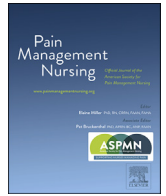




Contents lists available at ScienceDirect

Pain Management Nursing

journal homepage: www.painmanagementnursing.org

Original Article

American Society for Pain Management Nursing Guidelines on Monitoring for Opioid-Induced Advancing Sedation and Respiratory Depression: Revisions



Download Clinical Guidelines

Carla R. Jungquist, PhD, ANP-BC, FAAN ^{*},
 Ann Quinlan-Colwell, PhD, RNC, AH, BC, FAAPM [†], April Vallerand, PhD, RN, FAAN [‡],
 Heather L. Carlisle, PhD, DNP, RN-BC, FNP-BC, AGACNP-BC [§],
 Maureen Cooney, DNP, FNP, RN-BC ^{||}, Susan J. Dempsey, MN, CNS, RN-BC, CCRN [¶],
 Danielle Dunwoody, PhD, RN, CNS [#], Angelika Maly, RN [‡], Kathy Meloche, BSN, RN-BC ^{**},
 Ashley Meyers, BSN, RN-BC, PCCN ^{††}, Jason Sawyer, RN-EC, BScN, MN, NP(BC) ^{‡‡},
 Navdeep Singh, RN [‡], Denise Sullivan, RN, MSN, ANP-BC, ACHPN ^{§§},
 Chris Watson, MBA, BSN, RN-BC ^{|||}, Rosemary C. Polomano, PhD, RN, FAAN ^{¶¶}

^{*} University at Buffalo, Buffalo, New York

[†] Private Practice Pain Management Consulting and Education, Wilmington, North Carolina

[‡] Wayne State University, Detroit, Michigan

[§] University of Arizona, Tucson, Arizona

^{||} Westchester Medical Center, Valhalla, New York

[¶] University of California, Los Angeles, Los Angeles, California

[#] Halton Healthcare, Oakville, Ontario, Canada

^{**} Harper University Hospital, Detroit, Michigan

^{††} Sparrow Hospital, DeWitt, Michigan

^{‡‡} Sunnybrook Health Sciences Centre, Toronto, Canada

^{§§} NYC Health+Hospitals/Jacobi, Bronx, New York

^{|||} East Alabama Medical Center, Opelika, Alabama

^{¶¶} University of Pennsylvania, Philadelphia, Pennsylvania

ARTICLE INFO

Article history:

Received 16 April 2019

Received in revised form

25 May 2019

Accepted 14 June 2019

ABSTRACT

Objectives: This report presents up-to-date evidence and expert consensus-based revisions to the ASPMN 2011 guidelines that inform interprofessional clinical decision-making for hospitalized adults receiving opioid analgesics.

Design: Systematic review of the literature.

Methods: A 14-member expert panel was charged with reviewing and grading the strength of scientific evidence published in peer reviewed journals and revising the ASPMN 2011 existing guidelines. Panel members formulated recommendations based on the strength of evidence and reached consensus through discussion, reappraisal of evidence, and voting by majority when necessary. The American Society of Anesthesiologists evidence categories for grading and classifying the strength of the evidence were used. Recommendations were subjected to a critical review by ASPMN members as well as external reviews.

Results: The 2011 guidelines were found to still be relevant to clinical practice, but new evidence substantiated refinement and more specific recommendations for electronic monitoring. The revised guidelines present risk factors divided into three categories: patient-specific, treatment-related, and environment of care. Specific recommendations for the use of electronic monitoring are delineated.

Conclusions: All hospitalized patients that are administered opioids for acute care are at risk of opioid induced advancing sedation and respiratory depression, but some patients are at high risk and required extra vigilance to prevent adverse events. All patients must be assessed for level of risk. Adaptations to the plan of care and monitoring strategies should be driven by iterative re-assessments according to level of risk.

Address correspondence to Carla R. Jungquist, PhD, ANP-BC, FAAN, University at Buffalo, 3435 Main St., Wende 312, Buffalo, NY 14214.

E-mail address: Carlajun@Buffalo.edu (C.R. Jungquist).

<https://doi.org/10.1016/j.pmn.2019.06.007>

1524-9042/© 2019 American Society for Pain Management Nursing. Published by Elsevier Inc. All rights reserved.

Nursing Practice Implications: Opioid medications continue to be a major component in the management of acute pain. Clinicians have the primary responsibility for safe and effective pain management. Evidence based monitoring strategies can improve patient safety with opioids.

© 2019 American Society for Pain Management Nursing. Published by Elsevier Inc. All rights reserved.

Opioid-induced unintended advancing sedation (OIUAS) and opioid-induced respiratory depression (OIRD) can lead to serious consequences (e.g., hypoxic and anoxic brain injury with subsequent death) in hospitalized adult patients and have negative effects on health care systems (Fouladpour, Jesudoss, Bolden, Shaman, & Auckley, 2016; Overdyk et al., 2014; Weingarten, Chong, Schroeder, & Sprung, 2016). More than 50% of patients admitted to hospitals receive systemic and/or neuraxial opioid medications, and between 0.003% and 4.2% of those will experience an opioid-related adverse event (defined by naloxone administration or an opioid-related adverse drug event diagnosis code), including respiratory depression (Davis et al., 2017; Herzig, Rothberg, Cheung, Ngo, & Marcantonio, 2014; Kessler, Shah, Gruschkus, & Raju, 2013; Rosenfeld et al., 2016). Patients who experience an adverse opioid event are estimated to have 55% longer hospital stays, 47% higher costs of care, 36% increased risk of 30-day readmissions, with 3.4 times greater risk of inpatient mortality (Kessler et al., 2013). In cases of death or serious anoxic brain injury from an opioid-related event resulting in litigation, hospitals have paid financial penalties on average of \$2.5 million (range \$650,000–\$7.7 million) (Fouladpour et al., 2016). Although opioid prescribing nationally has decreased since 2011, opioids remain a key component of multimodal perioperative analgesia (Jahr et al., 2017).

The continuing problem of opioid-related adverse events in hospitals has been a major focus by The Joint Commission (TJC), the Institute for Healthcare Improvement (IHI), and Centers for Medicaid and Medicare Services (CMS) (Centers for Medicare and Medicaid Services, 2014; Institute for Healthcare Improvement, 2012; The Joint Commission, 2017). In 2011 the American Society for Pain Management Nursing (ASPMN) published guidelines on monitoring for opioid-induced sedation and respiratory depression (Jarzyna et al., 2011). Despite these and other guidelines addressing how to assess, prevent, and manage OIUAS and OIRD, these serious adverse events continue to occur. This report presents up-to-date evidence and expert consensus-based revisions to the ASPMN 2011 guidelines in response to requests from ASPMN members, other health care professionals, and health care organizations.

Methods

Expert Panel Composition

The ASPMN convened a 14-member expert panel (see author list) led by C.R.J. and R.C.P. The panel was charged with reviewing and grading the strength of scientific evidence published in peer reviewed journals and revising the ASPMN 2011 existing guidelines. Conflicts of interest were evaluated for each panel member and disclosed according to ethical practice. Guideline panel members formulated recommendations based on the strength of evidence and reached consensus through discussion, reappraisal of evidence, and voting by majority when necessary. All recommendations were subjected to a critical review by ASPMN member representatives to enhance the integrity of the guideline development processes and reduce potential bias.

Scope and Target Users

These updated guidelines present the analysis of recent scientific literature and current recommendations to guide the

implementation of standards of care for assessing and monitoring patients for opioid-induced unintended advancing sedation and respiratory depression. These guidelines inform interprofessional clinical decision making for hospitalized adults receiving opioid analgesics. The target users of these guidelines are members of the nursing staff, (e.g. clinical nurses, advanced practice registered nurses). These guidelines may also be useful for other members of the health care team and thus the term *clinicians* will be used. The focus of these guidelines is for hospitalized adult patients receiving systemic opioids (e.g., oral, intravenous [IV], transdermal, epidural) for the management of acute pain. Because there are up-to-date guidelines for the management of acute pain, the workgroup avoided duplication of pain management topics addressed by Chou et al. (2016). As such, recommendations may or may not pertain to patients receiving opioids solely for the treatment of chronic pain or those requiring end-of-life pain management.

Review of Evidence

The ASPMN guideline panel performed an extensive review of peer-reviewed journal publications over the past 10 years (time frame since last reviewed for 2011 manuscript). Panel members replicated search strategies (e.g., MeSH [Medical Subject Heading] terms and electronic databases) previously used in the development of the 2011 ASPMN guidelines (Jarzyna et al., 2011). Additionally, panel members expanded literature searches to encompass broader targets for topics such as electronic monitoring practices and devices, newer analgesics, and multimodal analgesic combinations to promote safe analgesia and reduce opioid-related adverse events. Literature searches were conducted through December 2017 and updated in October 2018.

Grading of Evidence and Recommendations

The panel once again applied the American Society of Anesthesiologists evidence categories for grading and classifying the strength of the evidence as adopted in the 2011 ASPMN guidelines (American Society of Anesthesiologists Task Force on Acute Pain Management, 2012; Jarzyna et al., 2011).

- *Category A* literature is considered strong and supportive.
- *Category B* literature is suggestive (in some situations such as assessing risk factors, where randomized controlled trials are not possible, this level of evidence is the strongest possible).
- *Category C* literature is considered equivocal.
- *Category D* reflects insufficient evidence.

Refer to the 2011 ASPMN guidelines for a complete description of this evidence grading system (Jarzyna et al., 2011) and Table 1 for a full explanation of levels of evidence. The panel then assigned a strength of the recommendation (strong or weak) and quality of evidence that the recommendation is based on (high, moderate, or poor) to each recommendation. The strength of the recommendation is derived from the evidence and consensus among panel members based on their expert opinions and knowledge of clinical practice. The strength rating balanced the risks versus benefits to patients as well as considered the demands of clinical care and burden to health care organizations. A strong rating represented

Table 1
American Society of Anesthesiologists (ASA) Evidence Categories

<p>Category A: Supportive Literature</p> <p><i>Level 1:</i> Multiple RCT and the aggregated findings are supported by meta-analysis</p>	<p><i>Level 2:</i> Multiple RCT but insufficient number of studies to conduct meta-analysis</p>	<p><i>Level 3:</i> A single RCT</p>
<p>Category B: Suggestive Literature</p> <p><i>Level 1:</i> Observational comparison (cohort, case-controlled design) or two or more clinical interventions or conditions and indicates statistically significant differences between clinical interventions for specific clinical outcomes</p>	<p><i>Level 2:</i> Noncomparative observational studies with associative (e.g., relative risk, correlation) or descriptive statistics</p>	<p><i>Level 3:</i> Case reports</p>
<p>Category C: Equivocal Literature</p> <p><i>Level 1:</i> Meta-analysis did not find significant differences among groups or conditions</p>	<p><i>Level 2:</i> There is an insufficient number of studies to conduct meta-analysis, and (1) RCT have not found significant differences among groups, or (2) RCT reports inconsistent findings</p>	<p><i>Level 3:</i> Observational studies report inconsistent findings or do not permit inference of beneficial or harmful relationships</p>
<p>Category D: Insufficient Evidence</p> <p><i>Silent:</i> No identified studies addressing the specific relationships among interventions or outcomes</p>	<p><i>Inadequate:</i> The available literature cannot be used to assess relationships among interventions or outcomes. The literature does not meet the criteria for content as defined in the focus of these guidelines or does not permit a clear interpretation of the findings owing to methodologic concerns</p>	
<p>Opinion-Based Evidence</p> <p>All opinion-based evidence relevant to each topic is considered in the development of these guidelines</p>		
<p>Category A: Expert opinion</p>	<p>Category B: Membership opinion</p>	<p>Category C: Informal opinion</p>

RCT = randomized controlled trials.

Printed with permission from the Committee on Standards and Practice Parameters, American Society of Anesthesiologists, 520 N. Northwest Highway, Park Ridge, IL 60068-2573.

the opinion that the benefits of the recommendation definitely outweigh the risks of any harm or burden of care. A weak rating indicated that a clinical recommendation may not be supported by strong evidence but may still be valuable to delivering safe patient care. The strength of the evidence is based on the type, number, size, and quality of the studies; strength of associations or effects on outcomes; and consistency of results among multiple studies. There was a scarcity of evidence to support development of recommendations. The lack of sufficient evidence led to the formulation of opinion-based evidence in the development of recommendations outlined in these guidelines.

Process for Guideline Revisions

The panel convened by teleconferencing in mid-2017 to discuss the guideline development process and formulate a plan to target revisions of the existing guidelines. During the conference call, panel members were asked to (1) identify current issues and problems with safe administration of opioids for acute pain; (2) examine the 2011 ASPMN existing guidelines for outdated or controversial information; and (3) evaluate the relevance of previous recommendations based on new research and evidence-based practice guidelines. Problems and shortcomings of the existing guidelines were discussed, and consensus was reached on areas of the guidelines requiring minor and major revisions. A new outline was created for the updated report, and panel members were assigned to subgroups reflecting division of work focused on individual patient, pharmacologic, and environment of care risks for OIUAS and OIRD. Another subgroup formed to address monitoring practices such as nursing assessments of sedation and monitoring with electronic technology. Each group conducted extensive and more expansive literature searches than completed for the 2011 ASPMN guidelines, and retrieved, evaluated, and summarized relevant literature.

The panel met monthly by teleconferencing, with each subgroup reporting on their findings. Subgroup members updated sections of the existing 2011 ASPMN guidelines and formulated initial recommendations for guideline revisions. After all subgroups completed their work on the synthesis and grading of

evidence, the panel drafted a list of new recommendations. Panel members modified the previous search and reporting categories to improve the translation of the guidelines to clinical practice. These changes included consolidating the search and reporting strategies to encompass *patient-specific*, *treatment-related*, and *environment of care* categories. Evidence from these categories was integrated and synthesized to formulate recommendations in each category. The *patient-specific* category included both risks associated with patient characteristics and clinical factors (e.g., comorbidities, type of surgery, length of surgery) that must be considered for safe patient care with opioid administration. The *treatment-related* category focused on research examining the use of pharmacologic agents and their association or, lack thereof, for advancing sedation and respiratory depression. Pharmacologic agents were analyzed independently and in combinations with other agents. *Environments of care* targeted studies on monitoring practices, plans of care, and nursing practice issues (e.g., staffing, resources). The panel organized recommendations based on these three distinct themes and graded the strength of scientific evidence.

The panel presented the newly drafted recommendations to interested members of ASPMN at the ASPMN annual meeting in September 2017. During the presentation, ASPMN members who attended provided feedback and discussed potential challenges or barriers to implementation of the revised guidelines. This feedback informed the final revisions to the guidelines outlined in this report.

Recommendations

Aligning Practice with Evidence and Standards

Recommendation 1

- The panel recommends that pain management strategies be individualized and aligned with peer-reviewed published evidence-based guidelines and The Joint Commission current pain standards (strong recommendation, high-level evidence).

Rationale. Individualized perioperative (i.e., preoperative, intraoperative, and postoperative) pain management strategies that are tailored to patients, their procedures, and health conditions are necessary for the delivery of safe and effective pain management (Chou et al., 2016; The Joint Commission, 2017). Several evidence-based guidelines recommend the use of multimodal pain management that has opioid-sparing effects to decrease the incidence of opioid-related adverse events (American Society of Anesthesiologists Task Force on Acute Pain Management, 2012; National Comprehensive Cancer Network, 2018). Further support of opioid-sparing pain management is evident in the growing list of Enhanced Recovery After Surgery (ERAS) protocols (American Society of Enhanced Recovery, 2018; Tebala et al., 2016). Recent evidence has led TJC to update their standards for pain assessment and management requirements (The Joint Commission, 2017). This ASPMN panel endorses TJC standards to promote quality care and patient safety when opioids are part of patient-centered perioperative multimodal analgesia.

Implementation. Clinicians should participate in developing pain management plans with the interprofessional team for all hospitalized patients. These plans of care should incorporate multimodal therapy approaches that are aligned with current evidence-based guidelines and research. Fundamental to developing such plans, all clinicians need to be educated in pain assessment, including types of pain, risk factors for severe pain and analgesic side effects, functional goals, and how to communicate with patients about risk of treatment and preferences. Clinicians also need to be educated in the principles, rationale, and components of evidence-based multimodal analgesia, so they are aware of effective options available to reduce the use of opioids for managing pain.

Risk Assessment

Recommendation 2

- The panel recommends that clinicians recognize that all hospitalized patients receiving systemic (e.g., transdermal, IV, oral) or neuraxial opioids for acute pain management are at risk of opioid-induced unintended advancing sedation and opioid-induced respiratory depression. Some patients are at high risk for opioid-induced adverse events (Table 2) (strong recommendation, high level evidence).

Rationale. OIUAS and OIRD occur as the result of the action of opioids within the central nervous system and μ receptors suppressing the respiratory center in the brain. Opioids blunt the normal respiratory rescue response to rising carbon dioxide and falling oxygen levels, which can lead to anoxic brain injury or death (Ladd et al., 2005; Lee et al., 2015; Sasaki, Meyer, & Eikermann, 2013). The incidence of adverse events from OIUAS and OIRD ranges between 0.6% and 4.2% (Cashman & Dolin, 2004; Herzig et al., 2014; Kessler et al., 2013). To address this continued problem, The Joint Commission, Institute for Healthcare Improvement, and Centers for Medicare and Medicaid Services recommend the (1) assessment of all patient and environmental risk factors, (2) implementation of systematic quality measures along with tracking opioid-related adverse events, and (3) education of all members of the health care team about risks with opioid administration (Centers for Medicare and Medicaid Services, 2014; Institute for Healthcare Improvement, 2012; The Joint Commission, 2017).

Table 2
Factors That Increase Risk for OIUAS and OIRD

Patient-Specific
Obesity hypoventilation syndrome (OHS) <ul style="list-style-type: none"> • BMI ≥ 30 kg/m² and • Arterial blood gas PaCO₂ >45 mm Hg (normal 35–45) or • Serum HCO₃ >27 mmol/L (without other cause of metabolic alkalosis)
Known or suspected sleep-disordered breathing <ul style="list-style-type: none"> • STOP-BANG total score >3 of 8 • Diagnosis of obstructive or central sleep apnea
Comorbidities <ul style="list-style-type: none"> • History of cardiac and/or pulmonary disease (previous or current smoker and/or need for supplemental oxygen) • Impaired renal function (blood urea nitrogen >30 mg/dL) • Impaired hepatic function (albumin level <30 g/L) • Obesity—BMI > 30 • Substantive functional limitations
American Society of Anesthesiologists (ASA) Physical Status Classification System >2
Substance use disorder (tobacco, alcohol, opioids, or other illicit substances)
History of or current (observed in the PACU) opioid-related sedation and/or respiratory event
Requirement for aggressive titration and dosing of opioids to manage pain
Treatment-Related
Continuous opioid infusion in opioid-naïve patients (e.g., IV PCA with basal rate)
Concomitant administration of sedating agents (e.g., benzodiazepines, antihistamines)
General anesthesia (especially if prolonged) as opposed to regional anesthesia
Surgical site (head, neck, chest, upper abdomen)
First 24 hours of initiating opioids (e.g., first 24 hours after surgery is a high-risk period for surgical patients)
Naloxone administration: Patients who are given naloxone for clinically significant opioid-induced respiratory depression are at risk for repeated episodes of respiratory depression
Environment of Care
Inadequate hand-off communication of pertinent information related to risks for opioid-induced sedation and respiratory depression and monitoring requirements
Ineffective interprofessional communication of pertinent information related to risks for opioid-induced sedation and respiratory depression and monitoring requirements
Inadequate staffing that limits frequency of observations and safe monitoring practices

OIUAS = opioid-induced unintended advancing sedation; OIRD = opioid-induced respiratory depression; BMI = body mass index; PACU = postanesthesia care unit; IV = intravenous; PCA = patient-controlled analgesia.

