Original Article

Applying a COVID Virtual Ward model, assessing patient outcomes and staff workload

S Gallier, C Atkin, V Reddy-Kolanu, D Parekh, X Zou, F Evison, S Ball & E Sapey

Abstract

A COVID virtual ward (CVW) is recommended by NHS England, but 'usual care' outcomes have not been reported.
A retrospective study of all adults with COVID-19 attending Queen Elizabeth Hospital Birmingham between 01/06/2020-31/01/2021, assessed against CVW criteria and followed for 28 days.
Of 2301 COVID-19 patients, 571(25%) would have met CVW criteria. Of these, 325(57%) were discharged after review and 246(43%) admitted. Of admitted patients who met CVW criteria, 81% required hospital-supported therapies; 11% died. Of the 325 discharged, 13% re-presented, 9% with COVID-related symptoms, 2% required intensive care admission, and one died (0.3%).
In this comparison, discharging patients without a CVW did not lead to more re-presentations, re-admissions, ITU escalations or deaths compared to published outcomes for hospitals with a CVW.

Keywords

Virtual ward, discharge, readmissions, mortality, intensive care

Suzy Gallier
PIONEER Technical Director, Lead for Research Analytics
Department of Health Informatics
Health Informatics, University Hospitals Birmingham NHS Foundation Trust

Catherine Atkin
NIHR Lecturer in Acute Medicine
Institute of Inflammation and Ageing, University of Birmingham

Vinay Reddy-Kolanu
Consultant in Acute Medicine
University Hospitals Birmingham NHS Foundation Trust

Dhruv Parekh
Senior Lecturer in Acute Care, Birmingham Acute Care Research Group
Institute of Inflammation and Ageing, University of Birmingham

Xiaoxu Zou
Research Analytics, Health Informatics
University Hospitals Birmingham NHS Foundation Trust

Felicity Evison
Senior Research Analysis
Health Informatics, University Hospitals Birmingham NHS Foundation Trust

Simon Ball
Cheif Medical Officer, Director of Better Care Programme
University Hospitals Birmingham NHS Foundation Trust

Elizabeth Sapey
University of Birmingham
Email: e.sapey@bham.ac.uk

Introduction

The global pandemic caused by SARS-CoV-2 continues to provide health challenges worldwide. During infection 'waves', affected areas experience a high number of hospital presentations and admissions,[1] requiring significant reconfiguration of staff and health services to meet the demands for care.

On 13th January 2021, National Health Service England (NHSE) published a document which provided a standard operating procedure for a 'COVID Virtual Ward' (CVW), with an aim of enabling the safe discharge of patients with COVID-19 from the hospital setting to the community early upon presentation to hospital, with daily contact and safety netting. NHSE recommended that all areas should pursue the roll out of a COVID virtual ward model to reduce pressures on acute hospital services, and that the CVW should be delivered by the acute hospital.[2]

The recommended CVW model was as follows[2]: Subject to completion of a satisfactory exercise test, patients with oxygen saturations of 95-100% and low NEWS2 (< 3) and improving clinical trajectories could be discharged to a COVID virtual ward where clinically appropriate. Patients with saturations of 93-94% with improving clinical trajectories (symptoms, signs, blood results, chest x-rays), could also be considered for the COVID virtual ward where clinically appropriate. Patients with oxygen saturations of 92% or lower or experiencing moderate/severe shortness of breath would generally be unsuitable for early supported discharge, unless the patient was stable, and this represented their usual baseline oxygen saturation.

In the CVW model, patients are discharged home with an oximeter and asked to take three readings each day and to call a staffed hospital number immediately if they note a reading of less than 92%, or they should attend their nearest emergency department within an hour or call 999. The patient would be proactively contacted by phone every day (seven days a week, as they would be for a hospital-based ward round). At 14 days (or before if deemed clinically appropriate) patients would either be discharged from the CVW or receive a further clinical assessment if symptomatic. A friend or family member, or an NHS Volunteer Responder, would then return the oximeter for decontamination and reuse.

To deliver this model, the CVW telephone line requires staffing for at least 12 hours a day (8am–8pm) seven days a week with locally arranged provision of out of hours cover. These staff should be supervised by an experienced, clinically registered professional who is also responsible for making the proactive daily calls, i.e., virtual ward round. The CVW should have a named medical consultant or senior trainee (ST3+ doctor), usually an acute or respiratory physician.

