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Pulse oximetry: an important first step in improving health outcomes, but is of little use if there is no oxygen

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According to the most recent Unicef estimates, 5.9 million children under age 5 died in 2015.¹ In low-income countries, mortality in early childhood is dominated by prematurity, sepsis, and pneumonia—diseases that frequently result in hypoxemic respiratory failure. Since the introduction of pulse oximetry into clinical practice in the 1980s, pulse oximeters have become ubiquitous in high-income countries and are increasingly used in the diagnosis and management of childhood disease in middle and low-resource settings. There is intuitive appeal of a point-of-care device such as pulse oximetry to detect hypoxaemia, particularly in first-level healthcare facilities staffed by minimally trained health workers. However, it is prudent to examine the evidence regarding its use in clinical management and effect on outcomes, particularly in childhood pneumonia.

In this month's issue, Enoch *et al*² evaluate the evidence underlying the assertion that pulse oximeters make a meaningful difference in the management of children. Five studies met criteria for inclusion in their systematic review, all before/after studies. Only one of these was conducted in a low-income country. Because of the heterogeneity in study design and outcomes, the authors were unable to conduct a meta-analysis but instead qualitatively summarised the findings.

Duke *et al*³ conducted the only study that examined the effect of introducing pulse oximetry *and oxygen concentrators* on pneumonia-related mortality in Papua New Guinea. Improving the detection of hypoxaemia *and treating it* did reduce pneumonia mortality by 35%. Based on their reported absolute risk reduction of 1.75%, the number of children needed to test with pulse oximetry and treat with supplemental oxygen in order to save one life (number needed to treat) was 57, a game-changing intervention in a disease that kills nearly one million young children per year. Notably, a portion of the observed reduction in mortality may also be related to the improved overall level of care children receive in a quality improvement initiative.

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Every year, there are 1.5 million episodes of hypoxemic pneumonia requiring hospitalisation worldwide,⁴ and even though oxygen is on the WHO's list of essential medicines, patients in most district hospitals and many referral hospitals in sub-Saharan African and Asia are unlikely to receive oxygen because of the continued lack of a consistent supply of supplemental oxygen.⁵ It is difficult to imagine that the introduction of pulse oximetry alone into this context will improve pneumonia outcomes.

Several studies in the systematic review found that knowledge of a patient's oxygen saturation was associated with a change in clinical management, and in some cases, intensification of care (admission to a hospital, administration of oxygen). In other cases, pulse oximetry findings were reassuring and led providers to deintensify care. These findings are intuitive and not altogether surprising, but they demonstrate that physicians find the information generated by pulse oximetry useful in managing their patients.

Floyd *et al*⁶ recently developed a model to evaluate the benefit of pulse oximetry in reducing childhood pneumonia mortality in resource-poor settings. According to their analysis, combining pulse oximetry with implementation of WHO (integrated management of childhood illness) treatment guidelines would prevent 148 000 pneumonia-related deaths annually in the 15 highest-burden countries, at a cost of less than US\$53 per disability-adjusted life year. Notably, the authors have found that at least 60% of hospitals must have oxygen available to their patients in order for pulse oximetry to offer any mortality benefit compared with IMCI-based clinical assessment alone. Unfortunately, in most resource-poor settings, oxygen availability is much less than 60%.

The studies reviewed by Enoch *et al*, along with the results of Floyd's model, demonstrate that an improvement in the outcomes of children with hypoxaemia is possible, and that pulse oximetry plays a critical role in identifying children with the greatest need of oxygen. For the families of children with prematurity, sepsis and pneumonia, this is good news indeed, but to reap the benefit, we must find a way to ensure that when hypoxaemia is detected by pulse oximetry, there is a consistent supply of oxygen to treat the hypoxaemia.

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