536**	**51%**

As seen in the Rapid Response referral data it is likely that the increase in referrals to Rapid Response coincided with the virtual ward being operational and came at a time when there was increased pressure on inpatient beds due to COVID-19 wave 2. The fact that additional independent sector beds were not required in wave 2 but were needed in wave 1, suggests that patients that would otherwise have needed an inpatient bed were being picked up by the virtual ward instead, therefore taking pressure off inpatient services at Croydon hospital.

2.6 Did the service deliver any cost savings?

The unit costs and cost savings per patient per day for telephone contacts and home visits have been laid out in table 18 below. Outpatient appointments, ED attendances and ED admissions have not been included as there were no significant differences between virtual ward and control patients.

The estimated daily cost per patient was £16 higher in the virtual ward patients than control patients for telephone contacts, however it was £73.20 lower for home visits. Therefore, the total estimated daily cost saving per patient on the virtual ward was £57.20. Multiplying by the average number of days spent on the virtual ward across all patients (9.128 days) gives a saving of £522.12 per virtual ward patient compared to the control.

Table 15: Unit costs and cost savings for home visits and outpatient appointments.

	Unit cost	Estimated cost per patient (unit cost × mean)		Cost saving per patient
		Virtual ward	Control	
Telephone contact	£20[1]	£25.40	£9.40	-£16.00
Home visits	£120[2]	£38.40	£111.60	£73.20
Total		**£63.80**	**£121.00**	**£57.20**

Table 19 below displays the cost savings in bed days among patients that were admitted during their stay on the virtual ward. Estimated cost saving per patient admitted was £1,080. Extrapolating this to the whole virtual ward

[1] Estimated based on a 10-minute phone call by a band 7 community nurse at £120 per hour.

[2] PSSRU: Unit costs of health and social care 2020. Cost per hour of patient-related work for a band 7 community nurse, based on average home visit length of 1 hour.

cohort of 250 patients, 51 of which were admitted, leads to a cost saving of £220.32[3] per virtual ward patient.

Table 16: Cost savings in bed days per patient admission to hospital.

	Unit cost	Estimated cost per patient admission (unit cost × mean)		Cost saving per patient admitted
		Virtual ward	Control	
Bed days	£400	£4,600	£5,680	£1,080

Combining cost savings for telephone contacts, home visits and bed days gives an estimated total cost saving of £742.44 per virtual ward patient, and a total of £185,610 across the whole 250 patient cohort, compared to the control group.

2.7 What was the patient outcome?

Of the 250 patients being monitored via the virtual ward, 162 (65%) remained at home on monitoring for the duration of their care, and a further 51 (20%) had an admission to hospital during their time on the virtual ward (Table 20). For a tenth of patients it was realised that telehealth was not appropriate and they were discharged early and referred on to more appropriate services for their needs, a further 4% of patients declined the monitoring devices or asked for them to be removed, due to a lack of confidence in using the technology and 2 patients died during their time on the virtual ward.

Table 17: Outcomes of virtual ward and control patients.

Patient outcome	Virtual ward patients		Control patients	
	n	%	n	%
Remained at home	162	65%	23	70%
Admitted to hospital	51	20%	10	30%
Telehealth not appropriate	25	10%		
Patient declined/requested removal	10	4%		
Died	2	1%		
Total	**250**		**33**	

Hospital admissions whilst under the care of the virtual ward

Whilst under the care of the virtual ward 51 patients (20%) had a hospital admission. Of the patients admitted, 5 (10%) required admission to critical care, 4 of these critical care patients were admitted to the virtual ward due to COVID-19 with 1 being admitted due to an infection, and 4 of the critical care patients received intubation whilst in hospital.