Implementation. All patients must be assessed for risk of OIUAS and OIRD, and appropriate interventions should reflect level of risk. Clinicians need to be educated on assessing risk. Electronic health records should include evidenced-based assessment tools and methods to link appropriate safety measures that reflect the patient's level of risk.

Recommendation 3

- The panel recommends that all patients who will receive opioids undergo a comprehensive assessment of level of individual risk before initiation of opioid therapy. Ongoing reassessment of risk that continues through the trajectory of clinical care is essential (strong recommendation, moderate level evidence).

Rationale. Several cohort studies have documented risk factors for opioid-related adverse events and the need for naloxone rescue (Khelemsky, Kothari, Campbell, & Farnad, 2015; Lee et al., 2015; Pawasauskas, Stevens, Youssef, & Kelley, 2014; Rosenfeld et al., 2016; Weingarten, Herasevich, et al., 2015; Weingarten, Warner, & Sprung, 2017). Please see Table 2 for a list of evidence-based patient risk factors.

Implementation. Screening patients for risk for OIUAS and OIRD should be an iterative process beginning before opioids are administered and continuing throughout a patient's hospitalization. Acknowledging that it may not be feasible to prescreen all patients (whether or not they are being prescribed opioids) on admission to the hospital, it is necessary to screen all patients before initiating opioid therapy. A patient's risk profile should always be documented in the electronic health record (EHR). EHR enhancements that link OIRD screening risk alerts to provider order entry systems may provide additional safeguards. Implementation of a risk factor checklist integrated into the EHR could also guide clinicians during a comprehensive assessment. Because assessment of risk should be an iterative process reflecting the response to care of a patient, it may be helpful to institute an EHR alert when a patient requires frequent doses of opioids, when a potential synergistic sedating medication is added, or when multiple formulations of opioids are used (e.g., long-acting oral opioid formulation in addition to short-acting or parenteral formulations). Implementation of this recommendation does require educating clinicians regarding the risk factors with relation to OIUAS and OIRD and how to appropriately intervene when an EHR alert is activated. Clinicians also need to be educated in how to assess patients on an ongoing basis throughout the trajectory of care and how to intervene when assessment yields concern.

Recommendation 4

- The panel recommends that ongoing individualized patient-centric plans of care be based on the patient's level of risk, which may change over the course of hospitalization, and be developed, revised as needed, and communicated among all members of the patient care team (strong recommendation, moderate level evidence).

Rationale. Knowledge that poor communication increases the likelihood of adverse events has led organizations such as TJC, the World Health Organization, and IHI (Institute for Healthcare Improvement, 2018; The Joint Commission, 2017, 2018a; World Health Organization, 2017) to develop recommendations that focus on improving communication among clinicians. Assessing

risk is only the first step in the process of ensuring safe pain management. Level of risk and recommendations for the appropriate monitoring strategies must be communicated to the patient, family, and entire health care team especially at handoff between levels of care and nursing shift changes (Bigani & Correia, 2018; Bittner-Fagan, Davis, & Savoy, 2017; Jewell & Committee On Hospital, 2016; Schirm, Banz, Swartz, & Richmond, 2018; Streeter & Harrington, 2017). Even though a patient may not be deemed high risk on preoperative assessment, a patient may still exhibit signs of OIUAS and OIRD while recovering in the postoperative care unit (PACU). Patients who exhibit OIRD in the PACU are 5–11 times more likely to have such an event on the general care unit (Weingarten et al., 2016). Effective communication among the health care team, especially in transitions of care, is known to improve patient safety (Thomas & MacDonald, 2016).

Implementation. The panel recommends multidisciplinary development and communication of a plan of care that includes pharmacists' input into safe prescribing of medications. The plan of care should be developed and communicated at the time of risk assessment or reassessment and used diligently while the patient is receiving opioid analgesia. EHR enhancements should be used to alert all clinicians of risks for opioid-induced adverse events and to allow for structured handoff communication tools or criteria to communicate pertinent patient information related to monitoring plans of care and responses to pain management therapies (Eckstrand et al., 2009).

Recommendation 5

- The panel recommends that clinicians identify patients at high risk of opioid-induced unintended advancing sedation and opioid-induced respiratory depression by using evidence-based criteria, which includes the use of validated assessment scales/instruments (strong recommendation, high level evidence).

Rationale

Obstructive sleep apnea (Category B). Obstructive sleep apnea (OSA) and obesity hypoventilation syndrome (OHS) are highly associated with OIUAS and OIRD (Fernandez-Bustamante et al., 2017; Gupta et al., 2018; Kaw et al., 2012; Nagappa et al., 2017; Shin et al., 2016; Weingarten, Herasevich, et al., 2015). Patients diagnosed with OSA or those who screen positive for OSA using the STOP-BANG questionnaire (Table 3) and experience an opioid-related respiratory arrest are more likely to experience a serious consequence such as anoxic brain injury and death (Fernandez-Bustamante et al., 2017; Fouladpour et al., 2016).

Obesity hypoventilation syndrome (Category B). Patients with obesity hypoventilation syndrome (OHS) are more susceptible to hypoventilation from opioids and more likely to (1) be admitted to the intensive care unit postoperatively, (2) require a tracheostomy, and (3) have increased hospital stays (Kaw et al., 2016). Diagnostic criteria for OHS are (1) body mass index (BMI) ≥ 30 kg/m², (2) hypoxemia (SpO₂ <90%) during sleep, and (3) hypercapnia during the day. The health care team can screen for OHS by assessing (1) BMI >30 kg/m², (2) daytime oxygen level (<95%), (3) PaCO₂ (via arterial blood gas) >45 mm Hg or serum HCO₃ >27 mmol/L (via admission chemistry profile) (Hart et al., 2014; Izrailtyan, Qiu, Overdyk, Ersilon, & Gan, 2018; Manuel, Hart, & Stradling, 2015).

ASA classification (Category B). When more than one comorbid condition exists, the likelihood of developing postoperative complication such as OIUAS and OIRD is increased (Fernandez-Bustamante et al., 2017; Gupta et al., 2018; Khelemsky et al., 2015; Lee et al., 2015; Pawasauskas et al., 2014; Rosenfeld et al.,

Table 3
Assessment Strategies

STOP-BANG Questionnaire
<ul style="list-style-type: none"> • The STOP-BANG questionnaire is the most consistently applied validated instrument to screen for OSA (Chung et al., 2016). • Although used widely in hospitals, there is sparse evidence on the sensitivity and specificity for detecting OIUAS and OIRD (Chung et al., 2016; Nagappa et al., 2017). In a study of postoperative patients, at least 18.3% of patients scoring <3 on the STOP-BANG developed moderate to severe sleep-disordered breathing after surgery (Chung et al., 2015). This finding in combination with results from other studies indicate that other factors are also predictive of patient risk for sleep-disordered breathing, calling for the need to expand screening procedures beyond the STOP-BANG questionnaire (Adams, Butas, & Spurlock, 2015). • A total score of >3 out of 8 on the STOP-BANG questionnaire is considered a positive screen for OSA; a total score of ≥5 on the STOP-BANG instrument has been found to have 74% specificity and 56% sensitivity for the detection of OSA (Chung, Yang, & Liao, 2013; Nagappa et al., 2015). • The total score of the STOP-BANG questionnaire should be used as opposed to just the individual items.

OSA = obstructive sleep apnea; OIUAS = opioid-induced unintended advancing sedation; OIRD = opioid-induced respiratory depression.

2016; Schug, Palmer, Scott, Halliwell, & Trinca, 2016). For 50 years, anesthesia providers have used the American Society of Anesthesiologists (ASA) Physical Status Classifications system to rate a patient's risk of undergoing anesthesia (Hurwitz et al., 2017). This classification system is highly subjective and interrater reliability is moderate to low, especially when used by nonanesthesiologists, who consistently underscore ASA classification (Curatolo et al., 2017). Despite the lack of evidence for specificity and sensitivity when the ASA classification is used in screening for OIUAS and OIRD risk, this classification system remains a standard method to assign preoperative risk status based on comorbid conditions posing serious threats to surgical populations. Patients who are classified at an ASA level >2 are more likely to require naloxone intervention and be identified as patients who are high risk for OIUAS and OIRD (Edwards, Jacobs, Hadden, & Barnes, 2017; Khelemsky et al., 2015; Lee et al., 2015; Ramachandran, Pandit, Devine, Thompson, & Shanks, 2017; Rosenfeld et al., 2016; Weingarten et al., 2016).

Specific diseases (Category B). There is strong evidence supporting the use of the ASA classification score as a predictor of risk for OIUAS and OIRD (Fernandez-Bustamante et al., 2017; Nadpara, Joyce, Carroll, Carroll, Barnard, & Zedler, 2018; Pawasauskas et al., 2014; Ramachandran et al., 2017; Weingarten et al., 2016; Yung, Lee, Hsu, Furnish, & Atayee, 2017; Zedler, Saunders, Joyce, Vick, & Murrelle, 2018). Additionally, there is substantial evidence to indicate that patients with diabetes mellitus (Fernandez-Bustamante et al., 2017; Gupta et al., 2018; Nadpara et al., 2018; Ramachandran et al., 2017; Weingarten et al., 2016; Zedler et al., 2018), renal impairment (Dahan, Overdyk, Smith, Aarts, & Niesters, 2013; Fernandez-Bustamante et al., 2017; Khanna et al., 2019; Nadpara et al., 2018; Pawasauskas et al., 2014; Yung et al., 2017; Zedler et al., 2018), and heart failure (Khanna et al., 2019; Nadpara et al., 2018; Pawasauskas et al., 2014; Ramachandran et al., 2017; Yung et al., 2017; Zedler et al., 2018) could be at high risk for OIUAS and OIRD.

Individual characteristics and other disease states (Category C). Although the evidence is weak, other individual risk factors potentially increase the likelihood for OIUAS and OIRD. These include age (Gupta et al., 2018; Khanna et al., 2019; Lee et al., 2015); liver disease (Fernandez-Bustamante et al., 2017; Ramachandran et al., 2017; Zedler et al., 2018); obesity (Fernandez-Bustamante et al., 2017; Overdyk et al., 2014; Yung et al., 2017); presence of substance use disorder, including opioid use disorder (Menendez, Ring, & Bateman, 2015; Nadpara et al., 2018; Zedler et al., 2018); being a smoker (Fernandez-Bustamante et al., 2017; Pawasauskas et al., 2014; Ramachandran et al., 2017); presence of genetic variations in opioids pharmacokinetics (Madadi et al., 2013; Manini, Jacobs, Vlahov, & Hurd, 2013); and opioid tolerance (Khanna et al., 2019; Lee et al., 2015). In the past, opioid tolerance has been subject to varying definitions. According to the U.S. Food and Drug Administration (FDA), an opioid-tolerant patient is one who has been taking oral morphine 60 mg/day for a week or longer, or at least transdermal fentanyl 25 mcg/hour; oral oxycodone 30 mg/day; oral hydromorphone 8 mg/day; oral oxymorphone

25 mg/day; or an equianalgesic dose of any other opioid (U.S. Food and Drug Administration, 2018). It is critical for clinicians to understand that regular exposure to opioids does not guarantee protection from OIUAS and OIRD (Hayhurst & Durieux, 2016; Jolley, Bell, Rafferty, Moxham, & Strang, 2015).

Treatment-related Factors

Treatment-related factors are ones that are addressable by clinicians. Such factors include communication, nurse/patient staffing ratios, type of anesthesia, nurse competencies, use of EHR alerts, institutional policies, procedures and surveillance, and issues surrounding pharmacologic interventions.

Supplemental oxygen (category C). The routine use of 2-3 liters per minute of supplemental oxygen, during the first 24 hours after surgery, continues despite consistent supporting evidence (Al-Mobeireek & Abba, 2002; Allegranzi et al., 2016; American Society of Anesthesiologists Task Force on Neuraxial Opioids et al., 2009; Gan et al., 2014; Myles & Kurz, 2017; Shapiro et al., 2005; Voepel-Lewis et al., 2013; Volk, Peters, & Sessler, 2017). Supplemental oxygen is recommended for patients experiencing intermittent or sustained hypoxia (<90%) after surgery (American Society of Anesthesiologists Task Force on Neuraxial Opioids et al., 2009; de Raaff et al., 2017). Although the benefits of supplemental oxygen therapy in the postoperative setting is thought to outweigh the risks, higher concentrations (50%) of supplemental oxygen may be associated with more pronounced respiratory depression and negative health effects (Chu et al., 2018; Dahan, Douma, Olofsen, & Niesters, 2016; Niesters, Mahajan, Aarts, & Dahan, 2013). Some authors contend that supplemental oxygen therapy may mask the detection of compromised respiratory status when using pulse oximetry as a method to assess blood oxygen saturation (Fu, Downs, Schweiger, Miguel, & Smith, 2004; Lam et al., 2017; Maddox, Williams, Oglesby, Butler, & Colclasure, 2006; Rozario, Sloper, & Sheridan, 2008; Shapiro et al., 2005; Sun et al., 2015; Whitney & Parkman, 2004). A recent study, however, disputes this notion that supplemental oxygen masks the detection of deteriorating respiratory status when monitoring with pulse oximetry (Taenzer, Perreard, MacKenzie, & McGrath, 2017).

Type of anesthesia (category B-1). Patients receiving general anesthesia tend to be at higher risk for OIUAS and OIRD compared with those given regional anesthesia (Khelemsky et al., 2015; Rosenfeld et al., 2016; Sultan, Gutierrez, & Carvalho, 2011).

Implementation. Comprehensive risk assessments for OIUAS and OIRD require use of reliable and valid instruments and policies to direct best practice. Electronic health record enhancement may be helpful to improve communication and provide timely safety alerts. Adding EHR alerts should be strategic to avoid alert fatigue. Organizational leaders should support continuing education for staff regarding roles and responsibilities to identify individual risk factors and appropriate monitoring and risk reduction interventions. It is

also necessary to assign responsibilities for nurses and other health care professionals in performing and communicating risk assessments across transitions of care. Assessing risk is only helpful if followed by applying appropriate interventions; therefore, practices should include actions and interventions to address and reduce risks. Organization leaders need to ensure that clinicians provide education for clinicians addressing individual risk factors, assessment of patients to identify risk factors, and appropriate risk reduction interventions to address risk factors, as well as the obligations/responsibilities of clinicians for safe care of patients at risk, including the transfer of patients to a higher level of care.

Pharmacological Risk

Recommendation 6

- The panel recommends that clinicians employ evidence-based pain management that incorporates opioid-sparing and multimodal analgesia therapies (strong recommendation, high level evidence)

Rationale

Comparison of opioid analgesics (category A-1). All full agonist opioid medications as well as partial agonists (e.g., tramadol, tapentadol, butorphanol, buprenorphine) can cause sedation and respiratory depression (Yung et al., 2017). Consequently, clinicians need to practice increased vigilance in assessing and monitoring all hospitalized patients receiving opioids for pain control to ensure effective and safe pain management (Chang, Bijur, Baccellieri, & Gallagher, 2009; Choi et al., 2008; Hutchison, 2006; Komatsu et al., 2007; Maestroni et al., 2007; Manolaraki et al., 2008; Sami Mebazaa, Mestiri, Kaabi, & Ben Ammar, 2008; Tsutaoka, Ho, Fung, & Kearney, 2015; van der Schrier et al., 2017; Yassen et al., 2007; Zeng et al., 2015). The onset and severity of OIUAS and OIRD depend on many factors, including opioid formulation, dose, and mode of delivery; coadministration with other medications; and patient-centered factors related to drug absorption, metabolism, and elimination (Shenk et al., 2016; Takmaz et al., 2008; Weingarten, Hawkins, et al., 2015; Weingarten, Herasevich, et al., 2015; Zedler, et al., 2018). The selection of perioperative and acute pain analgesic regimens need to be evidence-based according to practice guidelines (Chou et al., 2016; Counsell, 2015; Hegmann et al., 2014; Schug et al., 2016). Multimodal analgesia can reduce opioid requirements, thus reducing risks for opioid-related adverse events, especially OIUAS and OIRD.

Multimodal analgesia is an important strategy for safe and effective pain management. It is important to consider the effect of coanalgesics and adjunct medications on sedation and respiratory depression when used in conjunction with opioids, and any potential risk must be evaluated. Classes of analgesics are presented next, and the category of evidence rating for the medications listed is the strength of the evidence that the medication either prevents or contributes to excessive sedation and respiratory depression when added to opioid medication.

Acetaminophen (category A-1). Although there is strong evidence that acetaminophen exerts opioid-sparing effects, most studies indicating reductions in opioid requirements with acetaminophen did not measure effects on respiratory depression or concluded that there were no significant differences in rates of respiratory depression (McNicol et al., 2011; Moon, Lee, Lee, & Moon, 2011). A meta-analysis of intravenous acetaminophen in combination with opioids found reductions in 24-hour opioid requirements with open surgeries (Blank et al., 2018). A recent claims database analysis for perioperative use of acetaminophen with

open colectomies revealed comparable opioid-related adverse event profiles between intravenous and oral acetaminophen use as an adjunct to opioid-based regimens (Wasserman et al., 2018).

Nonsteroidal anti-inflammatory drugs (NSAIDs) (category A-1). Clinical practice guidelines for ERAS protocols recommend the addition of NSAIDs as part of multimodal analgesia. (Carmichael et al., 2017; Tebala et al., 2016; Wick, Grant, & Wu, 2017). Authors of meta-analyses and individual studies conclude that nonselective NSAIDs are opioid sparing and reduce the incidence of opioid-induced sedation, but evidence on the effects on respiratory depression is lacking (Kumar, Kirksey, Duong, & Wu, 2017; Larson et al., 2014; Marret, Kurdi, Zufferey, & Bonnet, 2005; Wick et al., 2017). A comparison of intravenous ibuprofen 800 mg to acetaminophen 1,000 mg administered every 6 hours after bariatric surgery found that mean opioid requirements with IV patient-controlled analgesia (PCA) was less with ibuprofen ($p = .055$) (Erdogan Kayhan, Sanli, Ozugul, Kirteke, & Yologlu, 2018).

