

Modeling the Cost Savings of Continuous Pulse Oximetry and Capnography Monitoring of United States Hospital Ward Patients Receiving Opioids

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Background/Introduction: Respiratory depression occurs in up to 46% of hospital ward patients receiving opioids, based on continuous pulse oximetry and capnography monitoring data from the Prediction of Opioid Induced Respiratory Depression by Capnography (PRODIGY) trial.¹ Respiratory depression is also associated with significantly higher hospital costs.² The objective of this analysis was to develop a model to predict the investment break-even point and likelihood of cost savings associated with implementation of continuous pulse oximetry and capnography monitoring on the hospital ward.

Methods: A decision model was developed from a hospital administrator perspective for an average sized United States hospital medical/surgical ward, with an average of 2,447 patients receiving opioids per year. PRODIGY data was used as the basis for the incidence of respiratory depression, length of stay, and hospital costs per patient. Device costs were estimated for Nellcor™ pulse oximetry and Microstream™ capnography (Medtronic). The model compares costs and outcomes of intermittent pulse oximetry monitoring to continuous pulse oximetry and capnography monitoring of medical/surgical ward patients. The three modeled scenarios include continuous monitoring of patients with 1) high risk 2) high or intermediate risk, and 3) any risk (high, intermediate, or low) for respiratory depression, based on the PRODIGY risk assessment tool.¹ Break-even and probabilistic sensitivity analyses were performed to estimate the investment break-even point and the likelihood of cost savings, respectively, when respiratory depression cases decrease 0% to 100%.

Results: If continuous pulse oximetry and capnography monitoring are implemented on patients with high risk of respiratory depression, and respiratory depression incidence is reduced by 20%, the annual cost savings are projected to reach \$535,531 (Figure), with a decreased cumulative length of stay of 103 days per average-sized United States hospital. Similarly, if continuous monitoring is implemented on patients at high or intermediate risk of respiratory depression or on all patients receiving opioids, the projected annual cost savings are \$606,463 and \$688,221, respectively (Figure), with cumulative length of stay reductions equaling 152 days and 204 days, respectively. The investment break-even points for implementation of continuous monitoring of patients at high risk, high or intermediate risk, or any risk for respiratory depression are predicted to occur if cases of respiratory depression decrease 1.5%, 2.5%, and 3.5%, respectively. Probabilistic sensitivity analysis identified a >80% probability of cost savings when high risk patients are continuously monitored and respiratory depression cases are reduced by ≥17%. Similarly, there is a >80% probability of cost savings if high and intermediate risk, or all risk-level patients are continuously monitored and respiratory depression incidence decreases by ≥27% and ≥31%, respectively.

Conclusion: This model sheds light on the cost benefit of implementing continuous pulse oximetry and capnography monitoring on United States medical/surgical ward patients receiving opioids who are at risk for respiratory depression. In each modeled scenario, the reduction in respiratory depression incidence needed to reach a break-even point is low, and there is a high probability of annual cost savings when respiratory depression decreases by $\geq 17\%$. Combined with use of the PRODIGY score to determine patient risk for respiratory depression, this model may assist clinicians and hospital administrators making decisions regarding the utilization of continuous pulse oximetry and capnography monitoring on hospital ward patients receiving opioids.

References:

1. Khanna AK, Bergese SD, Jungquist CR, et al. Prediction of Opioid-Induced Respiratory Depression on Inpatient Wards Using Continuous Capnography and Oximetry: An International Prospective, Observational Trial. *Anesth Analg.* 2020; Publish Ahead of Print.
2. Saager L, Jiang W, Khanna AK, et al. Respiratory Depression on General Care Floors Increases Cost of Care: Results from the Prodigy Trial. *ANESTHESIOLOGY Annual Meeting.* 2019:A2242.

Figure. Projected cost savings of continuous pulse oximetry and capnography monitoring.