This model, or similar, have been applied in several care settings. In June 2020, an article reported that of 200 patients managed on a CVW in a UK secondary care hospital, 13% of all cases re-presented to hospital, and 10% of all cases were readmitted.[3] In November 2020, a retrospective study of 273 COVID-19 was published assessing a similar system, but with 5 days of virtual follow up rather than the 14 days described by NHSE, and an

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option for discharge without enrolment to the CVW for those at lowest risk.[4] The authors describe an 11% readmission rate and one death. A multi-site mixed methods study assessing clinical sites which had implemented a similar service suggested the cost of implementing such a service was approximately £400 to £553 per patient.[5]

These studies support the safety of the CVW system. However, there are implied assumptions; first that all patients would otherwise be admitted to hospital and second, that the provision of the CVW impacts positively on re-presentations (either reducing unnecessary readmissions or identifying where re-assessment is needed). Also, there are no descriptions of the patients who did not meet the CVW criteria, to understand the volume of patients who still required in-patient care. Implementation of such a system as the CVW has an opportunity cost, as staff must be redeployed from other clinical areas and the reliance on acute or respiratory physicians to deliver the CVW may re-direct care from high intensity clinical environments during pandemic waves. Traditionally these care pathways would be assessed in randomised control trials with health economic reviews. In the absence of such trials, understanding both the "natural history" of those discharged who meet the CVW criteria and the care burden which remains in the hospital is important to place the staffing needs of the CVW in context.

Birmingham is one of the most ethnically diverse cities in the UK with a high burden of COVID-19 cases and COVID-19 associated mortality in all the UK COVID-19 waves.[6,7]

The study was conducted to understand the potential impact of a CVW by studying retrospective, routinely collected health data. The study hypothesis was that introducing a CVW system was would a significant burden to staff workload, without improving hard outcomes such as death and readmission.

The study objectives were:

- To retrospectively assess the proportion of patients who would have met criteria for a potential virtual ward
- To evaluate outcomes in patients with COVID-19 who were discharged within 24 hours of admission without the support of a CVW
- To assess the proportion of admitted patients meeting potential CVW criteria who required hospital level intervention, and their outcomes
- To estimate the additional time required to deliver a CVW service for patients who would have met criteria for management through CVW

Retrospectively, patients were labelled as either meeting or not meeting the criteria for inclusion in a putative CVW, based on reported NHSE criteria. Their outcomes and clinical pathways were assessed, assessing those who would have met the criteria for a CVW, were one in operation, and the potential time and staffing levels needed to deliver such a system, in a hospital trust with a high burden of COVID-19 presentations.

Methods

This data study was supported by PIONEER, a Health Data Research Hub in Acute Care. All study activities complied with the ethical approvals provided by the East Midlands – Derby REC (reference: 20/EM/0158).

University Hospitals Birmingham NHS Foundation Trust (UHB), UK is one of the largest Trusts nationally, covering 4 NHS hospital sites, treating over 2.2 million patients per year and housing the largest single intensive care unit (ICU) in Europe. UHB saw the highest number of COVID admissions in the UK (>10,000 confirmed cases by March 2021) and the highest number of patients ventilated, with an expanded ICU capacity of >200 beds.

Study population

Health data from all adults with a confirmed positive severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) swab result between 1st June 2020 and 31st January 2021 who attended UHB at the time of or up to two weeks following a positive SARS-CoV-2 swab test were included. COVID cases were confirmed following a nasopharyngeal and oropharyngeal swab in all cases,[8] processed in accordance with NHS guidance within UHB NHS laboratories (9).

UHB has built and runs its own electronic health record (EHR) and developed a structured electronic clerking proforma where all patients with suspected COVID-19 could be identified on admission. For all patients, the results of the first positive swab were included but patient records were checked for subsequent positive swab results if associated with a subsequent admission. Mortality and patient admission status (discharged and alive, continued admission and alive) were assessed 28 days after the first positive swab result.