Along with opioid-sparing effects, NSAIDs are associated with negative effects such as possible increased risk of bleeding and acute renal failure (Blouin & Rhoads, 2014; Shukla, Rai, Prasad, & Agarwal, 2017; Van Koughnett & Wexner, 2014; Warth et al., 2016). Patients should be carefully evaluated for potential risks for adverse events with NSAIDs.

Anticonvulsants (category A-1). Anticonvulsant medications, including gabapentin and pregabalin, are commonly recommended as part of ERAS protocols and clinical practice guidelines (Carmichael et al., 2017; Chou et al., 2016). There is substantive evidence that gabapentinoids (pregabalin up to 300 mg preoperatively or 75 mg bid for 5 days and or gabapentin 600 mg bid) are opioid-sparing and are not associated with serious opioid-induced adverse events (Balaban, Yagar, Ozgok, Koc, & Gullapoglu, 2012; Giansello, Pavoni, Barboni, Galeotti, & Nella, 2012; Gurunathan, Rapchuk, King, Barnett, & Fraser, 2016; Kim et al., 2011). Recent systematic reviews, however, warn of possible increased sedation from gabapentin and pregabalin (Cavalcante, Sprung, Schroeder, & Weingarten, 2017; Fabritius, Geisler, et al., 2017; Fabritius, Strom, et al., 2017; Fabritius, Wetterslev, Mathiesen, & Dahl, 2017; Savelloni et al., 2017; Yung et al., 2017).

Antidepressants (category C-2). Existing research primarily focuses on the use of antidepressants in the treatment of chronic (persistent) pain. There is weak evidence of increased somnolence when nortriptyline or mirtazapine are administered in combination with opioids medications (Gilron, Tu, Holden, Jackson, & DuMerton-Shore, 2015; Mehta & Roth, 2015; Rowbotham, 2015).

Clonidine (category B-2). Clonidine is a centrally acting α agonist used to treat central pain syndromes; however, evidence suggests a useful role as an opioid-sparing medication with anesthesia and analgesia (Blaudszun, Lysakowski, Elia, & Tramer, 2012; Tripathi, Shah, Dubey, Doshi, & Raval, 2011). Studies document increased sedation when clonidine is added to opioid-based regimens (Huang et al., 2007; McCartney, Duggan, & Apatu, 2007; Vukovic, Ramakrishnan, & Milan, 2012) but no appreciable effects of clonidine in causing respiratory depression.

Ketamine (category A-1). Ketamine, an anesthetic agent that induces sedation and memory loss, is used in subanesthetic doses as an analgesic for acute pain. There is sufficient evidence to document the role of low-dose ketamine in reducing opioid requirements without increasing risk of respiratory depression (Laskowski, Stirling, McKay, & Lim, 2011; Mathews, Churchhouse, Housden, & Dunning, 2012; Parikh, Maliwad, & Shah, 2011; Rakhman et al., 2011; Sen et al., 2009). Although low-dose ketamine may be beneficial as part of multimodal pain management, even at low doses patients can experience adverse effects such as delirium, agitation, dysphoria, hallucinations, vivid dreams, and sedation (Schwenk et al., 2016).

Dexmedetomidine (category A-1). Dexmedetomidine, indicated for purposeful sedation of mechanically ventilated patients, also has opioid-sparing effects and decreases pain intensity without posing significant risks for respiratory depression in postoperative populations (Bharti, Sardana, & Bala, 2015; Blaudszun et al., 2012; Garg et al., 2016; Song, Shim, Song, Kim, & Kwak, 2016; Techanivate, Dusitkasem, & Anuwattanavit, 2012).

Benzodiazepines (category B-1). Benzodiazepines are commonly used during anesthesia because they promote relaxation and amnesia. Lately, attention to the combination of opioids with benzodiazepines has raised awareness of serious interactions in outpatients, leading to opioid overdose and even deaths (Food and Drug Administration, 2016; Gressler, Martin, Hudson, & Painter, 2017). Coadministration of benzodiazepines with opioid analgesics in the in-patient setting also carries a significant risk for respiratory depression, secondary to its potential to produce sedation (Gordon & Pellino, 2005; Griffiths et al., 2012; Izrailtyan et al., 2018; Kim, McCarthy, Mark Courtney, Lank, & Lambert, 2017; Lee et al., 2015; Lyons et al., 2017; Overdyk et al., 2016; Ramachandran et al., 2017; Silva et al., 2015; Zedler et al., 2018). This has prompted the Food and Drug Administration to issue warnings regarding coprescribing of opioids and benzodiazepines (U.S. Food and Drug Administration, 2016).

Antihistamines (category C). It was once thought that antihistamine medications such as diphenhydramine were helpful in treating pain and reducing postoperative nausea and vomiting (Lin et al., 2005; Tu et al., 2006). More recent evidence has led clinicians to be concerned about the synergistic effects resulting in OIUAS and OIRD when antihistamines are added to opioid regimens (Becker, 2012; Siddik-Sayyid et al., 2010). Unfortunately, there is not strong evidence to substantiate this assumption. A recent study, however, documented the lack of opioid-sparing effects of diphenhydramine with postoperative pain in doses up to 50 mg but failed to address effects on sedation or respiratory depression (De Oliveira, Bialek, Marcus, & McCarthy, 2016). Ondansetron, although effective for postoperative nausea and vomiting, does not appear to be associated with respiratory depression (Moslemi, Rasooli, Baybordi, & Golzari, 2015; Moustafa, Baaror, & Abdelazim, 2016; Zhou, Huang, Lu, Zhang, & Zhang, 2015).

Implementation. In order for clinicians to participate in clinical decision making around the administration of multimodal analgesia, they must be educated about effectiveness, synergistic adverse effects, and contraindications to it. Using EHR alerts at time of entering prescriptions may act as a reminder. Other sources for supporting the patient's opioid history can be obtained via the state's Prescription Drug Monitoring Program (PDMP). Prescribers of opioids should have access to this database and may access this information to inform safe prescribing. The data on the PDMP can help clinicians understand opioid requirements and assess for possible multiple prescribers, which may be a sign of opioid misuse or opioid use disorder, although easier procedures for accessing data are needed (Elder, DePalma, & Pines, 2018; Poon et al., 2016). All clinicians need to be educated in safe and effective pain management using a multimodal approach, including the spectrum of pharmacologic and nonpharmacologic components of multimodal analgesia available at the organization where they are employed.

Environment of Care

Recommendation 7

- The panel recommends that hospital policies and procedures reflect evidence-based and nationally published standards and ensure (1) effective communication among all members of the

patient care team, (2) adequate and safe staffing ratios, and (3) purposeful hourly rounding by nursing staff (strong recommendation, weak to high levels of evidence)

Rationale

Communication (category C). Evidence-based and standardized methods of communication at transitions of care and shift-to-shift handoffs can decrease the risk of adverse events in the perioperative setting (Institute for Healthcare Improvement, 2018; Riesenber, Leitzsch, & Cunningham, 2010; Robinson, 2016; The Joint Commission, 2018a). Clinicians value structured communication handoff tools to improve patient safety (Lane-Fall et al., 2014). There is strong evidence to indicate that effective collaboration and communication among health care professionals in the perioperative setting improve patient outcomes and support a culture of patient safety (Institute for Healthcare Improvement, 2018; Magill et al., 2017). Despite recommendations that institutions develop standardized communication procedures for health care teams, a limited number of studies have determined criteria and mechanisms of communication that ensure safe and effective pain management.

Staffing and practice environment (category C). The previous 2011 ASPMN consensus report on monitoring for OIUAS and OIRD detailed numerous studies that address staffing practices for optimal patient care. Clinicians should consult this report for an analysis of research pertaining to nurse staffing and its relationship to achieving safe patient care and outcomes. Research is still lacking to determine specific staffing guidelines for sedation and respiratory monitoring with opioid analgesics. However, the ASPMN expert panel continues to endorse compliance with state mandates, standards promulgated by professional organizations, and institution-specific staffing procedures and acuity measures to determine safe staffing levels. The panel recognizes the work of the American Society of PeriAnesthesia Nurses in identifying safe staffing ratios in the PACU and making this a top priority for national research agendas (Mamaril, Ross, Poole, Brady, & Clifford, 2009).

Purposeful rounding (category C). There are no definitive data indicating that intentional hourly rounding improves detection of opioid-induced adverse events. Moderate strength of evidence exists supporting improvements in patients' perception of nursing responsiveness and reductions in patient falls and call light use (Mitchell, Lavenberg, Trotta, & Umscheid, 2014). There is weak evidence (one quality improvement project) supporting hourly rounding to improve pain management. Hourly rounding to address pain issues in the context of a quality improvement project led to an increase in patient satisfaction with pain outcomes (Daniels, 2016). Extending the focus to purposeful rounding for monitoring patients receiving opioids holds promise for improving early detection of opioid-related adverse events.

Implementation. All hospitals should have patient safety and quality improvement committees that interact with hospital leadership to promote safe and effective pain management strategies (ECRI Institute, 2017). Leadership should be educated on safe and effective pain management strategies and should be accountable for overseeing the development of organization-wide policies and procedures and monitoring adherence to practices outlined in these policies and procedures. All clinicians need to be educated in the organizational policies regarding hourly rounding with attention to safe and effective pain management. Educational activities for clinicians should focus on the importance of effective communication regarding the plan of care, safety issues, patient assessments of risks for OIUAS and OIRD, changes in patients' condition,

and clinical decision-making criteria in determining the appropriate level of care to ensure optimal patient safety.

Monitoring

Recommendation 8

- The panel recommends that the nature, timing, frequency, and intensity of monitoring practices be based on ongoing nursing assessment and reassessment of patients' risks and response to pain therapies. Adaptations to the plan of care are driven by iterative assessments (strong recommendation, moderate level of evidence).

Rationale. Identifying risk factors for OIUAS and OIRD is an iterative process that informs the need to increase or decrease vigilance with monitoring practices. Clinical staff have the responsibility to obtain knowledge of risk factors and apply critical thinking skills in the adaptation of patient assessment data into level of monitoring vigilance. As recommended by the [Chou et al. \(2016\)](#) guidelines, endorsed by several professional organizations, for the management of postoperative pain, clinical staff should perform a thorough history and physical examination to develop an individually tailored pain management plan of care. This comprehensive evaluation should also include assessing the patient's risk of opioid adverse events, including respiratory depression. See [Table 2](#) for list of risk factors.

Implementation. An individualized pain management plan should include recommendations for assessment and monitoring procedures. When developing the initial plan for monitoring procedures, three main issues must be considered: (1) patient risk factors, (2) formulation of opioid, and (3) presence of respiratory interventions such as oxygen therapy, artificial ventilation, or positive airway pressure therapy. The assessment process is iterative and should be ongoing and adjusted according to the patient's responses to clinical care. The organization leaders need to provide education for clinicians regarding the potential safety risks of opioids, the importance of consistent assessment and monitoring, the organization's requirements for each, and how to intervene when patient risk increases during hospitalization including potential transfer to a higher level of care.

Recommendation 9

- The panel recommends evidence-based systematic nursing assessments for opioid-induced unintended advancing sedation and respiratory depression inclusive of (1) level of sedation, (2) respiratory rate and quality, and (3) oxygen saturation before initiation of opioid therapy, before administering an opioid dose, and at peak effect of opioid and/or other sedating medication coadministered within the therapeutic window of an opioid. Systematic nursing assessments should not be replaced with continuous electronic monitoring (strong recommendation, moderate level evidence).

Rationale. There is strong evidence (category B-1) that the incidence of opioid-related adverse events such as OIRD is highest in the first postoperative 24 hours ([Epstein, Dexter, Lopez, & Ehrenfeld, 2014](#); [Lee et al., 2015](#); [Rosenfeld et al., 2016](#); [Weingarten, Herasevich, et al., 2015](#)). There is also moderate quality evidence (category B-2) that increasing vigilance from every 4 hours to using continuous monitoring or assessments to every

≤2.5 hours during the first 24 hours will decrease the use of naloxone and rapid response team calls ([Adams, Butas, & Spurlock, 2015](#); [Jungquist et al., 2016](#); [Lam et al., 2017](#); [Stites, Surprise, McNeil, Northrop, & De Ruyter, 2017](#)).

Nurses increasingly are expected to assume an integral role in improving patient safety ([Institute for Safe Medication Practice \[ISMP\], 2013](#); [The Joint Commission, 2017](#); [World Health Organization, 2017](#)). Although there are few rigorous studies to base specific monitoring practices, there are published guidelines that provide strong recommendations based in expert opinion ([American Society of Anesthesiologists Task Force on Acute Pain, 2012](#); [American Society of Anesthesiologists Task Force on Neuraxial Opioids et al., 2009](#); [Chou et al., 2016](#); [Chung et al., 2016](#); [Jarzyna et al., 2011](#); [Schug et al., 2016](#)). There is consistent agreement among published guidelines that the frequency, intensity, and duration of monitoring should be based on the type of opioid therapy, patient risk factors, and response to treatment; and that current nursing assessments every 4 hours may not be adequate for early detection of opioid-induced adverse events. In one study instituting increased nursing assessments (every 1 hour for 12 hours, then every 2 hours for 12 hours) and the Pasero Opioid-Induced Sedation Scale, the facility documented no adverse opioid-related events after the policy was effectively instituted ([Smith, Farrington, & Matthews, 2014](#)).

Debates exist regarding whether patients on opioids should be monitored using continuous electronic monitoring devices for their entire hospital stay, as evidenced by variations in hospital practices ([Jungquist, Willens, Dunwoody, Klingman, & Polomano, 2014](#)). Although mentioned in a 2012 TJC alert, TJC has not recommended continuous electronic monitoring of all patients on opioids. Developing highest level and rigorous evidence to substantiate continuous monitoring of all patients would require longitudinal randomized controlled trials with large sample sizes that are representative of diverse hospitalized populations limiting the feasibility of such studies. Thus clinicians must depend on available evidence and the ethical tenant of "do no harm." Patients are hospitalized because they are not safe and stable to be cared for at home. Hospital administrators and clinicians are responsible for the safety of the patient and thus must provide, at minimum, intermittent pulse oximetry, especially at peak effect of opioid pain medications. Because of the accumulation, summation, and clearance factors of anesthetic and pain medications, along with the increased collapsibility of the airway during sedation and sleep during the first 24 hours after surgery, it is not always clear when peak effect is occurring. Nurses on the general care units cannot observe patients at all times; thus instituting continuous electronic monitoring will aid nurses in the detection of respiratory issues and improve patient safety. To date, none of the published guidelines advocate for continuous electronic monitoring of respiratory status in *all* patients receiving opioid medications, despite increased awareness from organizations such as the Anesthesia Patient Safety Foundation and the Association for Advancement of Medical Instrumentation ([Weinger, 2011](#); [Williams, 2015](#)). Evidence-based published guidelines are recommending continuous electronic monitoring of those at higher risk. Continuous electronic monitoring of all patients can lead to the problem of alarm fatigue, added work demands, and activity restrictions when patients are tethered to their bed.

Alarm fatigue can be associated with patient harm. According to TJC, there were 98 alarm fatigue-related sentinel events (death or serious permanent patient harm) reported between 2009 and 2012, with 80 of the 98 events resulting in patient death. Additionally, The U.S. Food and Drug Administration reported 500 alarm-related deaths over a 5-year period ([The Joint Commission, 2013](#)). Although tested measures to combat alarm fatigue are evolving, the best ways to combat this concerning problem are yet to be determined.

Table 4
Assessment Strategies

Sedation Scales
<ul style="list-style-type: none"> In a survey of ASPMN members (N = 102), respondents identified the most common sedation scales used at their institution. These included the Pasero Opioid-Induced Sedation Scale (POSS), Richmond Agitation-Sedation Scale (RASS), Ramsay Sedation Scale (RSS), and Sedation-Agitation Scale (SAS). Other, less common, sedation scales were the Aldrete Scale, Riker Scale, Motor Activity Assessment Scale, Glasgow Coma Scale, University of Michigan Scale, and other individually developed institutional scales (Jungquist, Willens, et al., 2014). Seventy-six percent of ASPMN members endorsed utilizing a sedation scale with opioid therapy for pain, and 66% felt that the use of scales was important to preventing and detecting adverse events (Jungquist, Willens, et al., 2014). The RASS is often used in intensive care units (ICUs) for intentional sedation (Bush et al., 2014; Kobelt, Burke, & Renker, 2014) but is also used on general care units when evaluating levels of sedation with limited data to document its utility with opioid-induced sedation (Nisbet & Mooney-Cotter, 2009). The POSS provides guidance for clinical decision making with interventions or actions that can be taken by clinicians in response to concerning levels of sedation. Reliability and validity have been established for the POSS for use on general care units in monitoring patients receiving opioid analgesics (Bartoszek et al., 2017; Cooper, Stannard, & Noble, 2015; Davis et al., 2017; Kobelt et al., 2014; Nisbet & Mooney-Cotter, 2009; Quinlan-Colwell, Thear, Miller-Baldwin, & Smith, 2017; Savelloni et al., 2017). Validated and standardized sedation scales or measures should be incorporated in routine monitoring of patients receiving opioids to guide critical thinking skills and informed decisions about managing pain, sedation, and patient safety.

ASPMN = American Society for Pain Management Nursing.

Studies thus far have not been convincing in identifying the benefits of continuous monitoring in yielding reduced rates for serious opioid adverse events. Research is needed to compare prevention and detection rates of OIUAS and OIRD between intermittent and continuous monitoring. Until such evidence exists, this panel recommends nursing assessments (respiratory rate and quality, level of sedation, oxygen saturation) before initiation of opioid therapy, before administering a dose, and at peak effect. In addition to nursing assessment, continuous electronic monitoring between nursing assessments may be warranted in high-risk patients. After the first 24 hours, the timing of assessments and duration of electronic monitoring should be adjusted according to patient status and responses to therapy.

Sedation scales (category B-3). Growing evidence indicates the value of using reliable and valid sedation scales to quantify and describe opioid-induced sedation (Dunwoody & Jungquist, 2018). Sedation or altered level of consciousness is a common effect of opioids, and unintended advancing sedation is a serious adverse event that often precedes opioid-induced respiratory depression (Ghelardini, Di Cesare Mannelli, & Bianchi, 2015; ISMP, 2013; Macintyre, Loadsman, & Scott, 2011; Motov, Rosenbaum, Vilke, & Nakajima, 2016; Oosten et al., 2011; Smith et al., 2014; Yamamoto, Fricova, Rokyta, & Slamberova, 2016). Clinicians continue to emphasize the importance of routine assessments of sedation levels as part of monitoring practices for opioid-related

adverse events (Dalton et al., 2001; Gordon, Pellino, Higgins, Pasero, & Murphy-Ende, 2008; Hayes & Gordon, 2015; Jarzyna et al., 2011; Pasero, 2009). See Table 4 for additional information regarding sedation assessment.

