Pre-hospital Forearm Muscle rSO_2 Monitoring with the Nonin SenSmart™ System Assists Patient Management by Predicting a Critical Perfusion Drop in Traumatic Shock

NONIN

rSO_2 CASE STUDY

Case Overview

A 17-year-old man suffered serious head, neck and chest trauma from an automobile accident. During the prehospital period the patient had difficulty breathing, had active bleeding from his oronasal cavities, palpable regular pulses and elevated blood pressure. His peripheral artery saturation was 44% without oxygen, Glasgow Coma Scale score was 3, pupils were mydriatic (dilated), and light reflexes were bilaterally absent. Because of these findings, the patient was urgently treated following pre-hospital trauma care protocols and then promptly transferred to a Level I Trauma Center.

Key Clinical Parameters:

- Airway: Partially obstructed, large amounts of blood evident
- C Spine: Suspected (MOI: crushing head injury, neck and chest trauma)
- Breathing: With difficulty, respiratory rate 6 BPM; peripheral artery saturation 44% without oxygen
- Circulation: Pulse present with tachycardia; heart rate 138 BPM and regular; blood pressure 150/90; skin color pale, capillary refill time (CRT) delayed (>5 sec)
- Disability: Loss of consciousness (LOC) before ambulance arrival, areflexic mydriasis (inability of the iris to constrict in response to changes in light), Glasgow Coma Scale (GCS) 3/15 (E1, V1, M1)
- Exposure: Crushing head injury with significant bleeding; neck and chest trauma

This case illustrates the potential value of muscle rSO_2 monitoring during trauma management in the pre-hospital environment. Several reports indicate that an initial rSO_2 value upon trauma center arrival, measured concurrently with or prior to vitals, may predict hemorrhagic shock requiring blood product transfusion.[1]

What the Nonin SenSmart System Showed

This case is an excellent example of the value of using the Nonin SenSmart™ Universal Oximetry System in the pre-hospital environment to measure changes in peripheral perfusion that might suggest internal hemorrhage in trauma patients. Regional oximetry (near-infrared spectroscopy; NIRS; Nonin Medical) was used to study muscle tissue oxygenation (forearm) during pre-hospital trauma care. *Figure 1 (on back page)* shows the first phase, in which rSO_2 improved following initial resuscitation measures. In this first phase, note that the blood pressure was normal but the tissue saturation was very low. In the next minutes of trauma management and transport, a progressive worsening of tissue saturation occurred followed by a progressive drop in the blood pressure. The care team assumed that this development was probably secondary to continuous bleeding. Indeed, in this case, rSO_2 was an important and rapid method to monitor and manage the development of traumatic shock, and with these findings the patient was quickly transferred to a Level I Trauma Center.

Discussion

There currently is no gold standard for the diagnosis of traumatic shock. Patients may have inadequate regional organ oxygen delivery despite apparently adequate systemic perfusion parameters. Traditional methods of identifying shock in emergency situations, such as blood pressure, have not always proven to be reliable, especially in acute situations. In this major trauma case it was interesting to observe the lack of direct relationship between regional oximetry and non-invasive BP values relative to the shock state.

Uncontrolled bleeding is the leading cause of preventable mortality among trauma patients, accounting for half of all trauma-related deaths.[2] A key contributor to the difficulty of diagnosing internal bleeding is the body's ability to compensate for significant hemorrhage.[3] Markers for bleeding, such as decreased systolic blood pressure and consciousness level and increased heart rate, may not appear until 30 to 40 percent of blood volume is lost. Many laboratory values are not helpful in acute shock, and invasive monitoring technologies are time-consuming and prone to complications. The early physiologic change during hemorrhagic shock (decreased perfusion of peripheral tissues due to redistribution to vital organs such as the heart and brain) could be detected quickly and noninvasively with NIRS rSO_2 monitoring.[4] ***This case showed the potential effectiveness of identifying early phase of traumatic shock before it manifested clinically in the pre-hospital environment.***

Pre-hospital Forearm Muscle rSO_2 Monitoring with the Nonin SenSmart™ System Assists Patient Management by Predicting a Critical Perfusion Drop in Traumatic Shock

