Evidence check

2 June 2020

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

Conducting virtual respiratory assessments and monitoring via telehealth

Rapid review question

What is the current evidence for conducting virtual respiratory assessments and monitoring in adults via telehealth?

In brief

- Conducting physical examinations remotely by telehealth is recognised to be a challenge in clinical practice.(1-3) However, there is evidence that telehealth assessments and monitoring can be carried out for a variety of respiratory illness, including chronic obstructive pulmonary disease (COPD), acute exacerbations of COPD (AECOPD), asthma, cystic fibrosis, pulmonary hypertension, interstitial lung disease and most recently, COVID-19.
- A previous Critical Intelligence Unit evidence check reported on a rapid review conducted by the Centre for Evidence-based Medicine (CEBM) at the University of Oxford, which found no validated tests for assessing breathlessness in acute primary care settings. The review identified insufficient evidence for the clinical accuracy of the Roth score test for breathlessness. It also advised against the use of smartphone apps to assess oxygen saturation.(4)
- A systematic review found that forced expiratory volume, assessed daily by using a spirometer, was the most common modality of remote respiratory assessments in people with COPD. Other measurements included resting respiratory rate, respiratory sounds and end-tidal carbon dioxide level. When combined with machine learning algorithms, remote assessments were found to be highly predictive of AECOPD. Daily remote respiratory assessments were found to be feasible and well tolerated in most people with COPD and had consistently high user satisfaction.(5)
- As part of delivering integrated care of chronic respiratory diseases, some experts advise screening via questionnaire be built into the care delivery system.(6)
- Patient-reported instruments which have been used or recommended for use for the virtual assessment of respiratory illnesses include: the COPD assessment test questionnaire, K-BILD, EXACT-PRO, Dyspnoea-12 questionnaire, Medical Research Council Dyspnoea & Breathlessness Scales and NHS 111 symptom checker.

Limitations

Evidence on this topic is emerging rapidly. Studies were often found to be context and disease specific. Studies and guidelines that solely focused on clinical management, rehabilitation, or other interventions and did not include a discussion on patient assessment, diagnosis, or monitoring via telehealth are beyond the scope of this review and were excluded. This rapid review found a paucity of published literature providing detailed clinical guidance and instructions (a 'how-to') on conducting virtual respiratory assessments via telehealth. This resource gap has been acknowledged in other research.(3, 4)

Background

This document provides an update and supplementary information to a Critical Intelligence Unit evidence check *Validated tools to diagnose respiratory illness via telehealth* that was published on 14 April 2020.

At the time of publication of this evidence check, a team at the University of New England is conducting a trial of a 'virtual hospital' to monitor home-isolated patients with mild to moderate COVID-19 in regional New South Wales.(7, 8) This trial will implement a remote monitoring device to continuously track patients' vital signs, including heart rate, temperature, oxygen saturation, blood pressure and breathing.(9)

Methods (Appendix 1)

A PubMed search was conducted on 21 May 2020. Google and snowball sampling were conducted on 25 and 26 May 2020. Australian and international clinical and research organisation websites were reviewed for guidance on virtual respiratory assessments and monitoring. The papers included in the previously mentioned evidence check were not included here.