Respiratory rate and quality (category B-2). The ability to assess respiratory status with opioid therapy requires attention to breathing patterns (ISMP, 2013).

Clinicians should observe breathing during sleep, then wake the patient to assess level of sedation. Waking the patient is critical to providing safe patient care. See Table 5 for additional information regarding respiratory assessment.

Intermittent pulse oximetry (category B-2). The oldest and most often used device to monitor for OIRD is pulse oximetry. The 2014 ASPMN membership survey (N = 102) found that 28% of nurses from unique hospitals endorsed using intermittent pulse oximetry to assess for OIRD (Jungquist, Willens, et al., 2014). Although expert panel members agree that the use of intermittent pulse oximetry has increased over time, many hospitals still face limited availability of pulse oximetry devices to safely monitor the high volume of patients receiving opioid analgesics (Willens, Jungquist, Cohen, & Polomano, 2013). See Table 6 for additional information regarding pulse oximetry.

Heart rate (no evidence rating). Cardiac electronic monitoring can be beneficial along with respiratory monitoring to detect changes in heart rate indicative of ensuing or actual respiratory

Table 5
Assessment Strategies

Respiratory Rate, Depth, and Quality
<ul style="list-style-type: none"> Because sleep states pose risks for pharyngeal collapsibility that may be increased with sedating agents and lack of voluntary control of breathing, it is important for clinicians to be extra vigilant with monitoring practices when patients are sleeping to ensure patient safety (Ehsan, Mahmoud, Shott, Amin, & Ishman, 2016; Jungquist, Smith, Nicely, & Polomano, 2017; Kulkas et al., 2010; Oudiette et al., 2018). The clinician should assess the respiratory status by observing the respiratory rate and depth and quality of respirations in the awake patient at rest and the sleeping patient before being aroused for 1 full minute. Normal awake respiratory rate for adults younger than 65 years ranges between 12-18 breaths per minute (BPM). Normal respiratory rate during sleep should remain between 12-20 BPM in patients younger than 60 years, 12-28 BPM between 65-80 years, and 10-30 BPM in those younger than 80 years (Flenady, Dwyer, & Applegarth, 2017; Rodriguez-Molinero, Narvaiza, Ruiz, & Galvez-Barron, 2013). A patient experiencing OIUAS and OIRD may exhibit a respiratory rate <12 breaths per minutes initially, but then as the body compensates, rates may increase to greater than 18 breaths per minute (Al-Khabori et al., 2014; Drummond, Dhonneur, Kirov, & Duvaldestin, 2013). Quality of breathing involves assessment of depth and rhythm. Tidal volume, represented by the depth of breath, decreases during sleep, at which time breathing may appear shallower (Rodriguez-Molinero, Narvaiza, Ruiz, & Galvez-Barron, 2013). The quality of rhythm of breathing during wakefulness should remain steady, but normal breathing rhythms during REM sleep may be irregular (Krieger, Maglasiu, Sforza, & Kurtz, 1990). In the presence of opioids and other sedating medications, tidal volume or depth of breath may be shallow, and rhythm may be irregular representing pharyngeal collapsibility/apneic events (Al-Khabori et al., 2014; Drummond et al., 2013). Clinicians should use their auditory senses to listen for snoring, which is a sign of varying degrees of pharyngeal collapse (Alakuijala & Salmi, 2016; Hong et al., 2017; Koo et al., 2017). Much like patients with OSA, patients experiencing OIUAS and OIRD could exhibit noisy breathing and a distinct pattern with pause in breaths for more than 10 seconds, then a louder snore as they arouse to open their airway (Wu et al., 2016).

OIUAS = opioid-induced unintended advancing sedation; OIRD = opioid-induced respiratory depression; REM = rapid eye movement; OSA = obstructive sleep apnea.

Table 6
Assessment Strategies

Oxygen Saturation
<ul style="list-style-type: none"> • Pulse oximetry is a reliable and valid measure of the percentage of red blood cells that are saturated with oxygen and can be accomplished using a probe that rests on the end of a finger (Al-Khabori et al., 2014). • The finger sensor should be gently applied to the finger and occur with the patient at rest and/or during sleep. • The most accurate reading will be the one that stabilizes and is present for the majority of the 60 seconds (Stausholm, Rosenberg-Adamsen, Edvardsen, Kehlet, & Rosenberg, 1997). • Factors that can interfere with accuracy of pulse oximetry are dark-colored nail polish, vasoconstriction (e.g., Raynaud's or sickle cell diseases), hypotension, and hypothermia (Desalu, Diakparomre, Salami, & Abiola, 2013; Hakverdioglu Yont, Akin Korhan, & Dizer, 2014; Stausholm et al., 1997). • Normal awake oxygen saturation in adults is 95% but can range 91% to 100% in adults older than 65 years. The limit of low normal in elderly patients is 91% (Rodriguez-Moliner et al., 2013). During sleep, oxygen saturation should remain $\geq 92\%$. • In the absence of supplemental oxygen, signs of respiratory compromise are (1) sustained periods of intermittent oxygen desaturation lasting at least 10 seconds $< 90\%$ during sleep, (2) average oxygen saturation $< 92\%$, (3) respiratory rate < 10 BPM, or (4) 3% drop in pulse oximetry lasting more than 15 minutes after a parenteral opioid is administered (Chung et al., 2012). • Recognizing slow patient deterioration and the summation effective of multiple doses of opioids requires comparing current pulse oximetry data with preopoid data as well as changes over time. • Patients who experience repeated oxygen desaturations dipping to 83% during sedation or sleep have impaired arousal thresholds and may be at higher risk of respiratory arrest when given sedating medications (Edwards et al., 2014). • Supplemental oxygen therapy can mask hypoventilation (Fu et al., 2004; Lam et al., 2017; Maddox et al., 2006; Rozario et al., 2008; Sun et al., 2015). For an accurate assessment of actual oxygen saturation, supplemental oxygen should be removed for at least 5 minutes before assessment of oxygen saturation. • Documentation of oxygen saturation should include whether the assessment occurred with or without supplemental oxygen. • Continuous pulse oximetry can be discontinued after 24 hours if parenteral or neuraxial opioids are stopped, as long as the patient does not demonstrate continued high-risk factors and does not have signs of trending or actual OIRD. • The alarm threshold for pulse oximetry is typically $\leq 90\%$. There is some evidence that an alarm threshold of 88% decreases the rate of false alarms without increasing sentinel OIUAS and OIRD events (Taenzer, Pyke, Herrick, Dodds, & McGrath, 2014).

BPM = breaths per minute; OIRD = opioid-induced respiratory depression; OIUAS = opioid-induced unintended advancing sedation.

events from opioids. Although acceleration or deceleration of heart rate is often associated with hypoxia, changes in heart rate may also be indicative of pain as well as a later sign of OIRD. Heart rate alerts with integrated respiratory and cardiac monitoring systems provides surveillance of changes in cardiac status secondary to pain and respiratory depression (Helfand, Christensen, & Anderson, 2011). The need for cardiac monitoring with opioids should be determined based on a patient's health status, criteria for such monitoring, and environments of care where telemetry and cardiac monitors are available.

Implementation. The recommended procedure for intermittently measuring oxygen saturation using pulse oximetry is similar to assessment of respiratory quality and depth. Clinicians should be especially vigilant, increasing assessment for respiratory compromise when the patient's respiratory status is the most vulnerable.

Recommendation 10

- The panel recommends that all patients deemed to be at risk for opioid-induced unintended advancing sedation and opioid-induced respiratory depression be evaluated for continuous electronic monitoring (Table 2); and that the type of electronic monitoring be appropriate to the condition of the patient, presence of supplemental oxygen or positive airway pressure therapy, patient's response to care, patient comfort and adherence to monitoring device, and detection capability of the technology (strong recommendation, weak level evidence).

Rationale. There are four types of continuous electronic monitoring devices available for clinical use on general medical/surgical units: (1) pulse oximetry/oxygen saturation, (2) acoustic respiratory rate monitor, (3) capnography/end tidal carbon dioxide, and (4) minute ventilation monitor. Making decisions as to the best type of electronic monitoring device requires a full understanding of breathing pattern changes that occur after an opioid dose is delivered. Once a parenteral dose of opioid is administered, the first change is a decrease in respiratory rate, followed by a decrease in tidal volume.

The resulting hypoventilation can cause a rise in carbon dioxide and subsequent decrease in oxygen saturation (Leino, Mildh, Lertola, Seppala, & Kirvela, 1999). Pulse oximetry monitoring, although common, is, at some hospitals, being replaced or augmented with capnography and minute ventilation monitoring practices based on expanding science in the etiology of OIRD and the availability of newer capnography and minute ventilation devices.

Pulse oximetry (category B-1). There is sufficient research and expert consensus recommending the use of pulse oximetry to detect OIRD with opioid-based therapies after surgery (American Society of Anesthesiologists Task Force on Neuraxial Opioids et al., 2009; Chung et al., 2012; Lam et al., 2017; Miner et al., 2013; Pedersen et al., 2014; Sivilotti, Messenger, van Vlymen, Dungey, & Murray, 2010; Voepel-Lewis et al., 2013). Continuous pulse oximetry monitoring is preferred for all patients at high-risk, recognizing that all patients are at high risk in the first 24 hours after initiating parenteral opioid therapy. See Table 6 for additional information regarding pulse oximetry. The use of pulse oximetry devices may be an ineffective method of respiratory assessment in patients who require supplemental oxygen or have a history of moderate to severe lung disease or obesity hypoventilation syndrome. Patients with moderate to severe lung disease and or OHS are more likely to retain carbon dioxide. In those patients, the use of capnography assessment may be indicated.

Examining trends in monitoring data is critical to early detection of compromised respiratory status and provides opportunities for early interventions such as decreasing doses of opioids, discontinuing opioids, and/or maximizing analgesia with opioid-sparing pain therapies. When interpreting pulse oximetry readings, it is important for nurses to use trend monitoring analysis of patient data to interpret current pulse oximetry values relative to baseline or preopoid values. For example, if a patient's baseline/preopoid oxygen saturation is 100% and readings are progressively declining with the administration of opioids, the patient is showing signs of changes in respiratory status.

Capnography (category B-1). Sufficient evidence exists validating capnography as an effective method to monitor for respiratory compromise (Heines, Strauch, Roekaerts, Winkens, & Bergmans, 2013; Kim, Choi, Bang, & Lee, 2016). Capnography is

Table 7
Assessment Strategies

End Tidal Carbon Dioxide (ETCO ₂)
<ul style="list-style-type: none"> • Capnography is a device that measures exhaled end tidal CO₂ levels via a cannula positioned under the nasal nares and a scoop that sits over the upper portion of the mouth. • Capnography is applied as a continuous monitoring strategy as opposed to intermittent. • Evidence for the effectiveness of continuous electronic monitoring using capnography indicates improved patient safety outcomes when using opioids (Carlisle, 2015; McCarter, Shaik, Scarfo, & Thompson, 2008; Overdyk et al., 2007). There is a lack of evidence that capnography is more effective than continuous pulse oximetry in the detection of OIRD (Wall, Magee, Campbell, & Zed, 2017). • Normal values of end tidal CO₂ range 35 to 45 mm Hg. • Really low values represent lack of breath/hypoventilation. • Values >50 represent carbon dioxide retention/respiratory insufficiency. • Monitoring with capnography has been found to significantly reduce the incidence of OIUAS and OIRD with patient-controlled analgesia (PCA) by 79% as measured by decreased rapid response team ($p < .001$) and rate of transfers to a higher level of care (Stites et al., 2017). • Barriers to the use of capnography on general care units are lack of nursing knowledge of the device and interpretation of ETCO₂ levels, cost, availability of equipment, and patient adherence (Carlisle, 2015; Langhan, Kurtz, Schaeffer, Asnes, & Riera, 2014).

OIUAS = opioid-induced unintended advancing sedation; OIRD = opioid-induced respiratory depression; OIUAS = opioid-induced unintended advancing sedation.

more effective in detecting respiratory depression events in contrast to intermittent every-4-hour pulse oximetry assessments (Hutchison, 2006). Other clinical studies have compared capnography with pulse oximetry and found capnography superior in detecting OIRD (Lam et al., 2017; Oswald, Zeuske, & Pfeffer, 2016; Sivilotti et al., 2010). See Table 7 for additional information on capnography.

Minute ventilation (category B-1). Minute ventilation is measured using a respiratory volume monitor. Clinical studies indicate that monitoring minute ventilation is effective, comfortable for the patient, and in some cases more effective in detecting OIRD than measuring respiratory rate, oxygen saturation, or end tidal CO₂ (Ebert, Middleton, & Makhija, 2017; Galvagno, Duke, Eversole, & George, 2016; Holley et al., 2016; Mehta, Cattano, Brayanov, & George, 2017; Voscopoulos, Theos, Tillmann Hein, & George, 2017; Voscopoulos et al., 2014). See Table 8 for additional information on minute ventilation.

Acoustic respiratory rate (category C-2). The first change in breathing patterns with OIUAS and OIRD is a decrease in respiratory rate. This device measures rate of breathing through a transducer attached to the patient's neck. Although studies document the reliability and validity of the devices, there is weak evidence that acoustic respiratory rate monitoring by itself reduces adverse events (Yang et al., 2017). There is evidence that in studies of postoperative respiratory depression, episodes of oxygen desaturation occurred that were not detected by changes in respiratory rate (Kawanishi, Inoue, & Kawaguchi, 2017; Ouchi, Fujiwara, & Sugiyama, 2017). Authors recommended pairing the acoustic respiratory rate monitor with pulse oximetry for more sensitive detection of OIRD (McGrath, Pyke, & Taenzer, 2017).

Implementation. The expert panel recommends a paradigm shift from only monitoring to a criterion threshold (e.g., a set value for determining a potential serious adverse event) to including a combination of threshold and trend monitoring. *Trend monitoring*

refers to examining patterns of change in patient monitoring data over time (e.g., a few hours, over a shift or 24 hours) to evaluate if monitoring outcomes are worsening, improving or remaining stable. Trend monitoring considers multiple variables such as respiratory rate, level of sedation, and ventilator parameters derived from electronic devices such as pulse oximetry, end tidal CO₂, and minute ventilation. This type of monitoring allows clinicians to assimilate patient data and identify those patients showing early signs and symptoms of impending OIUAS and OIRD that require immediate actions (e.g., more frequent monitoring, reduction in opioid dose, discontinuation of an opioid, and/or activation of a rapid response team). It is important for organizations to provide and require completion of education of clinicians in how to effectively assess and use trend monitoring analysis of patient data to promote patient safety. Education regarding the proper implementation, use and interpretation of equipment, use of demonstrated data, and interventions to promote patient safety is also essential. Alarm events from electronic monitoring devices also signal potential or actual changes in respiratory status that may necessitate prompt interventions to prevent a decline in respiratory status. Additionally, safe patient care includes the assessment for adverse effects of monitoring procedures. According to a new TJC alert, periodic physical, psychological, and psychosocial assessment for pressure injury from continuous monitoring devices is recommended (The Joint Commission, 2018b). Clinicians need to be educated on how to use assessment tools, interpret patient data, and appropriately intervene to provide optimal safe patient care within the organization where they are employed.

Timing of assessments for opioid-induced advancing sedation and respiratory depression should be standardized using hospital policies and procedures. Clinical staff must receive appropriate education, and EHR systems could include alerts and reminders reflecting timing. Clinicians must be supported in using their critical thinking skills when evaluating patients for safe and effective pain management strategies. Policies and procedures should

Table 8
Assessment Strategies

Minute Ventilation
<ul style="list-style-type: none"> • Minute ventilation (MV) is calculated using a measure of tidal volume (TV) and respiratory rate (RR). • The respiratory volume monitor uses bioimpedance to provide real-time measurement of MV via electrodes placed at the sternal and midaxillary placements (Holley et al., 2016). • The display shows the MV, TV, and RR as well as a comparison with the patient's normal readings. • Traditionally, the alarm is set at $\leq 40\%$ of predicted/normal MV. • Possible issues with the measurement of MV include lack of detection of breath in obese patients, electrodes not adhering and delivering inconsistent and accurate readings as a result of chest wall hair and artifact from patient movement. • To date, few companies manufacture RVM devices for use on general care units. This technology is relatively new but has been well tested and is being used in PACUs, during procedural sedation in ambulatory centers, and more recently in the pediatric population.

RVM = respiratory volume monitoring; PACU = postanesthesia care unit.

support the autonomy of nurses to initiate appropriate monitoring strategies directed at improving patient safety especially in the first 24 hours of postoperative care or after initiation of parenteral opioids. Clinicians need to be educated regarding safety concerns, as well as the policies and procedures for assessment and monitoring of patients who receive intravenous and neuraxial opioids at the organization where they are employed.

Clinicians need ongoing education to ensure full understanding of the importance of pain, sedation, and respiratory assessments; which tools and assessment criteria are to be used; and how to most effectively intervene when sedation progresses and/or respiratory function is compromised (e.g., rapid response, transfer to higher level of care, code blue) at the organization where they are employed. Some facilities that have instituted continuous monitoring have published their procedures and outcomes to aid other facilities in the implementation of monitoring practices (Carlisle, 2015; Stites et al., 2017; Supe et al., 2017; van Loon, van Zaane, Bosch, Kalkman, & Peelen, 2015).

Recommendation 11

- The panel recommends the judicious use of naloxone based on patient evidence of life-threatening adverse events (strong recommendation, moderate level evidence).

Rationale. Naloxone rescue should be initiated at a dose less than or equal to 0.05 mg intravenous or intramuscular over 1 minute and repeated frequently based on institutional protocol and patient response until sedation and respiratory issues resolve (Connors & Nelson, 2016). The panel recommends that when naloxone reversal is required, clinicians consider the duration of action of naloxone and the duration of action of the opioid and implement frequent monitoring of the patient for any ongoing signs of OIUAS and OIRD.

Implementation. All clinicians need to be educated regarding indications for naloxone, pharmacology of naloxone, appropriate administration, and monitoring of patients after administration. Nurses should be involved in tracking the frequency of and reasons for naloxone administration to better understand factors contributing to its use.

Education

Recommendation 12

- The panel recommends clinician education on evidence-based and best practices for (1) determining patient risks for opioid-induced unintended advancing sedation and respiratory depression; (2) best practices on assessing level of sedation and respiratory status; (3) use of trend monitoring as opposed to threshold monitoring when evaluating indicators for respiratory status; (4) appropriate use of positive airway pressure therapy; (5) early implementation of appropriate interventions when advancing sedation and respiratory depression are imminent; and (6) appropriately educating patients and family members who want to know how to participate in safety efforts (strong recommendation, weak level evidence).

Rationale. Education of clinicians is paramount to promoting safe patient care and empowering clinicians to make independent and interdependent clinical decisions in designing sedation and respiratory monitoring plans of care and interpreting and responding to monitoring data (Youngcharoen, Vincent, & Park, 2017). The

ASPMN expert panel strongly endorses interprofessional education, team-based care, and hospital- and system-wide structures and processes to support safe administration of opioid analgesics. Patients and family members who want to participate in patient safety efforts can offer important assistance with those efforts (Duhn & Medves, 2018; Schwappach, 2010; See, Chan, Huggan, Tay, & Liaw, 2014).

