Implementation of Capnography Monitoring to Improve Outcomes among Intensive Care Unit Patients on Patient-Controlled Analgesia or Opioids

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Background

Background: Patient-controlled analgesia (PCA) administration of opioids is associated with risk for respiratory depression. Capnography is a non-invasive way to identify early respiratory depression and prevent adverse patient events.

Purpose: This project evaluated the effectiveness of capnography versus standard monitoring in reducing adverse events among patients admitted to an intensive care unit (ICU) who were prescribed PCA opioids and evaluated patients at high-risk for respiratory depression according to age, gender, diagnosis, co-morbidities, and type of opioid prescribed.

Methods: This project used a pre- and post-intervention design to compare differences in the number of adverse events among 20 adult patients admitted to an ICU during a six-month period who were prescribed PCA opioids and received either capnography monitoring or standard monitoring. A chi-square test was conducted to evaluate group differences.

Results: The number of adverse events was not significantly different between patients who received standard monitoring versus those who received capnography (X^2=0.00, *df*=1, *N*=20, *p*>0.05). Adverse events were not significantly associated with age, gender, number of co-morbidities, type of opioid, and diagnosis (*p*>0.05).

Conclusions: Implementation of capnography among ICU patients on PCAs did not prevent adverse events. However, there were favorable trends noted with regards to sedation level and a decrease in the occurrence of bradypnea in patients receiving capnography. Results from this project will guide the implementation of capnography throughout the institution.

Objectives

Objectives for this project included:

1. Decrease adverse respiratory events in adult high-risk patients in the ICU who receive PCAs or narcotic to less than one (< 1) during the 3-month period after implementation of capnography by December 2020 .
2. Analyze project results to define high risk patient characteristics when capnography implemented on patient care units outside of the ICU.
3. . Analyze data and use project findings to inform the development of policies and procedures for capnography monitoring for patients on PCAs or receiving narcotics by January 2021 .

Methods

Design: This evidenced based practice project implemented a pre- and post-intervention design.

Setting and Participants:

- The setting for this project was an ICU.
- Participants were adult patients (18 years or older) prescribed epidural or intravenous (IV) PCAs or high doses of opioids, not on PCAs.
- Critically ill patients and those receiving end of life care were excluded.

Methods:

- A retrospective chart review during a three-month period (June through August 2020) of 10 eligible ICU patients who received standard monitoring was conducted. The number and type of adverse events was measured for these patients.
- Capnography monitoring was then implemented for a three-month period (September-December 2020) for 10 patients. Adverse events were tracked for these patients.

Analysis:

- The comparison of capnography monitoring versus standard monitoring to prevent adverse events was analyzed using Chi-square test of independence were *p* <.05.
- Adverse events associated with age, gender, diagnosis, number of co-morbidities, and type of opioid was also analyzed using Chi-square test of independence where *p* <.05.

Results

Descriptive Statistics

Characteristics	Standard Monitoring	Capnography Monitoring
Age	58.1 (± 18)	59.7 (± 15)
Gender		
Male	60%	50%
Female	40%	50%
Primary Diagnosis		
Cancer	80%	70%
Immunodeficiency/ transplant	10%	20%
Other	10%	10%
Number of co-morbidities (COM)		
None	50%	10%
One COM or smoker, lung/cardiac disease, OSA	10%	40%
Two or more COM plus Above	40%	50%
Opioid Type		
Epidural PCA	40%	70%
IV PCA	60%	20%
High dose opioids	0%	10%

Comparison of Capnography Monitoring and Number of Adverse Events

Capnography Events	*N*	Adverse		Chi Square Statistics			
		N	%	*df*	*N*	*p*	X^2
No capnography	10	3	30%	1	20	1.00	0.00
Capnography	10	3	30%				
Total	20	6	30%				

Results

Percentage of Patients with Monitoring Events

Monitoring Event	Standard Monitoring	Capnography Monitoring
Systolic BP<90/60		
Yes	10%	20%
No	90%	80%
ETCO2>45		
Yes	N/A	30%
No	N/A	70%
SpO2<90		
Yes	10%	30%
No	90%	70%
Respiratory Rate		
12-20 breaths per minute	70%	80%
<12 breaths per minute	30%	20%
Sedation Level		
Alert/oriented	90%	80%
Difficult to arouse	10%	0%
Confused hallucinating	0%	10%
Unable to arouse	0%	10%

Comparison of Adverse Events with Age, Gender, Number of Co-morbidities and Opioid Type *N=20*

Variable	Adverse Event (percentage)	*df*	*p*	Chi-Square Statistic (X^2)
Age				
55 or older	30%	1	.091	2.857
< 55	0%			
Gender				
Male	10%	1	.202	1.626
Female	20%			
Number of Co-morbidities (COM)				
None	5%	2	.440	1.640
One COM or > 20py smoking or lung/cardiac disease and/or OSA	5%			
Two COM + above	20%			
Opioid Type				
Epidural	25%	2	.241	2.846
IV PCA	5%			
High dose not epidural or IV PCA	0%			
Diagnosis				
Cancer	30%	2	.240	2.857
Immunodeficiency/transplant	0%			
Other	0%			

Conclusions and Recommendations

Conclusions:

- There was no statistically significant difference in the number of adverse events for patients receiving capnography versus standard monitoring.
- Although not statistically significant, patients older than 55 years of age, females, those receiving epidural patient-controlled analgesia, and those with two or more co-morbidities plus a history of lung or cardiac disease, obstructive sleep apnea, or greater than a 20-pack year history of smoking, had more observable adverse events.
- Implementing capnography monitoring among patients with these risk factors may allow for earlier intervention.
- Limitations with this project included the small sample size, ICU setting in which this project was implemented, eligibility criteria and issues with the nasal cannula equipment.

Recommendations:

- Although capnography monitoring had no impact on prevention of adverse events, patients with certain characteristics can benefit from capnography monitoring.
- Future directions with capnography monitoring include further defining patients who would profit from capnography, determining added equipment purchases, and development of nursing education and medical policies so that capnography is a part of standardized practice.

Acknowledgements: I would like to thank the nursing, medical and respiratory staff of the ICU who helped implement this project. Also thank you to Drs. Kolakowski and Whitt who advised and supported me during this journey.