Results

Table 1 Methods used to measure breathlessness remotely

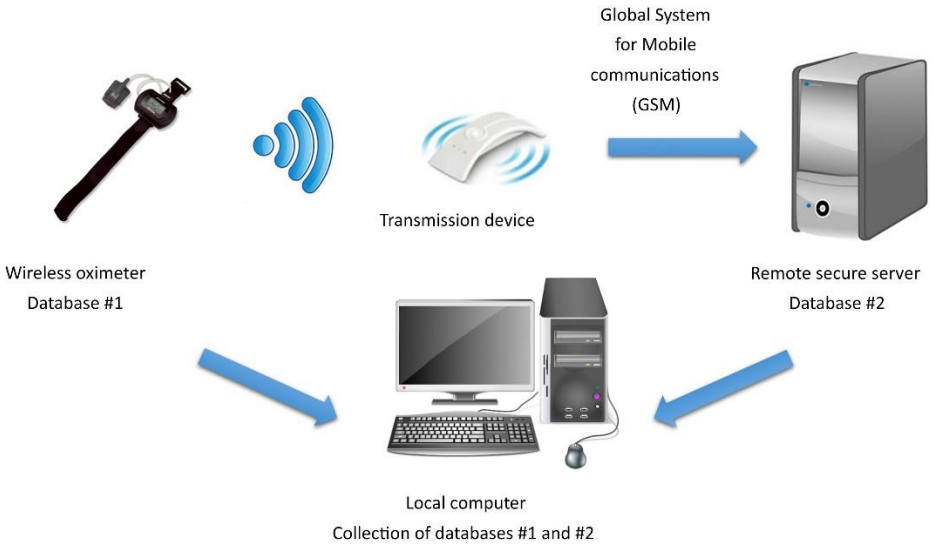
Diseases/conditions for which telehealth assessment and monitoring have been used	• Asthma • COPD/AECOPD • Cystic fibrosis • Pulmonary hypertension • Interstitial lung disease • COVID-19
Telehealth modalities	Synchronous (delivered in real-time) • Telephone consultations‡ • Videoconferencing Asynchronous (not delivered in real-time) • Direct data upload/transmission via IT system • Smartphone apps‡‡ • Email ‡A CEBM review found no evidence that attempts to measure a patient's respiratory rate over the phone would give an accurate reading.(4)

	‡‡The same CEBM review recommends against the use of smartphone technology for measuring blood oxygen saturation for clinical use, questioning the scientific basis of such technologies. It advises against using oxygen saturation levels obtained from smartphone apps in the clinical assessment of patients.(10)
Home-based assessment and telemonitoring technologies	• Pulse oximeter (11, 12) • Spirometer (5, 12) • Heart rate monitor (13) • Blood pressure monitor (13)
Parameters/measures used to assess respiratory illness via telehealth [NOTE: list will be dependent on condition under assessment]	Respiratory parameters • Forced expiratory volume (5) • Peak expiratory flow (13) • Resting respiratory rate (5) • End-tidal carbon dioxide level (5) • Oxygen saturation (11, 14) • Respiratory sounds, including audible wheeze (5, 15) Other symptoms • Heart rate, pulse (5, 13, 14) • Blood pressure (15) • Cough, phlegm (14, 16) • Temperature, presence of fever (14-16) • Colour of face and lips (4, 15) • Ease, comfort of speech (4, 15) • General demeanour (15) • Presence of other conditions (e.g. cold) (16) Patient account • Patients' own description of current condition and change in symptoms (4, 15, 16)
Instruments/tools which have been used or are recommended for use to assess and monitor patients via telehealth	• Roth score*‡ (17) • K-BILD* (18, 19) • COPD assessment test questionnaire* (6, 12) • EXACT-PRO (Exacerbations of Chronic Pulmonary Disease Tool, Patient-Reported Outcomes)* (6) • Dyspnoea-12 questionnaire* (19, 20) • Medical Research Council Dyspnoea and Breathlessness Scales* (19, 21) • NHS 111 symptom checker (3 questions) (4) *validated or evaluated in research ‡A CEBM rapid survey of experts recommends against the use of Roth scores due to limited evidence supporting its clinical efficacy (4)

Table 2 Extraction of data from relevant scientific and grey literature

Source	Summary
Peer reviewed sources	
The virtual physical exam in the 21st century Ansari, et al. 2019 (12)	• Telemedicine interventions are focusing on early detection of disease exacerbation for early symptom management. Although **forced spirometry** is important in the early diagnosis of chronic obstructive pulmonary disease (COPD) and asthma, web-based remote support demonstrated better quality of testing in the primary care setting using **smartphone applications for peak flow recordings**. • Though pulmonologists are still trying to better characterise the benefits of telemedicine, instruments such as **COPD Assessment Test questionnaires**, **telespirometry** and **teleoximetry** have made it easier to determine patients who can benefit the most from telemedicine. • Through video, clinicians can comment on how many words patients are saying in a sentence or even the colour of their skin as part of the inspection of a physical exam. Electronic stethoscopes also perform as well in the respiratory exam as in the cardiac exam.
Advances in Remote Respiratory Assessments for People with Chronic Obstructive Pulmonary Disease: A Systematic Review Baroi, et al. 2018 (5)	• A systematic review of 15 studies on the use of remote respiratory assessments in people with COPD. • **Forced expiratory volume assessed daily by using a spirometer** was the most common modality. Other measurements included **resting respiratory rate, respiratory sounds and end-tidal carbon dioxide level**. • Remote assessments when combined with machine learning algorithms were highly effective and could predict 71.8–75.8% of AECOPDs between 1–5 days in advance of clinical records. • Daily remote respiratory assessments were feasible and well tolerated in most people with COPD, as demonstrated by the consistently high user satisfaction. • Benefits included early detection of AECOPD (acute exacerbations of chronic obstructive pulmonary disease), improved health-related outcomes and the ability to replace hospital care with a virtual ward.
People undertaking pulmonary rehabilitation are willing and able to provide accurate data via a remote	• A multicentre, prospective, observational study of 105 adults with chronic respiratory disease who were referred to pulmonary rehabilitation. • Participants were taught to use a system for recording and transmitting their pulse oximetry data. Each participant then undertook a prescribed exercise session on a cycle ergometer with the oximeter in situ. At