Data collection and variable definitions

Patient demographics and clinical data were collected from the UHB EHR. Clinician confirmed co-morbidities were available from the EHR, the summary primary care record (Your Care Connected) and diagnostic codes derived from previous hospital episodes, including NHS Digital

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SNOMED CT coding,[10] mapped to historically entered ICD-10 codes.[11]

English Indices of Deprivation scores were calculated using postcodes.[12] Ethnicity was self-reported by the patient or their family members on admission, grouped as per national guidelines.[13]

All adult patients with a positive COVID-19 swab admitted during the time period were included with no exceptions. Patients with or suspected with COVID-19 have a structured assessment at UHB as part of usual care. This includes serial physiology and NEWS2 recordings, a rapid walk test (which consists of patients taking 40 steps around their assessment area (of any step length) with oxygen saturations measured both before and after the 40 steps) and a Chest radiograph. Usual care in UHB does not include a CVW, but instead patients are either admitted for assessment and treatment in designated COVID wards or discharged with safety netting advice to contact health services if needed. Patients are not invited for post-COVID follow-up unless they are referred by their GP or referred by their hospital physician for complications of COVID. Patients are not routinely provided with pulse oximeters.

The current study was observational only. Results of the 40 steps walk test, physiological assessments, chest radiograph reports and acuity scores were used to retrospectively determine whether a patient could have been suitable for a COVID virtual ward. Clinical trajectories were considered using the same parameters over the first 24 hours of admission. For the purposes of this study, patients with either oxygen saturations of 95-100% and low NEWS2 (<3) or with saturations of 93-94% with improving clinical trajectories over the first 24 hours of admission were considered suitable for a potential COVID virtual ward, if they did not desaturate after completing a 40 step walk test below levels described above. Trajectories had to include oxygen saturations improving to >94% on room air without deterioration in NEWS2 scores to meet the CVW criteria, except where oxygen saturations of 92% or lower were compatible with baseline levels as demonstrated through previous monitoring. Decisions as to whether a patient would have met the criteria for a CVW were made against objective parameters by one clinically qualified person and ratified by another (both acute medicine trained), with blinding to all patient outcomes.

In all admitted cases, clinical note reviews were undertaken to assess whether any assessments or treatments were delivered which would preclude discharge and could not be given at home – these included intravenous therapies, supplemental oxygen or other respiratory support, initiation of treatment dose anti-coagulation subcutaneously or requirement for increased social care.

Outcomes

Primary outcome was re-presentation to QEHB (via the Emergency Department or Acute Medical Unit) for any cause, or death within 28 days of discharge, as per national reporting.[14] For those patients discharged from hospital, primary care records were reviewed and any patients who had died in the community within the censor period were noted. Those with an on-going admission were censored 28 days after a positive swab result.

Statistics

Statistical analysis was performed using STATA (SE) version 15 (StataCorp LLC, Texas, USA). Baseline characteristics for the total population are presented as mean (standard deviation) or median (interquartile range) for continuous variables and as frequency (percentage) for categorical variables. Continuous variables were compared between datasets using Mann-Whitney U tests. Categorical variables were compared using Fisher's exact and Chi-Square tests. Results were considered significant if the p-value was <0.05. There was no adjustment for multiple comparisons, but exact p values are given.

Results

In total, 2301 swab confirmed cases of COVD-19 were assessed in the 245day time period. Of note, 23,803 patients who were COVID negative were assessed in the same period, of which 2827 (11.9%) were discharged and 20740 (87.1%) admitted. Figure 1 shows overall patient numbers across categories.

Patient demographics

Overall demographics of all patients presenting with COVID-19 during the time period criteria are given in table 1, divided by whether they would have met the criteria for a CVW. Table 2 compares the demographics of patients who retrospectively met potential CVW criteria, comparing those discharged within 24 hours of presentation and those admitted for ≥24 hours. In general, patients admitted for ≥24 hours were more likely to be older, with 14.5% of patients aged >65 years in the discharged group, compared to 44.8% in the admitted group. Those admitted were more likely to have significant comorbidities, including dementia, stroke, active malignancies, and heart disease.

