

Overuse of Continuous Pulse Oximetry for Bronchiolitis The Need for Deimplementation Science

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Bronchiolitis, a viral infection of the lower respiratory tract, is the most common cause of hospitalization among children younger than 2 years, and generated estimated direct hospital costs of \$734 million in 2016.¹ Clinical practice recommendations from the Choosing Wisely campaign and the American Academy of Pediatrics (AAP) specifically target medical overuse for children with bronchiolitis in an effort to improve value of medical care for the approximately 130 000 infants admitted each year with this disease.^{2,3} Amid recommendations related to prevention, diagnosis, and management of bronchiolitis, these guidelines recommend restricting the use of continuous pulse oximetry for hospitalized children receiving supplemental oxygen. Despite data suggesting that continuous pulse oximetry is associated with increased length of stay (LOS), health care costs, and patient harm, little is known about the prevalence of or contextual factors associated with continuous pulse oximetry use for patients admitted with bronchiolitis.



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In this issue of *JAMA*, Bonafide et al⁴ present the results of a cross-sectional study to quantify continuous pulse oximetry use in a research network of 49 hospitals offering different levels of pediatric inpatient services. The authors studied the prevalence of continuous pulse oximetry in otherwise healthy children with a clinical diagnosis of bronchiolitis not requiring supplemental oxygen, and ultimately conducted a total of 3612 in-person patient observations during a single bronchiolitis season. Continuous pulse oximetry was directly observed in 46% (95% CI, 40%-53%) of clinical encounters, the majority of which occurred in different patients. Variables associated with continuous pulse oximetry use included younger age combined with full-term or preterm birth, shorter time since weaning from supplemental oxygen, documented apnea or cyanosis during the current illness, use of an enteral feeding tube, and nighttime observation. Use ranged from 6% to 82% after risk standardization, with freestanding children's hospitals, children's hospitals within a hospital, and community hospitals represented among both the high-use and low-use outliers, suggesting that the scope of pediatric services offered did not affect the use of continuous pulse oximetry. However, 27% of observed variation was attributed to unmeasured hospital-level factors.

National initiatives, such as Choosing Wisely, seek to advance the dialogue on low-value care by educating physicians and the lay public about unnecessary tests, treatments, and procedures. With AAP support for limiting use of continuous pulse oximetry, pediatricians must be intentional in addressing factors that contribute to overuse. Amidst 14 recommendations for bronchiolitis care, the AAP recommendation against continuous pulse oximetry carries the worst evidence-quality grade (D) and weakest recommendation strength. Perhaps pediatricians deprioritize this recommendation in favor of those with stronger evidence quality, especially because most quality reports describing institution-specific bronchiolitis guidelines lack any mention of pulse oximetry monitoring practices.⁵ Additionally, some clinicians may perceive there is a benefit of continuous monitoring in bronchiolitis care. One study highlighted that parents of children hospitalized with bronchiolitis perceive that continuous pulse oximetry is protective, even knowing it may delay discharge.⁶ However, outside of this study the data are not equivocal, but rather nonexistent.⁷ Despite movement toward evidence-based medicine, physicians still struggle with uncertainty, especially in an era in which patient-level data, such as pulse oximetry measurements, affect medical decisions.⁸

A more plausible hypothesis for persistent overuse of continuous pulse oximetry is barriers to deimplementation: the act of reducing, replacing, or stopping the use of low-value clinical practices. Barriers to deimplementation are multifactorial and exist at individual-, institution-, and systems-wide levels. For individual pediatricians, bronchiolitis care comes with much uncertainty. Diagnostic uncertainty occurs as physicians weigh clinical features that mimic other prevalent pediatric illnesses, such as asthma and pneumonia, both of which are managed with therapies (steroids and antibiotics, respectively) that may cause harm to a patient with bronchiolitis. Physicians spend hours at the bedside of infants in varying degrees of respiratory distress while addressing exhausted parents asking "why aren't you doing anything for my child?" In this case, continuous pulse oximetry obviates the uncertainty experienced by parents, nurses, and physicians, providing a perceived guarantee that worsening patients will be immediately identified. However, the data suggest continuous pulse oximetry provides reassurance without improved clinical outcomes, hence deviating from the ultimate goal of delivering high-quality and cost-effective patient care.

Successful deimplementation strategies are emerging in pediatrics. Multifaceted approaches that include clinician and family education, audit and feedback, and clinical decision support are more effective than singular ones, although physician education alone may yield positive change as well.^{9,10} Narrow-scope and single-site vs multisite efforts are also associated with greater effectiveness, which speaks to the importance of local context and effective engagement of clinicians and parents. Approaches that address the roles of both interdisciplinary care teams and families in overuse may have the greatest potential to reduce low-value care.^{9,10}

Many hospitals have standardized their approach to bronchiolitis care, yet few have taken on deimplementation of

continuous pulse oximetry. One community hospital-based quality improvement effort instituted a continuous pulse oximetry clinical pathway through multidisciplinary team collaboration and reduced LOS by 20 hours at 2 institutions.¹¹ Another children's hospital inpatient unit employed staff education, nursing hand offs, and clinical decision support to decrease median time receiving continuous pulse oximetry from 10.7 to 3.1 hours, although there was no associated decrease in LOS.¹² The study by Bonafide and colleagues⁴ establishes a quality "baseline" for institutional comparison and elucidates patient-level factors associated with overuse of continuous pulse oximetry, thereby identifying specific targets for institutions motivated to improve value of medical care for patients with bronchiolitis.

