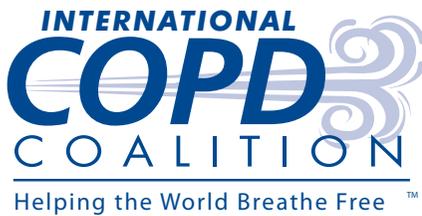


CLINICAL USE OF PULSE OXIMETRY POCKET REFERENCE 2010



GLOBAL PRIMARY CARE AND PATIENT EDUCATION

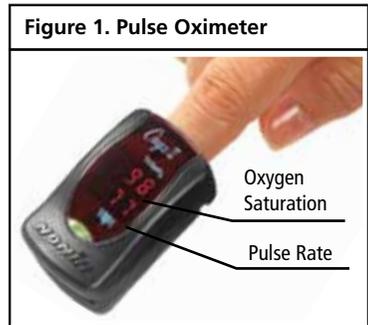
THE PURPOSE OF THIS GUIDE

Chronic respiratory diseases such as COPD and asthma are among the most common health conditions seen in primary care practices, affecting more than 1 billion patients worldwide. Primary care clinicians are also often the first point of contact for patients suffering from acute respiratory infections such as influenza and pneumonia. These health care professionals need tools to help them evaluate, monitor, and decide when to refer patients with respiratory conditions.

Pulse oximetry is a technology that enables the noninvasive measurement of oxygen saturation, contributing to this measure's rapid acceptance as a "fifth vital sign" (in addition to temperature, blood pressure, pulse, and respiratory rate) in clinical assessment. Although the technology has been available since the 1970s, recent advances have reduced the size and cost of pulse oximeters, and as a result these devices (Figure 1) are becoming increasingly used in respiratory patient monitoring in specialty and primary care practice.

In most countries, oximeters are only sold to patients under the guidance of a licensed health care professional, and use by patients should be supervised by their physicians or other qualified health care provider. Incorrect or inappropriate use of oximeters will not provide useful information, and they should be used as part of a broader clinical assessment and not in isolation.

Primary care clinicians have varying levels of awareness of pulse oximetry and knowledge of its proper uses. Therefore, this World Organization of Family Doctors (Wonca) and International COPD Coalition (ICC) guide offers advice for those who wish to use pulse oximeters in patient care. It presents the clinical situations in which the devices are being used and the scientific evidence for such uses, and it points out the limitations of the devices and inappropriate uses.



In addition to scientific articles, we are guided in our recommendations by the expert opinions of the faculty who have overseen the development of this pocket guide. It will be important for clinicians and their patients to monitor the appearance of new published, peer-reviewed clinical research concerning the clinical and home uses of pulse oximetry.

This document was prepared by the Wonca expert panel including Antonio Anzueto, Richard Casaburi, Stephen Holmes, and Tjard Schermer, with Yousser Mohammad, Chair. It was developed in collaboration with the International Primary Care Respiratory Group (IPCRG) and the European Federation of Allergy and Airways Diseases Patients Associations (EFA). The panel members have also solicited input from various experts working in developing countries in order to produce a document that will be relevant to a variety of health care systems and socioeconomic conditions.

BACKGROUND AND PRINCIPLES OF PULSE OXIMETRY

Pulse oximetry is a noninvasive method that enables rapid measurement of the oxygen saturation of hemoglobin in arterial blood. [1] It can rapidly detect changes in oxygen saturation, thus providing an early warning of dangerous hypoxemia. [2, 3]

The use of pulse oximetry for patient assessment and monitoring is well established in critical care, anesthesiology, and emergency departments. [2] In recent years, the availability of small, user-friendly, portable and affordable pulse oximeters, including those worn on the finger-tip has opened up the potential for use of this technique in an expanded variety of clinical settings, including primary care. [4]

A pulse oximeter shines light at two wavelengths—red and infrared—through a part of the body that is relatively translucent and has good arterial pulsed blood flow (e.g., finger, toe, earlobe) (Figure 2a). The ratio of red to infrared light that passes through the measurement site and is received by the oximeter’s detector depends on the percentage of oxygenated versus deoxygenated hemoglobin through which the light passes (Figure 2b). [2] The percentage of oxygen saturation thus calculated is referred to as the percent SpO_2 . [3]

