Triage Into the Community for COVID-19 (TICC-19) Patients Pathway - Service evaluation of the virtual monitoring of patients with COVID pneumonia

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Abstract

Introduction: COVID-19 pneumonia presented a unique problem for healthcare systems with the potential to overwhelm hospitals and lead to unnecessary morbidity and mortality. Safe triage and follow up systems are required to manage this unprecedented demand.

Methods: We designed a pathway for the triage and assessment of patients based on their resting oxygen saturations and response to a 30 metre rapid walking test. We admitted patients to a 'Virtual Ward' for remote oximetry monitoring from the Emergency Department, step down from inpatient wards and from the local Primary Care 'Hot Hub'. This allowed the safe and managed readmission of those patients who deteriorated at home.

Results: During the first wave of COVID-19 we entered 273 onto the pathway for Virtual Ward follow up. Of these, 31 patients were readmitted to hospital, two were admitted to Intensive Care and one patient died. Median oxygen saturation at presentation was 97 % (IQR 96-98%) and following a 30 metre walk test 96% (IQR 94-97%). Median NEWS-2 score was 2 (IQR 1-3). On feedback 99.5% of patients were likely or extremely likely to recommend the service to their family and friends. There was a cost avoidance of £107,600 per month.

Conclusion: It is safe, feasible and cost effective to set up a triage system with remote oximetry monitoring for patients with COVID-19 and overwhelmingly patients find it a positive experience.

Keywords

COVID; Virtual Wards; Triage; TICC-19; Lung Ultrasound; POCUS.

Key Messages

- Triage pathways and safe patient follow up is needed for surges in COVID-19
- As silent hypoxia is a common cause of deterioration, NEWS2 may not be the best trigger tool
- Follow up in a virtual ward with remote pulse oximetry is feasible
- Follow up in a virtual ward also appears to be safe and in line with NHS guidelines

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Introduction

Following the description of a novel coronavirus – SARS–CoV–2 in Wuhan province in China in December of 2019[1] and the clinical syndrome it causes (COVID-19), healthcare systems struggled to keep up with the surge of admissions of patients with respiratory failure. This first became apparent in Northern Italy in late February 2020 but quickly spread to involve other countries in Europe and around the world. As this condition is mainly one of hypoxic respiratory failure[2] often with little respiratory distress it is unclear whether the National Early Warning Score (NEWS–2) score would tend to overcall the need for admission. We therefore developed a pathway for the triage and follow up of patients with milder forms of COVID-19 pneumonia and here present the feasibility of setting up such a service and the results from the first wave of patients.

Methods

Through an international lung ultrasound online group we received a copy of a triage pathway being used in Brescia in Italy.[3] Two NHS midwives who are fluent in Italian translated the document for us and we further adapted it after circulating it for comments amongst the Emergency Department Consultants and the Acute Medicine Consultants at the Royal Berkshire Hospital. Following Clinical Governance approval the pathway was rolled out for use on the 4th April 2020.

ED Triage Pathway

Patients who attended our Emergency Department (ED) with symptoms that were consistent with COVID-19 were assessed using the algorithm in the pathway (see Figure 1). Triage was into three separate groups. Those with oxygen saturations of less than 90% on room air (or less than 86% in patients with

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# Triage Flowchart for Covid-19 Positives/ Suspected

Dry Cough?
Shortness of breath?
Fever >37.9C?
Pneumonia suspected or already diagnosed (imaging positive)?
or other clinical suspicion of Covid-19

* FLOW CHART IS A GUIDELINE ONLY *

Aims:

1. Identify suspected Covid-19 patients who do not require hospital admission.

2. Start intensive therapy pathways for those with respiratory insufficiency.
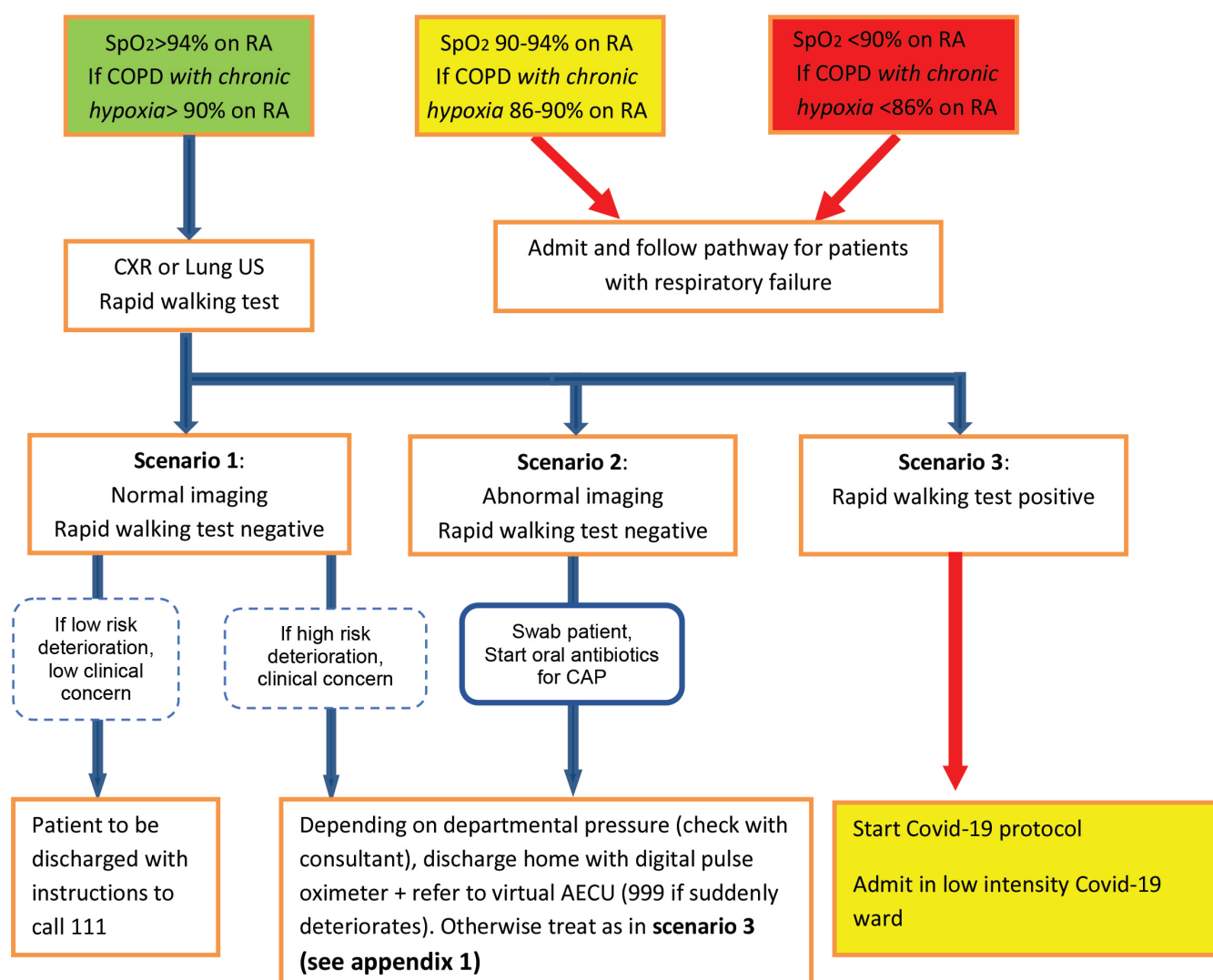
Figure 1. Flow chart of patients presenting to the Emergency Department with suspected or confirmed COVID-19. Those with oxygen saturations over 94% are further assessed with a 30 metre walk test and imaging.

known COPD and chronic hypoxia) were triaged as 'red' and placed on supplemental oxygen with early consideration of CPAP; those with saturations of 90 to 94% on room air (or 86 to 90% with known COPD and chronic hypoxia) were triaged as 'yellow' and were admitted for supplemental oxygen and monitoring; those with saturations of >94% on room air (or >90% with known COPD and chronic hypoxia) were triaged as 'green' and then further assessed within the algorithm.

Patients triaged into the green pathway would need either a CXR, lung ultrasound or CT scan to confirm a diagnosis of COVID pneumonia rather than just COVID infection.[4] They would then undergo a 30 metre rapid walking test, which had been measured out within the ED. A 30 metre rapid walk test was considered to be positive if the patients saturations dropped by more than 5%.