Of the 51 hospital admissions, 43 (84%) resulted in patients being discharged back home, including two patients that were admitted to critical care. Of those patients admitted 8 (16% of those admitted to hospital) died whilst in hospital, including 3 patients in critical care. For those patients that died, the reason for admission to the virtual ward were the contraction of COVID-19 (4 patients), heart failure (3 patients) and chronic disease management (1 patient). In order to understand whether the proportion of virtual ward patients that died in hospital is in line with what would be expected amongst acute ward patients at the time, more data is needed on the discharge destination of Croydon Health Services inpatient wards as a meaningful comparator.

Of the 45 hospital admissions that resulted in patients being discharged back home, information was obtained regarding readmissions to hospital at both 7 days after discharge, and 28 days post discharge. At 7 days post discharge, 4 patients (9%) had a readmission to hospital. At 28 days post discharge, an additional patient was readmitted to hospital, meaning 12% of patients discharged from hospital had a readmission with 28 days. The

[3] Calculation: (Cost saving per patient admitted * no. patients admitted) / total patients.

reasons for readmissions were due to a pulmonary embolism, hypoxia (including one patient that had hypoxia as a result of hospital acquired pneumonia) and an exacerbation of bronchiectasis.

Outcomes following discharge from virtual ward

Table 21 shows that following discharge from the virtual ward, only 5 patients (3%) were admitted to hospital in the following 7 days, and 15 (9%) were admitted in the following 8 to 28 days.

Among the 208 patients who completed the virtual ward pathway or ended the pathway in hospital, there were 5 (2%) deaths in the 7 days following discharge, and 8 (4%) deaths in the 28 days following discharge from the virtual ward (this includes deaths within the first 7 days).

Patients admitted to the virtual ward due to COVID-19 were more likely to be admitted to hospital than those admitted due to LTCs or emergency episodes. They were also more likely to be admitted to critical care. However the percentage of deaths both whilst in hospital and post-discharge was slightly higher in LTC/emergency episode patients. Hospital admission post discharge from the virtual ward were low in both groups, although admission in the 28 days post discharge from the virtual ward was higher in the LTC/emergency episode group (13%) than the COVID-19 group (7%).

Readmissions and admissions post discharge from the virtual ward were higher in the control group than the virtual ward patients, at both 7 days and 28 days post-discharge.

Table 18: Outcomes of virtual ward and control patients.

Outcome	Virtual ward			Covid-19			LTC/emergency ep.			Control		
	n	%	Base	n	%	Base	n	%	Base	n	%	Base
Hospital admission while on virtual ward	51	20%	250	36	22%	161	15	17%	89	6	18%	33
Admissions to Critical Care	5	10%	51	4	11%	36	1	7%	15	0	0%	6
Discharge destination of hospital admissions												
Home	43	84%	51	32	89%	36	11	73%	15	5	83%	6
Died	8	16%	51	4	11%	36	4	27%	15	0	0%	6
Readmissions												
7 days after discharge	4	9%	43	2	6%	32	2	18%	11	2	33%	6
8-28 days after discharge (cumulative)	5	12%	43	3	9%	32	2	18%	11	5	83%	6
Admissions post discharge from virtual ward (full pathway)												
7 days after discharge	5	3%	170	3	3%	106	2	3%	64	5	15%	33
28 days after discharge (cumulative)	15	9%	170	7	7%	106	8	13%	64	10	30%	33
Deaths of virtual ward patients completing pathway or ending pathway in hospital												
7 days after discharge from virtual ward	5	2%	208	2	2%	133	3	4%	75	1	3%	33
28 days after discharge (cumulative)	8	4%	208	4	3%	133	4	5%	75	1	3%	33

Table 22 displays the oxygen status of virtual ward and control patients. None of the control patients were given oxygen during their time with the Rapid Response team.

Of the patients admitted to hospital during their time under the care of the virtual ward due to COVID-19, 4 (11%) were given oxygen, 5 (14%) non-invasive ventilation (NIV) and 3 (8%) invasive ventilation.