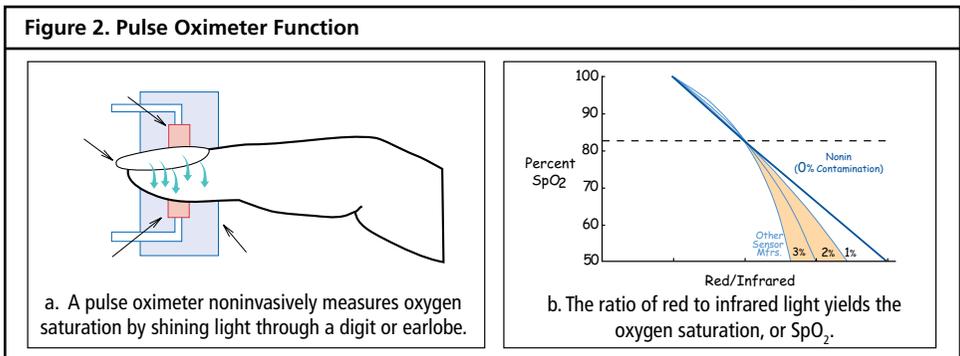


Table 1. Evaluation of SpO_2 measurements
<ul style="list-style-type: none">o An SpO_2 of greater than 95% is generally considered to be normal.o An SpO_2 of 92% or less (at sea level) suggests hypoxemia.<ul style="list-style-type: none">• In a patient with acute respiratory illness (e.g., influenza) or breathing difficulty (e.g. an asthma attack), an SpO_2 of 92% or less may indicate a need for oxygen supplementation.• In a patient with stable chronic disease (e.g., COPD), an SpO_2 of 92% or less should prompt referral for further investigation of the need for long-term oxygen therapy [5, 6].

Pulse oximetry can be a useful aid to clinical decision-making, but is not a substitute for a clinical assessment nor sufficient for diagnosis by itself. [4] Arterial blood gas measurements, obtained by arterial puncture, remain the gold standard for measurement of oxygen saturation. [2] Pulse oximetry is valuable in triaging potentially hypoxic patients in the home, office, and clinic or hospital settings to determine which patients should have arterial blood gas measurements.

CURRENT CLINICAL USES OF PULSE OXIMETRY

A small but growing body of research, detailed in Table 2, is establishing the usefulness of pulse oximetry in primary care, particularly—but not exclusively—for the management of acute and chronic respiratory disease.

In patients with **COPD**, pulse oximetry is useful in stable patients with severe disease ($FEV_1 < 50\%$ predicted), and in patients with worsening symptoms or other signs of an acute exacerbation, as a tool for patients to use at home to assist with their management under physician guidance. It is important to note that pulse oximetry complements, rather than competes with, spirometry in the assessment of COPD patients. Spirometry remains the gold standard for diagnosing and staging COPD, while pulse oximetry provides a method for rapid assessment especially of short-term respiratory compromise.

In patients with **asthma**, pulse oximetry complements peak flow meters in assessing the severity of asthma attacks/exacerbations and response to a treatment.

In patients with **acute respiratory infection**, pulse oximetry is useful in evaluating the severity of the illness and, in conjunction with other criteria, determining whether and how to refer patients for further treatment.

Table 2 gives further details about the recommended indications for use of pulse oximetry in various primary care situations. Recommendations about the use of pulse oximetry in specific primary care situations have also been incorporated into some guideline documents for respiratory care. [For a summary of recommendations from several such documents, see Ref. 7; also see 6, 8, 9, 10, 11.] Although pulse oximeters may also have additional applications in certain health care settings, the most common and best-evidenced primary care uses of pulse oximeters are covered here.

LIMITATIONS OF PULSE OXIMETRY

Despite recent technological improvements, pulse oximeters have some limitations that can affect the accuracy of the measurement. Clinicians should be aware of certain situations where the oximeter reading may not be accurate (Table 3).