Following these two assessments, there were three possible scenarios:

Scenario 1. Patient had normal chest imaging, and a 'negative' rapid walking test (ie <= to 5% drop in saturations on 30 metre rapid walking test). These patients were deemed unlikely to have COVID pneumonia and therefore discharged home with safeguarding advice.

Scenario 2. Patient had abnormal chest imaging and a 'negative' 30 metre walk test. These patients were deemed likely to have COVID pneumonia and were discharged to the virtual ward for monitoring and virtual follow up.

Scenario 3. Patient had abnormal chest imaging and a 'positive' 30 metre walk test. These patients were deemed very likely to have COVID pneumonia and crossed over to the yellow group for admission to hospital for monitoring +/– supplemental oxygen therapy.

To allow clinicians additional confidence, it was possible for patients from scenario 1 to be referred to the virtual follow up clinic where there were specific clinical concerns.

Patients who were deemed suitable for the virtual ward follow up were given an oxygen saturations probe (ChoiceMMed OxyWatch), a patient leaflet which included the contact details for the virtual ward, and an electronic referral was made.

Hospital Step Down Referral Pathway
Clinicians who wanted to discharge patients from wards in the hospital. Patients on the Acute Medical Unit were assessed using the same pathway as for the ED triage. For those patients discharged from medical wards, the clinician discharging the patient would decide what saturation ranges would be used to trigger readmission (see supplementary appendix).

Primary Care Referral Pathway
We set up a direct referral service from our Primary Care hot hub where GP practices throughout the CCG referred their patients with COVID–19 for assessment. Local GPs trained in the use of Lung
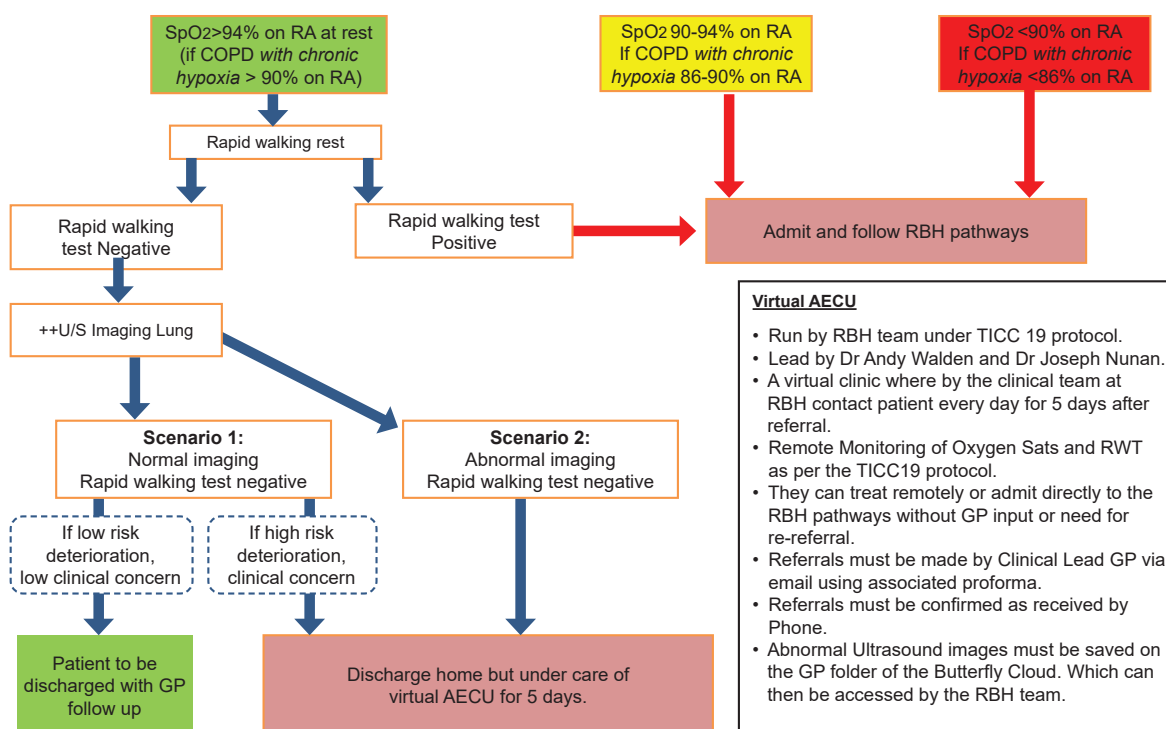
Figure 2. Flow chart for patients seen in the GP hot hub. The flow is similar to the pathway for ED patients however the saturation and exercise test were performed prior to lung imaging which was uniquely done with point of care ultrasound.