Thirteen (5%) of virtual ward patients were on home oxygen prior to admission to the virtual ward, and the same number were put on oxygen during their time on the virtual ward. LTC/emergency episode patients were more likely to have been on oxygen prior to the virtual ward, while COVID-19 patients were more likely to be put on oxygen during, although these numbers were still quite low at 7% and 6% respectively.

Of those on home oxygen, 42% had their oxygen discontinued during their time on the virtual ward. Almost two-thirds (64%) of COVID-19 patients had their oxygen discontinued or reduced, compared to 38% of LTC/emergency episode patients.

Table 19: Oxygen status of virtual ward and control patients.

Oxygen status	Virtual ward			Covid-19			LTC/emergency ep.			Control		
	n	%	Base	n	%	Base	n	%	Base	n	%	Base
Oxygen/ventilation for patient admissions (COVID-19 patients only)												
O2				4	11%	36				0	0%	6
NIV				5	14%	36				0	0%	6
Invasive				3	8%	36				0	0%	6
On home oxygen?												
On home oxygen prior to virtual ward	13	5%	250	5	3%	161	6	7%	89	0	0%	33
Put on home oxygen during time on ward	13	5%	250	10	6%	161	3	3%	89	0	0%	33
Was oxygen discontinued during time on virtual ward?												
Yes	10	42%	24	7	50%	14	3	38%	8			
Reduced	2	8%	24	2	14%	14	0	0%	8			
No	12	50%	24	5	36%	14	5	63%	8			

A total of 308 clinical tests were recorded as having been ordered for patients whilst on the virtual ward, an average of 1.2 tests per patient. The majority of tests were types of blood tests. Table 23 below sets out the types of tests ordered for two or more patients whilst on the virtual ward.

The control group had a higher average number of tests at 3.4 tests per patient; however, this is not broken down by type of test.

Table 20: Tests ordered for virtual ward patients.

Test	No. ordered	% of tests ordered
Full blood count	71	23.1%
Urea and electrolytes	66	21.4%
C-reactive protein	47	15.3%
Liver function test	29	9.4%
Bone	14	4.5%
Covid-19 swab	11	3.6%
Thyroid function test	9	2.9%
Electrocardiogram	6	1.9%
HbA1C (blood glucose)	5	1.6%
D-Dimer	4	1.3%
Natriuretic Peptide Test	4	1.3%
Mid-stream urine	3	1.0%
Magnesium	3	1.0%
Clotting screen	3	1.0%
Vitamin D	3	1.0%
Blood	3	1.0%
Troponin	2	0.6%
Urine dip	2	0.6%
Bladder Scan	2	0.6%

Data was not obtained re the results of these tests and any resulting action taken so it is not clear what proportion of these tests led to improved clinical outcomes.

Telehealth monitoring has found significant pathology that was detected earlier or would otherwise not have been detected with possible fatal outcomes if not treated. This includes five patients with new pulmonary embolism, 2 with heart arrhythmias, 2 patients with obstructive sleep apnoea and one incidental atrial myxoma.

Feedback from patients on improved outcomes:

There was a range of feedback from the 3 patients that were interviewed regarding their observations of improved clinical outcomes and improved quality of life

There was remarkable feedback associated with the level of professionalism and personalised care under the virtual ward team during admission to the virtual ward from all three patients and one carer. Patients described instances in which their vital levels being monitored dropped below normal ranges. On each occasion a response from a healthcare professional was provided quickly and the problem was addressed proportionately whether it resulted in a call, home visit, or in more severe cases, a hospital admission. The virtual ward also prevented admissions according to the patients, who described how they were able to receive specialist care at home before developing symptoms on occasions where they were deteriorating without being aware of this.

Patients described the changes to their overall wellbeing as a result of the virtual ward. All patients reported being impacted long term by their health conditions, including the effects of long covid for those that had COVID-19. Patients felt overall that the virtual ward and support from the team had improved their quality of life, particularly by increasing their knowledge, confidence, and independence. One patient described the ability to manage and detect symptoms which they could not do before their care under the virtual ward team.