Outcomes for those discharged from hospital after initial review

Outcomes at 28 days for the 325 swab positive patients who would have met the COVID virtual ward criteria and were discharged within 24 hours were assessed. 281 patients (86.4%) were not readmitted and were still alive at 28 days post initial

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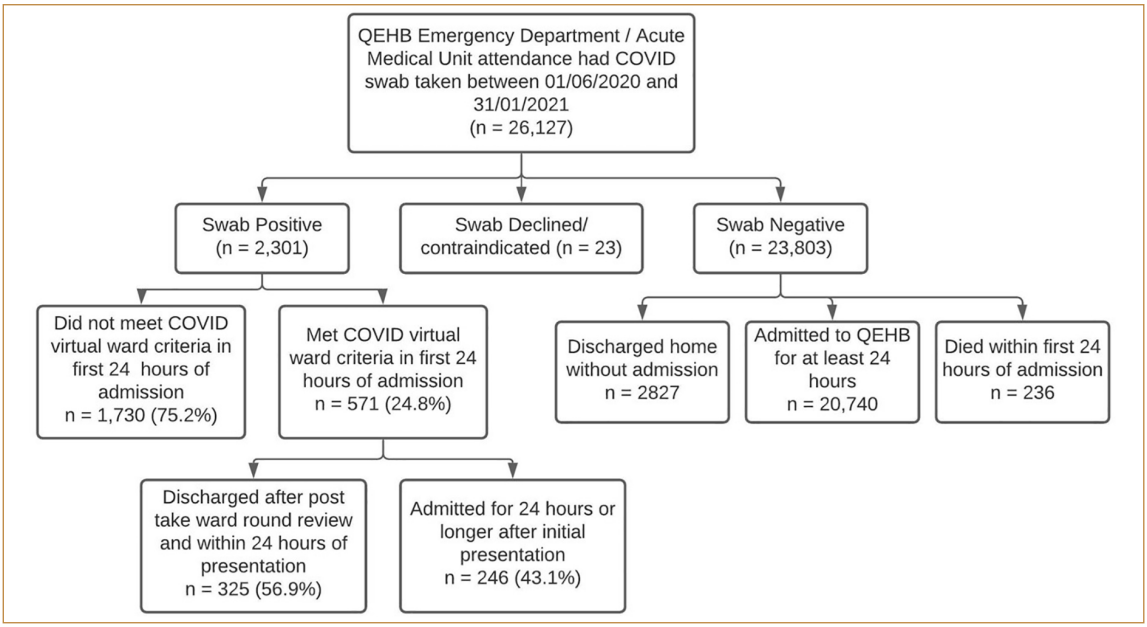

Figure 1. Modified consort diagram of patients presenting to the Emergency Department or Acute Medical Unit at Queen Elizabeth Hospital Birmingham

Legend. Presentations were all presentations for the time period stated. Only those with a confirmed positive PCR SARS-CoV-2 Swab were included in pathway mapping. Those with no swab results (23 individuals where swabs were declined or contraindicated due to facial injury) were not included in the pathway analysis. Patients were labelled as those retrospectively meeting potential COVID Virtual Ward criteria or those who did not meet these criteria, and their "usual care" outcomes followed for 28 days. QEHB: Queen Elizabeth Hospital Birmingham

presentation. 44 patients (13.5%) re-presented within 28 days, 30 due to COVID-related symptoms (68.2% of re-presentations or 9.2% of those meeting CVW criteria) and 14 with a diverse list of conditions (Table 3). The median length of time at home prior to re-presentation was 2.5 days (IQR 1.5 – 5 days).

Nine (20.5%) of the 44 patients were discharged within 24 hours of this second presentation. Of the COVID-associated re-presentations, the overall median length of stay in hospital was 4 days (IQR 1 – 7.5 days). Of the 44 re-presenting patients, 5 (11.4%) were transferred to ITU. One (2.3%) patient died within 28 days.

Outcomes for those who were admitted to hospital after initial review

Treatment pathways and outcomes for the 246 swab positive patients who met the potential COVID virtual ward and were admitted to hospital for ≥24 hours were assessed. 191 patients (77.6%) received an intravenous infusion including fluids or antibiotics, and 94 patients (38.2%) required oxygen therapy after the first 24 hours of admission. 14 patients (5.7%) received therapeutic dose anticoagulation. 47 (19.1%) patients did not require intravenous treatment, supplemental oxygen, or a community care assessment in hospital.

For these 246 patients, the median length of hospital stay was 4 days (IQR 2 – 9 days). 9 patients (3.7%) were transferred to intensive care. 26 patients (10.6%) died within 28 days of presentation. Of those 26 who died, 18 died during the inpatient stay.

Of those who survived to discharge, 215 (87.4%) patients were discharged to their own home (204 patients) or to their usual care home (11patients). 12 (4.8%) were discharged to a community hospital.