Implementation Strategies and Surveillance. Several publications offer evidence-based and best practices in redesigning processes and outcome measures to promote safer environments of care (Durham et al., 2017; Jungquist, Pasero, et al., 2014; Jungquist et al., 2017).

Policies and Procedures

Recommendation 13

- The panel recommends that hospital leadership support the development of practice and administrative policies and procedures that outline the implementation of strategies focusing on (1) clinician, patient, and family awareness of and strategies to avoid the problem; (2) education of clinicians, patient, and family on risk assessment and adaptation of individualized monitoring procedures and policies; and (3) proper training on the use of electronic monitoring systems with potential use of risk alerts within electronic health record systems (strong recommendation, moderate level evidence).
- The panel recommends the development of evidence-based policies and procedures that support education of clinicians, patients, and family members about the patient's use of positive airway pressure devices to treat obstructive sleep apnea and obesity hypoventilation syndrome during hospitalization (strong recommendation, weak level evidence).

Rationale. As per recommendations from the IHI and TJC, health care facilities are responsible to ensure safe patient care. Appropriate policies and procedures that promote safe care are mandatory for safe care (Ghahramanian, Rezaei, Abdollahzadeh, Sheikhalipour, & Dianat, 2017; Youngcharoen et al., 2017). The addition of communication alerts within the EHR may be a useful tool to remind clinicians of risk factors. Surveillance of adverse events continues to be recommended, with root cause analysis performed on events resulting in patient harm. Quality assurance reviews and surveillance of rapid response calls and naloxone administration are helpful to discover trends in near-miss events (Jungquist, Pasero, et al., 2014). Clinical guidelines for the perioperative management of the patient with sleep-disordered breathing are available to support implementation of positive airway pressure therapy. Policies and procedure development should be followed with clinician education.

Implementation. It is imperative that all clinicians are educated about the policies and procedures regarding pain, opioids, and related assessments and monitoring. Competency-based education should be considered for monitoring technology to ensure proficiency and the appropriate level of technical skills for troubleshooting device issues and interpreting monitoring data. Reeducation of all clinicians is necessary after any updates or modifications of the policies and procedures.

Conclusions

ASPMN charged a panel of experts with revising the 2011 published guidelines for monitoring hospitalized patients for opioid-

induced unintended advancing sedation and respiratory depression. The panel reviewed the most recent (past 10 years) evidence and developed revised recommendations that are more specific regarding assessment of risk and monitoring procedures. Many of the 2011 published recommendations remain current and should continue to be followed. Key revisions include (1) multiparameter nursing assessment, including respiratory rate and quality, pulse oximetry, and level of sedation before opioid and again at peak effect; (2) clinician reassessments comparing present patient data to previous data to assess change over time (trend monitoring); (3) the consideration for continuous electronic respiratory monitoring during the first 24 hours after surgery or initiation of parenteral opioid medications; and (4) patient-centric selection of type of electronic monitoring device.

Lastly, it is the responsibility of the entire health care team to ensure safe prescribing and use of opioids across all transitions of care. Although these ASPMN guidelines are applicable to safe and effective management of pain in hospitalized adults, all health care professionals should be mindful of the same, especially for ambulatory postoperative patients at discharge. The panel urges clinical nurses and advanced practice registered nurses, especially prescribers of opioids, to consult recent opioid prescribing guidelines for common surgical procedures (Chou et al., 2016; Overton et al., 2018).

Appendix: The guidelines authors wish to thank the external reviewers for their time and expertise.

List of External Reviewers

- Michele Yurgil, M.S.N., R.N., A.C.N.S.-B.C., A.P.N., Clinical Nurse Specialist, Pain Management, Aurora St. Luke's Medical Center, 2901 W. Kinnickinnic River Parkway, MOB 1, Suite 405, Advanced Practice Nursing, Milwaukee, WI 53215 USA. Michele.Yurgil@aurora.org
- Stephanie Uses, Pharm.D., M.J., J.D., ECRI Institute, 5200 Butler Pike Plymouth Meeting, PA 19462-1928 USA. suses@ecri.org
- Michael R. Cohen, R.Ph., M.S., Sc.D.(hon.), D.P.S.(hon.), F.A.S.H.P., President, Institute for Safe Medication Practices, 200 Lakeside Drive, Suite 200 Horsham, PA 19044 USA. mcohen@ismp.org
- Elizabeth Card, M.S.N., A.P.N., F.N.P.-B.C., C.P.A.N., C.C.R.P., ASPAN Director of Research, American Society of Peri-Anesthesia Nurses—(ASPAN), 90 Frontage Road, Cherry Hill, NJ 08034 USA. ecard@aspan.org
- Sue Jervik B.S.N., R.N.-B.C., Pain Management Educator, PIH Health Hospital, Whittier, CA, USA. Sue.Jervik@pihhealth.org
- Deb Gordon, R.N., D.N.P., F.A.A.N., Anesthesiology & Pain Medicine, Co-Director Harborview Integrated Pain Care Program, University of Washington Box 359733 Office 6EC-05, 325 Ninth Ave, Seattle WA 98104 USA. Debrag3@u.washington.edu
- Jeffrey Fudin, Pharm.D., D.A.I.P.M., F.C.C.P., F.A.S.H.P., F.F.S.M.B., Chief Executive Officer & Chief Medical Officer, Remitigate, LLC, Owner & Managing Editor, PainDr.com & Pain Blog, Adjunct Associate Professor, Western New England University College of Pharmacy, Adjunct Associate Professor of Pharmacy Practice & Pain Management, Albany College of Pharmacy & Health Sciences, Section Co-Editor, Pain Medicine (Opioids, Substance Abuse and Addictions Section). <http://www.paindr.com> | <http://www.noverdoseapp.cpm>
- Colleen J. Dunwoody, M.S., R.N., Research Associate, University of Pittsburgh School of Nursing, 140 LaVale Drive, Apt 512, Monroeville, PA 15146 USA
- Paul Arnstein, Ph.D., R.N., F.A.A.N., 55 Fruit Street #FND 345, Boston, MA 02114 USA. PMARNSTEIN@mgh.harvard.edu
- Suzanne Karan, M.D., Anesthesiology, University of Rochester Medical Center, Rochester, NY 14642 USA. Suzanne_Karan@URMC.Rochester.edu
- Frank J. Overdyk, M.S.E.E., M.D., Professor of Anesthesiology, Medical University of South Carolina, Charleston, SC 29403 USA. foverdyk@gmail.com

References

- Adams, L., Butas, S., & Spurlock, D., Jr. (2015). Capnography (ETCO₂), respiratory depression, and nursing interventions in moderately sedated adults undergoing transesophageal echocardiography (TEE). *Journal of Perianesthesia Nursing*, 30(1), 14–22.
- Al-Khabori, M., Al-Riyami, A. Z., Al-Farsi, K., Al-Huneini, M., Al-Hashim, A., Al-Kemyani, N., & Daar, S. (2014). Validation of a non-invasive pulse CO-oximetry based hemoglobin estimation in normal blood donors. *Transfusion and Apheresis Science*, 50(1), 95–98.
- Al-Mobeireek, A. F., & Abba, A. A. (2002). An audit of oxygen therapy on the medical ward in 2 different hospitals in Central Saudi Arabia. *Saudi Medical Journal*, 23(6), 716–720.
- Alakuijala, A., & Salmi, T. (2016). Predicting obstructive sleep apnea with periodic snoring sound recorded at home. *Journal of Clinical Sleep Medicine*, 12(7), 953–958.
- Allegranzi, B., Zayed, B., Bischoff, P., Kubilay, N. Z., de Jonge, S., de Vries, F., Gomes, S. M., Gans, S., Wallert, E. D., Wu, X., Abbas, M., Boormeester, M. A., Dellinger, E. P., Egger, M., Gastmeier, P., Guirao, X., Ren, J., Pittet, D., Solomkin, J., & the WHO Guidelines Development Group. (2016). New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: An evidence-based global perspective. *Lancet Infectious Diseases*, 16(12), e288–e303.
- American Society of Anesthesiologists Task Force on Acute Pain Management. (2012). Practice guidelines for acute pain management in the perioperative setting: An updated report by the American Society of Anesthesiologists Task Force on Acute Pain Management. *Anesthesiology*, 116(2), 248–273.
- American Society of Anesthesiologists Task Force on Neuraxial Opioids, Horlocker, T. T., Burton, A. W., Connis, R. T., Hughes, S. C., Nickinovich, D. G., Palmer, C. M., Pollock, J. E., Rathmell, J. P., Rosenquist, R. W., Swisher, J. L., & Wu, C. L. (2009). Practice guidelines for the prevention, detection, and management of respiratory depression associated with neuraxial opioid administration. *Anesthesiology*, 110(2), 218–230.
- American Society of Enhanced Recovery. (2018). Society Webpage. Retrieved from www.aserhq.org. (Accessed 24 July 2019).
- Balaban, F., Yagar, S., Ozgok, A., Koc, M., & Gullapoglu, H. (2012). A randomized, placebo-controlled study of pregabalin for postoperative pain intensity after laparoscopic cholecystectomy. *Journal of Clinical Anesthesia*, 24(3), 175–178.
- Bartoszek, M. W., McCoart, A., Hong, K. J., Haley, C., Highland, K. B., & Plunkett, A. R. (2017). An observational feasibility study to assess the safety and effectiveness of intranasal fentanyl for radiofrequency ablations of the lumbar facet joints. *Journal of Pain Research*, 10, 359–364.
- Becker, D. E. (2012). Pharmacodynamic considerations for moderate and deep sedation. *Anesthesia Progress*, 59(1), 28–42.
- Bharti, N., Sardana, D. K., & Bala, I. (2015). The analgesic efficacy of dexmedetomidine as an adjunct to local anesthetics in supraclavicular brachial plexus block: A randomized controlled trial. *Anesthesia and Analgesia*, 121(6), 1655–1660.
- Bigani, D. K., & Correia, A. M. (2018). On the same page: Nurse, patient, and family perceptions of change-of-shift bedside report. *Journal of Pediatric Nursing*, 41, 84–89.
- Bittner-Fagan, H., Davis, J., & Savoy, M. (2017). Improving patient safety: Improving communication. *FP Essent*, 463, 27–33.
- Blank, J. J., Berger, N. G., Dux, J. P., Ali, F., Ludwig, K. A., & Peterson, C. Y. (2018). The impact of intravenous acetaminophen on pain after abdominal surgery: A meta-analysis. *Journal of Surgical Research*, 227, 234–245.
- Blaudszun, G., Lysakowski, C., Elia, N., & Tramer, M. R. (2012). Effect of perioperative systemic alpha₂ agonists on postoperative morphine consumption and pain intensity: Systematic review and meta-analysis of randomized controlled trials. *Anesthesiology*, 116(6), 1312–1322.
- Blouin, M., & Rhoads, M. (2014). Use of nonsteroidal anti-inflammatory drugs in colorectal surgery: Do the risks cast a shadow on the benefits? *Annals of Pharmacotherapy*, 48(12), 1662–1664.
- Bush, S. H., Grassau, P. A., Yarmo, M. N., Zhang, T., Zinkie, S. J., & Pereira, J. L. (2014). The Richmond Agitation-Sedation Scale modified for palliative care inpatients (RASS-PAL): A pilot study exploring validity and feasibility in clinical practice. *BMC Palliative Care*, 13(1), 17.
- Carlisle, H. (2015). Promoting the use of capnography in acute care settings: An evidence-based practice project. *Journal of PeriAnesthesia Nursing*, 30(3), 201–208.
- Carmichael, J. C., Keller, D. S., Baldini, G., Bordeianou, L., Weiss, E., Lee, L., Boutros, M., McClane, J., Feldman, L. S., & Steele, S. R. (2017). Clinical practice

- guidelines for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons and Society of American Gastrointestinal and Endoscopic Surgeons. *Diseases of the Colon and Rectum*, 60(8), 761–784.
- Cashman, J. N., & Dolin, S. J. (2004). Respiratory and haemodynamic effects of acute postoperative pain management: Evidence from published data. *British Journal of Anaesthesia*, 93(2), 212–223.
- Cavalcante, A. N., Sprung, J., Schroeder, D. R., & Weingarten, T. N. (2017). Multimodal analgesic therapy with gabapentin and its association with postoperative respiratory depression. *Anesthesia and Analgesia*, 125(1), 141–146.
- Centers for Medicare and Medicaid Services. (2014). *Requirements for hospital medication administration, particularly intravenous (IV) medications and post-operative care of patients receiving IV opioids*. Baltimore, MD: Author.
- Chang, A. K., Bijur, P. E., Baccellieri, A., & Gallagher, E. J. (2009). Efficacy and safety profile of a single dose of hydromorphone compared with morphine in older adults with acute, severe pain: A prospective, randomized, double-blind clinical trial. *American Journal of Geriatric Pharmacotherapy*, 7(1), 1–10.
- Choi, S. H., Koo, B. N., Nam, S. H., Lee, S. J., Kim, K. J., Kil, H. K., Lee, K. Y., & Jeon, D. H. (2008). Comparison of remifentanyl and fentanyl for postoperative pain control after abdominal hysterectomy. *Yonsei Medical Journal*, 49(2), 204–210.
- Chou, R., Gordon, D. B., de Leon-Casasola, O. A., Rosenberg, J. M., Bickler, S., Brennan, T., Carter, T., Cassidy, C. L., Chittenden, E. H., Degenhardt, E., Griffith, S., Manworren, R., McCarberg, B., Montgomery, R., Murphy, J., Perkal, M. F., Suresh, S., Sluka, K., Strassels, S., Thirlby, R., Viscusi, E., Walco, G. A., Warner, L., Weisman, S. J., & Wu, C. L. (2016). Management of postoperative pain: A clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *Journal of Pain*, 17(2), 131–157.
- Chu, D. K., Kim, L. H., Young, P. J., Zamiri, N., Almenawer, S. A., Jaeschke, R., Szczeklik, W., Schünemann, H. J., Neary, J. D., & Alhazzani, W. (2018). Mortality and morbidity in acutely ill adults treated with liberal versus conservative oxygen therapy (IOTA): A systematic review and meta-analysis. *Lancet*, 391(10131), 1693–1705.
- Chung, F., Liao, P., Elsaid, H., Islam, S., Shapiro, C. M., & Sun, Y. (2012). Oxygen desaturation index from nocturnal oximetry: A sensitive and specific tool to detect sleep-disordered breathing in surgical patients. *Anesthesia and Analgesia*, 114(5), 993–1000.
- Chung, F., Liao, P., Yang, Y., Andrawes, M., Kang, W., Mokhlesi, B., & Shapiro, C. M. (2015). Postoperative sleep-disordered breathing in patients without preoperative sleep apnea. *Anesthesia and Analgesia*, 120(6), 1214–1224.
- Chung, F., Memtsoudis, S. G., Ramachandran, S. K., Nagappa, M., Opperer, M., Cozowicz, C., Patrawala, S., Lam, D., Kumar, A., Joshi, G. P., Fleetham, J., Ayas, N., Collop, N., Doufas, A. G., Eikermann, M., Englesakis, M., Gali, B., Gay, P., Hernandez, A. V., Kaw, R., Kezirian, E. J., Malhotra, A., Mokhlesi, B., Parthasarathy, S., Stierer, T., Wappler, F., Hillman, D. R., & Auckley, D. (2016). Society of Anesthesia and Sleep Medicine guidelines on preoperative screening and assessment of adult patients with obstructive sleep apnea. *Anesthesia and Analgesia*, 123(2), 452–473.
- Chung, F., Yang, Y., & Liao, P. (2013). Predictive performance of the STOP-BANG score for identifying obstructive sleep apnea in obese patients. *Obesity Surgery*, 23(12), 2050–2057.
- Connors, N. J., & Nelson, L. S. (2016). The evolution of recommended naloxone dosing for opioid overdose by medical specialty. *Journal of Medical Toxicology*, 12(3), 276–281.
- Cooper, A., Stannard, D., & Noble, K. A. (2015). Nurse perceptions of confidence in using the Pasero Opioid-Induced Sedation Scale to assess unintended patient sedation in hospital settings: A quantitative systematic review protocol. *JBI Database of Systematic Reviews and Implementation Reports*, 13(9), 3–10.
- Counsell, S. R. (2015). 2015 updated AGS Beers Criteria offer guide for safer medication use among older adults. *Geriatric Nursing (New York, N.Y.)*, 36(6), 488–489.
- Curatolo, C., Goldberg, A., Maerz, D., Lin, H. M., Shah, H., & Trinh, M. (2017). ASA physical status assignment by non-anesthesia providers: Do surgeons consistently downgrade the ASA score preoperatively? *Journal of Clinical Anesthesia*, 38, 123–128.
- Dahan, A., Douma, M., Olofsen, E., & Niesters, M. (2016). High inspired oxygen concentration increases the speed of onset of remifentanyl-induced respiratory depression. *British Journal of Anaesthesia*, 116(6), 879–880.
- Dahan, A., Overdyk, F., Smith, T., Aarts, L., & Niesters, M. (2013). Pharmacovigilance: A review of opioid-induced respiratory depression in chronic pain patients. *Pain Physician*, 16(2), E85–E94.
- Dalton, J. A., Carlson, J., Blau, W., Lindley, C., Greer, S. M., & Youngblood, R. (2001). Documentation of pain assessment and treatment: How are we doing? *Pain Management Nursing*, 2(2), 54–64.
- Daniels, J. F. (2016). Purposeful and timely nursing rounds: A best practice implementation project. *JBI Database of Systematic Reviews and Implementation Reports*, 14(1), 248–267.
- Davis, C., Geik, C., Arthur, K., Fuller, J., Johnston, E., Levitt, F., Leung, E., McCart, G., McMichael, D., Painter, J., Staublin, T., & Walroth, T. (2017). A multisite retrospective study evaluating the implementation of the Pasero Opioid-Induced Sedation Scale (POSS) and its effect on patient safety outcomes. *Pain Management Nursing*, 18(4), 193–201.
- De Oliveira, G. S., Jr., Bialek, J., Marcus, R. J., & McCarthy, R. (2016). Dose-ranging effect of systemic diphenhydramine on postoperative quality of recovery after ambulatory laparoscopic surgery: A randomized, placebo-controlled, double-blinded, clinical trial. *Journal of Clinical Anesthesia*, 34, 46–52.
- de Raaff, C. A. L., Gorter-Stam, M. A. W., de Vries, N., Sinha, A. C., Jaap Bonjer, H., Chung, F., Coblijn, U. K., Dahan, A., van den Helder, R. S., Hilgevoord, A. A. J., Hillman, D. R., Margaron, M. P., Mattar, S. G., Mulier, J. P., Ravesloot, M. J. L., Reiber, B. M. M., van Rijswijk, A. S., Singh, P. M., Steenhuis, R., Tenhagen, M., Vanderveken, O. M., Verbraecken, J., White, D. P., van der Wielen, N., & van Wagensveld, B. A. (2017). Perioperative management of obstructive sleep apnea in bariatric surgery: A consensus guideline. *Surgery for Obesity and Related Diseases*, 13(7), 1095–1109.
- Desalu, I., Diakparomre, O. I., Salami, A. O., & Abiola, A. O. (2013). The effect of nail polish and acrylic nails on pulse oximetry reading using the Lifebox oximeter in Nigeria. *Nigerian Postgraduate Medical Journal*, 20(4), 331–335.
- Drummond, G. B., Dhonneur, G., Kirov, K., & Duvaldestin, P. (2013). Effects of an opioid on respiratory movements and expiratory activity in humans during isoflurane anaesthesia. *Respiratory Physiology & Neurobiology*, 185(2), 425–434.
- Duhn, L., & Medves, J. (2018). A 5-facet framework to describe patient engagement in patient safety. *Health Expectations*, 21(6), 1122–1133.
- Dunwoody, D. R., & Jungquist, C. R. (2018). Sedation scales: Do they capture the concept of opioid induced sedation? *Nursing Forum*, 53(4), 399–405.
- Durham, M. L., Egan, A., Jankiewicz, A., Murphy, M. P., Nedved, P., Luvich, R., Goh, A., & Fogg, L. (2017). Addressing safe opioid monitoring practices using an inter-professional approach. *Journal of Nursing Administration*, 47(11), 537–544.
- Ebert, T. J., Middleton, A. H., & Makhija, N. (2017). Ventilation monitoring during moderate sedation in GI patients. *Journal of Clinical Monitoring and Computing*, 31(1), 53–57.
- Eckstrand, J. A., Habib, A. S., Williamson, A., Horvath, M. M., Gattis, K. G., Cozart, H., & Ferranti, J. (2009). Computerized surveillance of opioid-related adverse drug events in perioperative care: A cross-sectional study. *Patient Safety in Surgery*, 3(1), 18.
- ECRI Institute. (2017). *ECRI Institute PSO deep dive opioid use in acute care*. Plymouth Meeting, PA: ECRI Institute.
- Edwards, B. A., Eckert, D. J., McSharry, D. G., Sands, S. A., Desai, A., Kehlmann, G., Bakker, J. P., Genta, P. R., Owens, R. L., White, D. P., Wellman, A., & Malhotra, A. (2014). Clinical predictors of the respiratory arousal threshold in patients with obstructive sleep apnea. *American Journal of Respiratory and Critical Care Medicine*, 190(11), 1293–1300.
- Edwards, P. K., Jacobs, C. A., Hadden, K. B., & Barnes, C. L. (2017). A perioperative patient support system was unable to mitigate the risk of hospital readmission for total hip arthroplasty patients with high american society of anesthesiologists grades. *Journal of Arthroplasty*, 32(4), 1100–1102.
- Ehsan, Z., Mahmoud, M., Shott, S. R., Amin, R. S., & Ishman, S. L. (2016). The effects of anesthesia and opioids on the upper airway: A systematic review. *Laryngoscope*, 126(1), 270–284.
- Elder, J. W., DePalma, G., & Pines, J. M. (2018). Optimal implementation of prescription drug monitoring programs in the emergency department. *Western Journal of Emergency Medicine*, 19(2), 387–391.
- Epstein, R. H., Dexter, F., Lopez, M. G., & Ehrenfeld, J. M. (2014). Anesthesiologist staffing considerations consequent to the temporal distribution of hypoxic episodes in the postanesthesia care unit. *Anesthesia and Analgesia*, 119(6), 1322–1333.
- Erdogan Kayhan, G., Sanli, M., Ozgul, U., Kirteke, R., & Yologlu, S. (2018). Comparison of intravenous ibuprofen and acetaminophen for postoperative multimodal pain management in bariatric surgery: A randomized controlled trial. *Journal of Clinical Anesthesia*, 50, 5–11.
- Fabritius, M. L., Geisler, A., Petersen, P. L., Wetterslev, J., Mathiesen, O., & Dahl, J. B. (2017a). Gabapentin in procedure-specific postoperative pain management—preplanned subgroup analyses from a systematic review with meta-analyses and trial sequential analyses. *BMC Anesthesiology*, 17(1), 85.
- Fabritius, M. L., Strom, C., Koyuncu, S., Jaeger, P., Petersen, P. L., Geisler, A., Wetterslev, J., Dahl, J. B., & Mathiesen, O. (2017b). Benefit and harm of pregabalin in acute pain treatment: A systematic review with meta-analyses and trial sequential analyses. *British Journal of Anaesthesiology*, 119(4), 775–791.
- Fabritius, M. L., Wetterslev, J., Mathiesen, O., & Dahl, J. B. (2017c). Dose-related beneficial and harmful effects of gabapentin in postoperative pain management—post hoc analyses from a systematic review with meta-analyses and trial sequential analyses. *Journal of Pain Research*, 10, 2547–2563.
- Fernandez-Bustamante, A., Bartels, K., Clavijo, C., Scott, B. K., Kacmar, R., Bullard, K., Moss, A. F. D., Henderson, W., Juarez-Colunga, E., & Jameson, L. (2017). Preoperatively screened obstructive sleep apnea is associated with worse postoperative outcomes than previously diagnosed obstructive sleep apnea. *Anesthesia and Analgesia*, 125(2), 593–602.
- Flenady, T., Dwyer, T., & Applegarth, J. (2017). Accurate respiratory rates count: So should you! *Australasian Emergency Nursing Journal*, 20(1), 45–47.
- Food and Drug Administration. (2016). Food and Drug Administration requires strong warnings for opioid analgesics, prescription opioid cough products, and benzodiazepine labeling related to serious risks and death from combined use. *Journal of Pain and Palliative Care Pharmacotherapy*, 30(4), 298–299.
- Fouladpour, N., Jesudoss, R., Bolden, N., Shaman, Z., & Auckley, D. (2016). Perioperative complications in obstructive sleep apnea patients undergoing surgery: A review of the legal literature. *Anesthesia and Analgesia*, 122(1), 145–151.
- Fu, E. S., Downs, J. B., Schweiger, J. W., Miguel, R. V., & Smith, R. A. (2004). Supplemental oxygen impairs detection of hypoventilation by pulse oximetry. *Chest*, 126(5), 1552–1558.

