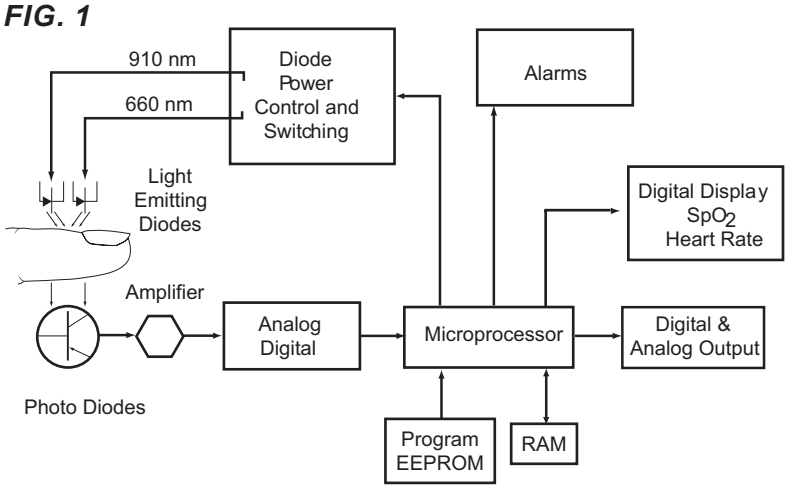
Principles of Pulse Oximetry

Introduction

Pulse oximeters provide a spectrophotometric assessment of functional arterial hemoglobin oxigenation (SpO2). Pulse Oximetry is based on the following two principles: First, hemoglobin (Hb) and oxygenated hemoglobin (HbO2) differ in their absorption of red and infrared light. Second, the volume of arterial blood in tissue (and therefore light absorption by the hemoglobin) changes during the pulse. A pulse oximeter passes red and infrared light into an arteriolar bed, measures changes in light absorption, and determines SpO2.

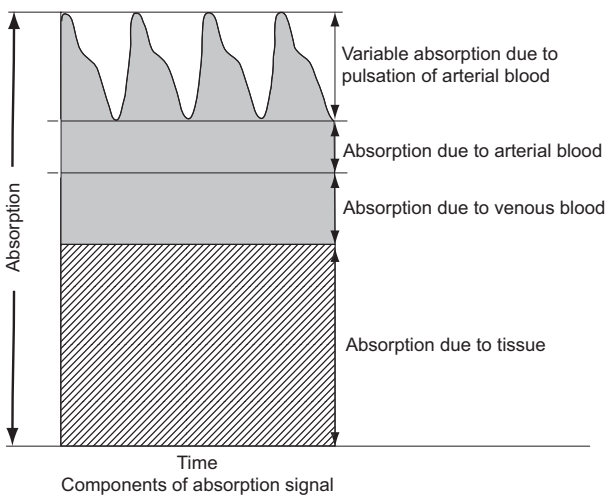
FIG. 1



How Pulse Oximeters Work

Pulse oximeter sensors have red and infrared low voltage light emitting diodes (LEDs) wich serve as light sources. The emitted light is transmitted through the tissue, then detected by the photodetector and sent to the microprocessor of the pulse oximeter (Figure 1) All constituents of the human body, venous and arterial blood, and tissue absorb light (Figure 2). The pulsating of arterial blood results in changes in the absorption to to added hemoglobin (Hb) and oxygenated hemoglobin (HbO2) in the path of the light. Since HbO2 and Hb absorb light to varying degrees, this varying absorption is translated into plethysmographic waveforms at both red and infrared wavelengths (Figure 3). The relationship of red and infrared plethysmographic signal amplitude can be directly related to arterial oxygen saturation. For example, when the plethysmographic amplitude ad 660nm and 910nm are equal and the ratio R/IR=1, the SpO2 is approximately 85% (Figure 4).

FIG. 2



Components of absorption signal

Calibration of Pulse Oximeters

The light absorption by hemoglobin is wavelength dependant. Mediaid Inc. red and infrared wavelengths are tightly controlled by testing each individual sensor. The LED intensity is auto-matically adjusted for amplitude. This allows Mediaid Inc. pulse oximetry sensors to be use interchangeably without calibration.

FIG. 3

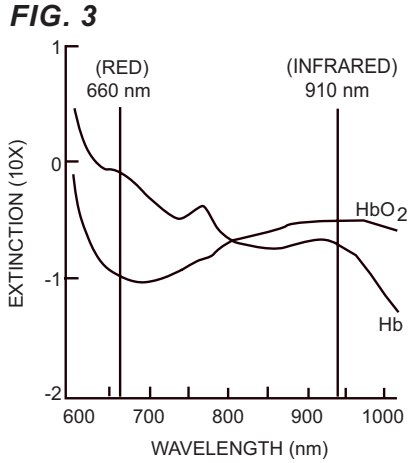
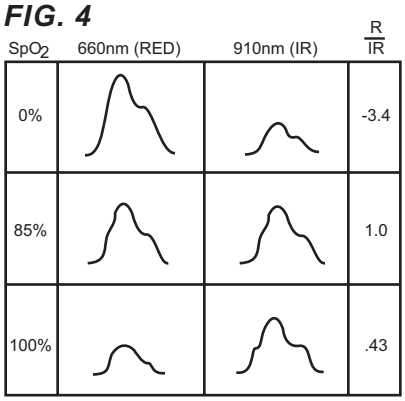