This has led to an improved quality of life and more independence to carry out their activities of daily living without

fear. Patients also described how the regular contact and close relationship that had formed with their care teams, provided a point of contact should they need it in future, which provided further reassurance. Overall, there has been a significant improvement to all three interviewed patients' quality of life since being under the care of the virtual ward team which was highlighted strongly during the interviews.

No patient reported feeling completely recovered from their condition for which they had been monitored by the team, however all reported that they had been stabilised during their care on the virtual ward. In addition, two of the patients received care by other teams at Croydon hospital who had access to their remote monitoring data (via the team uploading their data to the acute system patient record) which greatly improved their care. On both occasions, respiratory teams took over the care for these patients for two or more weeks and continued to use the clinical data to inform when the patients could be discharged and provide them with further care e.g. rehabilitation.

"My COPD has improved since the respiratory team took over and helped me with rehabilitation. I still do the exercises when I need them. They helped me get back to where I should be before the infection."
Patient describing their improved outcomes

Data on the patient outcomes of a small number of patients was used to create some case studies to demonstrate the impact that virtual wards can have on individual patients outcomes. Information included in the below case studies comes from staff working on the virtual ward as well as interviews conducted with three of these patients.

Case Study 1: Patient X

Situation prior to admission to virtual ward:

Prior to admission to the virtual ward patient X had been in hospital with COVID-19. They'd had a hospital stay which lasted a month and included stays on a critical care ward as well as a COVID-19 inpatient ward.

Patient X had an early supported discharge to a next of kin's home to recover from COVID-19 as they were unable to be discharged to their own home due to the severity of their COVID symptoms and was therefore treated at a next of kin's home for several months after their hospital stay

Patient X's next of kin was visited by the virtual ward team the day prior to Patient X's discharge from hospital to ensure the suitability of the home environment and the next of kin's ability to care for Patient X's needs out of hospital including domestic care.

Impact the monitoring/ treatment had on the patient's health outcomes

Patient X experienced a long stay on the virtual ward which lasted five months.

A number of actions were picked up as a result of the virtual ward including leg pain that resulted in a review for deep vein thrombosis and pulmonary embolism which was excluded and did not need admission or outpatient attendance.

A home visit was made in order to review the patient for tachycardia and to rule out an infection. Home visits were also made for blood gases and ambulatory oxygen assessments as part of oxygen weaning.

This patient also received daily phone calls from the virtual ward team in order to have the opportunity to talk and discuss any concerns.

"Someone is there 24/7 looking after me and making sure if your oxygen levels are ok or going down. The first week [community nurse] called me the first time I had a bath and I had to explain 'sorry, I had to have a quick wash!'... that's because my [oxygen sats] levels were going low. It saved my life, I did feel safe.... I had regular calls the first week, after that I knew what to do and my next of kin knew what to do but if anything did happen, they did get in contact."

Patient X describing the first week on the virtual ward.

As a result of the monitoring and treatment received this patient was able to be managed effectively at home. The patient was able to mobilise more and due to being at home patient X was also able to have a bath, eat and drink things that they liked and see family and friends easily.

Case Study 2: Patient Y

Situation prior to admission to virtual ward:

Patient Y had two episodes of care under the virtual ward, the first was for an infective exacerbation of asthma and the second following a positive COVID-19 diagnosis in order to avoid a hospital admission. Monitoring both times was for up to 4 weeks.

Impact the monitoring/ treatment had on the patient's health outcomes:

During the first episode of care provided by the virtual ward there was an incidental finding of hypertension. This resulted in Patient Y's meds being changed and a referral to an outpatient clinic.

During the second episode of care there was an Emergency Department attendance due to shortness of breath and episodes of hypoxia. Patient Y had blood tests and a chest x-ray. An irregular heart rate was also identified by the ambulance service but returned to normal on its own. The patient's hypertension was managed by the team remotely through changes in meds and monitoring.