- Galvagno, S. M., Jr., Duke, P. G., Eversole, D. S., & George, E. E. (2016). Evaluation of respiratory volume monitoring (RVM) to detect respiratory compromise in advance of pulse oximetry and help minimize false desaturation alarms. *Journal of Trauma and Acute Care Surgery*, 81(5 Suppl 2), S162–S170.
- Gan, T. J., Diemunsch, P., Habib, A. S., Kovac, A., Kranke, P., Meyer, T. A., Watcha, M., Chung, F., Angus, S., Apfel, C. C., Bergese, S. D., Candiotti, K. A., Chan, M. T., Davis, P. J., Hooper, V. D., Lagoo-Deenadayalan, S., Myles, P., Nezat, G., Philip, B. K., Tramèr, M. R., & Society for Ambulatory, A. (2014). Consensus guidelines for the management of postoperative nausea and vomiting. *Anesthesia and Analgesia*, 118(1), 85–113.
- Garg, N., Panda, N. B., Gandhi, K. A., Bhagat, H., Batra, Y. K., Grover, V. K., & Chhabra, R. (2016). Comparison of small dose ketamine and dexmedetomidine infusion for postoperative analgesia in spine surgery—A prospective randomized double-blind placebo controlled study. *Journal of Neurosurgical Anesthesiology*, 28(1), 27–31.
- Ghahramanian, A., Rezaei, T., Abdollahzadeh, F., Sheikhalipour, Z., & Dianat, I. (2017). Quality of healthcare services and its relationship with patient safety culture and nurse-physician professional communication. *Health Promotion Perspectives*, 7(3), 168–174.
- Ghelardini, C., Di Cesare Mannelli, L., & Bianchi, E. (2015). The pharmacological basis of opioids. *Clinical Cases in Mineral and Bone Metabolism*, 12(3), 219–221.
- Gianesello, L., Pavoni, V., Barboni, E., Galeotti, L., & Nella, A. (2012). Perioperative pregabalin for postoperative pain control and quality of life after major spinal surgery. *Journal of Neurosurgical Anesthesiology*, 24(2), 121–126.
- Gilron, I., Tu, D., Holden, R. R., Jackson, A. C., & DuMerton-Shore, D. (2015). Combination of morphine with nortriptyline for neuropathic pain. *Pain*, 156(8), 1440–1448.
- Gordon, D. B., & Pellino, T. A. (2005). Incidence and characteristics of naloxone use in postoperative pain management: A critical examination of naloxone use as a potential quality measure. *Pain Management Nursing*, 6(1), 30–36.
- Gordon, D. B., Pellino, T. A., Higgins, G. A., Pasero, C., & Murphy-Ende, K. (2008). Nurses' opinions on appropriate administration of PRN range opioid analgesic orders for acute pain. *Pain Management Nursing*, 9(3), 131–140.
- Gressler, L. E., Martin, B. C., Hudson, T. J., & Painter, J. T. (2017). The relationship between concomitant benzodiazepine-opioid use and adverse outcomes among U.S. veterans. *Pain*, 159(3), 451–459.
- Griffiths, J. D., Gyte, G. M., Paranjothy, S., Brown, H. C., Broughton, H. K., & Thomas, J. (2012). Interventions for preventing nausea and vomiting in women undergoing regional anaesthesia for caesarean section. *Cochrane Database of Systematic Reviews*, 9, CD007579.
- Gupta, K., Prasad, A., Nagappa, M., Wong, J., Abrahamyan, L., & Chung, F. F. (2018). Risk factors for opioid-induced respiratory depression and failure to rescue: A review. *Current Opinion in Anaesthesiology*, 31(1), 110–119.
- Gurunathan, U., Rapchuk, I. L., King, G., Barnett, A. G., & Fraser, J. F. (2016). The effect of pregabalin and celecoxib on the analgesic requirements after laparoscopic cholecystectomy: A randomized controlled trial. *Journal of Anesthesia*, 30(1), 64–71.
- Hakverdioglu Yont, G., Akin Korhan, E., & Dizer, B. (2014). The effect of nail polish on pulse oximetry readings. *Intensive and Critical Care Nursing*, 30(2), 111–115.
- Hart, N., Mandal, S., Manuel, A., Mokhlesi, B., Pepin, J. L., Piper, A., & Stradling, J. R. (2014). Obesity hypoventilation syndrome: Does the current definition need revisiting? *Thorax*, 69(1), 83–84.
- Hayes, K., & Gordon, D. B. (2015). Delivering quality pain management: The challenge for nurses. *AORN Journal*, 101(3), 328–334. quiz 335–327.
- Hayhurst, C. J., & Durieux, M. E. (2016). Differential opioid tolerance and opioid-induced hyperalgesia: A clinical reality. *Anesthesiology*, 124(2), 483–488.
- Hegmann, K. T., Weiss, M. S., Bowden, K., Branco, F., DuBruelee, K., Els, C., Mandel, S., McKinney, D. W., Miguel, R., Mueller, K. L., Nadig, R. J., Schaffer, M. I., Studt, L., Talmage, J. B., Travis, R. L., Winters, T., Thiese, M. S., Harris, J. S., & American College of Occupational and Environmental Medicine. (2014). ACOEM practice guidelines: Opioids for treatment of acute, subacute, chronic, and postoperative pain. *Journal of Occupational and Environmental Medicine*, 56(12), e143–e159.
- Heines, S. J., Strauch, U., Roekaerts, P. M., Winkens, B., & Bergmans, D. C. (2013). Accuracy of end-tidal CO₂ capnometers in post-cardiac surgery patients during controlled mechanical ventilation. *Journal of Emergency Medicine*, 45(1), 130–135.
- Helfand, M., Christensen, V., & Anderson, J. (2011). *Technology assessment: Early sense for monitoring vital signs in hospitalized patients. VA evidence-based synthesis program evidence briefs*. Washington, DC: Department of Veterans Affairs.
- Herzig, S. J., Rothberg, M. B., Cheung, M., Ngo, L. H., & Marcantonio, E. R. (2014). Opioid utilization and opioid-related adverse events in nonsurgical patients in US hospitals. *Journal of Hospital Medicine*, 9(2), 73–81.
- Holley, K., MacNabb, C. M., Georgiadis, P., Minasyan, H., Shukla, A., & Mathews, D. (2016). Monitoring minute ventilation versus respiratory rate to measure the adequacy of ventilation in patients undergoing upper endoscopic procedures. *Journal of Clinical Monitoring and Computing*, 30(1), 33–39.
- Hong, S. N., Yoo, J., Song, I. S., Joo, J. W., Yoo, J. H., Kim, T. H., Lee, H. M., Lee, S. H., & Lee, S. H. (2017). Does snoring time always reflect the severity of obstructive sleep apnea? *Annals of Otolaryngology and Rhinology*, 126(10), 693–696.
- Huang, Y. S., Lin, L. C., Huh, B. K., Sheen, M. J., Yeh, C. C., Wong, C. S., & Wu, C. T. (2007). Epidural clonidine for postoperative pain after total knee arthroplasty: A dose-response study. *Anesthesia and Analgesia*, 104(5), 1230–1235. tables of contents.
- Hurwitz, E. E., Simon, M., Vinta, S. R., Zehm, C. F., Shabot, S. M., Minhajuddin, A., & Abouleish, A. E. (2017). Adding examples to the ASA-Physical Status Classification improves correct assignment to patients. *Anesthesiology*, 126(4), 614–622.
- Hutchison, R. (2006). Capnography monitoring during opioid PCA administration. *Journal of Opioid Management*, 2(4), 207–208.
- Institute for Healthcare Improvement. (2018). SBAR communication technique. Retrieved from <http://www.ihc.org/Topics/SBARcommunicationTechnique/Pages/default.aspx>. (Accessed 24 July 2019).
- Institute for Healthcare Improvement. (2012). *How to guide: Prevent harm from high-alert medications*. Cambridge, MA: Author.
- Institute for Safe Medication Practices. (2013). Fatal PCA adverse events continue to happen ... better patient monitoring is essential to prevent. *ISMP Medication Safety Alert! Acute Care Edition*, 181(1–3).
- Izraillyan, L., Qiu, J., Overdyk, F. J., Ersilon, M., & Gan, T. J. (2018). Risk factors for cardiopulmonary and respiratory arrest in medical and surgical hospital patients on opioid analgesics and sedatives. *PLoS One*, 13(3), e0194553.
- Jahr, J. S., Bergese, S. D., Sheth, K. R., Bernthal, N. M., Ho, H. S., Stoicea, N., & Apfel, C. C. (2017). Current perspective on the use of opioids in perioperative medicine: An evidence-based literature review, national survey of 70,000 physicians, and multidisciplinary clinical appraisal. *Pain Medicine*, 19(9), 1710–1719.
- Jarzyna, D., Jungquist, C. R., Pasero, C., Willens, J. S., Nisbet, A., Oakes, L., Dempsey, S. J., Santangelo, D., & Polomano, R. C. (2011). American Society for Pain Management Nursing guidelines on monitoring for opioid-induced sedation and respiratory depression. *Pain Management Nursing*, 12(3), 118–145.e10.
- Jewell, J. A., & Committee On Hospital, C. (2016). Standardization of inpatient handoff communication. *Pediatrics*, 138(5).
- Jolley, C. J., Bell, J., Rafferty, G. F., Moxham, J., & Strang, J. (2015). Understanding heroin overdose: A study of the acute respiratory depressant effects of injected pharmaceutical heroin. *PLoS One*, 10(10), e0140995.
- Jungquist, C. R., Correll, D. J., Fleisher, L. A., Gross, J., Gupta, R., Pasero, C., Stoelting, R., & Polomano, R. (2016). Avoiding adverse events secondary to opioid-induced respiratory depression: Implications for nurse executives and patient safety. *Journal of Nursing Administration*, 46(2), 87–94.
- Jungquist, C. R., Pasero, C., Tripoli, N. M., Gorodetsky, R., Metersky, M., & Polomano, R. C. (2014a). Instituting best practice for monitoring for opioid-induced advancing sedation in hospitalized patients. *Worldviews Evidence Based Nursing*, 11(6), 350–360.
- Jungquist, C. R., Smith, K., Nicely, K. L., & Polomano, R. C. (2017). Monitoring hospitalized adult patients for opioid-induced sedation and respiratory depression. *American Journal of Nursing*, 117(3 Suppl 1), S27–S35.
- Jungquist, C. R., Willens, J. S., Dunwoody, D. R., Klingman, K. J., & Polomano, R. C. (2014b). Monitoring for opioid-induced advancing sedation and respiratory depression: ASPMN membership survey of current practice. *Pain Management Nursing*, 15(3), 682–693.
- Kaw, R., Bhatnagar, P., Paz, Y. M. H., Hernandez, A. V., Ramaswamy, A., Deshpande, A., & Aboussouan, L. S. (2016). Postoperative complications in patients with unrecognized obesity hypoventilation syndrome undergoing elective noncardiac surgery. *Chest*, 149(1), 84–91.
- Kaw, R., Chung, F., Pasupuleti, V., Mehta, J., Gay, P. C., & Hernandez, A. V. (2012). Meta-analysis of the association between obstructive sleep apnea and postoperative outcome. *British Journal of Anaesthesia*, 109(6), 897–906.
- Kawanishi, H., Inoue, S., & Kawaguchi, M. (2017). A retrospective analysis of oxygen desaturation during acoustic respiratory rate monitoring in non-ICU patients following tracheal extubation after general anesthesia. *Anesthesiology Research and Practice*, 2017, 4203156.
- Kessler, E. R., Shah, M., Gruschus, S. K., & Raju, A. (2013). Cost and quality implications of opioid-based postoperative pain control using administrative claims data from a large health system: Opioid-related adverse events and their impact on clinical and economic outcomes. *Pharmacotherapy*, 33(4), 383–391.
- Khanna, A., Buhre, W., Saager, L., Stefano, P., Weingarten, T., Dahan, A., ... Overdyk, F. (2019). Derivation and validation of a novel opioid-induced respiratory depression risk prediction tool. *Critical Care Medicine*, 47(1), 18.
- Khelemsky, Y., Kothari, R., Campbell, N., & Farnad, S. (2015). Incidence and demographics of post-operative naloxone administration: A 13-year experience at a major tertiary teaching institution. *Pain Physician*, 18(5), E827–E829.
- Kim, H. S., McCarthy, D. M., Mark Courtney, D., Lank, P. M., & Lambert, B. L. (2017). Benzodiazepine-opioid co-prescribing in a national probability sample of ED encounters. *American Journal of Emergency Medicine*, 35(3), 458–464.
- Kim, J. C., Choi, Y. S., Kim, K. N., Shim, J. K., Lee, J. Y., & Kwak, Y. L. (2011). Effective dose of peri-operative oral pregabalin as an adjunct to multimodal analgesic regimen in lumbar spinal fusion surgery. *Spine*, 36(6), 428–433.
- Kim, K. W., Choi, H. R., Bang, S. R., & Lee, J. W. (2016). Comparison of end-tidal CO₂ measured by transportable capnometer (EMMA capnograph) and arterial pCO₂ in general anesthesia. *Journal of Clinical Monitoring and Computing*, 30(5), 737–741.
- Kobelt, P., Burke, K., & Renker, P. (2014). Evaluation of a standardized sedation assessment for opioid administration in the post anesthesia care unit. *Pain Management Nursing*, 15(3), 672–681.
- Komatsu, R., Turan, A. M., Orhan-Sungur, M., McGuire, J., Radke, O. C., & Apfel, C. C. (2007). Remifentanyl for general anaesthesia: A systematic review. *Anaesthesia*, 62(12), 1266–1280.
- Koo, S. K., Kwon, S. B., Moon, J. S., Lee, S. H., Lee, H. B., & Lee, S. J. (2017). Comparison of snoring sounds between natural and drug-induced sleep recorded using a smartphone. *Auris, Nasus, Larynx*, 45(4), 777–782.