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Ultrasound to diagnose COVID used an adapted pathway to refer patients directly into the virtual ward with no need for admission to hospital (see Figure 2 and supplementary appendix).
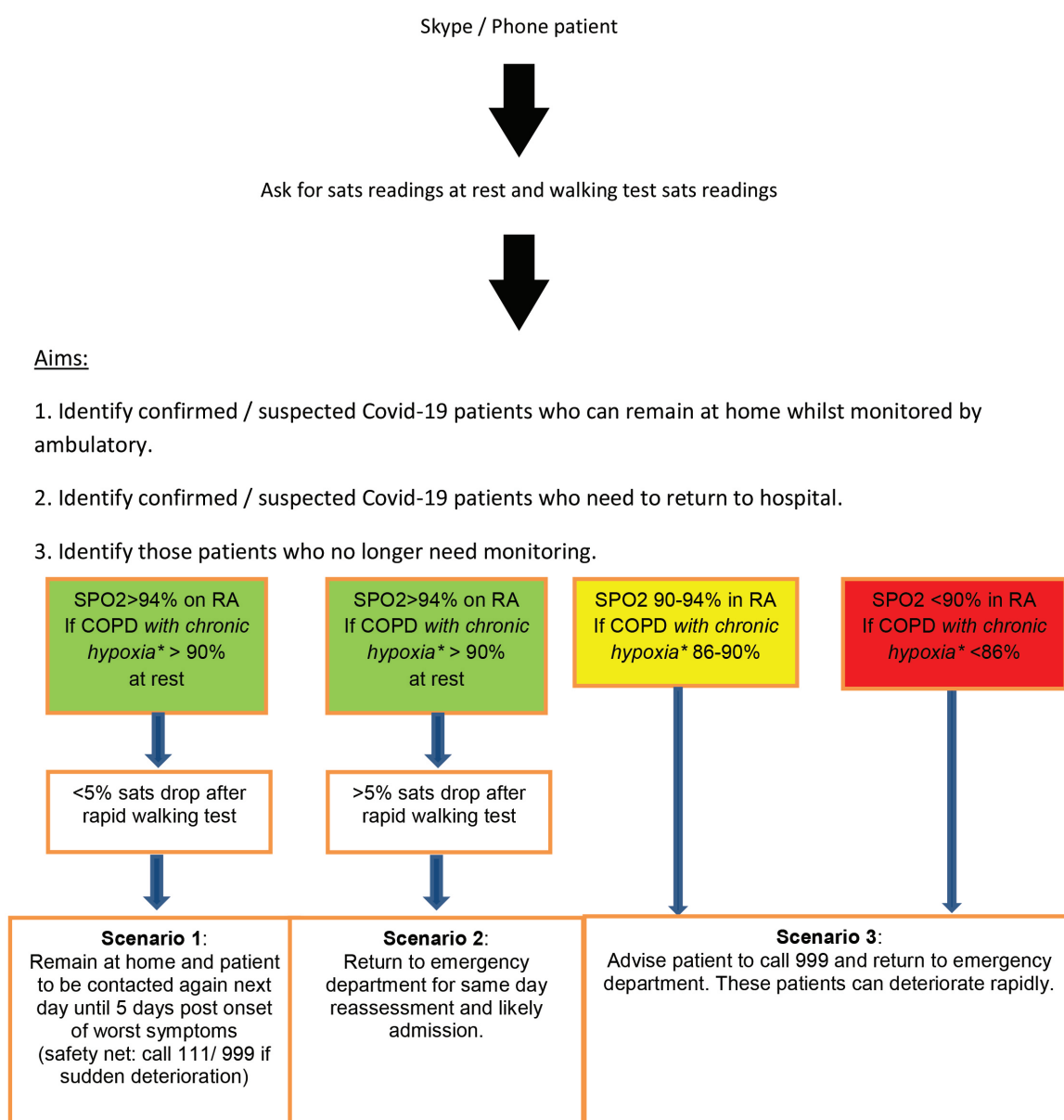
Virtual Ward

Those patients who were deemed appropriate for virtual ward follow up were given an oxygen saturation probe with a patient information leaflet and link to a website with video information of how to use the oxygen saturations monitor (see supplementary appendix and website https://ticc19.com/patients/).