Source	Summary
Peer reviewed sources	
pulse oximetry system: a multicentre observational study Bonneville et al. 2019 (11)	a subsequent session, participants were requested to independently activate and use the **oximetry monitoring system** for another cycling session. • Outcome measures included the number of sessions needed to become autonomous, participant satisfaction with the system and measures of the validity of the transmitted data. • Participants became autonomous quickly: 86% at the first testing session and 100% within three testing sessions. • At least 98% of participants agreed that the system was easy to use and they would be willing to use it throughout pulmonary rehabilitation. • The transmitted data were valid: The system transmitted usable data from 98% (95% CI: 96-100) of sessions and introduced minimal artefact. Mean absolute differences were 0.365 beats/minute for **heart rate** and 0.133% for **oxyhaemoglobin saturation**. For heart rate, exact agreement was 72% (SD 9) and similar agreement (within 3 beats/minute) was 99% (SD 1). For oxyhaemoglobin saturation, exact agreement was 87% (SD 3) and similar agreement (within 3%) was 100% (SD 0). • The results indicate that the system is suitable for use in telerehabilitation and that the data can be interpreted as clinically equivalent to the acquired signal. **Figure 1. Hardware components of the telerehabilitation platform**

Source	Summary
Peer reviewed sources	
	
Assessment of Respiratory Distress by the Roth Score Chorin, et al. 2016 (17)	• This study introduces the Roth score as a telemedicine tool that uses patient counting times to risk-stratify dyspnea severity in terms of hypoxia. • Roth score index is measured by having the patient count from 1 to 30 in their native language, in a single breath, as rapidly as possible. The primary result of the Roth score is the duration of time and the highest number reached. • The Roth score has strong correlation with dyspnea severity as determined by hypoxia. • This tool is reproducible, low resource-utilisation and amenable to telemedicine. It is **not intended to replace full clinical workup and diagnosis of respiratory distress**, but it is useful in risk-stratifying severity of dyspnea that warrants further clinical evaluation.

Source	Summary
Peer reviewed sources	
	[NOTE: As per the findings reported in our previous evidence check, a rapid survey of experts conducted by the Centre for Evidence Based Medicine (CEBM) recommends against the use of Roth scores due to limited evidence supporting its clinical efficacy.]
A Randomised Controlled Trial of the Effect of Automated Interactive Calling Combined with a Health Risk Forecast on Frequency and Severity of Exacerbations of COPD Assessed Clinically and Using EXACT PRO Halpin, et al. 2011 (22)	• A four month prospective randomised controlled trial using clinical criteria and the EXACT PRO questionnaire to identify exacerbations. Patients were randomly allocated to receive alert calls. All patients completed a diary including the **EXACT PRO questionnaire on a BlackBerry Smartphone each day**. They were contacted and assessed if they appeared to be exacerbating.
Delivering telemedicine interventions in chronic respiratory disease Hernandez, et al. 2014 (6)	• The authors recommend that as part of best practices to develop telemedicine as a component of an integrated care system for the delivery of chronic respiratory disease, **screening via questionnaire should be built into the system** with patients prompted to complete the data. The nurse clinician can have access to the clinical view using an office platform screen with easily accessible past reports. The authors do not provide recommendations on specific questionnaires for use.
The Development and Validation of the King's Brief Interstitial Lung Disease (K-BILD) Health Status Questionnaire Patel, et al. 2012 (18)	• K-BILD is a health status questionnaire developed and validated specifically for patients with interstitial lung disease (ILD). • It is the first health status questionnaire developed for use in patients with ILDs other than idiopathic pulmonary fibrosis. • The K-BILD questionnaire is brief, containing just 15 items that measure health status in three domains. • It is simple to administer and most patients found it easy to complete. • Recommended by the British Thoracic Society as one of a number of validated self-reported measures of breathlessness for the remote assessment of breathlessness for pulmonary rehabilitation.