NONIN
rSO_2 CASE STUDY

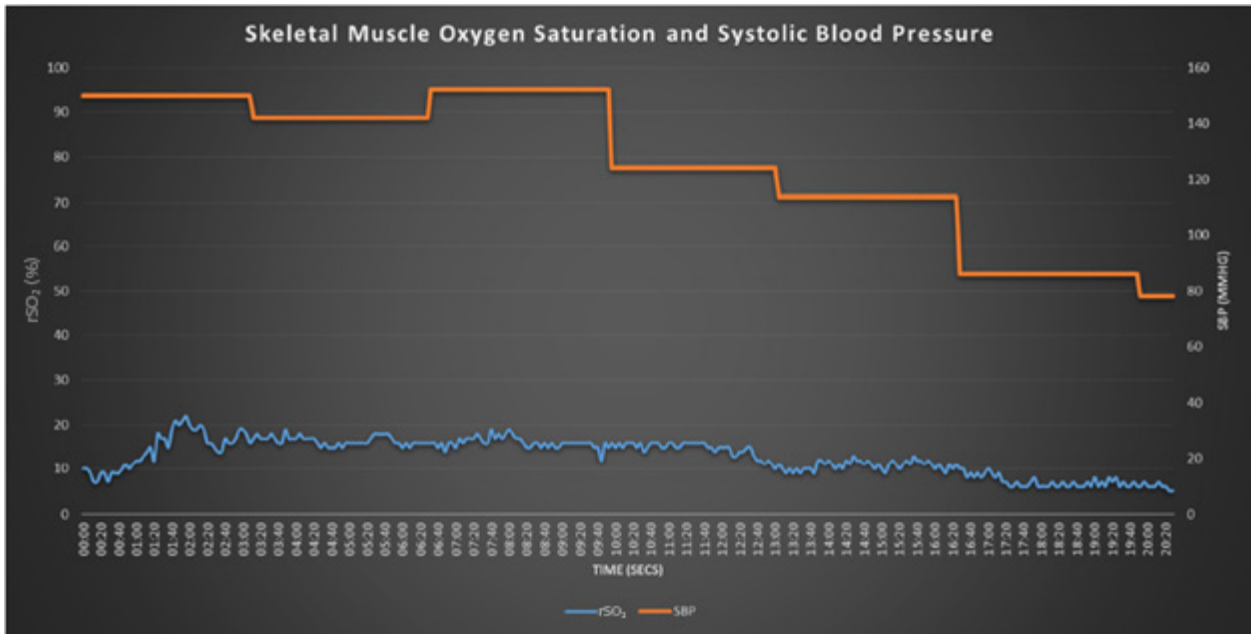

Figure 1: Note that during the first phase of treatment, the patient's blood pressure remained normal, and regional oxygen saturation (forearm muscle rSO_2), after initially slight increasing during treatment, still remained extremely low. However, during transport, the condition deteriorated, as both systolic blood pressure and regional oxygen saturation dropped.

[1]Khasawneh MA et al; World J Surg 2014 Aug; 38:1892.
[2]Holcomb JB; Crit Care 2004; 8 Suppl 2:S57-60.
[3]Mitra B et al; Shock. 2014 Oct. 42:307.
[4]Smith J et al; Am Surg 2008; 74:1006.

Case submitted by **Dr. Alberto Gabrieli**, Emergency Medical Service (EMS) Verona, Veneto, Italy.

References:

- Weatherall, A., et al; *Feasibility of cerebral near-infrared spectroscopy monitoring in the pre-hospital environment*; Acta Anaesthesiologica Scandinavica 56.2 (2012): 172-177.
- Crookes, Bruce A., et al; *Noninvasive muscle oxygenation to guide fluid resuscitation after traumatic shock*; Surgery 135.6 (2004): 662-670.
- Beekley, Alec C., et al; *Continuous noninvasive tissue oximetry in the early evaluation of the combat casualty: a prospective study*; Journal of Trauma and Acute Care Surgery 69.1 (2010): S14-S25.
- Ward, Kevin R., et al; *Near infrared spectroscopy for evaluation of the trauma patient: a technology review*; Resuscitation 68.1 (2006): 27-44.
- Cohn, Stephen M., et al. *Tissue oxygen saturation predicts the development of organ dysfunction during traumatic shock resuscitation*; Journal of Trauma and Acute Care Surgery 62.1 (2007): 44-55.
- Khasawneh, Mohammad A., et al; *Low tissue oxygen saturation is associated with requirements for transfusion in the rural trauma population*; World journal of surgery 38.8 (2014): 1892- 1897.
- Holcomb JB; *Methods for improved hemorrhage control*; Critical Care Medicine; 8 (2004); Suppl 2:S57-60.
- Smith J et al; *Tissue oxygen saturation predicts the need for early blood transfusion in trauma patients*; American Journal of Surgery; 74.10 (2008)1006-11.
- Khasawneh MA et al; Low Tissue Oxygen Saturation Is Associated with Requirements for Transfusion in the Rural Trauma Population;World Journal of Surgery 38.8 (2014); 1892-7.
- Holcomb JB; *Methods for improved hemorrhage control*; Critical Care 8 (Sup 2, 2004) S57-S60.
- Mitra B et al; *Long-Term Outcomes of Patients Receiving a Massive Transfusion After Trauma*; Shock 42.4 (2014); 307-312.
- Smith J et al; *Tissue oxygen saturation predicts the need for early blood transfusion in trauma patients*; The American Surgeon 74.10 (2008); 1006-1011.

NONIN
Leaders in *Nonin*vasive Medical Monitoring

sensmart.com
nonin.com

Nonin Medical, Inc.
13700 1st Avenue North
Plymouth, MN • 55441-5443 • U.S.A.
Tel: +1.763.553.9968 1.800.356.8874
Fax: +1.763.577.5521
E-mail: info@nonin.com

Nonin Medical B.V.
Prins Hendriklaan 26
1075 BD Amsterdam • Netherlands
Tel: +31 (0)13-79 99 040
Fax: +31 (0)13-79 99 042
E-mail: infointl@nonin.com