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Clinical update

The role of pulse oximetry in chiropractic practice: a rationale for its use

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Abstract
Objective: Pulse oximetry is used regularly to assess oxygen saturation levels. The objective of this commentary is to discuss a rationale for using pulse oximetry in chiropractic practice.
Discussion: Pulse oximetry may offer doctors of chiropractic a way to monitor patients' oxygen saturation levels. Quantification of saturation values with heart rate may give clinical aid to the management of chiropractic patients. Markedly reduced saturation levels may necessitate medical referral, whereas mildly reduced levels could lead to changes in chiropractic management.
Conclusions: Pulse oximetry has the potential to be an integral part of chiropractic practice.

Introduction

Pulse oximetry is a standard measure of peripheral arterial oxygen saturation in many health care venues. It has become a routine assessment in critical care units,[1] labor and delivery units,[2] paediatrics,[3] dentistry,[4] and even veterinary medicine.[5,6] Some professionals believe it is so important that it has been called the *fifth vital sign*.[7-11] The prevalence of undersaturation in the general population has yet to be determined, but is estimated to be approximately 30% in those presenting to hospital emergency departments.[7,8]

A pulse oximeter is a simple, inexpensive, and noninvasive method for quickly measuring a patient's heart rate and oxygen saturation values. It is used to detect hypoxemia[1] or deficient oxygenation in the blood.[12] More specifically, it measures the percentage of hemoglobin bound to oxygen in arterial blood, denoted as SpO_2.[1] Hypoxemia often leads to hypoxia (ie, reduced tissue oxygenation[13]), which results in oxidative stress, a condition associated with a wide variety of degenerative processes.[14]

Doctors of chiropractic (DCs) are trained to assess vital signs and the clinical signs of oxidative stress, such as cyanosis, pallor, fatigue, and mental confusion. However, previous studies have found that clinicians using these signs alone failed to detect hypoxemia/hypoxia in emergency department patients.[7,8] Furthermore, it has been shown that the absence of these positive findings does not eliminate the possibility of

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serious cardiopulmonary or cerebrovascular disease.[7,8,15] Pulse oximetry, which has been shown to accurately and reliably detect undersaturation,[16] may improve DCs' ability to assess patients' risk of potentially life-compromising illnesses. The purpose of this article is to provide a rationale supporting the regular use of pulse oximetry in chiropractic practice.

Conceptual model of pulse oximetry in a chiropractic setting

Pulse oximetry is used regularly in acute care settings, such as emergency departments and critical care units. Although there are not much data to date on its use in outpatient settings, it is becoming more widely used in such settings as general practices,[17-19] pediatrics,[20-22] dentistry,[23,24] sport science,[25] acupuncture,[26] and even at home.[21,27] The authors believe that there are strong arguments for its use within the chiropractic clinical practice.

The principal reasons that pulse oximetry should be used in chiropractic practice include the following:

1. Pulse oximetry allows for quick and reliable retrieval of oxygen saturation and heart rate values previously not readily obtained or used.
2. Pulse oximetry allows for immediate assessment of potentially hypoxic patients.
3. Pulse oximetry allows for important changes in patient management potentially influencing outcomes and safety.

The use of an oximeter in a chiropractic practice affords the practitioner a quick capture of both heart rate and oxygen saturation. Heart rate varies with many aspects of the clinical examination process, such as temperature, anxiety, pain, and altered sympathetic/parasympathetic regulation.[28] If not for an oximeter, oxygen saturation altogether would not be captured during the routine chiropractic examination.

Use of palpation of peripheral pulses to check for patency of peripheral arteries has been shown to be of questionable accuracy.[29-32] A more reliable method to assess cardiovascular health is warranted. It has been recommended that patients at risk for hypoxic conditions be monitored using pulse oximetry.[12,14,33-37] Hypoxia is commonly found in the elderly[38] and those at risk for coronary vascular disease,[39] coronary artery disease,[39] sleep disordered breathing,[39] disorders of balance, hypertension,[39] chronic migraines, and anxiety and mood disorders,[39] all of which can be present within a population of chiropractic patients. See Table 1 for a complete list of clinical signs and symptoms indicating use of pulse oximetry.