In addition, some patients with severe chronic lung disease experience hypoxic drive, in which respiration is driven by low oxygen levels rather than elevated carbon dioxide levels. These patients often have severe disease and may already be on long-term oxygen therapy. This condition does not affect the accuracy of pulse oximetry readings, but it does affect the goals of monitoring and treatment. Specifically, to avoid hypercapnia, for some of these patients the goal should be to maintain SpO_2 at a somewhat lower target (e.g., between 88-92%). [3]

Table 2. Current Clinical Uses of Pulse Oximetry in Primary Care**COPD***Stable disease*

- Establishing a baseline value in patients with stable disease. [4]
- Monitoring of patients with exercise-related dyspnea. [4]
- In patients with moderate to severe COPD, a screening tool to identify patients (i.e., those with $\text{SpO}_2 < 92\%$) who should be referred for comprehensive oxygen assessment. [3]
 - In patients with stable COPD or those recovering from an exacerbation at home, an SpO_2 88% or less is a strong indication to initiate long-term oxygen therapy. [12] However, ideally the decision to initiate oxygen therapy should be made based on arterial oxygen tension ($\text{PaO}_2 < 7.3 \text{ kPa} / 55 \text{ mm Hg}$).
- Titrating oxygen flow setting in patients on long-term oxygen therapy, provided their disease is stable and they have good circulation. In general, the goal should be to maintain $\text{SpO}_2 > 90\%$ during all activities. [7]
- Evaluation of patients with severe disease ($\text{FEV}_1 < 50\%$ predicted), cyanosis, or cor pulmonale for possible respiratory insufficiency/failure. [4, 7]

Exacerbations

- Assessment of patients with acutely worsening symptoms, especially dyspnea, and determination of the severity of the exacerbation. [4, 7]
- Triage for arterial blood gas measurement, referral to emergency department, and/or determination of whether to initiate oxygen therapy or other treatment for exacerbation. [4]
- Monitoring patients after the initiation of oxygen therapy. Measure SpO_2 regularly—every 5 to 30 minutes [13], especially if the patient's clinical condition deteriorates. For patients at risk of hypercapnic respiratory failure, aim to maintain SpO_2 88-92%; for all other patients, aim for SpO_2 94-98%. [14].
- Evaluating patients for initiation of hospital-at-home/intermediate care, and monitoring them once they are enrolled in this form of care. [7]

Asthma*During an asthma attack:*

- Evaluation and assessment of severity, complementing peak flow meter data. [3, 4]
- Triage for arterial blood gas measurement, referral to emergency department, and/or determining when to initiate acute oxygen therapy. [7]
- Monitoring patients after the initiation of oxygen therapy or response to other therapy (see COPD Exacerbations above).
- Particularly important in children with severe acute wheezing. [7]
- Follow-up of patients after a severe or complicated exacerbation. [4]

Acute respiratory infection (e.g., community-acquired pneumonia, influenza, AIDS-related lung infections)

- Assessing the severity of a lower respiratory tract infection. [4]
- Triage for arterial blood gas measurement, referral to emergency department/specialist, and/or determining when to initiate acute oxygen therapy. [4, 7]
- Monitoring patients after the initiation of oxygen therapy (see COPD Exacerbations above).

Breathlessness in children

- Part of clinical assessment for children with suspected significant respiratory tract infection.
- Part of clinical assessment in children with acute asthma. [15, 16, 17, 18]

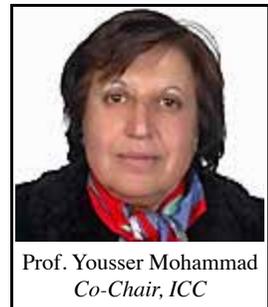
Table 3. Limitations of Pulse Oximetry*	
Conditions	Problem
SpO ₂ values < 80%	Pulse oximeters can overestimate oxygen saturation, particularly in those with darkly pigmented skin. [19]
Poor perfusion (cold digits) due to hypotension, hypovolemic shock, cold environment, or cardiac failure	May result in the machine not providing a reading. [3]
Anemia	Oxygen delivery to tissues is inadequate but SpO ₂ is normal.
Carbon monoxide poisoning	Carbon monoxide binds to hemoglobin, resulting in inadequate oxygen transport despite normal pulse oximeter readings. [3]
Certain antiretroviral medications	Affect oxygen's affinity for hemoglobin. [20]
Movement, shivering patient, heart arrhythmias	Oximeter may not be able to identify an adequate pulse signal. [3]
Nail polish, dirt, artificial nails	Can cause false low readings or no readings. [3]
Bright artificial light (as in an operating room)	Can cause false low readings. [3]
Older patients	Normal oxygen saturation levels may be slightly lower than in younger people. [3]
Sickle cell disease	Does not confound SpO ₂ results in adults [21], but may in children. [22]

* Consult manufacturers' recommendations regarding the effects of low perfusion and performance in darkly pigmented skin.