Source	Summary
Peer reviewed sources	
Effectiveness of telemonitoring integrated into existing clinical services on hospital admission for exacerbation of chronic obstructive pulmonary disease: researcher blind, multicentre, randomised controlled trial Pinnock, et al. 2013 (16)	• A telemonitoring equipment and secure broadband link was installed in the homes of intervention participants (with COPD), and education was provided on using the technology and self-management. Participants had access to technological advice and support throughout the trial. • As part of the interventions, participants were asked to use touch-screen telemonitoring equipment to record and transmit a daily questionnaire about symptoms and use of treatment, and monitored oxygen saturation using linked validated instruments. The patient was asked to assess **if their dyspnoea, sputum purulence and volume, cough, wheeze had increased or if they had developed an upper respiratory tract infection or had a fever**. Data was interpreted and validated by clinicians who knew the patient's medical history, who then decided on an appropriate clinical management pathway for the patient.
A home telehealth program for patients with severe COPD: The PROMETE study Segrelles Calvo, et al. 2014 (13)	• A cluster assignment, controlled trial study design of 60 patients with COPD, of which, 30 were enrolled in telehealth monitoring and intervention and 30 in conventional care (non-telehealth). • Daily follow-up of patients with severe COPD at the home by monitoring the following parameters: blood pressure, oxygen saturation and heart rate on a daily basis, and **peak expiratory flow (PEF)** three times a week. • PEF was chosen as a measurement by the authors as previous studies have demonstrated its acceptability to be carried out autonomously by patients, and because the fall of percentage of peak-flow has been associated with a high risk to develop COPD exacerbations. • The parameters were collected using a **spirometer**, a **pulse-oximeter** and heart rate monitor, and blood pressure monitor. Measurements were made once a day in the morning, and given the following set of conditions: 20 min after medication had been taken, at rest and while on oxygen therapy. Data were sent automatically via a modem via the patient's telephone line.

