

DE NOVO CLASSIFICATION REQUEST FOR ORi

REGULATORY INFORMATION

FDA identifies this generic type of device as:

Hyperoxia monitoring device adjunct to pulse oximetry. A hyperoxia monitoring device adjunct to pulse oximetry is a device that monitors elevated hemoglobin oxygen saturation levels as an adjunct to arterial oxygen saturation monitoring.

NEW REGULATION NUMBER: 21 CFR 870.2720

CLASSIFICATION: Class II

PRODUCT CODE: QWE

BACKGROUND

DEVICE NAME: ORi

SUBMISSION NUMBER: DEN200076

DATE DE NOVO RECEIVED: December 21, 2020

SPONSOR INFORMATION:

Masimo Corporation
52 Discovery
Irvine, CA 92618

INDICATIONS FOR USE

The ORi feature is intended to be used in patients undergoing surgery as an adjunct to SpO2 for increased monitoring resolution of elevated hemoglobin oxygen saturation levels (e.g., due to the administration of supplemental oxygen).

The ORi feature is indicated for the monitoring of hemoglobin oxygen saturation levels in patients 18 years and older (adults and transitional adolescents) on supplemental oxygen during no-motion conditions perioperatively in hospital environments.

LIMITATIONS

The sale, distribution, and use of the ORi are restricted to prescription use in accordance with 21 CFR 801.109.

The device is not intended to be used as a stand-alone diagnostic device.

The device output does not reduce the operator's responsibility for informed clinical judgement and best clinical procedure.

The ORi feature is an adjunct to SpO2 only to be used in titration of supplemental oxygen in patients over age 18 undergoing surgery.

Arterial blood gas analysis remains the gold standard in diagnosis of hypoxemia.

PLEASE REFER TO THE LABELING FOR A COMPLETE LIST OF WARNINGS, PRECAUTIONS AND CONTRAINDICATIONS.

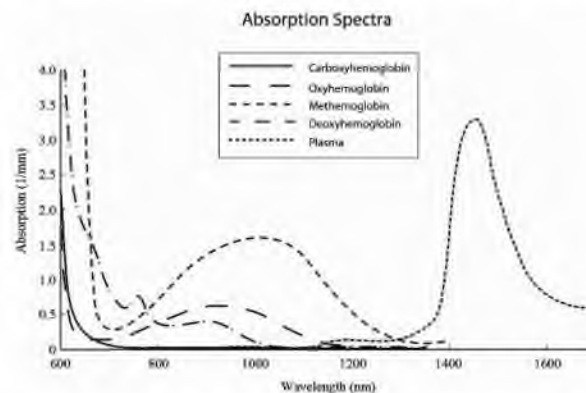
DEVICE DESCRIPTION

ORi is a device that provides an adjunct oximeter function that extends the monitoring resolution of hemoglobin oxygen saturation at elevated oxygen levels (e.g., due to the administration of supplemental oxygen). The feature is intended to be used in conjunction with SpO2 monitoring provided by a pulse oximeter. The ORi feature utilizes the similar principles of operation as pulse oximetry, utilizing hemoglobin wavelength absorption characteristics to determine relative blood oxygen saturation. Whereas SpO2 monitoring provides visibility to blood oxygen saturation in the transition from normoxia to hypoxia on the hemoglobin oxygen disassociation curve, ORi provides visibility to the transition from normoxia to hyperoxia.

Principle of Operation

The ORi feature is an index that relies on the same principles of operation used in pulse oximetry to increase the resolution of the monitoring of hemoglobin oxygen saturation under elevated blood oxygen levels. Like pulse oximetry (SpO2 monitoring), ORi utilizes the well understood absorption profile characteristics of hemoglobin to absorb red and infrared wavelengths of light differently based upon it being bound to oxygen (oxyhemoglobin) or unbound to oxygen (deoxyhemoglobin). See Figure 12.1 which illustrates the different absorption characteristics of hemoglobin based upon its oxygenation state.