For the 47 patients who did not require intravenous therapies, oxygen or community care review, the median length of stay was 34 hours (IQR 28 – 40 hours). None of these patients were readmitted during the follow-up period. They were younger (median age 47 years (35-59), p=0.002) but with co-morbidities. A notes review revealed that these patients were not reviewed by an Acute Medicine or Respiratory consultant within the first 24 hours of their admission.

Comparing reported outcomes

Outcomes for patients discharged from hospital within the current study were compared to previous studies assessing CVW services (Table 4). No difference was demonstrated in the proportion of patients re-presenting to hospital, or the proportion who re-presented who required ITU care or who died.

Time required for service provision

If modelling virtual care requirements of the 325 patients sent home within 24 hours, assuming 14 days

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Table 1. Demographics of all swab positive patients, comparing patients who would or would not have met potential COVID virtual ward criteria
Legend: Data is number (percentage) unless otherwise stated. Ethnicity was self-reported (see Methods). English Indices of deprivation (IMD) were calculated using postcode. Diabetes includes type 1 and type 2 diabetes. COPD= Chronic Obstructive Pulmonary Disease. Patients could (and often did) have more than one co-morbid condition*

		Would have met the COVID virtual ward criteria	Would not have met COVID virtual ward criteria	p-value
	Overall Count	571 (24.8%)	1730 (75.2%)	
Sex	Female	309 (54.1%)	803 (46.4%)	p = 0.001
	Male	262 (45.9%)	926 (53.5%)	
Age	Median (IQR)	51 (37-68)	62 (50-78)	
	50 and under	285 (49.9%)	445 (25.7%)	p<0.001
	51-65	129 (22.6%)	525 (30.3%)	
	66-75	52 (9.1%)	267 (15.4%)	
	76-85	54 (9.5%)	280 (16.2%)	
	Over 85	51 (8.9%)	213 (12.3%)	
Ethnicity	White	238 (41.7%)	823 (47.6%)	p = 0.124
	Black	30 (5.3%)	79 (4.6%)	
	South Asian	141 (24.7%)	425 (24.6%)	
	Mixed	14 (2.5%)	34 (2%)	
	Chinese	3 (0.5%)	9 (0.5%)	
	Any Other Ethnic Group	18 (3.2%)	61 (3.5%)	
	Unknown or declined to self-report	127 (22.2%)	299 (17.3%)	
IMD Quintile	1 (Most Deprived)	308 (53.9%)	943 (54.5%)	p = 0.765
	2	127 (22.2%)	351 (20.3%)	
	3	79 (13.8%)	266 (15.4%)	
	4	40 (7%)	108 (6.2%)	
	5 (Least Deprived)	16 (2.8%)	60 (3.5%)	
	Unknown	1 (0.2%)	2 (0.1%)	
Co-morbidities*	Chronic Kidney Disease	69 (12.1%)	259 (15%)	p = 0.087
	Dementia	38 (6.7%)	170 (9.8%)	p = 0.022
	Interstitial Lung Disease	5 (0.9%)	29 (1.7%)	p = 0.169
	Stroke or cerebrovascular	65 (11.4%)	243 (14%)	p = 0.105
	Ischaemic heart disease	108 (18.9%)	364 (21%)	p = 0.275
	Asthma	101 (17.7%)	343 (19.8%)	p = 0.262
	Hypertension	205 (35.9%)	903 (52.2%)	p < 0.001
	Diabetes	132 (23.1%)	586 (33.9%)	p < 0.001
	Any active malignancy	91 (15.9%)	334 (19.3%)	p = 0.072
	COPD	28 (4.9%)	224 (12.9%)	p < 0.001
	Atrial fibrillation	63 (11%)	236 (13.6%)	p = 0.108
BMI	Underweight	13 (2.3%)	40 (2.3%)	p = 0.003
	Normal weight	93 (16.3%)	338 (19.5%)	
	Overweight	91 (15.9%)	463 (26.8%)	
	Obese	78 (13.7%)	508 (29.4%)	
	Morbid obesity Unknown	21 (3.7%) 275 (48.2%)	136 (7.9%) 245 (14.2%)	

of follow-up (as per NHSE guidance) and a steady admission rate during the assessed time period, 4550 telephone calls would be required in the 245 days of the study period plus 14 days to allow for follow-up (259 days), an average of 18 calls per day. If each telephone contact required 25 minutes (5 minutes preparation/5 minutes note making and 15 minutes conversation with the patient), the daily workload