How it works

Pulse oximetry depends upon the optical characteristics of pulsating arterial blood.[1] Using the Beer-Lambert law on the absorption of light, the pulse oximeter has a pair of small light-emitting diodes that are placed on a translucent part of the patient's body, such as an earlobe or fingertip,[57] and left in place for 5 minutes. One light-emitting diode emits red light and the other emits infrared light, which are absorbed at significantly different rates by oxygenated hemoglobin compared with deoxygenated hemoglobin.[1] With each heart beat, the change in blood volume causes pulsating changes in the amounts of red and infrared light absorbed.[1] From this information, SpO_2 can be calculated using an algorithm programmed into the device. Most pulse oximeters display both the SpO_2 (in percentage saturation) and heart rate (in beats per minute) (Fig 1). It must be noted that detection of a pulse is imperative for the operation of a pulse oximeter[1]; therefore, attention must be given to the correct placement and use of the oximeter for its results to be meaningful.

Pulse oximetry norms have been established for SpO_2, with values greater than 95% considered normal.[1] For most devices, accuracy to within 2% has become an acceptable standard; and most are considered sufficiently accurate and reliable for many clinical purposes.[14,16,58-60]

Interpreting results

Ideally, an oxygen saturation value of 100% or near 100% saturation is preferred for optimum efficiency. However, daytime SpO_2 values greater than 95% are considered normal by many.[7,8,57,61] Conversely, daytime values less than 90% are cause for alarm and immediate attention.[12,13,33,34] Because SpO_2 values may fall 4% to 6% or more at night, daytime values of 90% to 95% may mean nighttime values less than 90%, which would also be cause for concern.[13,34] Chiropractors that detect daytime saturation values less than 97% should monitor this patient's SpO_2 each

Table 1 Signs and symptoms indicating use of pulse oximetry

History
Inadequate external respiration
Decreased O_2 in environment
High altitudes[40]
Enclosures without outside ventilation[41]
Smoke inhalation[41]
Toxic gas inhalation[41]
Inadequate mechanical ventilation
Pain[26,42]
Emphysema[42]
Pleurisy[43]
Sleep disordered breathing (eg, apnea)[44]
Traumatic injuries
Rib fractures[41,42]
Pneumothorax[41]
Flail chest[45]
Crushing neck or chest injuries[41,42]
Other conditions
Airway obstruction[46]
Anxiety[42,47]
Depression[48]
Chronic migraines[49]
Chronic illness[50-52]
Inadequate oxygen diffusion
Pulmonary edema[41]
Pneumonia[53]
COPD[54]
Pulmonary emboli[41]
Inadequate oxygen transport
Anemia
Inadequate hemoglobin[55]
Inadequate # RBCs[55]
Poisoning
Carbon monoxide poisoning[41]
Inadequate circulation
Shock[41]
Arteriolosclerosis
Hypothermia[41]
Physical examination
Signs and symptoms of respiratory compromise
Dyspnea[55]
Accessory muscle use[42]
Inability to speak in full sentences
Adventitious breath sounds[55]
Irregular breathing pattern[55]
Abdominal breathing only[42]
Increased or decreased respiratory rate[55]
Shallow breathing[55]
Flared nostrils or pursed lips
Unusual anatomy (eg, barrel chest)[55]
Signs and symptoms of hypoxia[55]
Restlessness
Altered or deteriorating mental status
Increased heart rate
Increased or decreased respiratory rate
Cyanosis
Other signs or symptoms
Hypertension[56]

Critical signs and symptoms indicating use of pulse oximetry. *COPD*, chronic obstructive pulmonary disease; *RBC*, red blood cell.

visit, whereas values less than 90% should prompt immediate referral for medical assessment.

The pulse oximeter also displays the patient's heart rate and, when correlated with oxygen saturation level, can round out the clinical picture. See Table 2 for a suggested action plan for interpreting results. Other factors can also influence oxygen saturation levels; therefore, the chiropractic physician must bear this in mind when designing a patient management plan.

Furthermore, it must be noted that there is no evidence to date to suggest that chiropractic treatments can influence the outcome of pulse oximetry assessments. However, no evidence does not mean that there

Fig 1. Pulse oximeter—placement on right index finger.