Figure 1 – Absorption Spectra of Hemoglobin



In SpO₂ monitoring, red and infrared light is passed through a capillary site, such as the fingertip, to measure the difference in the absorption characteristics at the two different wavelengths to determine the ratio of oxygenated and deoxygenated hemoglobin, presented as SpO₂. Similarly, ORi utilizes the same red and infrared wavelengths of light to measure the same ratio of oxygenated and deoxygenated hemoglobin at the same capillary sites. The difference with ORi is that additional wavelengths of light are used to provide additional absorption characteristics to help increase monitoring resolution at higher blood oxygen levels. The output is a numerical value on a 0 to 1 scale. When SpO₂ values are below 96%, ORi will always display as 0. When SpO₂ is at 96% or above ORi ‘provides visibility to the transition from normoxia to hyperoxia’. The device includes high limit alarm with a threshold of ORi value 0.7.

Figure 2 – Illustration of the Graphical Display of ORi



Mechanism of Action for Achieving the Intended Effect

ORi achieves its intended effect through a multi-wavelength optical sensor that is applied to a capillary site of the patient. Multiple wavelengths of light are passed from the sensor emitter through the capillary site to a photodetector. The absorption profiles at the different wavelengths of light are then processed to provide a numeric index that represents the patient’s blood oxygen at higher blood oxygen levels. The numeric index is displayed on a monitor (e.g., Rad-97, Radical-7, and Root) along with the SpO₂ values enabled through the same optical sensor. At the

upper limit where the sensitivity of ORi is diminished, the numeric value is fixed and no longer provides additional numeric increases. At this point, the changes in the index are reflected only through a directional indicator or a trend line. At the lower limit where SpO2 values are known to have sufficient resolution (i.e., SpO2 values below 96%), the numeric index is designed to provide no value or 0.

SUMMARY OF NONCLINICAL/BENCH STUDIES

BIOCOMPATIBILITY

Biocompatibility testing for the ORi device were leveraged from the previously cleared device, Masimo Root Monitoring System and Accessories cleared under K171121, because the patient contacting components are identical to those of the subject device.

REPROCESSING/CLEANING

Similarly, reprocessing testing was leveraged from the previously cleared device, Masimo Root Monitoring System and Accessories cleared under K171121.

ELECTROMAGNETIC CAPABILITY & ELECTROMAGNETIC SAFETY

The ORi is a medical device installed on a previously cleared device, Masimo Root Monitoring System and Accessories cleared under K171121. The electrical safety and EMC tests are leveraged from a prior 510K submitted for the subject device.

SOFTWARE

Software documentation for ORi was provided according to the FDA Guidance Document, *Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices*, issued May 11, 2005. The software was found to have a Moderate Level of Concern as malfunction of the device software or a latent design flaw in the device software may lead to an erroneous diagnosis or a delay in the delivery of appropriate care, which would likely result in minor injury but would likely not result in serious injury or death due to the availability of other patient vital signs.

The software documentation addressed the ORi algorithm and implementation on the host Radical-7 pulse oximeter and included:

1. Software Description
2. Level of Concern
3. Device Hazard Analysis
4. Software Requirements Specification
5. Architecture Design Chart
6. Software Design Specification
7. Traceability Analysis
8. Software Development Environment Description
9. Verification and Validation Documentation

10. Revision Level History
11. Unresolved Anomalies

ORi validation testing was performed to demonstrate the device software meets its performance requirements using patient data. Additional details are provided in the “Summary of Clinical Information” section.

SUMMARY OF CLINICAL INFORMATION

To support the current IFU, a total of 206 subjects with a total of 2330 data pairs (SpO₂, SaO₂) from two retrospective and one prospective study were submitted by the sponsor for calculation of the ORi values. The retrospective studies were conducted on 52 healthy volunteers (Masimo desaturation laboratory study) and 126 hospitalized participants (Loma Linda) while the prospective study (UC Davis) was conducted on 28 hospitalized patients. Importantly, the two clinical studies on hospitalized patients were conducted on those undergoing general anesthesia.

There were no adverse events when the device was used with concomitant SpO₂ monitoring in the operating room environment on patients receiving supplemental oxygen. While there were no study sub-analyses for subpopulations such as but not limited to obese, neonatal, and post-arrest, the device demonstrated benefits for detection of changing PaO₂ in the range of 100 to 250mmHg better than pulse oximetry alone. In this way, benefit-risk profile was determined to be favorable for the intended patient populations for the intended use as prescribed by the current IFU.

