



Clinician's Guide Document for Evaluating the At-Home COVID-19 Monitoring Dashboard

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There are constraints in following the guide document where the resources are not available to utilize certain aspects of the guide. Therefore, individual healthcare professionals will have to decide what is achievable within their resources particularly for vulnerable patient groups. The guide does not however override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of individual patients in consultation with the patient and/or guardian.

This guidance document is not a policy document. Feedback from local faculty and individual members on ease of implementation of these guides is welcomed.

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1. Introduction

Impact of COVID-19 on Healthcare and Remote Patient Monitoring

In the coming months there will be many patients that will be COVID-19 Positive (here after called COVID-19 patients). COVID-19 management data from other countries indicates that 80% of these COVID-19 patients will present mild illness [1]. The remaining 20% of patients may follow a more severe illness pathway with approximately 14% needing supportive care, and 5-6 % suffering critical illness, with some requiring ITU care and early ventilation [2].

However, given the limitation in availability of hospital-based care, it will not be feasible to manage the majority of patients in hospital. Most of these COVID-19 patients with mild illness will be managed at-home with appropriate supports. The critical issue for COVID-19 patients at home is to detect the early warning signs of deterioration/viral pneumonia [3,4].

GPs are currently deploying a primary screening using telehealth or telephone based approaches, followed by a secondary screening in a hospital or a COVID-19 ward. The secondary screening can be easily replaced by deploying remote patient monitoring solutions [5], which will have several advantages over current in-hospital secondary screenings. These advantages include (1) ability to triage patients, (2) ability to remotely monitor patient and (3) ability to collect valuable time dependent medical data to map patient progress.

In this guide document we first list the clinical symptoms of COVID-19 followed by how pulse oximetry can be used to manage it. We then discuss the manual INEWS scoring system currently used by clinicians to manage the disease, followed by our novel automated CEWS scoring system.

Clinical Symptoms of COVID-19

The signs and symptoms vary, especially in older patients, those with multimorbidity and or who may be immunocompromised.

These are the most common:

- Fever (83–99%)
- Cough (59–82%)
- Fatigue (44–70%)
- Anorexia (40–84%)
- Shortness of breath (31–40%)
- Sputum (28–33%)
- Myalgia (11–35%)

Who is most at Risk of Developing Severe Illness and Dying?

Age

- People in their 80s have a 16% fatality rate
- People in their 70s have an 8 % fatality rate
- People in their 60s have a 4% fatality rate
- People aged 55-64y have a 1-3% fatality rate
- People aged 0-55y is have a fatality rate of <1%

Co-morbidities

- Patients with cardiovascular disease have an 11% fatality rate
- Patients with diabetes mellitus have a 7% fatality rate
- Patients with COPD have a 6% fatality rate
- Patients with Hypertension have a 6% fatality rate
- Patients with cancer have a 6% fatality rate

Role of Pulse Oximetry in COVID-19 management

Overall clinical judgment of COVID-19 viral pneumonia is based on a high index of suspicion, clinical history and parameters including:

- SpO₂ <91
- heart rate >100
- temperature >=38
- respiratory rate > 20
- and/or new onset confusion

Although respiratory rate and temperature can be used for initial screening, SpO₂ is the primary marker for early recognition of patients with severe acute respiratory infection (SARI) associated with COVID-19 [6]. Thus, SpO₂ measurements are being used across the world in the monitoring and triaging of patients with COVID-19.

Current COVID-19 Early Warning Scoring System

The Irish National Early Warning scoring system (INEWS) is intended for use in the 'COVID Wards' and is based on the National Early Warning Score – 2(NEWS2) developed by the National Health Services (NHS) in UK.

Table 1: Irish National Early Warning System (INEWS) Scoring Key for use in the Community with Covid19 (March 2020)

Score	3	2	1	0	1	2	3	Observation	Parameter Score
Respiratory Rate (bpm)	≤8		9-11	12-20		21-24	≥25		
SpO2 (%)	≤91	92-93	94-95	≥96					
Inspired O2 (FIO2)				Air			Any O2		
Systolic BP (mmHG)	≤90	91-100	101-110	111-249	≥250				
HR (BPM)		≤40	41-50	51-90	91-110	111-130	≥131		
ACVPU/CNS Response				A (Alert)			New confusion (C), Voice (V), Pain (P), Unresponsive (U)		
Temp (*C)	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1			
Patients with an INEWS score of < 3 may be suitable to be cared for at home or in the Community.								Total INEWS Score	

Novel COVID-19 Early Warning Score

We have developed a novel COVID-19 Early Warning Score (CEWS) system that is an improvement on the current INEWS scoring system. CEWS leverages our RPM platform's ability to capture historical biometric data as opposed to a spot checks used in INEWS.