Patient Y describes how the virtual ward team were able to arrange a comprehensive care package which included three health and care visits over a period of weeks when their health had deteriorated due to an infection.

"My sats were low and I went into hospital to do some blood work and gave me some antibiotics and then they realised I needed a care package, this was all arranged by the Rapid Response team... I couldn't manage alone, I was too weak. I [subsequently] received three visits a day to help me shower, eat, make sure I was ok..."

Patient Y describing the RR team arranging additional care for them

The monitoring meant that Patient Y was able to be cared for at home. When required, care was escalated by arranging a home visit and blood tests and where necessary ED attendance. Patient Y was supported back home so there was no need for full hospital admission following the ED attendance.

The monitoring undertaken by the virtual ward has given patient Y more confidence in how to manage their health and when to escalate any health concerns:

"It [virtual ward] has made me aware for example thinking if I am too hot or getting too cold. I was always thinking things would be alright, but now I am able to say for example if I have a cough, I'll take a couple of days to monitor it before taking action."

Patient Y on how they manage their health since the virtual ward

Case Study 3: Patient Z

Situation prior to admission to virtual ward:

Patient Z was admitted to the virtual ward due to an infective exacerbation of COPD. They were monitored for approximately 4 weeks.

"[I was admitted] due to my COPD, I wasn't aware at that point I had a very severe chest infection. [I] ended up in A&E three times and developed to the point I could not breathe two to three times..... during my last visit to the emergency room, they did bloods on me and on being discharged told me the Rapid Response team would follow up.... Never heard of them before so by 10am the next day I was surprised they were in touch to make an appointment to visit me at home that afternoon."

Patient Z on the circumstances which led to their care under the Rapid Response team

Impact the monitoring/ treatment had on the patient's health outcomes:

During their time on the virtual ward there was an incidental finding of atrial fibrillation which resulted in an Emergency Department attendance.

An unresolved infection led to further anti-biotics and a home visit to take blood tests. Patient Z was also referred to an outpatient department for a chest x-ray.

There was also an incidental finding of hypertension as a result of the monitoring which resulted in a medication review.

"I am grateful for it, I don't know how I would have managed without it. Several times during those weeks they had to call and check on me and readmit me because of my readings but I wouldn't have realised.... I wouldn't have known it but my respiration was getting dangerous and I was only resting when they called to ask what I was doing. A doctor actually called to tell me they had to bring me in... It was very reassuring because I live on my own, I know I can call my children anytime but having the monitor and knowing I can get a medical advice straight away is so assuring and they called me before I even have chance to call them!"

Patient Z describing the effective response from the Rapid Response team

As a result of the monitoring Patient Z was able to be managed at home. Patient Z recorded being able to manage their health conditions more effectively following discharge from the virtual ward due to the learning they had gained during their time on the ward.

"Yes, it has given me a lot more confidence where I have always been active, I am not totally unfit...And I think the whole thing [illness] scared me badly..... It shunned my confidence going out but talking to them and their support has helped me get back and how to overcome it when I go out for example the breathing techniques.... My quality of life is back to what it should be."

Patient Z describing the impact of the virtual ward on their quality of life

Case Study 4: Patient Q

Situation prior to admission to virtual ward:

Patient Q is a 77-year-old with pulmonary fibrosis, COPD, myocardial infarction and on long term oxygen living alone. They were referred for long term condition management. For the 12 months before admission to the virtual ward they had 19 emergency department attendances, with 11 hospital stays.

Impact the monitoring/ treatment had on the patient's health outcomes:

Once supported with telehealth patient Q had zero admissions or attendances. As well as being monitored via the virtual ward patient Q also had combined respiratory and Rapid Response input. Using the saturation data their oxygen was increased. Patient Q required 2 home visits and 35 telephone calls over 37 days. On discharge from the service they continued to stay at home with zero admissions or attendances for the following 8 months.