Physician Associate students rang each patient in the virtual ward on a daily basis and went through a scripted set of questions about their symptoms

Ambulatory Pathway for Suspected / Confirmed COVID patients
FLOW CHART IS A GUIDELINE ONLY

Skype / Phone patient

Ask for sats readings at rest and walking test sats readings

Aims:

1. Identify confirmed / suspected Covid-19 patients who can remain at home whilst monitored by ambulatory.

2. Identify confirmed / suspected Covid-19 patients who need to return to hospital.

3. Identify those patients who no longer need monitoring.

| SPO2>94% on RA If COPD *with chronic hypoxia** > 90% at rest | SPO2>94% on RA If COPD *with chronic hypoxia** > 90% at rest | SPO2 90-94% in RA If COPD *with chronic hypoxia** 86-90% | SPO2 <90% in RA If COPD *with chronic hypoxia** <86% |

| <5% sats drop after rapid walking test | >5% sats drop after rapid walking test |

| **Scenario 1**: Remain at home and patient to be contacted again next day until 5 days post onset of worst symptoms (safety net: call 111/ 999 if sudden deterioration) | **Scenario 2**: Return to emergency department for same day reassessment and likely admission. | **Scenario 3**: Advise patient to call 999 and return to emergency department. These patients can deteriorate rapidly. |

Figure 3. Flow chart for patients being followed up in the COVID-19 virtual ambulatory clinic. Those patients whose baseline oxygen saturations are below 95% or whose saturations drop by more than 5% after the rapid walking test are readmitted to hospital for reassessment and oxygen therapy.

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(see supplementary appendix). They then got the patients to check oxygen saturations at rest and after a period of exertion by walking 30 metres. There were three possible scenarios (see Figure 3):

Scenario 1. Saturations >94% at rest (or >90% in a COPD patient with chronic hypoxia) with a <=5% drop following exertion. These patients were reassured and daily follow up was continued for five to seven days depending on symptoms.

Scenario 2. Saturations >94% at rest (or >90% in a COPD patient with chronic hypoxia) with a >5%

drop following exertion. These patients would be told to make their way back up to the ED for further assessment.

Scenario 3. Saturations <=94% at rest (or <=90% in a COPD patient with chronic hypoxia). For these patients, the Physician Associate students called Ambulance Control on a direct phone number and organized readmission to hospital via emergency ambulance to the Emergency Department.

The PA students were supported by three Emergency Department Associate Specialist doctors who had been furloughed. They provided advice where patients had other questions or where there was uncertainty about the clinical situation.

Patients continued to be followed up daily until they either had normal oxygen saturation measurements for a period of five days and felt their symptoms were improving, or they required readmission to hospital.

Patient Feedback

Following discharge from the Virtual Ward, patients were contacted and asked two simple questions using a five point Likert scale. The questions were 1. Would you recommend us to your family and friends; and 2. On a scale of 1 to 5 how reassured and safe did you feel being called daily and having the pulse oximeter at home with you? 1 being completely reassured and 5 being not reassured at all.

Statistical Analysis

Patient characteristics, including demographics, oxygen saturation, NEWS score components, and lab tests, between the readmission and the non-readmission group were compared using univariate analysis. Lab test results were categorized into groups and regarded as categorical variables in statistical tests. Detailed rules for categorization are presented in supplementary Table 2. Independent samples t-test for continuous variables, and chi-squared test for categorical or binary variables were performed and the corresponding p-values were extracted. Missing values for each variable were omitted for the computation of p-value. All statistical analysis was performed with the software R (version 3.6.3).[5]

Ethical considerations

This was a service evaluation and therefore no formal process of ethical approval was required however the pathway went through a process of review and approval through clinical governance meetings of the Acute Medicine and Emergency Medicine departments. A data protection impact assessment was performed by the Royal Berkshire

Table 1. Demographic Data on 279 patients admitted to the TiCC19 pathway.
* Race/Ethnic group - Other includes those where data was unavailable and those who had not specified
** Imaging type - not everyone on the pathway had imaging. Patients put on for clinical concern and some of those who were stepping down from the ward would not have had positive imaging at the time of referral.