Source	Summary
Peer reviewed sources	

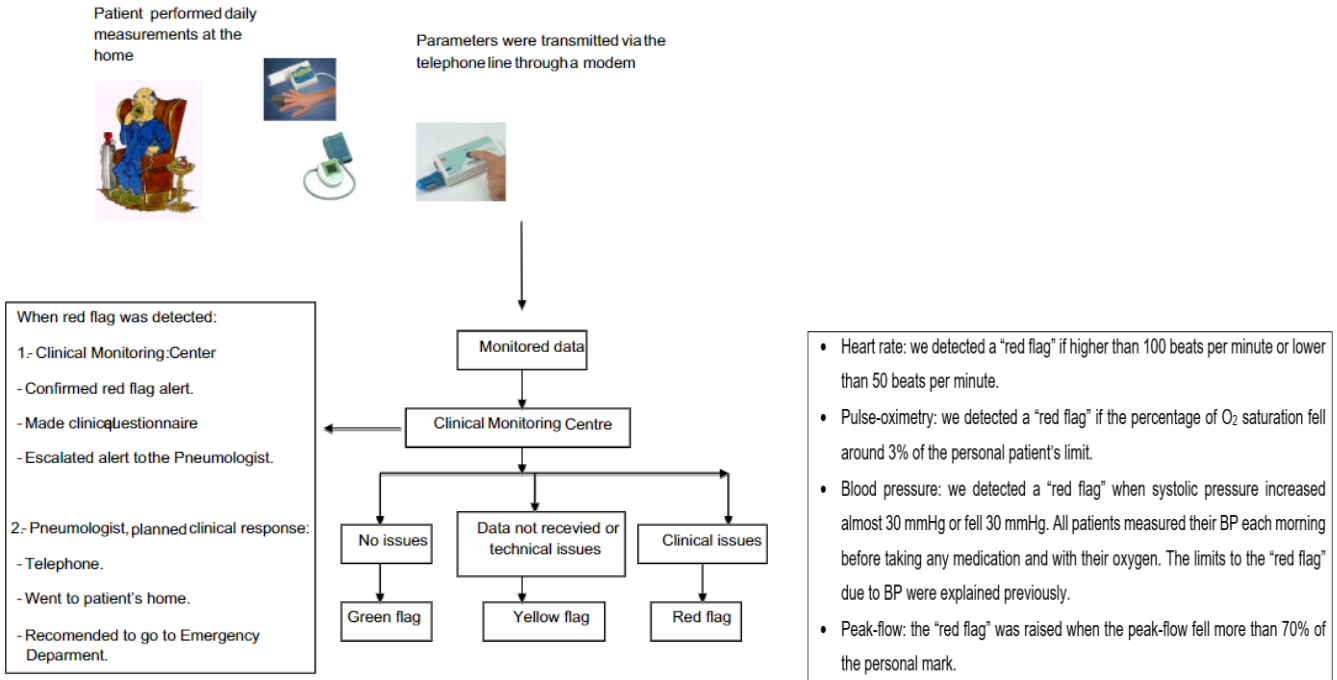


Figure 2 Telemonitoring protocol and Clinical Monitoring Center follow-up.

- This method allowed for **detecting early changes in measurable parameters and therefore identify an AECOPD prematurely**. The authors detected more milder exacerbations with home telehealth since they were able to monitor daily changes in the patients' condition.
- Combining early detection and intervention, this trial led to **a significant reduction in emergency room visits**, **hospitalisations and length of hospital stay** of COPD patients enrolled in home telehealth, with equivalent safety and high acceptance as those receiving conventional care.

Source	Summary
Peer reviewed sources	
Quantification of dyspnoea using descriptors: development and initial testing of the Dyspnoea-12 Yorke, et al. 2010 (20)	• The Dyspnoea-12 instrument is derived from the largest pool of breathlessness descriptors that has been assembled. It quantifies breathlessness using descriptions by patients of its qualities and its affective sequelae. • Uniquely, this instrument was developed in three disease populations: COPD, interstitial lung disease (ILD) or chronic heart failure (CHF). • Patients found the Dyspnoea-12 was easy to complete and understand and helpful in expressing their experience of being breathless. • Recommended by the British Thoracic Society as one of a number of validated self-reported measures of breathlessness for the remote assessment of breathlessness for pulmonary rehabilitation.
Grey literature	

Pulmonary Rehabilitation Remote Assessment
 	
British Thoracic Society 2020 (19)
	• A resource for pulmonary rehabilitation healthcare professionals conducting assessments remotely during the COVID-19 pandemic. Only resources available free of charge have been provided. It provides links and summaries of resources on the following:
	  ○ Methods of remote assessment (tele- or video-conferencing platforms)
	  ○ Assessment of physiological parameters
	  ○ Assessment of exercise capacity
	  ○ Assessment of muscle strength
	  ○ Assessment of balance
	  ○ Assessment of functional performance
	  ○ Assessment of breathlessness [NOTE: resources – MRC Dyspnoea Scale (21), Dyspnoea-12 (20), K-BILD (18) – abstracted separately in this Table].
	• Assessment of health-related quality of life.

Question: Should the Roth score be used in the remote assessment	• The author recommends against the use of the Roth score to assess breathlessness over the phone for the following reasons: ○ There are no validated tests for assessing breathlessness over the phone in an acute primary care setting.