One important limitation noted by the authors is that observations from patients admitted to freestanding children's hospitals were overrepresented in their sample.⁴ Whereas 74% of study observations came from freestanding children's hospitals, fewer than 25% of all pediatric bronchiolitis hospitalizations occur at such hospitals in the US.¹³ Infants admitted to general hospitals have lower illness severity and are less likely to have complex chronic disease compared with infants admitted to freestanding children's hospitals, thus being more optimally suited for care via standardized clinical approaches. Smaller-volume community hospitals may face challenges when introducing pediatric-specific value initiatives given proportionately higher volumes of adult patients and fewer ties to research and quality networks that are often centered in urban academic institutions. In the pay-for-performance era, some community hospitals have found success through regional collaborative improvement programs organized and funded by payers.¹⁴ These collaboratives often center on clinical conditions that are common and costly. Given that the rate of growth of costs for pediatric care has outpaced that of adults in recent

years—growth primarily driven by spending on children's inpatient services—bronchiolitis represents a perfect opportunity for payer-sponsored improvement collaboratives among community hospitals where the vast majority of the nation's children receive care.¹⁵

The study by Bonafide et al⁴ demonstrates both some success and limited progress toward eliminating an overused, low-value care practice across hospitals providing pediatric inpatient care. Yet, many questions remain. For whom might continuous pulse oximetry monitoring hold benefit among individuals with bronchiolitis or other respiratory illnesses? What factors motivate physicians to choose continuous monitoring? Should institutions continue to focus on overuse in individuals with bronchiolitis, or should other efforts take priority? A 2019 systematic review established several additional examples of medical overuse in pediatric care: antibiotic prophylaxis for urinary tract infections, routine opioid prescriptions, prolonged antibiotics for latent tuberculosis, and routine admission to the intensive care unit and pharmacologic therapy for neonatal abstinence syndrome.¹⁶

Bonafide and colleagues⁴ have laid the groundwork for pediatricians to reflect on the benefit of a simple intervention, such as continuous pulse oximetry monitoring, and to determine strategies to use it appropriately in patients with bronchiolitis. At a time when implementation science is helping to bring evidence-based practices to the bedside, an even greater challenge for physicians is to advance deimplementation science as an equally necessary strategy to reduce overused care practices. Their work highlights the need to construct multifaceted approaches that incorporate education, feedback, and system-based and family-centered interventions to change clinical practice and create significant, sustainable improvements in value of medical care for patients and families.

ARTICLE INFORMATION

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REFERENCES

- Fujiogi M, Goto T, Yasunaga H, et al. Trends in bronchiolitis hospitalizations in the United States: 2000-2016. *Pediatrics*. 2019;144(6):e20192614.
- Ralston SL, Lieberthal AS, Meissner HC, et al. Clinical practice guideline: the diagnosis, management, and prevention of bronchiolitis. *Pediatrics*. 2014;134(5):e1474-e1502.
- Quinonez RA, Garber MD, Schroeder AR, et al. Choosing wisely in pediatric hospital medicine. *J Hosp Med*. 2013;8(9):479-485.
- Bonafide CP, Xiao R, Brady PW, et al. Prevalence of continuous pulse oximetry monitoring in hospitalized children with bronchiolitis not requiring supplemental oxygen. *JAMA*. Published April 21, 2020. doi:10.1001/jama.2020.2998
- Tyler A, Krack P, Bakel LA, et al. Interventions to reduce over-utilized tests and treatments in bronchiolitis. *Pediatrics*. 2018;141(6):e20170485.
- Hendaus MA, Nassar S, Leghrouz BA, et al. Parental preference and perspectives on continuous pulse oximetry in infants and children with bronchiolitis. *Patient Prefer Adherence*. 2018;12:483-487.
- Fouzas S, Priftis KN, Anthracopoulos MB. Pulse oximetry in pediatric practice. *Pediatrics*. 2011;128(4):740-752. doi:10.1542/peds.2011-0271
- Schuh S, Freedman S, Coates A, et al. Effect of oximetry on hospitalization in bronchiolitis. *JAMA*. 2014;312(7):712-718.
- Walker LL, Quinonez R. Choosing better: standard of care should be data-driven, not just habit-forming. *Pediatrics*. 2018;141(2):e20173859.
- Colla CH, Mainor AJ, Hargreaves C, et al. Interventions aimed at reducing use of low-value health services. *Med Care Res Rev*. 2017;74(5):507-550.
- Mittal S, Marlowe L, Blakeslee S, et al. Successful use of quality improvement methodology to reduce inpatient length of stay in bronchiolitis through judicious use of intermittent pulse oximetry. *Hosp Pediatr*. 2019;9(2):73-78.
- Schondelmeyer AC, Simmons JM, Statile AM, et al. Using quality improvement to reduce continuous pulse oximetry use in children with wheezing. *Pediatrics*. 2015;135(4):e1044-e1051.
- Leyenaar JK, Ralston SL, Shieh M-S, et al. Epidemiology of pediatric hospitalizations at general hospitals and freestanding children's hospitals in the United States. *J Hosp Med*. 2016;11(11):743-749.
- Share DA, Campbell DA, Birkmeyer N, et al. How a regional collaborative of hospitals and physicians in Michigan cut costs and improved the quality of care. *Health Aff (Millwood)*. 2011;30(4):636-645. doi:10.1377/hlthaff.2010.0526
- Health Care Cost Institute. Children's health spending: 2010-2013. Published July 8, 2015. Accessed March 1, 2020. <https://healthcostinstitute.org/hcci-research/children-s-health-spending-2010-2013>
- Money NM, Schroeder AR, Quinonez RA, et al. 2019 Update on pediatric medical overuse. *JAMA Pediatr*. Published online February 3, 2020. doi:10.1001/jamapediatrics.2019.5849