



## Pulse Oximetry at Home

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### INTRODUCTION

The use of pulse oximetry at home has expanded over the past twenty years and is expected to be one of the major growth areas in home monitoring during the next decade.<sup>1</sup> Initial use at home in the early 1990s focused on continuous monitoring with home mechanical ventilation and sleep studies.<sup>2-6</sup> Intermittent spot-check use at home has become more common in recent years with conditions such as Chronic Obstructive Pulmonary Disease (COPD), Congestive Heart Failure (CHF) and others requiring longterm oxygen therapy. Self-monitoring enables patients to become more active participants in their health care. As the population ages and the incidence of pulmonary and cardiac diseases continue, home pulse oximetry can provide objective data for determining health status and the possible need for medical consultation or interventions.

The type of patient being monitored along with the complexity of the medical situation can help drive the decision to use a continuous, alarmed device or a simpler spot-check device. A patient in a more severe state, such as dependence on a ventilator or life-support system, is more likely to require continuous monitoring, while others will be sufficiently served with a spot-check device.

The use of spot-check devices can eliminate the “nuisance alarm” situations sometimes encountered with continuous use and are easy for a patient to use. If spot checks are sufficient, proven fingertip pulse oximeters such as Nonin’s Onyx® 9500, Onyx® II 9550 and GO2™ are useful in providing assurance and peace of mind to the patient and family.

The first fingertip oximeter, Onyx 9500, was introduced in 1995 by Nonin Medical which revolutionized the portability and availability of pulse oximetry to both caregivers and individual patients. Fingertip pulse oximeters are portable, battery operated, and user friendly. However, other factors to consider when choosing a personal device are durability and accuracy. Quality fingertip pulse oximeters can yield solid results and provide an assessment of oxygen status and health stability in the homecare setting.

With fingertip pulse oximeters being introduced to the market, patients and caregivers alike will have added questions on how to choose and use a fingertip pulse oximeter in the home environment. Throughout this paper, we will describe our experience in using fingertip pulse oximeters in the home environment, as well as the key features and functions to consider when choosing a quality fingertip pulse oximeter for home health use.

### THE UNIVERSITY OF COLORADO HOSPITAL – INTEGRATED eHEALTH HOME PROGRAM

At the University of Colorado Hospital, we incorporated the use of home pulse oximetry spot-checks into the, “Integrated eHealth for COPD” remote home monitoring program from 2004 to 2009.<sup>7-11</sup> Three formal studies were conducted with over 650 patients enrolled. At the enrollment clinic visit, patients were assessed at rest and during a six minute walk test (defined as “exercise” for this group). Patients enrolled in the “treatment” group received a personal fingertip pulse oximeter, a Health Buddy® telecommunication device and other monitoring equipment for use in the home.

For the majority of participants in our project, we chose the Onyx II 9550 fingertip pulse oximeter, which is widely used in the hospital setting and by the US military, for its proven durability in the most challenging environments. All units proved durable throughout the program and the only replacements resulted from missing or lost devices. (See below for key features and functions.)

## Ideal Features and Functions for Spot-Check Oximeters

### Feature

- Small and portable
- Lightweight
- Easy to use
  - Automatic on/off
  - Simple battery changes
  - Easy-to-read results
- Fits all finger sizes

### Function

- Reliable - meets  $\pm 2$  accuracy like other oximeters
- Works with a variety of blood pressures and perfusion levels
- Accurate to 70% saturation
- Accurate with some motion
- Durable – able to withstand drops and some moisture

We instructed patients to check their oxygen saturation each morning at rest and at the completion of their sixminute walk. Patients were able to use the pulse oximeter beyond these specific times if desired. The personal fingertip oximeters were one of the most important pieces of equipment used in the program; often providing an early warning of deteriorating conditions. The opportunity to use a personal fingertip oximeter was also one of the main reasons people reported a willingness to enroll in the program.

The Nonin Onyx II 9550 fingertip oximeter was used as part of the largest controlled trial with these patients. Five hundred and eleven patients were assessed with the Onyx II 9550 at the clinic during enrollment and completion visits. Additionally, 352 of the 511 participants were randomized to the treatment group and received Onyx II 9550 oximeters to use at home. The remaining participants were in the control group and thus did not have a personal oximeter as part of the program.

In addition to serving as an early warning of health deterioration, the use of the Onyx II 9550 proved to be beneficial on several levels:

- Improved control of oxygen delivery both at rest and during exercise – as a result of feedback that enabled patients to better understand their oxygen needs
- Pulse rate could be assessed, and exercise goals established based on the pulse rate
- Anxiety related to shortness of breath and oxygen use were reduced
- Improved delivery of evidence-based care by incorporating oximetry assessments

Consistent with our experience in the clinic environment, the Onyx II 9550 was successfully used in a variety of patient sizes, skin colors, and perfusion levels.<sup>12</sup> The fact that the Onyx II 9550 accommodates a wide range of finger sizes (0.3-1.0in or 8mm-26mm) made it possible to monitor patients ranging from the smallest little lady with emphysema, to the tallest rotund man with chronic bronchitis and congestive heart failure. The engineering of the spring mechanism ensures the correct pressure is attained without occluding perfusion to the monitoring site.

