# Peripheral electrical stimulation for sedation-induced respiratory depression during procedural sedation and analgesia

## Overview

Sedation-induced respiratory depression is common during procedures performed with procedural sedation because the medications used are central nervous system depressants.

This project aims to develop a closed-loop system capable of delivering low-level transcutaneous electrical stimuli (TES) when respiratory depression is detected. The trigger for detecting respiratory depression will be derived from a transcutaneous carbon dioxide (TcCO2) monitoring system. Specifically, the TES will be triggered when the rise in TcCO2 over a specified interval has exceeded a set threshold.

Prior studies have confirmed the safety of applying peripheral transcutaneous electrical stimulation in a similar setting.(Smith et al. 2019; Suen and Chung 2019) Recently, a randomized controlled trial of TES was undertaken for 106 post-operative patients with obstructive sleep apnea. There were no adverse events related to the use of TES in this study.(Smith et al. 2019) Results of the study also demonstrated initial evidence for the efficacy of this approach.(Smith et al. 2019) Patients with obstructive sleep apnea who were randomized to receive TES had reduced duration and magnitude of hypoxemia during their stay in the post-anesthetic care unit.(Smith et al. 2019)

Although there are similarities between this previous study and our plans for the application of TES for respiratory depression during procedural sedation, there are some significant differences to consider. First, it will be essential to ensure that the application of TES does not ‘over-stimulate’ the patient and interfere with the efficacy of sedation. Second, it is common for patients receiving procedural sedation to receive supplemental oxygen routinely to reduce the risk of hypoxemia. This delays detection of respiratory depression by pulse oximetry. Ventilation can be monitored more directly with capnography or transcutaneous carbon dioxide monitoring, which overcomes pulse oximetry limitations. Therefore, we intend to

## Methods

* TcCO2 as input (Sentec digital monitoring system with Vsign-2 sensor)
* Peripheral nerve simulator (DS7A, Digimeter - or similar) will be used to deliver electrical stimulation using a bar electrode to as closely replicate the system used by Smith et al. (2019) as possible.

The system is somewhat more straightforward than that used for the closed-loop system that used SpO2 as the trigger because the motion sensor, which is used to detect aberrant SpO2 measurements, is not required for monitoring TcCO2.

## References

Smith, Hugh M, Joan Kilger, Christopher M Burkle, Darrell R Schroeder, and Bhargavi Gali. 2019. “Peripheral Electrical Stimulation Reduces Postoperative Hypoxemia in Patients at Risk for Obstructive Sleep Apnea: A Randomized-Controlled Trial.” *Canadian Journal of Anesthesia/Journal Canadien d’anesthésie* 66 (11): 1296–1309.

Suen, Colin M, and Frances Chung. 2019. “Pulse-Ox Paradox: Potential Versus Pitfalls of Pulse Oximetry Monitoring in Surgical Patients with Obstructive Sleep Apnea.” *Canadian Journal of Anesthesia/Journal Canadien d’anesthésie* 66 (11): 1286–90.