



Evidence-Based Protocols to Guide Pulse Oximetry and Oxygen Weaning in Inpatient Children with Asthma and Bronchiolitis: A Pilot Project^{1,2}

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Nurses', respiratory therapists' (RTs), and physicians' concerns about oxygen weaning practices and pulse oximetry use in healthy children during inpatient admissions prompted this multidisciplinary evidence-based project. A nurse-led inter-professional team found lack of consistent oxygen weaning practices and lack of guidelines for nurses or RTs regarding pulse oximetry use with children admitted for acute respiratory illness. The team created and piloted evidence-based oxygen weaning and pulse oximetry protocols. After a 6 month pilot, children in the pilot had shorter length of stay, time on oxygen, and time on continuous pulse oximetry. Protocols improved patient outcomes and decreased associated charges.

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PULSE OXIMETRY IS a simple, noninvasive monitoring tool that has been widely used in the acute care setting since the early 1980s. Often called the “fifth vital sign,” pulse oximetry is helpful in determining oxygen necessity in patients who are at risk for being hypoxic, usually before signs of respiratory distress appear (Mower, Sachs, Nicklin, & Baraff, 1997). Oxygen saturation (SpO₂) has been found to be a reliable indicator of disease severity in conditions associated with ventilation/perfusion (V/Q) mismatch, such as exacerbations of asthma, acute bronchiolitis, and pneumonia (Bradley et al., 2011; Callahan, 2008; Fouzas, Priftis, & Anthracopoulos, 2011; Khemani et al., 2012; Mower et al., 1997). Despite its popularity and usefulness, pulse oximetry does have several limitations, including motion artifacts, poor perfusion at the site of measurement, irregular rhythms, ambient light or electromagnetic interference, and time lag in detecting hypoxic events. In addition, poor performance can occur with certain skin pigmentation,

nail polish, probe positioning, venous pulsations, intravenous dyes, calibration assumptions, and presence of abnormal hemoglobin molecules (Fouzas et al., 2011). Successful use of continuous pulse oximetry is also hindered by staff competency and understanding of the above limitations, frustration with false alarms, and failure to follow manufacturer guidelines regarding proper oximetry use (Mininni, Marino, Kohler, & Stephan, 2009).

Researchers have hypothesized that the increased use of pulse oximetry since the 1980s has been associated with increased admissions and length of stay because of unclear guidelines about safe SpO₂ levels in children discharged from the hospital, especially in the bronchiolitis population (Shay et al., 1999; Zentz, 2011). Approximately 149,000 children were hospitalized with bronchiolitis in the U.S. in 2002 (Pelletier, Mansbach, & Camargo, 2006). Average length of hospitalization was 3.3 days nationwide with the majority of these children under the age of 1 year. The number of inpatient pediatric hospitalizations related to asthma reached 335,000 in 2006, with a mean length of stay of 2.2 days (Stranges, Merrill, & Steiner, 2008). While researchers have suggested a connection between increasing

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admissions and longer lengths of stay related to pulse oximetry use, scientific support of this belief is scarce.

Effective use of pulse oximetry should be associated with improved patient outcomes, providing necessary information to guide delivery of supplemental oxygen and other care. However, in a complex pediatric medical environment, pulse oximetry practices may vary, poorly impacting patient outcomes and driving up costs. No clear guidelines currently exist to provide standardized pulse oximetry and oxygen weaning practice in hospitalized children with acute respiratory illness (Fouzas et al., 2011).

Background/Significance

Nurses participating in their hospital Nursing Evidence-Based Practice and Research (NEBPR) Council at a 429 bed free-standing children's hospital in the southwestern United States recognized practice problems related to use of pulse oximetry and oxygen. A staff survey of registered nurses (RNs), respiratory therapists (RTs), and physicians highlighted the following issues: (1) lack of consistency in use of pulse oximetry; (2) no evidence-based definition of how and when to wean oxygen; and (3) no explicit permission for staff to use pulse oximetry or deliver oxygen to children on inpatient medical units without a physician order. The nurses formed a task force and developed the following question: "Will oxygen weaning and pulse oximetry protocols for inpatient children with acute respiratory illnesses result in consistent practices as noted by chart audits and decrease: time on oxygen, time on pulse oximetry, length of stay, and charges to patients?"