Characteristic	
Age - yrs	50∓15.3
Male - no. (%)	111 (40.7)
Race/Ethnic group - no (%)*	
Asian	19 (6.8)
Black	18 (6.5)
Other	66 (23.6)
White	177 (63.2)
Time from onset of symptoms - days (IQR)	8 (5-15)
Referral source - no (%)	
ED	165 (60.4)
GP hot hub	56 (20.5)
Ward step down	52 (19.1)
Imaging type - no (%)**	
CXR	148 (54.2)
Ultrasound	58 (21.25)
CT scan	3 (1.1)
NEWS 2 - no (%)	
<3	132 (62.0)
≥3	81 (38.0)
Saturations % (IQR)	
Resting	97 (96-98)
Post 30m walk	96 (94-97)
Readmission - no (%)	31 (11.4)

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Table 2. Univariate Analysis of Patient Characteristics against Readmission.			
Characteristics	**Non-readmitted**	**Readmitted**	**P-value**
n	242 (88.6%)	31 (11.4%)	
Age, mean (SD)	50.2 (15.1)	50.9 (16.8)	0.820
Female, n (%)	147 (60.7%)	15 (48.4%)	0.261
Ethnicity, n (%)			**0.102***
White	156 (64.5%)	16 (51.6%)	
Asian	20 (8.3%)	5 (16.1%)	
Black	17 (7.0%)	0 (0.0%)	
Other	46 (19.0%)	9 (29.0%)	
Sats at discharge, mean (SD)	96.9 (1.95)	96.1 (2.07)	**0.055***
Sats change, mean (SD)	-1.54 (2.25)	-2.33 (2.08)	**0.071***
NEWS Component Score, mean (SD)			
Systolic Blood Pressure	0.147 (0.4)	0.185 (0.557)	0.733
Pulse	0.718 (0.768)	0.889 (0.892)	0.351
Respiration Rate	0.695 (1.1)	0.926 (1.14)	0.332
SpO2	0.311 (0.553)	0.37 (0.742)	0.691
Oxygen therapy	0.057 (0.332)	0.222 (0.641)	**0.198***
Body Temperature	0.051 (0.22)	0.259 (0.656)	**0.113***
Consciousness	0.017 (0.225)	0.000 (0.000)	0.319
Total	2.28 (1.96)	2.96 (1.93)	**0.098***
Total, excluding SpO2 Component	1.97 (1.92)	2.59 (1.8)	**0.107***
Referral source, n (%)			0.311
AMU	17 (7.0%)	0 (0.0%)	
ED	143 (59.1%)	21 (67.7%)	
GP	54 (22.3%)	5 (16.1%)	
Other	27 (11.2%)	5 (16.1%)	
Comorbidities, n (%)	110 (45.5%)	15 (48.4%)	0.895
C-reactive protein, n (%)			0.375
Low	11 (4.5%)	0 (0.0%)	
Borderline	28 (11.6%)	3 (9.7%)	
Moderately high	28 (11.6%)	5 (16.1%)	
Markedly high	81 (33.5%)	17 (54.8%)	
Lymphocyte count, n (%)			0.779
Lymphopenia	40 (16.5%)	8 (25.8%)	
Normal	118 (48.8%)	17 (54.8%)	
Lymphocytosis	6 (2.5%)	1 (3.2%)	
D-dimer, n (%)			-
Normal	0 (0.0%)	0 (0.0%)	
High	0 (0.0%)	0 (0.0%)	
Severe	57 (23.6%)	14 (45.2%)	
Ferritin, n (%)			0.537
Low	2 (0.8%)	0 (0.0%)	
Normal	19 (7.9%)	5 (16.1%)	

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Characteristics	Non-readmitted	Readmitted	P-value
High	17 (7.0%)	2 (6.5%)	
Creatinine, n (%)			0.725
Low	142 (58.7%)	23 (74.2%)	
Normal	17 (7.0%)	2 (6.5%)	
High	3 (1.2%)	0 (0.0%)	
CXR/US/CT result, n (%)			0.960
Positive	127 (52.5%)	16 (51.6%)	
Negative	99 (40.9%)	12 (38.7%)	
Indeterminate	6 (2.5%)	1 (3.2%)	
On any antibiotics, n (%)	138 (57.0%)	21 (67.7%)	0.264

** < 0.05; * < 0.2

NHS Foundation Trust (RBHFT) Information Governance team and a data transfer agreement was signed between the RBHFT and the Henley Business School.