- Krieger, J., Maglasius, N., Sforza, E., & Kurtz, D. (1990). Breathing during sleep in normal middle-aged subjects. *Sleep*, *13*(2), 143–154.
- Kulkas, A., Huupponen, E., Virkkala, J., Saastamoinen, A., Rauhala, E., Tenhunen, M., & Himanen, S. L. (2010). Tracheal sound parameters of respiratory cycle phases show differences between flow-limited and normal breathing during sleep. *Physiological Measurement*, *31*(3), 427–438.
- Kumar, K., Kirksey, M. A., Duong, S., & Wu, C. L. (2017). A review of opioid-sparing modalities in perioperative pain management: Methods to decrease opioid use postoperatively. *Anesthesia and Analgesia*, *125*(5), 1749–1760.
- Ladd, L. A., Kam, P. C., Williams, D. B., Wright, A. W., Smith, M. T., & Mather, L. E. (2005). Ventilatory responses of healthy subjects to intravenous combinations of morphine and oxycodone under imposed hypercapnic and hypoxaemic conditions. *British Journal of Clinical Pharmacology*, *59*(5), 524–535.
- Lam, T., Nagappa, M., Wong, J., Singh, M., Wong, D., & Chung, F. (2017). Continuous pulse oximetry and capnography monitoring for postoperative respiratory depression and adverse events: A systematic review and meta-analysis. *Anesthesia and Analgesia*, *125*(6), 2019–2029.
- Lane-Fall, M. B., Beidas, R. S., Pascual, J. L., Collard, M. L., Peifer, H. G., Chavez, T. J., Barry, M. E., Gutsche, J. T., Halpern, S. D., Fleisher, L. A., & Barg, F. K. (2014). Handoffs and transitions in critical care (HATRICC): Protocol for a mixed methods study of operating room to intensive care unit handoffs. *BMC Surgery*, *14*, 96.
- Langhan, M. L., Kurtz, J. C., Schaeffer, P., Asnes, A. G., & Riera, A. (2014). Experiences with capnography in acute care settings: A mixed-methods analysis of clinical staff. *Journal of Critical Care*, *29*(6), 1035–1040.
- Larson, D. W., Lovely, J. K., Cima, R. R., Dozois, E. J., Chua, H., Wolff, B. G., Pemberton, J. H., Devine, R. R., & Huebner, M. (2014). Outcomes after implementation of a multimodal standard care pathway for laparoscopic colorectal surgery. *British Journal of Surgery*, *101*(8), 1023–1030.
- Laskowski, K., Stirling, A., McKay, W. P., & Lim, H. J. (2011). A systematic review of intravenous ketamine for postoperative analgesia. *Canadian Journal of Anaesthesia*, *58*(10), 911–923.
- Lee, L. A., Caplan, R. A., Stephens, L. S., Posner, K. L., Terman, G. W., Voepel-Lewis, T., & Domino, K. B. (2015). Postoperative opioid-induced respiratory depression: A closed claims analysis. *Anesthesiology*, *122*(3), 659–665.
- Leino, K., Mildh, L., Lertola, K., Seppala, T., & Kirvela, O. (1999). Time course of changes in breathing pattern in morphine- and oxycodone-induced respiratory depression. *Anaesthesia*, *54*(9), 835–840.
- Lin, T. F., Yeh, Y. C., Yen, Y. H., Wang, Y. P., Lin, C. J., & Sun, W. Z. (2005). Antiemetic and analgesic-sparing effects of diphenhydramine added to morphine intravenous patient-controlled analgesia. *British Journal of Anaesthesia*, *94*(6), 835–839.
- Lyons, P. G., Snyder, A., Sokol, S., Edelson, D. P., Mokhesi, B., & Churpek, M. M. (2017). Association between opioid and benzodiazepine use and clinical deterioration in ward patients. *Journal of Hospital Medicine*, *12*(6), 428–434.
- Macintyre, P. E., Loadman, J. A., & Scott, D. A. (2011). Opioids, ventilation and acute pain management. *Anaesthesia and Intensive Care*, *39*(4), 545–558.
- Madadi, P., Sistonen, J., Silverman, G., Gladly, R., Ross, C. J., Carleton, B. C., Carvalho, J. C., Hayden, M. R., & Koren, G. (2013). Life-threatening adverse events following therapeutic opioid administration in adults: Is pharmacogenetic analysis useful? *Pain Research & Management*, *18*(3), 133–136.
- Maddox, R. R., Williams, C. K., Oglesby, H., Butler, B., & Colclasure, B. (2006). Clinical experience with patient-controlled analgesia using continuous respiratory monitoring and a smart infusion system. *American Journal of Health-System Pharmacy*, *63*(2), 157–164.
- Maestroni, U., Astesana, L., Ferretti, S., Ciuffreda, M., Troglio, R., Simonazzi, M., & Cortellini, P. (2007). Postoperative analgesia by epidural infusion of ropivacaine and fentanyl versus intravenous administration of morphine in patients undergoing radical retropubic prostatectomy: Results of a prospective study. *Archivio Italiano di Urologia, Andrologia*, *79*(1), 7–11.
- Magill, S. T., Wang, D. D., Rutledge, W. C., Lau, D., Berger, M. S., Sankaran, S., Lau, C. Y., & Imershein, S. G. (2017). Changing operating room culture: Implementation of a postoperative debrief and improved safety culture. *World Neurosurgery*, *107*, 597–603.
- Mamari, M., Ross, J., Poole, E. L., Brady, J. M., & Clifford, T. (2009). ASPAN's Delphi Study on National Research: Priorities for Perianesthesia Nurses in the United States. *Journal of PeriAnesthesia Nursing*, *24*(1), 4–13.
- Manini, A. F., Jacobs, M. M., Vlahov, D., & Hurd, Y. L. (2013). Opioid receptor polymorphism A118G associated with clinical severity in a drug overdose population. *Journal of Medical Toxicology*, *9*(2), 148–154.
- Manolaraki, M. M., Theodoropoulou, A., Stroumpou, C., Vardas, E., Oustamanolakis, P., Gritzali, A., Chlouverakis, G., & Paspatis, G. A. (2008). Remifentanyl compared with midazolam and pethidine sedation during colonoscopy: A prospective, randomized study. *Digestive Diseases and Sciences*, *53*(1), 34–40.
- Manuel, A. R. G., Hart, N., & Stradling, J. R. (2015). Is a raised bicarbonate, without hypercapnia, part of the physiologic spectrum of obesity-related hypoventilation? *Chest*, *147*(2), 362–368.
- Marret, E., Kurdi, O., Zufferey, P., & Bonnet, F. (2005). Effects of nonsteroidal anti-inflammatory drugs on patient-controlled analgesia morphine side effects: Meta-analysis of randomized controlled trials. *Anesthesiology*, *102*(6), 1249–1260.
- Mathews, T. J., Churchhouse, A. M., Housden, T., & Dunning, J. (2012). Does adding ketamine to morphine patient-controlled analgesia safely improve post-thoracotomy pain? *Interactive Cardiovascular and Thoracic Surgery*, *14*(2), 194–199.
- McCarter, T., Shaik, Z., Scarfo, K., & Thompson, L. J. (2008). Capnography monitoring enhances safety of postoperative patient-controlled analgesia. *American Health Drug Benefits*, *1*(5), 28–35.
- McCartney, C. J., Duggan, E., & Apatu, E. (2007). Should we add clonidine to local anesthetic for peripheral nerve blockade? A qualitative systematic review of the literature. *Regional Anesthesia and Pain Medicine*, *32*(4), 330–338.
- McGrath, S. P., Pyke, J., & Taenzer, A. H. (2017). Assessment of continuous acoustic respiratory rate monitoring as an addition to a pulse oximetry-based patient surveillance system. *Journal of Clinical Monitoring and Computing*, *31*(3), 561–569.
- McNicol, E. D., Tzortzopoulou, A., Cepeda, M. S., Francia, M. B., Farhat, T., & Schumann, R. (2011). Single-dose intravenous paracetamol or propacetamol for prevention or treatment of postoperative pain: A systematic review and meta-analysis. *British Journal of Anaesthesia*, *106*(6), 764–775.
- Mehta, J. H., Cattano, D., Braynov, J. B., & George, E. E. (2017). Assessment of perioperative minute ventilation in obese versus non-obese patients with a non-invasive respiratory volume monitor. *BMC Anesthesiology*, *17*(1), 61.
- Mehta, R. D., & Roth, A. J. (2015). Psychiatric considerations in the oncology setting. *CA: A Cancer Journal for Clinicians*, *65*(4), 300–314.
- Menendez, M. E., Ring, D., & Bateman, B. T. (2015). Preoperative opioid misuse is associated with increased morbidity and mortality after elective orthopaedic surgery. *Clinical Orthopaedics and Related Research*, *473*(7), 2402–2412.
- Miner, J. R., Moore, J. C., Plummer, D., Gray, R. O., Patel, S., & Ho, J. D. (2013). Randomized clinical trial of the effect of supplemental opioids in procedural sedation with propofol on serum catecholamines. *Academic Emergency Medicine*, *20*(4), 330–337.
- Mitchell, M. D., Lavenberg, J. G., Trotta, R. L., & Umscheid, C. A. (2014). Hourly rounding to improve nursing responsiveness: A systematic review. *Journal of Nursing Administration*, *44*(9), 462–472.
- Moon, Y. E., Lee, Y. K., Lee, J., & Moon, D. E. (2011). The effects of preoperative intravenous acetaminophen in patients undergoing abdominal hysterectomy. *Archives of Gynecology and Obstetrics*, *284*(6), 1455–1460.
- Moslemi, F., Rasooli, S., Baybordi, A., & Golzari, S. E. (2015). A comparison of patient controlled epidural analgesia with intravenous patient controlled analgesia for postoperative pain management after major gynecologic oncologic surgeries: A randomized controlled clinical trial. *Anesthesiology and Pain Medicine*, *5*(5), e29540.
- Motov, S., Rosenbaum, S., Vilke, G. M., & Nakajima, Y. (2016). Is there a role for intravenous dissociative-dose ketamine administered as an adjunct to opioids or as a single agent for acute pain management in the emergency department? *Journal of Emergency Medicine*, *51*(6), 752–757.
- Moustafa, A. A., Baaror, A. S., & Abdelazim, I. A. (2016). Comparative study between nalbuphine and ondansetron in prevention of intrathecal morphine-induced pruritus in women undergoing cesarean section. *Anesthesia, Essays and Researches*, *10*(2), 238–244.
- Myles, P. S., & Kurz, A. (2017). Supplemental oxygen and surgical site infection: Getting to the truth. *British Journal of Anaesthesia*, *119*(1), 13–15.
- Nadpara, P. A., Joyce, A. R., Carroll, N. W., Carroll, N. V., Barnard, M., & Zedler, B. K. (2018). Risk factors for serious prescription opioid-induced respiratory depression or overdose: Comparison of commercially insured and Veterans Health Affairs populations. *Pain Medicine*, *19*, 79–86.
- Nagappa, M., Liao, P., Wong, J., Auckley, D., Ramachandran, S. K., Memtsoudis, S., Mokhesi, B., & Chung, F. (2015). Validation of the STOP-BANG questionnaire as a screening tool for obstructive sleep apnea among different populations: A systematic review and meta-analysis. *PLoS One*, *10*(12), e0143697.
- Nagappa, M., Patra, J., Wong, J., Subramani, Y., Singh, M., Ho, G., Wong, D. T., & Chung, F. (2017). Association of STOP-BANG questionnaire as a screening tool for sleep apnea and postoperative complications: A systematic review and Bayesian meta-analysis of prospective and retrospective cohort studies. *Anesthesia and Analgesia*, *125*(4), 1301–1308.
- National Comprehensive Cancer Network. (2018). NCCN clinical practice guidelines on oncology: Adult cancer pain. Retrieved from <https://www.nccn.org>. (Accessed 24 July 2019).
- Nieters, M., Mahajan, R. P., Aarts, L., & Dahan, A. (2013). High-inspired oxygen concentration further impairs opioid-induced respiratory depression. *British Journal of Anaesthesiology*, *110*(5), 837–841.
- Nisbet, A. T., & Mooney-Cotter, F. (2009). Comparison of selected sedation scales for reporting opioid-induced sedation assessment. *Pain Management Nursing*, *10*(3), 154–164.
- Oosten, A. W., Oldenmenger, W. H., van Zuylen, C., Schmitz, P. I., Bannink, M., Lievever, P. J., Bromberg, J. E., & van der Rijt, C. C. (2011). Higher doses of opioids in patients who need palliative sedation prior to death: Cause or consequence? *European Journal of Cancer*, *47*(15), 2341–2346.
- Oswald, L., Zeuske, T., & Pfeffer, J. (2016). Implementing capnography in the PACU and beyond. *Journal of PeriAnesthesia Nursing*, *31*(5), 392–396.
- Ouchi, K., Fujiwara, S., & Sugiyama, K. (2017). Acoustic method respiratory rate monitoring is useful in patients under intravenous anesthesia. *Journal of Clinical Monitoring and Computing*, *31*(1), 59–65.
- Oudiette, D., Dodet, P., Ledard, N., Artru, E., Rachidi, I., Similowski, T., & Arnulf, I. (2018). REM sleep respiratory behaviours mental content in narcoleptic lucid dreamers. *Scientific Reports*, *8*(1), 2636.
- Overdyk, F., Dahan, A., Roozkrans, M., van der Schrier, R., Aarts, L., & Nieters, M. (2014). Opioid-induced respiratory depression in the acute care setting: A compendium of case reports. *Pain Management*, *4*(4), 317–325.