The purpose of this project was to develop evidence-based guidelines to empower RNs and RTs in clinical decisions related to use of pulse oximetry and oxygen in children with acute respiratory illnesses. The task force hoped to standardize care of children with asthma, bronchiolitis, croup, and pneumonia on medical units, thus improving outcomes and reducing costs.

Literature Review Pulse Oximetry Use

Pulse oximetry should help health care professionals assess a child's risk for respiratory failure and decrease code blue events on medical floors. However, Akre et al. (2010) found that out of 187 code blue or rapid response events in children, 67% of patients had continuous pulse oximetry prior to the event. Akre et al. determined that a multi-system symptoms assessment driving practice, such as the Pediatric Early Warning Score (PEWS) or other similar scoring tools, could reduce code blue events. PEWS systems categorize patient symptoms on a continuum and include measures such as behaviors and respiratory and cardiovascular symptoms. The cut-off scores to determine illness level vary based on the population, setting, and specific scoring tool. In other non-PEWS scoring systems, symptoms in children with respiratory illnesses may be

categorized as mild, moderate, or severe to guide treatment and monitoring (Global Initiative for Asthma, 2014; Royal Children's Hospital, Melbourne, 2011). Children with mild illness may only require spot check pulse oximetry every 4 hours or less. Moderately ill children need spot check pulse oximetry every 2 to 4 hours with consideration of continuous monitoring if showing signs of instability. Symptoms of severe illness in children necessitate continuous pulse oximetry and regular consideration of the need for transfer to an intensive care (Children's Hospital of Colorado, 2011; Global Initiative for Asthma, 2014; Johnson, 2009; Lieberthal et al., 2006; Royal Children's Hospital, Melbourne, 2011; Scottish Intercollegiate Guidelines Network (SIGN), 2009; Woods, 2013; Zentz, 2011).

Ten years prior to the study by Akre et al. (2010), experts from the Child Healthcare Corporation of America (CHCA) taskforce recommended development of an objective decision tree for frequency and duration of pulse oximetry in children (Pulse Oximetry Forum, 2000). To date, no current blueprint exists in literature to guide use of pulse oximetry.

Recommendations for SpO₂ Ranges

In children admitted for acute respiratory illnesses, ranges of recommended SpO₂ minimums have little scientific support. Most experts recommend keeping oxygen saturations at or above 90% (Global Initiative for Asthma, 2014; Lieberthal et al., 2006; Royal Children's Hospital, Melbourne, 2011; Zentz, 2011). Other physician groups provide more conservative guidelines, instructing caregivers to maintain baseline oxygen saturation levels at 92–93% [Children's Hospital of Colorado, 2011; Scottish Intercollegiate Guidelines Network (SIGN), 2009] (Table 1).

Recommendations for Oxygen Use and Weaning

In children with bronchiolitis, there is strong scientific support to maintain SpO₂ at 90% or greater by increasing or decreasing rates of supplemental oxygen based on hourly assessments (Ramsey, 2012; Royal Children's Hospital, Melbourne, 2011; Zentz, 2011). Children with oxygen concentration needs greater than 40–50% require care management in intensive care units (Royal Children's Hospital, Melbourne, 2011). Weaning oxygen by protocol includes reducing oxygen according to the patient status and recording observations at least hourly for a couple of hours after weaning oxygen (Royal Children's Hospital, Melbourne, 2011; Zentz, 2011).

Oxygen weaning practices in adults are available as a guide in the absence of specific pediatric guidelines. University of Toledo Medical Center Respiratory Care Department (2010) policy included a daily attempt to wean oxygen in adults, rechecking SpO₂ 15 minutes after weaning. Weaning may be done incrementally, reducing oxygen by half of the difference between 21% oxygen concentration

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