The advantages of CEWS over INEWS includes,

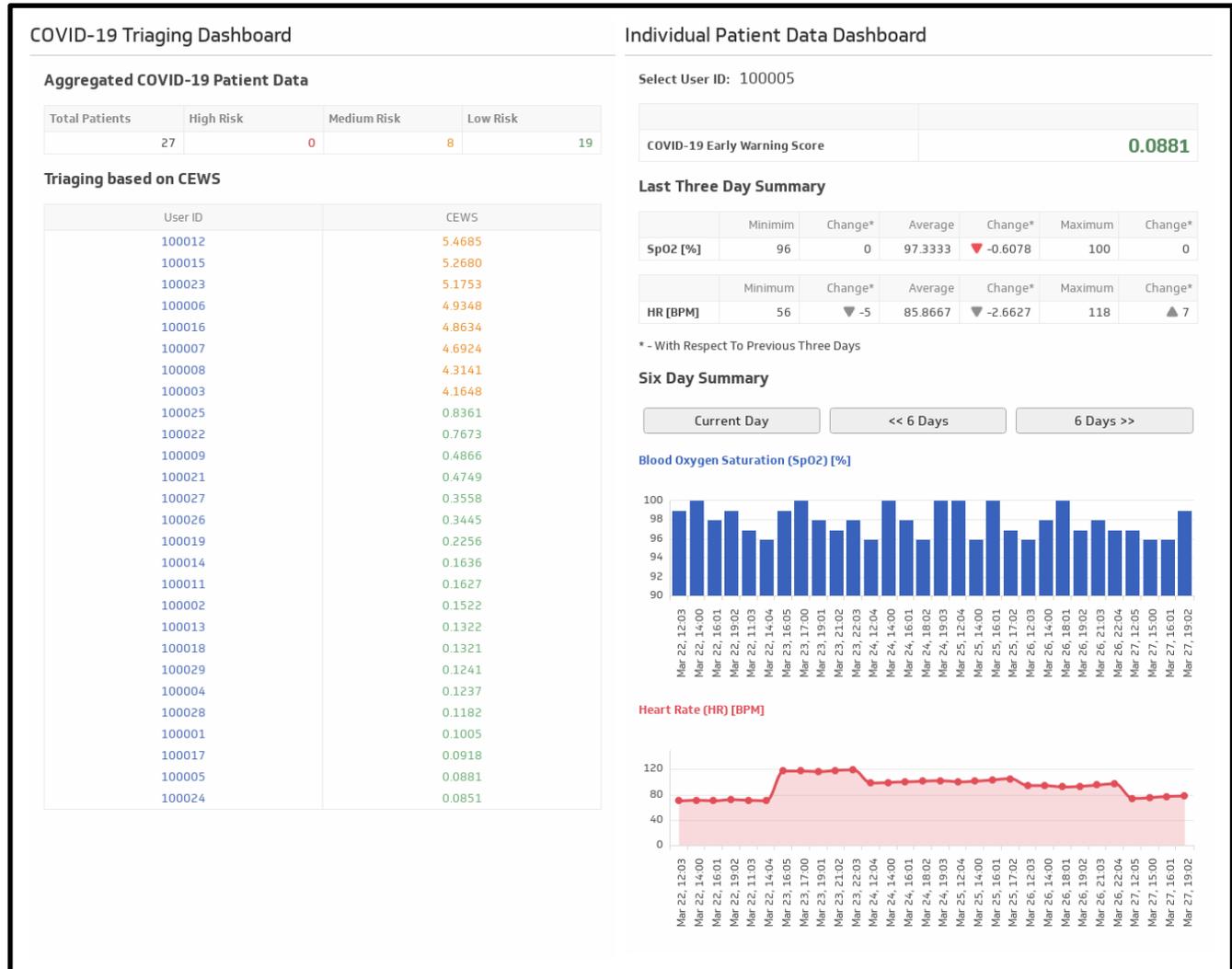
- Rate of change of SpO2 is taken into account
- Uses a continuous ranking (0-3) as opposed to a manual discreet ranking (1,2,3)
- Not all clinical parameters are given equal weight.
- Averages over three days used as opposed to spot checks