HOME USE OF OXIMETRY

Dear Patient,

A pulse oximeter is an indispensable tool that helps your physician or other health care provider measure the amount of oxygen in your blood when you visit a clinic or hospital. Small, simple to use, battery-powered pulse oximeters are also available to use at home. Monitoring your oxygen saturation level (or SpO₂) will help you to adjust your oxygen flow at home, during exercise, and during social activities. It can also assist your doctor in deciding if your COPD is getting worse. Pulse oximetry can save you time, anxiety, and doctor visits, and in general helps you live an active life with respiratory disease.



Your doctor or other health care professional will give you more details on how to use your oximeter. Here are some basic principles:

- Simply attach the oximeter to your finger and wait until the screen indicates your SpO₂—the proportion of oxygenated hemoglobin in your blood. This number reflects the amount of oxygen available in your blood to deliver to your heart, brain, lungs, and other muscles and organs.

- The oximeter will also indicate your pulse rate on the screen.
- Your doctor may ask you to keep a record of your home oximetry measurements on a chart.
- In general, you should work with your doctor to learn how to adjust your oxygen flow rate as needed to keep your SpO₂ **above** 90 to 92%.

The following table provides further tips for you and your family in the use of home oximetry initiated by your primary care doctor.

Table 4. Home Oximetry Tips for Patients [23]
Home oximetry goals
<ul style="list-style-type: none"> • Your doctor will prescribe the specific oxygen saturation target for you, and the regular flow rate that should usually keep your oxygen saturation at that level. A self-management plan or your doctor’s instructions will let you know how and when to adjust your oxygen flow. In general, maintaining oxygen saturation over 90% in all activities is the goal.
When to use your oximeter
<ul style="list-style-type: none"> • You can use your oximeter at rest or during activities, such as walking or other exercise. • However, your oximeter should not be submerged in water.
Titration of oxygen flow
<ul style="list-style-type: none"> • With your doctor’s guidance, you can use your oximeter to help you “titrate” your oxygen flow, adjusting the setting to make sure you are getting the right amount of oxygen in any situation. • More oxygen is often needed during physical activity, which can include activities of daily living. • More oxygen is often needed when you are traveling on an airplane. • By learning the lowest flow rate on your portable oxygen device that provides your target oxygen saturation, you can increase the duration of your oxygen supply. This gives you more time away from home, more time between refills, and more confidence that you have enough oxygen with you. • With your doctor’s okay, you might like to find out how long your oxygen saturation remains above 90% when your oxygen is turned off. This can give you a feeling of confidence if your oxygen flow is stopped for a short period. Pursed-lip breathing can help elevate your oxygen saturation in this scenario.
Troubleshooting
<ul style="list-style-type: none"> • Nail polish (especially dark shades) and/or artificial nails may affect the oximeter’s performance. • Accurate oxygen measurements by oximetry require a good blood flow through the tissues. When your fingers are cold, the blood flow is reduced and poor or abnormal readings are possible. Warming the hands by rubbing them together or with warm water helps improve blood flow. • Do not smoke! Smoking reduces the amount of oxygen reaching your tissues—while the oximeter will falsely suggest that oxygen level is satisfactory. • You may be more short of breath when your oxygen is low, but oxygen alone may not fully not relieve shortness of breath. Exercise training and pulmonary rehabilitation are usually helpful in this situation.
Warning signs
<ul style="list-style-type: none"> • A sudden drop in your oxygen level—for example during a severe cold or the flu—can be a sign of trouble. Call your doctor if your normal oxygen setting is no longer maintaining your saturation and you feel sick. Also, call your supplier if you feel your oxygen system is not working. • A high resting pulse rate of greater than 100 or a low pulse of less than 40 (check with your doctor to determine your individual pulse ranges) are also reasons to call your doctor. • During a severe breathing attack, it is possible to have a normal oxygen level. Seek medical help if you have severe shortness of breath, wheezing, or increased pulse rate, even if your oxygen saturation is normal.

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