FIG. 4



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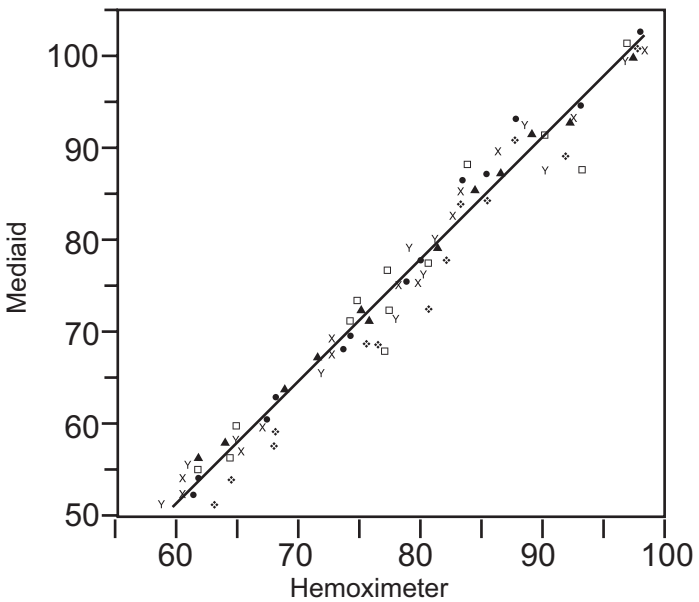
Validation of Accuracy

Mediaid Inc. pulse oximeters and sensors are tested for accuracy at the Anesthesia Research Laboratory at the University of California Medical Center in San Francisco. Validation consists of inducing hypoxemia in healthy subjects and comparing pulse oximeter readings (SpO2) using arterial samples. Figure 5 & 6 compare results from a typical Mediaid pulse oximeter and a Nellcor N-200. Both instruments show a small bias and similar distribution of sampling points.

FIG. 5

Mediaid by Hemoximeter



Linear Fit

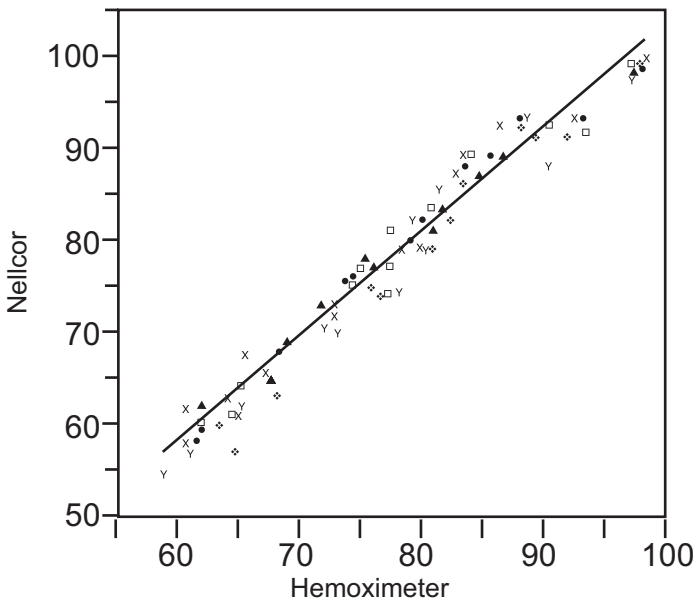
Palco 1 = 2.88649 + 0.95822 Hemoximeter

Summary of Fit

RSquare 0.970468
RSquare Adj 0.970079
Root Mean Square Error 1.840107
Mean of Response 77.74423
Observations (or Sum Wgts) 78

FIG. 6

Nellcor by Hemoximeter



Linear Fit

Nellcor = -10.165 + 1.13615 Hemoximeter

Summary of Fit

RSquare 0.963883
RSquare Adj 0.963408
Root Mean Square Error 2.421018
Mean of Response 78.59295
Observations (or Sum Wgts) 78

Clinical use of Pulse Oximetry

Pulse oximeters may be used in a variety of situations that call for monitoring oxygenation and pulse rates. Pulse oximeters increase patient safety by alerting the hospital staff to the onset of hypoxia during or following surgery. Oximeters confirm adequate oxygenation during mechanical ventilation. Physician and dental offices utilize pulse oximetryfor spot checking respiratory status, as well as for monitoring during procedures that call for sedation. Truly, pulse oximetry is the fifth vital sign, essential to complete patient monitoring.

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