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Table 2. Comparison of demographics between swab positive patients who would have met the potential COVID virtual ward criteria who were either discharged within 24 hours of attendance or admitted to hospital for > 24 hours
Legend: Data is number (percentage) unless otherwise stated. Ethnicity was self-reported (see Methods). English Indices of deprivation (IMD) were calculated using postcode. Diabetes includes type 1 and type 2 diabetes. COPD= Chronic Obstructive Pulmonary Disease. Patients could (and often did) have more than one co-morbid condition

		Discharged within 24 hours	Admitted for > 24 hours	p-value
	Overall Count	325 (56.9%)	246 (43.1%)	
Sex	Female	185 (56.9%)	124 (50.4%)	p = 0.122
	Male	140 (43.1%)	122 (49.6%)	
Age	Median (IQR)	45 (34-57)	63 (44-80)	
	50 and under	202 (62.2%)	83 (33.7%)	p < 0.001
	51-65	76 (23.4%)	53 (21.5%)	
	66-75	25 (7.7%)	27 (11%)	
	76-85	12 (3.7%)	42 (17.1%)	
	Over 85	10 (3.1%)	41 (16.7%)	
Ethnicity	White	114 (35.1%)	124 (50.4%)	p = 0.010
	Black	16 (4.9%)	14 (5.7%)	
	South Asian	90 (27.7%)	51 (20.7%)	
	Mixed	10 (3.1%)	4 (1.6%)	
	Chinese	1 (0.3%)	2 (0.8%)	
	Any Other Ethnic Group	13 (4%)	5 (2%)	
	Unknown	81 (24.9%)	46 (18.7%)	
IMD Quintile	1 (Most Deprived)	175 (53.8%)	133 (54.1%)	p = 0.012
	2	76 (23.4%)	51 (20.7%)	
	3	48 (14.8%)	31 (12.6%)	
	4	23 (7.1%)	17 (6.9%)	
	5 (Least Deprived)	2 (0.6%)	14 (5.7%)	
	Unknown	1 (0.3%)	0 (0%)	
Co-morbidities*	Chronic Kidney Disease	14 (4.3%)	55 (22.4%)	p < 0.001
	Dementia	6 (1.8%)	32 (13%)	p < 0.001
	Interstitial Lung Disease	2 (0.6%)	3 (1.2%)	p = 0.443
	Stroke or cerebrovascular	9 (2.8%)	56 (22.8%)	p < 0.001
	Ischaemic heart disease	32 (9.8%)	76 (30.9%)	p < 0.001
	Asthma	50 (15.4%)	51 (20.7%)	p = 0.097
	Hypertension	66 (20.3%)	139 (56.5%)	p < 0.001
	Diabetes	41 (12.6%)	91 (37%)	p < 0.001
	Any active malignancy	20 (6.2%)	71 (28.9%)	p < 0.001
	COPD	13 (4%)	15 (6.1%)	p = 0.250
	Atrial fibrillation	15 (4.6%)	48 (19.5%)	p < 0.001
BMI	Underweight	2 (0.6%)	11 (4.5%)	p = 0.436
	Normal weight	19 (5.8%)	74 (30.1%)	
	Overweight	22 (6.8%)	69 (28%)	
	Obese	21 (6.5%)	57 (23.2%)	
	Morbid obesity Unknown	8 (2.5%) 253 (77.8%)	13 (5.3%) 22 (8.9%)	

would be 450 minutes/7.5 hours each day (without break), or 52.5 hours per week, for every week of the study period. While it is unlikely that all patients who met the CVW criteria within the first 24 hours of presentation would have been deemed medically fit for discharge to the virtual ward, the same modelling for the 571 cohort who met the CVW criteria would require 7994 telephone calls over the study period plus

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Table 3. Reasons for COVID-positive patients re-presenting to hospital within 28 days after initial discharge.
Legend: Data was collected via routine clinical coding, but individual notes were checked to confirm medical reason for re-presentation by a consultant physician

Readmission diagnosis	Number	Percentage of readmissions
COVID- associated re-presentation	30	68.20%
Poisoning	3	6.82%
Musculoskeletal / limb pain	3	6.82%
Fractured bone	2	4.55%
Congestive heart failure	1	2.30%
Epilepsy, unspecified	1	2.30%
Headache	1	2.30%
Pilonidal cyst with abscess	1	2.30%
Pulmonary embolism	1	2.30%
Syncope and collapse	1	2.30%
Total	44	

follow-up period of 14 days, which equates to 31 calls per day, taking 775 minutes or 13 hours per day. This excludes the provision of a manned telephone service that patients could call if concerned. This would require at least 2 or 3 staff members each day, as well as senior medical oversight and out of hours cover.