3. Conclusions

Croydon virtual ward was implemented at pace following COVID-19 wave 1 in order to take pressure off Croydon's acute hospital and enable patients to receive the support they needed at home. The ward itself admitted 250 patient episodes between July 2020 and June 2021, of which 64% had COVID-19 or long covid, 26% were being helped to manage a long-term condition and 10% had an emergency episode that had caused a decline in their health. All patients admitted were acutely unwell with an average of 4 comorbidities, but some patients had up to 13 comorbidities.

Early data from the virtual ward shows that using continuous remote monitoring technology is generally accepted and appropriate with 89% of survey respondents finding it easy to learn how to use the kit and 89% thinking it is simple and easy to understand. Of the 250 patient episodes there was a small number (10 patients, 4%) that asked for the devices to be removed or declined the device in the first place due to a lack of confidence in using the technology, but the vast majority 96% were happy to use the device.

Patient experience scores were very high with a net promoter score of 55, which is classed as 'excellent'. This means that most patients that completed the questionnaire would recommend the Current Health devices to family and friends. Patient interviews were used to understand the experience of the service. Patients provided very positive feedback with regards to using the technology. They reported feeling they were being cared for by staff, being enabled to be in their home rather than in hospital and learning more about how to manage their conditions beyond the virtual ward by the learning they undertook around their observation data.

Data on wider healthcare utilisation of virtual ward patients compared to a small control group of Rapid Response patients that were seen by the team during COVID-19 wave 1 were obtained. This data indicated that the number of telephone contacts that virtual ward patients had per day was significantly more than the control, as expected; however, the number of home visits per day was lower.

Referrals to Rapid Response went up by over 50% when the virtual ward became fully operational in September 2020. This indicates a move of patients that would have accessed healthcare via the acute hospital that were referred to Rapid Response instead. During COVID-19 wave 1, the acute Trust opened 1.5 private wards that were then closed in June 2020. The Trust did not need to increase acute capacity during COVID-19 wave 2.

Almost two-thirds (65%) of virtual ward patient episodes remained at home during their time on the virtual ward, with 20% being admitted to hospital. Of the hospital admissions, 10% resulted in an admission to critical care. Following a hospital admission, 84% of patients went home, with 16% of hospital admissions dying whilst in hospital. A small number of patients (4, 9%) that were discharged to their home had a readmission within 7 days, with one patient being readmitted between 8-28 days after discharge.

Admission rates of the virtual ward cohort that completed a pathway and were discharged from the ward was 3% within 7 days of discharge from the virtual ward and 9% within 28 days of discharge (which includes patients admitted within the first 7 days), this is lower than the control whereby 15% were readmitted within 7 days of discharge from Rapid Response and 30% within 28 days. In terms of mortality, 2% of patients that completed a virtual ward pathway or ended their pathway in hospital died within 7 days of being discharged from the virtual ward, with 4% dying within 28 days of being discharged from the ward (similar to rates seen amongst the control group).

A total of 308 clinical tests were recorded as having been ordered for patients whilst on the virtual ward, an average of 1.2 tests per patient. Telehealth monitoring has found significant pathology that was detected earlier or would otherwise not have been detected with possible fatal outcomes if not treated. This includes five patients with new pulmonary embolism, 2 with heart arrhythmias, 2 patients with obstructive sleep apnoea and one incidental atrial myxoma.

As well as quantitative data around outcomes of virtual ward patients, a small number of case studies have been created which show the impact the ward has had on individual patient outcomes which include early identification of conditions as well as appropriate input from staff to avoid long stays in hospital and enable patients to be at home and improve their quality of life.

Whilst some of this data is small in number and hard to definitively prove, it is clear that Croydon virtual ward was able to appropriately deliver care in patients' homes for 65% of virtual ward patients, (all of which were acutely unwell), manage a cohort of up to 30 patients at one time using 2 additional roles (a telehealth project manager and a Rapid Response GP) as well as training existing staff and deliver a service with which patients were largely satisfied. More data would need to be obtained on a larger control group and including COVID-19 and long-term conditions patients to truly understand whether the differences in outcomes and utilisation are significant.