Results

The virtual ward opened on the 4th of April 2020 and at the point of data censor for analysis on the 12th of June 2020, 279 patients had been admitted into the ward of whom six remained on the pathway and 273 had completed their virtual ward stay.

Of these 273 patients, 242 patients had been discharged from follow up and 31 (11.4%) had required reassessment in hospital.

Baseline data is summarised in Table 1. The median age of patients was 50.3 years (range from 18 to 94) years. Male to Female ratio 0.41. The referral source was from the Emergency Department in 165 (60.4%), Primary Care (via the GP run 'hot hub') in 56 (20.5%) and ward step down in 52 (19.05%). Swabs were sent in 131 patients with a positivity rate of 48%. In total 209 of the patients had imaging of

which 148 (70.8%) were CXR, 58 (27.8%) were lung ultrasound and 3 (1.4%) were CT scans.

The median saturation at presentation was 97 % (IQR 96-98%) and following a 30 metre walk test 96% (IQR 94-97%). NEWS-2 data was only available on the ED referred and ward step down patients. The median NEWS-2 score was 2 (IQR 1-3). Of note, 81 (37%) of these 217 patients had a NEWS-2 score of >=3.

Of the 31 patients who re-attended the Emergency Department, 12 were discharged back on to the pathway and subsequently discharged off the pathway, and 19 were readmitted to hospital. Of the 19 patients readmitted, three patients required CPAP, two were admitted to ICU and one patient died.

Univariate analysis did not demonstrate any statistically significant difference between those who re-attended compared to those who did not (see Table 2) although there was a trend to a difference with ethnicity, the measured baseline saturations, change in saturations following a 30 walk and the
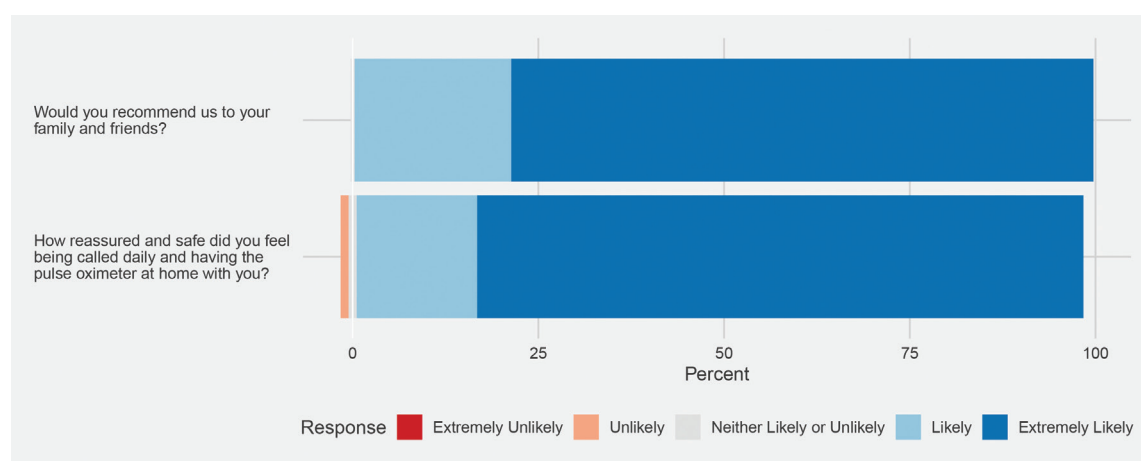
Figure 4. Likert Scale summarising results of patients feedback for the two questions: 1] Would you recommend us to your family and friends? 2] How reassured and safe did you feel being called daily and having the pulse oximeter at home with you?

total NEWS score. (For full list of variables analysed please see supplementary appendix).