Discussion

This retrospective analysis of health data for patients admitted to hospital with a positive COVID-19 swab result found that 24.8% of patients would have met criteria for management via a Covid Virtual Ward. Of these patients, 56.9% were discharged from hospital without the provision of a CVW and received usual care. In this cohort, only 13% re-presented to hospital and 10% were readmitted. The outcomes from the current study are similar to reported outcomes from CVWs, but in the current study, these outcomes were achieved without the additional and considerable time and staffing commitment required to deliver a CVW service during the peak of a wave.

Of the 246 patients who would have met criteria for management via a CVW and were admitted to hospital, 80.9% required other management necessitating hospital admission such as intravenous treatment, and these patients were older and had significant co-morbidities, which are known to significantly contribute to the need for admission in patients affected by COVID-19.[15] Those who were admitted to hospital for >24 hours were more likely to have chronic kidney disease, ischaemic heart disease, diabetes and active malignancy and COVID-19 outcomes are poorer in patients with these conditions.[18,19]

The NHSE CVW was developed to facilitate the care of COVID-19 patients who had presented to hospital, but who could be cared for at home. Thrice daily oxygenation saturations and daily contact by trained hospital staff were provided for appropriate safety netting. The hope for the service was that it would free hospital beds, enable staff to focus on the most unwell patients with COVID-19, while providing a safe clinical service for patients.

To date, the CVW has not been evaluated in a gold standard, robust randomised clinical trial. Instead, CVWs have been reported in a series of observational studies and summarised in a recent systematic review.[16] These studies present some evidence of the safety of the CVW service but have not described the burden of COVID where criteria were not met, nor described the natural history of

Table 4. Comparing outcomes in patients managed without CVW at Queen Elizabeth Hospital Birmingham to outcomes from published evaluations of CVW services
Legend. UHB numbers are those who retrospectively met the criteria for potential management through CVW and were discharged without CVW service, compared to those who were discharged to a CVW in Thornton and Nunan studies. Re-presentation is defined as reattendance at the Emergency Department or acute medical unit. Figures are compared using Fisher's Exact tests. * = comparing reported Nunan at el(4) and UHB re-presentation rates.**= comparing reported Thornton(3) and UHB reported re-presentation rates.

	Total number	Re-presented to hospital n (%)	Did not re-present n (%)	p-value	Admitted to ITU n (%)	p value	Died n (%)	p value
UHB	325	44 (13.5%)	281(86.5%)		5 (1.5%)		1 (0.3%)	
Nunan et al[4]	273	31 (11.4%)	242 (88.6%)	p=0.458*	2 (0.7%)	p=0.693	1 (0.4%)	p=0.999
Thornton[3]	200	26 (13.0%)	174 (87.0%)	p=0.895**	Not reported			

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discharged patients without this service, to enable a comparison of opportunity costs as well as gains.

This study presents retrospectively analysed, routinely collected health data for all patients admitted to QEHB with a positive COVID-19 swab result. Patients were assessed as to whether they would have met the criteria for the CVW parameters as presented by NHSE[2] either on initial presentation or during the first 24 hours, using time-stamped data available in the clinical record.

Of note, 75.2% (1730) of patients presenting to hospital during this period did not meet the CVW criteria, suggesting that during a wave of COVID-19, the CVW would only be suitable for a quarter of patients. In the 24.8% (571) who did meet the CVW criteria, 325 (56.9%) patients were discharged despite the lack of a CVW facility and with no planned follow-up, and of those discharged, 13% re-presented and 10% were admitted. Patient outcomes for those discharged within 24 hours in this study were compared to those discharged with CVW support in published evaluations of CVW services, to determine whether any difference in outcome was seen in this cohort discharged without CVW support. No difference in outcome was demonstrated, suggesting that in this cohort, and the lack of a CVW made no difference to hard outcomes, such as death, re-admission, or admission to ITU(4). In this study, the single patient death following re-presentation and re-admission was due malignancy. It was reported as a COVID-19 related death, in line with national reporting criteria for deaths occurring within 28 days of a positive swab result.[17] Of note, 20.5% of patient reviewed in ED and AMU who did not have COVID were readmitted for assessment in the same period of time (8041/39269 patients).