4. Limitations

There are a number of limiting factors in this evaluation which are listed below:

Obtaining data on an appropriate control group for this evaluation has proved to be very difficult. In using data from Rapid Response prior to the virtual ward being implemented and applying retrospective clinical judgement to identify those that would have been appropriate for admission to the virtual ward we have managed to identify a small number of patients that are comparable to the virtual ward cohort. This control is, however, small in number and, therefore, hard to prove statistically significant differences between the virtual ward and control patients in terms of utilisation of services and patient outcomes. Furthermore, by having a small sample it is impossible to say whether these results are replicable as the control group is not necessarily representative of all patients that might have benefited from the ward. This is partly due to the fact that not all referrals to the virtual ward were made by the Rapid Response team and the control group only consists of Rapid Response patients, but also as it is hard to understand how many of the patients within the control group were being treated as a result of COVID-19, since community testing for COVID-19 was not available during the time period these control patients required healthcare.

This evaluation focuses on a series of 250 patient episodes, of which there are five patients with more than one episode on the virtual ward. Ideally, in order to report fully on patient outcomes, it would've been more appropriate to do the analysis at a patient level rather than an episode level.

Data obtained by Current Health on patient satisfaction of Croydon virtual ward patients with using the kits has been really useful to understanding patients' experience and acceptability of the technology; however, the proportion of Croydon patients using Current Health kits that completed a survey is low.

There has not been a focus within this evaluation on any return on investment to understand the full costs of setting up a virtual ward, and the subsequent financial return. A health economic evaluation would be needed to understand this aspect.

Finally, the evaluation objectives and analysis included within this evaluation were designed based on data that was already being collected by Croydon Health Services and Current Health due to the rapid nature of this evaluation.

Had there been more time, bespoke data collection could have taken place to answer a range of different evaluation questions or explore those included in this evaluation in more depth than was possible in the time given.

5. Recommendations

There are a few key areas where further evidence is needed to answer some of the evaluation questions, including staff interviews or focus groups to understand the factors essential to setting up a virtual ward, gaining more control data including a sample of COVID-19 patients to compare to the virtual ward cohort and improving response rates on the patient survey. Furthermore, an economic evaluation would be needed to understand the return on investment, value for money and cost -effectiveness of providing a virtual ward and understanding if continuous monitoring is more effective than spot monitoring for patients being monitored due to a long-term condition.

As well as further data or evaluation on some aspects, the process of evaluating the Croydon virtual ward has been onerous due to the limited amount of structured data available to the team at Croydon Health Services. Setting up some structured forms in EMIS (the patient record system for Croydon Health Services community services teams) to collect and monitor outcome data more routinely, as well as integrating Current Health observation data into EMIS, would be a huge improvement for the service and would provide rich data in future. Furthermore, the integration of patient records and observation data into acute hospital records would help Croydon inpatient and outpatient services to use this data to detect health deterioration and provide useful observations to ensure appropriate treatment.

There have been some encouraging findings from this evaluation in terms of picking up on health conditions, some of which are potentially fatal such as pulmonary embolisms, heart arrhythmias, obstructive sleep apnoea and incidental atrial myxoma. All of these conditions described were picked up from continuous monitoring which escalated their care to acute pathways for diagnosis. Amongst virtual ward patients an average of 1.2 tests were conducted per patient, the majority of which were types of blood test. Further exploration of whether point of care testing in patients' homes would be beneficial in avoiding hospital admissions and mortality in future would be useful.

Despite the limitations and further evaluation questions, the Croydon virtual ward has proved that, for some patients, outcomes and quality of life have vastly improved as a result of the service, life limiting conditions have been picked up and treated early due to access to continuous monitoring, clinical tests and that acutely unwell patients can be managed effectively at home using continuous monitoring. The recommendation is, therefore, to continue to provide, monitor and develop the service.