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Neuroscientists use electrical stimulation to restore breathing in surgery patients undergoing opioid-based anesthesia

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New UCLA research points to a novel treatment for respiratory depression associated with opioid use by administering electrical pulses

to the back of the neck, helping patients regain respiratory control following high dosage opioid use. This could offer an alternative to pharmacological treatments, which can cause withdrawal symptoms, heart problems and can negatively affect the central nervous system.

Breathing difficulties are the main cause of death following opioid use. Opioid misuse causes death by suppressing respiratory activity. Breathing problems can occur after opioid use or as post-operative complications from anesthesia because opioids desensitize the brain stem to rises in carbon dioxide. This can cause respiratory failure, which can be fatal. Current treatments, such as manual lung inflation and medication, can work in the short term to combat breathing problems following opioid use, but getting patients to breathe independently remains a challenge. Therefore, this new research, which administers epidural electrical stimulation (EES) offers the possibility of an alternative, non-pharmacological treatment.

EES administered at the cervical spinal cord, which is located at the back of the neck, activates a network of neurons in the brainstem that stimulates and coordinates respiratory muscles and improves the rate and depth of breathing.

Researchers from the David Geffen School of Medicine at UCLA targeted sensory-motor circuits in the cervical spinal cord of 18 patients with degenerative spine diseases who were anesthetized for surgical treatment. They delivered 30 Hertz of EES to the cervical spinal cord continuously for no longer than 90 seconds.

They found that short periods of continuous low-intensity EES not only increased the volume of breath but also actively controlled the frequency and rhythm during opioid-induced breathing problems. The rhythmic breathing pattern was sustained briefly after the EES stopped in the presence of high-dose opioids.

Dr. Daniel Lu, senior author and UCLA professor and vice chair of neurosurgery, said "Our results provide proof of principle that cervical EES could improve respiration following opioid use. We can compare the human body to a car, our goal is to jump start the body so it can run by itself without periodic pushes. We hope to use EES to provide novel approaches to restore breathing for healthcare providers as we are now using defibrillation devices for restoring cardiac activities."

Future trials in humans with larger cohorts will be conducted to further assess the practical application and impact of EES to determine whether EES can alleviate or reduce the need for ventilator support in acute pathological conditions such as OIRD, stroke, and traumatic brain, brain stem or spinal cord injury. Experimental studies in mice will be carried out to further investigate the role specific neurons play in response to EES.

More information: Ruyi Huang et al, Epidural electrical stimulation of the cervical spinal cord opposes opioid-induced respiratory depression, *The Journal of Physiology* (2022). DOI: 10.1113/JP282664

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