Table 2: COVID-19 Early Warning Score (CEWS) used in our At-Home COVID-19 Monitoring Platform (April 2020)

Score	3	2	1	0	1	2	3
Avg. SpO2 (3 days) (%)	≤91	92-93	94-95	≥96			
Change of Avg SpO2 (From 6 to 3 days) (%)		9-6	6-3				
Avg. HR (BPM)		≤40	41-50	51-90	91-110	111-130	>130
ACVPU/CNS Response				A (Alert)	New confusion (C), Voice (V), Pain (P), Unresponsive (U)		
Inspired O2 (FiO2)				Air	Any O2		

2. At-Home COVID-19 Monitoring Dashboard

Image 1: Our “At-Home COVID-19 Monitoring Dashboard” which includes the “COVID-19 Triaging Dashboard” on the left and the “Individual Patient Data Dashboard” on the right. (10 April 2020)



COVID-19 Triage Dashboard

This section of the “At-Home COVID-19 Monitoring Dashboard” is the triaging tool. It can be used by hospital systems to qualitatively monitor the condition of its entire COVID-19 patient population. This section of the dashboard does not have any patient specific data, and hence can be used in isolation by a non-clinical healthcare professional. This dashboard can also be used in isolation as a reporting tool for the payor or the national healthcare authorities.

Aggregated Patient Data

This panel is on the top left corner and summarizes the total number of patients who are currently using the “At-Home COVID-19 Monitoring Platform.” It also summarizes the number of high risks COVID-19 patients i.e. CEWS > 6 (marked in red) and medium risk patients i.e. with $3 < \text{CEWS} < 6$ (marked in orange). This aggregated patient data is designed to help hospital administrators qualitatively monitor the condition of its entire COVID-19 patient population in real-time.

Triage based on CEWS

The panel on the bottom left corner is the triaging dashboard that automatically ranks patients based on the CEWS scoring system. The patients on the top of the chart are at the highest risk and needs immediate hospitalization. The clinician can see more detailed clinical information about a specific patient (in the “Individual Patient Data” section by clicking on the corresponding “USER ID” in this panel.

Individual Patient Data Dashboard

This section of the “At-Home COVID-19 Monitoring Dashboard” is the remote patient monitoring tool. It can be used by hospital systems to quantitatively monitor the condition of an individual COVID-19 patient. This section of the dashboard contains patient data, and hence can only be used by clinical professionals.

CEWS

The panel on the top right shows the patient’s CEWS score. If $\text{CEWS} > 6$ (marked in red) then the patient is at-high risk, and should be immediately moved to the ED. If the $3 < \text{CEWS} < 6$ (marked in red) then the patient is in medium risk and should be immediately moved to a COVID-19 monitoring ward or similar clinical facility. If $\text{CEWS} < 3$ (marked in green) then the patient should be kept under continuous remote patient monitoring but may not need immediate medical intervention. If $\text{CEWS} = 0$ then patient can be considered safe.

Last Three-Day Summary

This panel on the center right shows the patient’s data over the last three days. In particular, it shows minimum, average and maximum blood oxygen saturation and heart rate. It also shows how these previous six parameters changed from the last six to three days. The blood oxygen saturation (SpO₂) is reported in % and heart rate is reported in BPM (Beats Per Minute). In critical patients these are important clinical parameters for the physician to determine the patient needs for supplemental oxygen or ventilation support.

Six Day Visual Summary

This bottom right panel shows the patient’s data six days at a time. The “Current Date” button can be used re-set the visualization to the day when the last reading was taken. The “<< 6 Days” button at the bottom can be used to toggle the view to the previous six days of data. The “6 Days >>” button at the bottom can be used to toggle the view to next six days of data. The “<< 6 Days” and the “6 Days >>” button will stop responding once the most

recent and the oldest available dates are displayed. The first graph shows blood oxygen saturation values from 80 to 100 %. The second graph shows heart rate values from 0 to 130 measured in BPM (Beats Per Minute).

References

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