in the pediatric ward and the pediatric ICU settings (Evidence level B, median appropriateness score 7.5).

Humidification of Oxygen

The use of humidification for low-flow oxygen therapy is a common practice with little evidence to support its use or to indicate that it is harmful. Complications of dry oxygen delivery have been linked to the use of high-flow oxygen delivery and are perceived to be present with lower severity with low-flow oxygen delivery. There are 2 options for humidification of low flow oxygen. The first and most common is unheated humidification, also referred to as bubble or pass-over, and the second is heated and humidified humidification via an active humidification device.

The evidence to support the use of humidification of any kind versus dry delivery of low-flow oxygen delivery to impact comfort or infection risk is scant. Three studies to date have investigated this comparison. Scolnik et al[21] concentrated on the croup population in the emergency department and performed a single-blinded, randomized controlled trial to deliver 3 levels of humidity for 30 min in the emergency department. The 3 groups were blow-by therapy, controlled 40% humidity, and controlled 100% humidity, all delivered with 40% oxygen, and pre- and post-assessment was conducted with the Westley Croup Score. The results showed that there was no significant difference in the Westley score or any of the secondary outcomes of vital signs and hospitalization rate with either level of humidity, which did not support the use of humidification in the emergency department for the treatment of croup.[21] The HHOT AIR study by Chen et al[19] was a prospective, randomized pilot study comparing dry versus heated and humidified low-flow oxygen defined as < 4 L/min in children < 24 months of age with mild to moderate bronchiolitis admitted to the general pediatric ward. Patients who required oxygen therapy were randomized to the control or to heat and humidification for oxygen delivery. The respiratory distress assessment instrument (RDAI) was used to score comfort and distress to compare for each group. Although the investigators saw a quicker change in the RDAI over time (1 h vs 12 h), there was not a significant difference in the score when comparing the 2 groups at the same timeframes. Although there was a trend in a quicker improvement of RDAI over time with the heated and humidified oxygen group, this did not show a significant difference in length of stay or vital signs. This may be a result of small sample size; however, these findings do not support the use of heated and humidified oxygen over dry gas for the treatment of bronchiolitis. Lorente Sánchez et al also investigated the use of humidification of low-flow oxygen therapy in children with mild to moderate bronchiolitis admitted to the general pediatric ward in a pre-post interventional trial.[20] The authors used unheated humidification and compared the number of nasal lavages pre- and post-universal use of a bubbler humidifier and changes in bronchiolitis score, vital signs, and hospital length of stay.[20] There was not a statistical difference in any outcome measure, indicating that the use of unheated humidification was not beneficial.

In summary, low level of evidence does not support the use of heated or unheated humidification with low-flow oxygen delivery (Evidence level B, median appropriateness score 8.25). More robust research is needed to make a clear determination.

Oxygenation Targets

Normoxia, or a pulse oximetry reading of 94% or higher, is often the recommended target for oxygen therapy in children. There are several clinical practice guidelines that recommend pulse oximetry targets by disease, yet practice and even recommendations vary between national guidelines. Current oximetry target recommendations for children with pneumonia are $> 92\%$ and $> 90\%$ for asthma if using the 2007 NHLBI National Asthma Education and Prevention Program, or 94–98% if using the revised 2019 British guideline on the management of asthma.[27-29] We identified only one category of respiratory disease in which there was enough evidence of specific oxygen targets in the pediatric population. This respiratory disease was acute lower respiratory tract infection, often referred to as bronchiolitis.

Lower respiratory tract infections account for about 128,000 hospitalizations of children < 2 y old each year in the United States at an estimated cost of $1.73 billion, which is an estimated 30% increase over the 9 y studied.[30] While trends in hospitalization for lower respiratory tract infections have decreased from 17.9 to 14.9 per 1,000 persons from 2000 to 2009, there was a 34% increase in admissions of children with high-risk medical conditions and a 21% increase in use of mechanical ventilation.[30] The American Academy of Pediatrics and the World Health Organization both recommend permissive hypoxemia of an oxygen saturation of 90% for children with lower respiratory tract infections, largely on the basis of expert opinion and consideration of resource-limited areas as there was not a high level of evidence presented in their publications.[31,32]

Since the publication of those national clinical practice guidelines on the management of bronchiolitis, there has been one double-blind, randomized, equivalence trial using 2 oximetry targets ($< 90\%$ modified vs $< 94\%$ standard) for oxygen therapy.[22] Cunningham et al[22] reported that the modified target of $\geq 90\%$ is as safe and clinically effective as the standard practice of $\geq 94\%$. Additionally, they observed a significantly lower time to fit to discharge (44.2 vs 30.2 h, $P < .001$), time to actual discharge (50.9 vs 40.9 h, $P = .003$), and time to no further supplemental oxygen