Feedback was obtained in 185 patients. On the question of whether they would recommend the service to their family and friends 145 (78.4%) said they were extremely likely; 39 (21.1%) said they were likely and 1 (0.5%) said they were neither likely nor unlikely. On the question 'On a scale of 1 to 5 how reassured and safe did you feel being called daily and having the pulse oximeter at home with you?', 151 (81.8%) gave a response of 1; 30 (16.2%) gave a response of 2; 2 (1.1%) gave a response of 3; and 2 (1.1%) gave a response of 4. (Please see figure 4 and narrative feedback in the supplementary appendix).

A cost avoidance analysis was done. Predicated on saving of bed days, the initial setting up costs of the saturation probes and ongoing staffing wages, a monthly cost avoidance spread over 6 months would be £'640,000 or £'106,700 per month (please see supplementary appendix).

Discussion

Here we present the results of a service evaluation of the Triage into the Community for COVID-19 (TICC-19) Virtual Ward which was used in the first wave of COVID-19 in both primary and secondary care. It appears that it is feasible, safe, cost effective and provides an excellent patient experience.

NHS Improvement and the Ambulatory Emergency Care Network provide guidance on the optimal functioning of ambulatory care pathways.[6] They recognise that pathways with no conversion to admission are likely to be of limited value and those with a high conversion to admission rate are unsafe. They recommend that a conversion rate to admission of 10% is optimal. It was therefore reassuring that our re-attendance rate was 11.7%. The very low admission to Intensive Care and the single death would also suggest that the service we set up was safe.

Of note in our cohort, NEWS-2 was of limited value in identifying those who needed admission. It was unclear to us at the start of the pandemic as to what the value of our existing NEWS-2 score would have in the assessment and triage of COVID-19 patients. National guidance on COVID-19 suggested that patients with a NEWS-2 score of ≥3 should be considered for admission. In a condition that causes a high fever but in which silent hypoxia is the main cause of deterioration[7] there was a risk that the use of NEWS-2 would cause patients to be admitted unnecessarily and might not identify those at risk of deterioration. Indeed, although a Chinese tool adding age to NEWS-2 has been proposed[8] this has not been validated and an appraisal of

the evidence questions the value of NEWS-2 in primary care.[9]

More recently the Pandemic Respiratory Infection Emergency System Triage (PRIEST) study examined the triage and 30 day outcomes of over 22,000 patients reviewed in Emergency Departments across the UK.[10] They found that the addition of age, sex and functional status to the NEWS score provided a sensitive way of identifying those at risk of death or organ support at 30 days. Whilst scoring systems like this may be useful for triage, the distinction in our pathway was that we were not trying to predict outcome but rather to manage patients in a Virtual Ward remotely and thus safely identify the deterioration to allow a managed readmission.

The use of oximetry is clearly important in the assessment of COVID[11] however the role of post exertion desaturation is less clear. In the PRIEST study a sub group analysis of 817 patients showed that there was modest impact on prognostication.[12] However there was no standardisation of the tests used and it remains unclear what the optimal exertional stress test should be.[13] There are multiple stress tests used in clinical practice including the 30 metre rapid walk and one minute sit to stand test[14] however these tests have only really been validated in chronic respiratory conditions and their value in an acute pneumonia is less clear.

A 40 step around the room test has been proposed as perhaps the lowest of exertion of any test and may be more pragmatic an approach than a 30 metre walk test which we used.[13]

There are limitations to the pathway we present. Firstly, whilst we admitted over 700 patients to our hospital during the first wave covered by this period, the surge was not as severe as we had anticipated and it is likely in retrospect that at least a proportion of the patients followed up on the virtual ward could have been admitted to hospital for monitoring. Secondly, this pathway may not work with the specifics of other hospitals. There is close working between the Emergency Department, Acute Medicine and Respiratory Medicine in our hospital which may not exist elsewhere. Thirdly, this is a service evaluation and so interpretation of post hoc statistical analysis has to be interpreted with caution.

In summary, we ran a triage pathway with Virtual Ward follow up with pulse oximetry which was feasible, safe, cost effective and with good patient feedback. Similar pathways could help in a second wave of the COVID pandemic.

Conflict of interests

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