- Overdyk, F. J., Carter, R., Maddox, R. R., Callura, J., Herrin, A. E., & Henriquez, C. (2007). Continuous oximetry/capnometry monitoring reveals frequent desaturation and bradypnea during patient-controlled analgesia. *Anesthesia and Analgesia*, *105*(2), 412–418.
- Overdyk, F. J., Dowling, O., Marino, J., Qiu, J., Chien, H. L., Erslon, M., Morrison, N., Harrison, B., Dahan, A., & Gan, T. J. (2016). Association of opioids and sedatives with increased risk of in-hospital cardiopulmonary arrest from an administrative database. *PLoS One*, *11*(2), e0150214.
- Overton, H. N., Hanna, M. N., Bruhn, W. E., Hutfless, S., Bicket, M. C., Makary, M. A., & Opioids After Surgery Workgroup. (2018). Opioid-prescribing guidelines for common surgical procedures: An expert panel consensus. *Journal of the American College of Surgeons*, *227*(4), 411–418.
- Parikh, B., Maliwad, J., & Shah, V. R. (2011). Preventive analgesia: Effect of small dose of ketamine on morphine requirement after renal surgery. *Journal of Anaesthesiology, Clinical Pharmacology*, *27*(4), 485–488.
- Pasero, C. (2009). Assessment of sedation during opioid administration for pain management. *Journal of PeriAnesthesia Nursing*, *24*(3), 186–190.
- Pawasauskas, J., Stevens, B., Youssef, R., & Kelley, M. (2014). Predictors of naloxone use for respiratory depression and oversedation in hospitalized adults. *American Journal of Health-System Pharmacy*, *71*(9), 746–750.
- Pedersen, T., Nicholson, A., Hovhannysyan, K., Moller, A. M., Smith, A. F., & Lewis, S. R. (2014). Pulse oximetry for perioperative monitoring. *Cochrane Database of Systematic Reviews*, *3*, CD002013.
- Poon, S. J., Greenwood-Erickson, M. B., Gish, R. E., Neri, P. M., Takhar, S. S., Weiner, S. G., Schuur, J. D., & Landman, A. B. (2016). Usability of the Massachusetts Prescription Drug Monitoring Program in the emergency department: A mixed-methods study. *Academic Emergency Medicine*, *23*(4), 406–414.
- Quinlan-Colwell, A., Thear, G., Miller-Baldwin, E., & Smith, A. (2017). Use of the Pasero Opioid-induced Sedation Scale (POSS) in pediatric patients. *Journal of Pediatric Nursing*, *33*, 83–87.
- Rakhman, E., Shmain, D., White, L., Ekstein, M. P., Kollender, Y., Chazan, S., Dadia, S., Bickels, J., Amar, E., & Weinbroum, A. A. (2011). Repeated and escalating preoperative subanesthetic doses of ketamine for postoperative pain control in patients undergoing tumor resection: A randomized, placebo-controlled, double-blind trial. *Clinical Therapeutics*, *33*(7), 863–873.
- Ramachandran, S. K., Pandit, J., Devine, S., Thompson, A., & Shanks, A. (2017). Postoperative respiratory complications in patients at risk for obstructive sleep apnea: A single-institution cohort study. *Anesthesia and Analgesia*, *125*(1), 272–279.
- Riesenberg, L. A., Leitzsch, J., & Cunningham, J. M. (2010). Nursing handoffs: A systematic review of the literature. *American Journal of Nursing*, *110*(4), 24–34. quiz 35–26.
- Robinson, N. L. (2016). Promoting patient safety with perioperative hand-off communication. *Journal of PeriAnesthesia Nursing*, *31*(3), 245–253.
- Rodriguez-Moliner, A., Narvaiza, L., Ruiz, J., & Galvez-Baron, C. (2013). Normal respiratory rate and peripheral blood oxygen saturation in the elderly population. *Journal of the American Geriatrics Society*, *61*(12), 2238–2240.
- Rosenfeld, D. M., Betcher, J. A., Shah, R. A., Chang, Y. H., Cheng, M. R., Cubillo, E. I., Griffin, J. M., & Trentman, T. L. (2016). Findings of a naloxone database and its utilization to improve safety and education in a tertiary care medical center. *Pain Pract*, *16*(3), 327–333.
- Rowbotham, M. C. (2015). Tricyclic antidepressants and opioids—better together? *Pain*, *156*(8), 1373–1374.
- Rozario, L., Sloper, D., & Sheridan, M. J. (2008). Supplemental oxygen during moderate sedation and the occurrence of clinically significant desaturation during endoscopic procedures. *Gastroenterology Nursing*, *31*(4), 281–285.
- Sami Mebazaa, M., Mestiri, T., Kaabi, B., & Ben Ammar, M. S. (2008). Clinical benefits related to the combination of ketamine with morphine for patient controlled analgesia after major abdominal surgery. *Tunisie Medicale*, *86*(5), 435–440.
- Sasaki, N., Meyer, M. J., & Eikermann, M. (2013). Postoperative respiratory muscle dysfunction: Pathophysiology and preventive strategies. *Anesthesiology*, *118*(4), 961–978.
- Savelloni, J., Gunter, H., Lee, K. C., Hsu, C., Yi, C., Edmonds, K. P., Furnish, T., & Atayee, R. S. (2017). Risk of respiratory depression with opioids and concomitant gabapentinoids. *Journal of Pain Research*, *10*, 2635–2641.
- Schirm, V., Banz, G., Swartz, C., & Richmond, M. (2018). Evaluation of bedside shift report: A research and evidence-based practice initiative. *Applied Nursing Research*, *40*, 20–25.
- Schug, S. A., Palmer, G. M., Scott, D. A., Halliwell, R., & Trinca, J. (2016). Acute pain management: Scientific evidence, fourth edition, 2015. *Medical Journal of Australia*, *204*(8), 315–317.
- Schwappach, D. L. (2010). Engaging patients as vigilant partners in safety: A systematic review. *Medical Care Research and Review*, *67*(2), 119–148.
- Schwenk, E. S., Goldberg, S. F., Patel, R. D., Zhou, J., Adams, D. R., Baratta, J. L., Viscusi, E. R., & Epstein, R. H. (2016). Adverse drug effects and preoperative medication factors related to perioperative low-dose ketamine infusions. *Reg Anesth Pain Med*, *41*(4), 482–487.
- See, M. T. A., Chan, W. C. S., Huggan, P. J., Tay, Y. K., & Liaw, S. Y. (2014). Effectiveness of a patient education intervention in enhancing the self-efficacy of hospitalized patients to recognize and report acute deteriorating conditions. *Patient Education and Counseling*, *97*(1), 122–127.
- Sen, H., Sizlan, A., Yanarates, O., Emirkadi, H., Ozkan, S., Dagli, G., & Turan, A. (2009). A comparison of gabapentin and ketamine in acute and chronic pain after hysterectomy. *Anesthesia and Analgesia*, *109*(5), 1645–1650.
- Shapiro, A., Zohar, E., Zaslansky, R., Hoppenstein, D., Shabat, S., & Fredman, B. (2005). The frequency and timing of respiratory depression in 1524 postoperative patients treated with systemic or neuraxial morphine. *Journal of Clinical Anesthesia*, *17*(7), 537–542.
- Shenk, E., Barton, C. A., Mah, N. D., Ran, R., Hendrickson, R. G., & Watters, J. (2016). Respiratory depression in the intoxicated trauma patient: Are opioids to blame? *American Journal of Emergency Medicine*, *34*(2), 250–253.
- Shin, C. H., Zaremba, S., Devine, S., Nikolov, M., Kurth, T., & Eikermann, M. (2016). Effects of obstructive sleep apnea risk on postoperative respiratory complications: Protocol for a hospital-based registry study. *BMJ Open*, *6*(1), e008436.
- Shukla, A., Rai, M. K., Prasad, N., & Agarwal, V. (2017). Short-term non-steroid anti-inflammatory drug use in spondyloarthritis patients induces subclinical acute kidney injury: Biomarkers study. *Nephron*, *135*(4), 277–286.
- Siddik-Sayyid, S. M., Yazbeck-Karam, V. G., Zahreddine, B. W., Adham, A. M., Dagher, C. M., Saasouh, W. A., & Aouad, M. T. (2010). Ondansetron is as effective as diphenhydramine for treatment of morphine-induced pruritus after cesarean delivery. *Acta Anaesthesiologica Scandinavica*, *54*(6), 764–769.
- Silva, R. A., Leng, J. C., He, L., Brock-Utne, J. G., Drover, D. R., & Leng, T. (2015). Risk factors for respiratory depression in patients undergoing retrobulbar block for vitreoretinal surgery. *Ophthalmic Surg Lasers Imaging Retina*, *46*(2), 243–247.
- Sivilotti, M. L., Messenger, D. W., van Vlymen, J., Dungey, P. E., & Murray, H. E. (2010). A comparative evaluation of capnometry versus pulse oximetry during procedural sedation and analgesia on room air. *Canadian Journal of Emergency Medicine*, *12*(5), 397–404.
- Smith, A., Farrington, M., & Matthews, G. (2014). Monitoring sedation in patients receiving opioids for pain management. *Journal of Nursing Care Quality*, *29*(4), 345–353.
- Song, Y., Shim, J. K., Song, J. W., Kim, E. K., & Kwak, Y. L. (2016). Dexmedetomidine added to an opioid-based analgesic regimen for the prevention of postoperative nausea and vomiting in highly susceptible patients: A randomised controlled trial. *European Journal of Anaesthesiology*, *33*(2), 75–83.
- Stausholm, K., Rosenberg-Adamsen, S., Edvardsen, L., Kehlet, H., & Rosenberg, J. (1997). Validation of pulse oximetry for monitoring of hypoxaemic episodes in the late postoperative period. *British Journal of Anaesthesia*, *78*(1), 86–87.
- Sites, M., Surprise, J., McNiel, J., Northrop, D., & De Ruyter, M. (2017). Continuous capnography reduces the incidence of opioid-induced respiratory rescue by hospital rapid resuscitation team. *Journal of Patient Safety*.
- Streeter, A. R., & Harrington, N. G. (2017). Nurse handoff communication. *Seminars in Oncology Nursing*, *33*(5), 536–543.
- Sultan, P., Gutierrez, M. C., & Carvalho, B. (2011). Neuraxial morphine and respiratory depression: Finding the right balance. *Drugs*, *71*(14), 1807–1819.
- Sun, Z., Sessler, D. L., Dalton, J. E., Devereaux, P. J., Shahinyan, A., Naylor, A. J., Hutcherson, M. T., Finnegan, P. S., Tandon, V., Darvish-Kazem, S., Chugh, S., Alzayer, H., & Kurz, A. (2015). Postoperative hypoxemia is common and persistent: A prospective blinded observational study. *Anesthesia and Analgesia*, *121*(3), 709–715.
- Supe, D., Baron, L., Decker, T., Parker, K., Venella, J., Williams, S., Beaton, K., & Zaleski, J. (2017). Research: Continuous surveillance of sleep apnea patients in a medical-surgical unit. *Biomedical Instrumentation and Technology*, *51*(3), 236–251.
- Taenzer, A. H., Perreard, I. M., MacKenzie, T., & McGrath, S. P. (2017). Characteristics of desaturation and respiratory rate in postoperative patients breathing room air versus supplemental oxygen: Are they different? *Anesthesia and Analgesia*, *126*(3), 826–832.
- Taenzer, A. H., Pyke, J., Herrick, M. D., Dodds, T. M., & McGrath, S. P. (2014). A comparison of oxygen saturation data in inpatients with low oxygen saturation using automated continuous monitoring and intermittent manual data charting. *Anesthesia and Analgesia*, *118*(2), 326–331.
- Takmaz, S. A., Inan, N., Goktug, A., Erdogan, I., Sunay, M., & Ceyhan, A. (2008). The analgesic effect of 8 and 16 mg lornoxicam administered before shock wave lithotripsy: A randomized, double-blind, controlled study. *Urology*, *72*(2), 282–285.
- Tebala, G. D., Keane, S., Osman, A., Ip, M., Khan, A. Q., & Perrone, L. (2016). Early discharge after colorectal resection: The positive impact of an enhanced recovery program on a rural colorectal surgery service. *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques*, *26*(6), e137–e144.
- Techanivate, A., Dusitkasem, S., & Anuwattanavit, C. (2012). Dexmedetomidine compare with fentanyl for postoperative analgesia in outpatient gynecologic laparoscopy: A randomized controlled trial. *Journal of the Medical Association of Thailand*, *95*(3), 383–390.
- The Joint Commission. (2018a). National patient safety goals. Retrieved from file:///C:/Users/gkoch/Downloads/NPSG_Chapter_HAP_Jan2018.pdf.
- The Joint Commission. (2018b). New Joint Commission advisory on pressure injuries related to medical devices. Retrieved from <https://www.jointcommission.org/issues/article.aspx?Article=icropPaZsUEfw2/GuFxnYvPzSGvvy+9iOdItFULm vPyQ=>. (Accessed 24 July 2019).
- The Joint Commission. (2017). Joint Commission enhances pain assessment and management requirements for accredited hospitals. Retrieved from https://www.jointcommission.org/joint_commission_enhances_pain_assessment_and_management_requirements_for_accredited_hospitals/. (Accessed 24 July 2019).
- The Joint Commission. (2013). Medical device alarm safety in hospitals. Retrieved from https://www.jointcommission.org/assets/1/6/SEA_50_alarms_4_26_16.pdf. (Accessed 24 July 2019).

- Thomas, A. N., & MacDonald, J. J. (2016). Patient safety incidents associated with failures in communication reported from critical care units in the North West of England between 2009 and 2014. *Journal of the Intensive Care Society*, 17(2), 129–135.
- Tripathi, D. C., Shah, K. S., Dubey, S. R., Doshi, S. M., & Raval, P. V. (2011). Hemodynamic stress response during laparoscopic cholecystectomy: Effect of two different doses of intravenous clonidine premedication. *Journal of Anaesthesiology*, 27(4), 475–480.
- Tsutaoka, B. T., Ho, R. Y., Fung, S. M., & Kearney, T. E. (2015). Comparative toxicity of tapentadol and tramadol utilizing data reported to the National Poison Data System. *Annals of Pharmacotherapy*, 49(12), 1311–1316.
- Tu, R. H., Grewall, P., Leung, J. W., Suryaprasad, A. G., Sheykhzadeh, P. I., Doan, C., Garcia, J. C., Zhang, N., Prindiville, T., Mann, S., & Trudeau, W. (2006). Diphenhydramine as an adjunct to sedation for colonoscopy: A double-blind randomized, placebo-controlled study. *Gastrointestinal Endoscopy*, 63(1), 87–94.
- U.S. Food and Drug Administration. (2018). Risk evaluation and mitigation strategy (REMS) for opioid analgesics. Retrieved from <https://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass/ucm163647.htm>. (Accessed 24 July 2019).
- U.S. Food and Drug Administration. (2016). FDA warns about serious risks and death when combining opioid pain or cough medicines with benzodiazepines; requires its strongest warning. Retrieved from <https://www.fda.gov/Drugs/DrugSafety/ucm518473.htm>. (Accessed 24 July 2019).
- van der Schrier, R., Roozkrans, M., Olofsen, E., Aarts, L., van Velzen, M., de Jong, M., Dahan, A., & Niesters, M. (2017). Influence of ethanol on oxycodone-induced respiratory depression: A dose-escalating study in young and elderly individuals. *Anesthesiology*, 126(3), 534–542.
- Van Koughnett, J. A., & Wexner, S. D. (2014). Surgery. NSAIDs and risk of anastomotic leaks after colorectal surgery. *Nature Reviews: Gastroenterology & Hepatology*, 11(9), 523–524.
- van Loon, K., van Zaane, B., Bosch, E. J., Kalkman, C. J., & Peelen, L. M. (2015). Non-invasive continuous respiratory monitoring on general hospital wards: A systematic review. *PLoS One*, 10(12), e0144626.
- Voepel-Lewis, T., Parker, M. L., Burke, C. N., Hemberg, J., Perlin, L., Kai, S., & Ramachandran, S. K. (2013). Pulse oximetry desaturation alarms on a general postoperative adult unit: A prospective observational study of nurse response time. *International Journal of Nursing Studies*, 50(10), 1351–1358.
- Volk, T., Peters, J., & Sessler, D. I. (2017). The WHO recommendation for 80% perioperative oxygen is poorly justified. *Anaesthetist*, 66(4), 227–229.
- Voscopoulos, C., Theos, K., Tillmann Hein, H. A., & George, E. (2017). A risk stratification algorithm using non-invasive respiratory volume monitoring to improve safety when using post-operative opioids in the PACU. *Journal of Clinical Monitoring and Computing*, 31(2), 417–426.
- Voscopoulos, C. J., MacNabb, C. M., Freeman, J., Galvagno, S. M., Jr., Ladd, D., & George, E. (2014). Continuous noninvasive respiratory volume monitoring for the identification of patients at risk for opioid-induced respiratory depression and obstructive breathing patterns. *Journal of Trauma and Acute Care Surgery*, 77(3 Suppl 2), S208–S215.
- Vukovic, J., Ramakrishnan, P., & Milan, Z. (2012). Does epidural clonidine improve postoperative analgesia in major vascular surgery? *Med Glas (Zenica)*, 9(1), 49–55.
- Wall, B. F., Magee, K., Campbell, S. G., & Zed, P. J. (2017). Capnography versus standard monitoring for emergency department procedural sedation and analgesia. *Cochrane Database of Systematic Reviews*, 3, CD010698.
- Warth, L. C., Noiseux, N. O., Hogue, M. H., Klaassen, A. L., Liu, S. S., & Callaghan, J. J. (2016). Risk of acute kidney injury after primary and revision total hip arthroplasty and total knee arthroplasty using a multimodal approach to perioperative pain control including ketorolac and celecoxib. *Journal of Arthroplasty*, 31(1), 253–255.
- Wasserman, I., Poeran, J., Zubizarreta, N., Babby, J., Serban, S., Goldberg, A. T., Greenstein, A. J., Memtsoudis, S. G., Mazumdar, M., & Leibowitz, A. B. (2018). Impact of intravenous acetaminophen on perioperative opioid utilization and outcomes in open colectomies: A claims database analysis. *Anesthesiology*, 129(1), 77–88.
- Weingarten, T. N., Chong, E. Y., Schroeder, D. R., & Sprung, J. (2016). Predictors and outcomes following naloxone administration during Phase I anesthesia recovery. *Journal of Anesthesia*, 30(1), 116–122.
- Weingarten, T. N., Hawkins, N. M., Beam, W. B., Brandt, H. A., Koepf, D. J., Kellogg, T. A., & Sprung, J. (2015a). Factors associated with prolonged anesthesia recovery following laparoscopic bariatric surgery: A retrospective analysis. *Obesity Surgery*, 25(6), 1024–1030.
- Weingarten, T. N., Herasevich, V., McGlinch, M. C., Beatty, N. C., Christensen, E. D., Hannifan, S. K., Koenig, A. E., Klanke, J., Zhu, X., Gali, B., Schroeder, D. R., & Sprung, J. (2015b). Predictors of delayed postoperative respiratory depression assessed from naloxone administration. *Anesthesia and Analgesia*, 121(2), 422–429.
- Weingarten, T. N., Warner, L. L., & Sprung, J. (2017). Timing of postoperative respiratory emergencies: When do they really occur? *Current Opinions in Anaesthesiology*, 30(1), 156–162.
- Weinger, M. B., & Lee, L. A. (2011). No patient shall be harmed by opioid-induced respiratory depression. Retrieved from www.apsf.org. (Accessed 24 July 2019).
- Whitney, J. D., & Parkman, S. (2004). The effect of early postoperative physical activity on tissue oxygen and wound healing. *Biological Research for Nursing*, 6(2), 79–89.
- Wick, E. C., Grant, M. C., & Wu, C. L. (2017). Postoperative multimodal analgesia pain management with nonopioid analgesics and techniques: A review. *JAMA Surgery*, 152(7), 691–697.
- Willens, J. S., Jungquist, C. R., Cohen, A., & Polomano, R. (2013). ASPMN survey—nurses' practice patterns related to monitoring and preventing respiratory depression. *Pain Management Nursing*, 14(1), 60–65.
- Williams, J. S. (2015). Opioid safety and patient monitoring: Conference compendium. Retrieved from www.aami.org. (Accessed 24 July 2019).
- World Health Organization. (2017). *Patient safety: Making health care safer*. Geneva, Switzerland: Author.
- Wu, H. T., Pan, W. Y., Liu, A. B., Su, M. C., Chen, H. R., Tsai, I. T., Lin, M. C., & Sun, C. K. (2016). Vibration signals of snoring as a simple severity predictor for obstructive sleep apnea. *Clinical Respiratory Journal*, 10(4), 440–448.
- Yamamoto, A., Fricova, J., Rokyta, R., & Slamberova, R. (2016). The effect of combined treatment of opioids with methylphenidate on nociception in rats and pain in human. *Physiological Research*, 65(Suppl 5), S567–S575.
- Yang, S., Menne, A., Hu, P., Stansbury, L., Gao, C., Dorsey, N., Chiu, W., Shackelford, S., & Mackenzie, C. (2017). Acoustic sensor versus electrocardiographically derived respiratory rate in unstable trauma patients. *Journal of Clinical Monitoring and Computing*, 31(4), 765–772.
- Yassen, A., Olofsen, E., Romberg, R., Sarton, E., Teppema, L., Danhof, M., & Dahan, A. (2007). Mechanism-based PK/PD modeling of the respiratory depressant effect of buprenorphine and fentanyl in healthy volunteers. *Clinical Pharmacology and Therapeutics*, 81(1), 50–58.
- Youngcharoen, P., Vincent, C., & Park, C. G. (2017). Theory of planned behavior constructs associated with nurses' pain assessment and pro re nata (PRN) opioid analgesic administration: A cross-sectional study. *Pain Management Nursing*, 18(3), 153–169.
- Yung, L., Lee, K. C., Hsu, C., Furnish, T., & Atayee, R. S. (2017). Patterns of naloxone use in hospitalized patients. *Postgraduate Medicine*, 129(1), 40–45.
- Zedler, B. K., Saunders, W. B., Joyce, A. R., Vick, C. C., & Murrelle, E. L. (2018). Validation of a screening risk index for serious prescription opioid-induced respiratory depression or overdose in a US commercial health plan claims database. *Pain Medicine*, 19(1), 68–78.
- Zeng, Z., Lu, J., Shu, C., Chen, Y., Guo, T., Wu, Q. P., Yao, S. L., & Yin, P. (2015). A comparison of nalbuphine with morphine for analgesic effects and safety: Meta-analysis of randomized controlled trials. *Scientific Reports*, 5, 10927.
- Zhou, Y., Huang, J. X., Lu, X. H., Zhang, Y. F., & Zhang, W. (2015). Patient-controlled intravenous analgesia for non-small cell lung cancer patient after thoracotomy. *Journal of Cancer Research and Therapeutics*, 11(Suppl 1), C128–C130.