Labeling mitigates the high intra- and inter-subject ORi variability with respect to PaO₂. However, the pooled data demonstrated an AUC >0.8 in PaO₂ ranges from 100-250mm Hg. When used with pulse oximetry, the trend of ORi values is beneficial to titrate O₂ delivery in surgical patients receiving supplemental O₂ therapy.

Specifics of the clinical studies are as below:

Masimo Clinical Lab: 52 subjects with 939 data pairs were collected during stable plateaus when FiO₂ was changes in a stepwise fashion. A pair of arterial blood samples were drawn at each FiO₂ level and the reference PaO₂ blood gas values was collected by using an ABL blood gas analyzer. *These reference PaO₂ values were time synched along with the ORi values and stored in the CDB file.*

University of California, Davis: 28 subjects undergoing general anesthesia induction had 140 data pairs (ORi and ABG) drawn at 4 time points: baseline, during oxygenation, induction, and laryngoscopy for endotracheal intubation.

Loma Linda University: 126 subjects undergoing elective surgery where supplemental oxygen was administered had 1251 data pairs drawn for analyses. ABG convenience samples were obtained as part of standard of care.

The retrospective study utilized data previously collected prospectively. Subjects included in this study were those who had rainbow R1 25 disposable sensors applied which were in turn connected to a Masimo monitoring system (Radical-7 and Root monitor). The Masimo

monitoring system should have collected data that was continuously logging ORi values or the necessary raw sensor wavelength absorption data to retrospectively calculate the ORi value.

The ORi feature extends monitoring resolution to the hemoglobin oxygen saturation under supplemental oxygen delivery as an adjunct to SpO2 in the range of PaO2 100 to 250 mmHg. The ORi device is to be used in patients undergoing surgery as in the presented clinical data. The retrospective calculation of the ORi in data collection in 2 of the 3 studies demonstrates a non-linear relationship of ORi to PaO2; there is ORi variability between subjects, and within the same subject.

One study demonstrates use of the device in concurrent determination of PaO2 by arterial blood gas analysis with ORi recording during induction of general anesthesia with the associated changes in oxygenation.

The pooled data demonstrated an AUC > 0.8 in determination of PaO2 for the range 100 - 250mmHg when compared to SpO2. The percentage of range of ORi was greater than that of SpO2 for the same PaO2 values.

The ORi feature is based on wavelength technology the same as with the SpO2 in pulse oximetry. This technology has been shown to have a positive bias in darkly pigmented individuals (Sjoding, 2020).

The UC Davis study was a prospective study with concurrent use of ORi and SpO2 during induction of general anesthesia in the operating room, it supports the proposed indications for use, and represents the real world clinical scenario.

While there are benefits for detection of impending oxygen desaturation and for monitoring of moderate hyperoxia, there are no analyses shown to assure accuracy for subpopulations of users (eg. obese, neonatal, post arrest). Pooled retrospective data analyses of adults (ages 21 to 86 years) are included in the studies.

Pediatric Extrapolation

For medical devices, the FD&C Act defines patients before their 22nd birthday as pediatric patients. ORi is indicated for patients ages 18 years and older, which includes transitional adolescents and adults. The Loma Linda clinical studies provided data that supported the use of ORi in subjects 18 years and older.

LABELING

ORi labeling consists of Instructions for Use that includes a summary of the clinical evaluation, and a summary of baseline demographic information and where appropriate, subgroup analyses for age, race, ethnicity, gender and/or sex.

The Instructions for Use also includes appropriate warnings and cautions associated with over reliance on device output in clinical setting.

ORi is an adjunct to SpO2 monitoring in the setting of the operating room with supplemental oxygen administration.

Labeling instructs the user to safely and accurately use the device according to the intended use in the intended use environment as below:

- Arterial blood gas remains the gold standard in diagnosis of hypoxemia. Reliance on other monitoring (pulse oximetry/SaO2 and ABG/PaO2) remains unchanged with use of ORi (i.e., ORi is an adjunct not a replacement for other monitoring). The trend of ORi correlates with PaO2. For changes in ORi values, whether decreasing or increasing, check the patient first. Changes in cardiopulmonary status can affect oxygenation.
- Instructions on acute decreases in ORi including appropriate troubleshooting and data interpretation such as checking delivery of O2 to patient, need to reposition sensor, clinical/cardiovascular changes and patient status that may contribute to findings