This study does not include a health economic analysis of service provision, nor have specific costs been suggested, as staffing models for CVW have varied across centres. However, we report the substantial staffing required to operate a CVW during COVID-19 waves, and this would be required for 7-day work patterns, as the CVW requires telephone calls to be made daily, irrespective of weekday or weekends. It is unclear whether there is the capacity to redeploy these skilled staff members from caring for the 75% of patients who did not meet CVW criteria to the 25% who did, especially if this does not confer improvements in hard outcomes such as mortality, ITU provision or re-presentation and admission. Previous studies have reported patient satisfaction with the CVW, reducing the potential anxiety of being discharged.[4] The current study does not assess this important factor.

Of note, a number of studies have reported remote monitoring for COVID-19 patients either initially in the community for positive patients as part of a triage system with lower presentations to hospital,[5] such as 4%,[18] which probably reflects the screening of milder cases, less likely to present to hospital in the current study. However, where focusing on a secondary care delivered CVW, a re-presentation rate of approximately 13% has been reported.[19]

This study has limitations. First, this study only labelled patients as being suitable for CVW or not, and then followed their usual care outcomes, it did not actually deploy a CVW model, and therefore results should be interpreted with this in mind. Second, by comparing outcomes across studies, there is an assumption that patient populations including demography, burden of disease and impact of COVID-19, are similar across published studies. Most studies to date have not presented in depth demography and therefore these direct comparisons should be reviewed with caution. Third, in the current paper, the objective criteria for the CVW were applied using the granular electronic health record at QEHB without the benefit of seeing the patient or considering the time of the initial presentation, and all these factors are important when making the decision to admit or discharge. Fourth, it is possible that more of the patients who met the CVW criteria might have been discharged were the CVW in place. Fifth, when assessing staffing needs it has been assumed that all patients will require follow up for 14 days, as described in the NHSE SOP. It is highly likely that some would require much less follow up prior to discharge. Sixth, this is not a formal health economic review, which would form part of the evaluation of any new service. Although we have included an estimate of the additional time that would be required to staff a CVW service based on the number of patients meeting CVW criteria in this analysis, there is no clear guidance for the staffing levels that would be needed to deliver a CVW service 7 days a week safely and effectively, and this may well vary from centre to centre, dependent on other factors including local population demographics. To fully assess the cost of a CVW service would require a full health economic analysis, which is beyond the scope of the current analysis.

The study has significant strengths. Decisions as to whether the patient met the CVW criteria were made independently by two senior clinical researchers, without knowledge of outcomes, thus reducing bias. All patients were included in the study, reducing the population bias which can hinder consented studies. As data includes all medications and electronic noting, reasons for continued admission could be assessed.

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In summary, this study reports similar percentage re-presentations, admissions, escalations to ITU and deaths in patients who were discharged without a CVW compared to studies where a CVW was implemented. The study also highlights that only 25% of COVID-19 admissions were suitable for the CVW based on objective criteria, and the potential intensity of work created by implementing a CVW. The study begins to explore the potential opportunity costs of the CVW system, but does not consider patient factors, such as the reassurance potentially given by discharge to a CVW setting.

Any new care pathways or initiatives have opportunity gains and costs, and in usual times, processes are often assessed using rigorous randomised control trials which often include quantitative, qualitative and health economic analyses. While the CVW was established to enhance patient safety and reduce unneeded hospitalisation, it is important to assess whether the service achieves this compares to usual care. More research is needed before this service is fully implemented.

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Conflicts of Interest

C.A, V.R-K, F.E, XZ have nothing to declare. D.P reports grant funding from NIHR. S.G and S.B report grant funding from HDR-UK. E.S reports grant funding from HDR-UK, Wellcome Trust, MRC, BLF, NIHR, EPSRC and Alpha 1 Foundation.

Author contributions

C.A, V.R-K, D.P assisted with clinical data insights, F.E, X.Z and S.G analysed the data. S.G, S.B and E.S designed the study and wrote the manuscript. All authors approved the final manuscript.

Data Access

Data from this study is available from PIONEER, the Health Data Hub in Acute care, in accordance with Hub processes. Contact PIONEER@uhb.nhs.uk for more details.

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