Table 2 Suggested interpretation of SpO_2 values

Daytime SpO_2 (%)[34]	Heart Rate	Interpretation	Possible Risks	Suggested Interventions
>97	Normal	Good health markers[1]		Education/awareness Chiropractic adjustments (spine, ribs, chest)[62] Monitor periodically[1]
	Elevated	Autonomic arousal[47,63]	Tension Stress Anxiety Fear	Education/awareness Chiropractic adjustments (spine, ribs, chest)[62] Monitor periodically[1] Lifestyle/exercise/stress reduction[63]
	Decreased	Training induced[64,65]	Athletic heart syndrome	Education/awareness Chiropractic adjustments (spine, ribs, chest)[62] Monitor periodically[1]
94-97	Normal, increased, or decrease	Early stages of lowered oxygenation[1,11]	Fatigue Malaise Migraine Sleep disturbance	Education/awareness Chiropractic adjustments (spine, ribs, chest)[62] Monitor each visit[1] Breathing exercises[66] Lifestyle/exercise/stress reduction[63] Possibly refer for medical assessment[11]
<93	Normal or increase	Cardiac dysfunction[39,67]	TIA Stroke Neurological compromise Dementia CAD CVD	Education/awareness Interprofessional communication/referral[11] Prescription oxygen[17] Ventilation assistance[17] Chiropractic adjustments (spine, ribs, chest)[62] Breathing exercises[66] Lifestyle/exercise/stress reduction[63] Monitor each visit[1]
	Decreased	Autonomic abnormality[28]	All of the above	Immediate referral[11]

SpO_2, oxygen saturation by pulse oximetry; *TIA*, transient ischemic attack; *CAD*, coronary artery disease; *CVD*, cardiovascular disease.

is no benefit; it simply means there is no evidence to date. Research in this domain is warranted.

Limitations and suggested research

Although pulse oximetry may be a useful diagnostic tool, it does not offer a comprehensive description of the complete oxygen transport system. Pulse oximetry is one part of the thorough assessment of a patient's oxygenation status, which should also include assessment of oxygen delivery and perfusion systems, and the patient's ability to ventilate.[57] Specific physiologic factors may have an influence on the accuracy of the SpO_2 values obtained and, therefore, must be considered.

The oxygen-carrying capacity of blood may be hindered by certain disease states, such as anemia[68] or reduced or abnormal hemoglobin.[1,57] In addition, increased pH or decreased body temperature may increase hemoglobin's oxygen affinity, thereby making oxygen less available to tissues.[57] Low perfusion states will also result in inaccurate SpO_2 readings due to low signal of the pulsating flow of blood.[1] Therefore, caution is recommended with conditions such as peripheral neuropathies[57] or peripheral artery disease.[69] Error may also be introduced with tremor or excessive movement because of signal loss, which may result in an underestimation of SpO_2.[1,57]

Sensor malpositioning can also result in inaccuracies. False-positive readings are common if the sensors detect excessive ambient light, such as from sunlight, fluorescent lights, infrared heating lights, or examination lights.[1] In adults, fingertip probes have been proven to be more accurate than earlobe probes,[1] whereas in children, ear probes were found to be more accurate than finger or toe probes.[3] Any discoloration of the nail bed or a dark nail polish may affect transmission of the light, resulting in an underestimation of SpO_2.[1,57] On the other hand, darkly pigmented skin does not seem to impact pulse oximetry whereas severe jaundice or hyperbilirubinemia might have an impact if SpO_2 is less than 90%.[1]

The use of pulse oximetry may also be misleading in patients whose ability to ventilate is compromised, such as those with chronic obstructive pulmonary disease[54,70] or acute asthma.[71,72] Although it may be helpful to monitor an acute exacerbation of these conditions, additional assessment must also be undertaken.[54,70-72] In addition to these physiological limitations, pulse oximetry also has technological limitations. As with any measuring device, the instrument is only as accurate as its empirical calibration. Despite this limitation, if using the same instrument to compare the same patient at different points in time, the degree of error can be minimized.[1] Error is especially minimized if saturation readings are greater than 80%.[1]

Because pulse oximetry has some accuracy limitations, practitioners must understand them fully to ensure effective use. Within these constraints, pulse oximetry can offer a valuable, noninvasive measure of arterial saturation.

Finally, because this article is a commentary, it does not offer evidence of the usefulness of pulse oximetry in chiropractic clinical practice. The purpose of this article is to propose a rationale for the use of this technology to assess patients presenting to DCs. Investigational studies are needed to establish if pulse oximetry has a place in a chiropractic setting. Future research should focus on the prevalence of undersaturation within chiropractic settings and on implementing pulse oximetry as an outcome measure to investigate chiropractic's therapeutic effect.

Conclusion

As primary health care providers, DCs should be vigilant in detecting signs of oxidative stress or hypoxemia in their patients. It is the authors' belief that the utilization of pulse oximetry should be considered a standard part of the clinical examination in the chiropractic office. Oxygen saturation values are important determinants of health and the status of peripheral tissues. Quantification of saturation values with heart rate may give clinical aid to the management of the chiropractic patient. When used appropriately, pulse oximetry may offer DCs a safe and effective way to monitor patients' oxygen saturation levels.

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