The use of a personal oximeter enabled patients to note oxygen saturation levels and better control the oxygen delivery to achieve appropriate oxygenation levels both at rest and during exercise. As it can be extremely



difficult for some people to face the need for supplemental oxygen, patients were able to recognize their desaturation episodes and, in many cases, realize that their doctor's advice to wear oxygen was indeed appropriate. (The fact that they could see the actual oxygen saturation levels during different activities of daily living opened a window of understanding for most patients.)

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The personal fingertip oximeters also helped to reinforce that exercise is possible and can be performed safely. They also provided objective information to the care coordinator who worked directly with the patient by phone. If the individuals were able to stay well-oxygenated while moving, pulse rate was less likely to reach excessively high levels and the patients were able to complete activities with more comfort. Having impartial data to reference in addition to the patient's subjective feedback enabled the caregiver to establish realistic and personalized activity/exercise goals.

While specific levels of anxiety related to shortness of breath and oxygen use were not assessed in this study, we had many anecdotal examples of anxiety being reduced. For example, one gentleman frequently missed medical appointments partly due to anxiety related to extreme shortness of breath experienced as he walked to his car. By regularly using his fingertip oximeter, he learned to pace himself and accomplish the transition without becoming anxious and dyspneic. This anxiety factor has also been documented in a Japanese study in which remote telemedicine support was used.<sup>13</sup> Because of the ease of transporting the fingertip oximeter, many people carried the oximeter with them at all times. This was helpful to their self-management as the oximeter allowed them to check their saturation at times when they were feeling short of breath or doing additional exercise.

By using the fingertip oximeters, we were able to document better adherence to the evidence-based guidelines of the Global Obstructive Lung Disease (GOLD) committee related to oxygen administration.<sup>14</sup> The oximeters helped to identify a significant problem with oxygenation during exercise for many of the COPD patients. During the course of the program, emphasis was placed on adequate oxygen titration to achieve oxygen saturation levels of 90% or greater during rest and exercise. This was accomplished with reliable oximetry monitoring, titration of oxygen and cooperation between patients, care providers (primary care and pulmonologists), home oxygen companies, and eHealth program care coordinators. In cases of dropping saturation, the assigned care coordinator contacted the patient and conducted a telephone interview and helped to facilitate calls to the appropriate health care provider or home oxygen company.

Given that the patient population was GOLD stage III and IV COPD (according to the Global Obstructive Lung Disease Guidelines), several comorbidities were also a concern within the patient group. The Onyx II 9550, with its proven low perfusion and pulse rate accuracy, delivered reliable results even with varying blood pressures and perfusion abilities. Dependable accuracy is especially important for the home-monitoring environment since a professional health care provider is not always present to further evaluate the patient's status.



The “ease of use” factor is also important from the health care provider’s perspective when training patients on use and assisting with troubleshooting. We found that by demonstrating the use of the fingertip oximeter and then having the patients use their device several times during the enrollment evaluation visits that they were well prepared to use them at home. We also gave them a small notebook to document their results. Each day patients entered their oxygen saturation, both at rest and following exercise, into their Health Buddy® device.

The Onyx II 9550 is especially patient friendly with automatic turn-on and turn-off mechanisms and easy battery change access. The two AAA batteries included with the units allow for 2500 spot-checks. With instructions to check their devices at minimum twice a day, we did not anticipate patients would need to change batteries during their nine-month enrollment. However, most participants presumably used them more often which resulted in the need for some to change batteries. For those units that did require battery changes, the changes were easily accomplished at home by the patient.

At the completion of the program, mean oxygen saturation with exercise was improved. Patients’ ability to walk a greater distance in six minutes was also improved and dyspnea levels were reduced. All of these factors most likely contributed to the improved quality of life scores that were also obtained with the treatment group participants in the program. In addition, health care expenses were projected to be reduced.<sup>7</sup>

## CAUTIONS

Home oximetry with spot checks is appropriate for intermittent monitoring situations that do not require continuous, alarm-set monitoring. Although the noninvasive nature of pulse oximetry has added value in the homecare setting, it does have some limitations. Pulse oximetry uses two wavelengths of light in producing results compared with the laboratory-based “gold standard” hemoximeters that measure blood oxygen saturation levels via four or more wavelengths. However, an invasive arterial blood gas (ABG) is required for the laboratory analysis. Measurement via ABG becomes important if the patient is a heavy smoker since carboxyhemoglobin cannot be discerned by pulse oximeters; a pulse oximeter may read erroneously high with heavy smokers or in rare situations of smoke inhalation.<sup>15</sup> Methemoglobinemia (a high level of methemoglobin in the blood) will also cause a false high reading in the pulse oximeter. This can be a factor if the patient is taking sulfa drugs.<sup>16</sup> Both conditions are rare, but worth noting for this patient population.

## CONCLUSIONS

The fingertip oximeter market has expanded significantly in recent years and promises to expand further with the increased use in the home setting. Our experience at the University of Colorado Integrated eHealth Program demonstrated successful use at home; patients were able to competently use the fingertip oximeter without problems.

The Onyx II 9550 functioned without fail in a variety of patients with different skin tones and varying perfusion levels. Oximetry helped to identify problems early so that interventions could be planned before problems requiring intensive medical care became necessary. The ability to monitor these severe COPD patients was important and helped to identify and correct a widespread problem related to oxygen desaturations and exercise.

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