Source	Summary
Peer reviewed sources	
of patients with possible COVID-19? Answer: No. CEBM 2020 (23)	○ Measuring a patient's respiratory rate over the phone using the Roth score does not provide an accurate assessment of hypoxia and may lead to false reassurance. ○ Experts recommend an overall clinical assessment, including questions about the nature and rate of change of the breathlessness.
Should smartphone apps be used clinically as oximeters? Answer: No. CEBM 2020 (10)	• The authors found no evidence that any smartphone technology is accurate for the measurement of blood oxygen saturation for clinical use. Furthermore, they argue that the scientific basis of such technologies is questionable. They recommend that oxygen saturation levels obtained from such technologies should not be trusted in the clinical assessment of patients.
MRC Dyspnoea scale / MRC Breathlessness scale Medical Research Council 2020 (21)	• The MRC dyspnoea scale has been in use for many years (first published in 1960) for grading the effect of breathlessness on daily activities. This scale measures perceived respiratory disability. • The MRC dyspnoea scale is simple to administer as it allows the patients to indicate the extent to which their breathlessness affects their mobility. • The 1-5 stage scale is used alongside the questionnaire to establish clinical grades of breathlessness. • Recommended by the British Thoracic Society as one of a number of validated self-reported measures of breathlessness for the remote assessment of breathlessness for pulmonary rehabilitation.
Chronic obstructive pulmonary disease in over 16s: diagnosis and management: Self-management interventions, education and telehealth monitoring. NICE guideline NG115 Evidence review National Institute for Health and Care Excellence 2018 (24)	• An expert panel discussing the findings of the NICE evidence review on COPD (NG115) noted that many of the telehealth monitoring interventions described in the studies included in this report were designed to detect fluctuations in key measurements that could indicate the beginning of an exacerbation sooner than relying on symptoms alone. In turn, this would trigger earlier treatment with the goal of reducing the severity of the exacerbation and preventing hospitalisations. • They also noted that earlier detection and treatment would only be expected to lead to benefits if people with COPD are not self-medicating or seeking help for an exacerbation in a timely manner, and that this could be addressed by telehealth monitoring. • However, the panel concluded that there was no convincing evidence for the effectiveness of telehealth monitoring interventions in reducing exacerbations, hospitalisations or other outcomes of interest to people with COPD. As a result**, they agreed to recommend that telehealth monitoring is not used routinely**

Source	Summary
Peer reviewed sources	
	in people with COPD, unless indicated for specific reasons (e.g. presence of comorbidities where telehealth monitoring has been proven effective, or for short-term monitoring after hospital discharge). • The panel discussed the possibility that **telehealth monitoring could increase anxiety in people with COPD by enabling them to see daily fluctuations in their measurements that they would not normally be aware of**, and that are not linked to worsening symptoms. Alternatively, it could reassure people if their readings remain the same. The committee noted that having people with COPD self-monitor could help empower them to manage their condition but sending the information to a remote centre for monitoring could disempower them and make them less likely to seek help unless prompted by medical personnel.

Appendix
PubMed search terms

Validated tools to diagnose respiratory illness via telehealth search – PubMed search updated from 14 April 2020:

((((("Respiratory illness"[All Fields] OR (("lung"[MeSH Terms] OR "lung"[All Fields]) OR "pulmonary"[All Fields])) (("dyspnoea"[All Fields]) OR "breathlessness"[All Fields])) OR "respiratory"[Title/Abstract]) AND ("review"[Publication Type] OR "systematic"[Filter])) AND ((("telehealth"[All Fields] OR "telemedicine"[MeSH Terms]) OR "telemedicine"[All Fields]) OR "telehealth"[All Fields])) AND ("review"[Publication Type] OR "systematic"[Filter])) AND ((((("assess*"[All Fields] OR "remote assessment"[All Fields]) OR "assessment"[All Fields]) OR "examin*"[All Fields]) AND ("review"[Publication Type] OR "systematic"[Filter]))

PubMed: ("Respiratory illness"[All Fields] OR "dyspnoea"[MeSH Terms] OR "dyspnoea"[All Fields]) OR ("breathlessness"[All Fields] OR "respiratory"[Title/Abstract]) AND ((((("telehealth"[All Fields] OR "telemedicine"[MeSH Terms]) OR "telemedicine"[All Fields]) OR "telehealth"[All Fields])) AND ("assess*"[All Fields] OR "remote assessment" [All Fields] OR "assessment"[All Fields] OR Examin*[All Fields])

Google and Twitter search terms

Google:

- How to conduct respiratory assessment by telehealth
- Conducting remote respiratory assessments
- How to measure breathlessness telehealth
- Pulmonary Rehabilitation Remote Assessment
- Respiratory assessment telehealth

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