RISKS TO HEALTH

The table below identifies the risks to health that may be associated with use of a hyperoxia monitoring device adjunct to pulse oximetry and the measures necessary to mitigate the risks

Risks to Health	Mitigation Measures
Inaccurate measurement of hyperoxia or hypoxia leading to escalation of unneeded therapy and false reassurance	Clinical performance testing
Incorrect or delayed treatment due to over-reliance on device output for clinical decision-making without using arterial blood gas values for confirmation	Clinical performance testing Human factors/usability testing Labeling
Procedure delay or inaccuracy due to software failure or corruption in data transfer	Software verification, validation, and hazard analysis
Patient or operator injury due to electrical hazards	Electrical safety testing Electromagnetic compatibility testing
Adverse tissue reaction	Biocompatibility evaluation
Inaccurate measurement or infection due to unclean surfaces	Reprocessing validation Labeling

SPECIAL CONTROLS

- (1) Clinical performance testing under anticipated conditions of use must evaluate the accuracy of hyperoxia monitoring by the device and evaluate all adverse events.

- (2) Human factors/usability testing must demonstrate that the user can correctly use the device, based solely on reading the instructions for use.
- (3) Performance data must demonstrate the electromagnetic compatibility (EMC) and electrical safety of the device.
- (4) The patient-contacting components of the device must be demonstrated to be biocompatible.
- (5) Performance testing must validate the reprocessing instructions for the device, including demonstration of device performance after repeated cleaning and disinfection.
- (6) Software verification, validation, and hazard analysis must be performed. Performance testing must demonstrate compatibility with pulse oximeter devices labeled to be compatible with the device.
- (7) Labeling must include:
 - (i) Cleaning and disinfection instructions;
 - (ii) A summary of the clinical performance testing with the device;
 - (iii) A warning against over-reliance on device output without using arterial blood gas values for confirmation; and
 - (iv) Instructions to monitor oxygen delivery and patient clinical/cardiovascular status when device output changes.

BENEFIT-RISK DETERMINATION

The probable risks of the device are based on data collected in a clinical study(ies) described above.

1. Adverse events such as pulmonary fibrosis, retinopathy of prematurity caused by hyperoxia due to inaccuracy of measurement.
2. Incorrect or delayed treatment due to over-reliance for clinical decision making without using arterial blood gas values.
3. Users without expertise operating the device leading to adverse events or ineffective procedures.
4. Incorrect or delayed treatment due to use outside of intended use environment.
5. Procedure delay due to corruption in data transfer.

The probable benefits of the device are also based on data collected in a clinical study(ies) as described above.

1. Benefits in detection of impending oxygen desaturation and for monitoring of moderate hyperoxia.
2. Monitoring resolution to the hemoglobin oxygen saturation under supplemental oxygen delivery as an adjunct to SpO₂ in the range of PaO₂ 100 to 250 mmHg

The retrospective calculation of the ORi in data collection demonstrates a non-linear relationship of ORi to PaO₂, however, there is ORi variability between subjects, and within the same subject. Subpopulations, including vulnerable ones, have not been individually identified, studied, or analyzed. This uncertainty is addressed through labeling and special controls. The device is limited to specific users and environment of use, and has a high limit alarm threshold of ORi 0.7. Special controls warn against use outside of an adjunct to pulse oximetry.

Patient Perspectives

This submission did not include specific information on patient perspectives for this device.

Benefit/Risk Conclusion

In conclusion, given the available information above, for the following indication statement:

The ORi feature is intended to be used in patients undergoing surgery as an adjunct to SpO₂ for increased monitoring resolution of elevated hemoglobin oxygen saturation levels (e.g., due to the administration of supplemental oxygen).

The ORi feature is indicated for the monitoring of hemoglobin oxygen saturation levels in patients 18 years and older (adults and transitional adolescents), on supplemental oxygen during no-motion conditions perioperatively in hospital environments.

The probable benefits outweigh the probable risks for the ORi device. The device provides benefits, and the risks can be mitigated by the use of general controls and the identified special controls.

CONCLUSION

The De Novo request for the ORi is granted and the device is classified as follows:

Product Code: QWE

Device Type: Hyperoxia monitoring device adjunct to pulse oximetry

Regulation Number: 21 CFR 870.2720

Class: II