2.1 Challenges to achieving universal pulse oximetry

Despite the establishment of pulse oximetry as a monitoring standard in the developed world nearly twenty years ago, it has been difficult to apply universally in resource-limited settings. In many developing countries, pulse oximetry is seen as a luxury, rather than a necessity. Inadequacies in financial resources, infrastructure and workforce are three critical factors that have impeded its widespread implementation.

The relatively high initial cost of pulse oximetry has been a significant barrier in many developing world settings. Most oximetry units cost at least several hundred dollars, with the exception of finger probe units which can be found for under US$50. More sophisticated models incorporating multiple monitoring modalities can cost over one thousand dollars. Given the limited availability of resources, many government officials and public health leaders in the developing world have focused on other therapies which are perceived to be more cost effective. For example, for the cost of an average oximeter, two HIV patients could be treated with antiretroviral therapy for one year in India. \(^1\) With respect to tuberculosis (TB), of the 22 countries with the highest burden of disease, the median cost of treatment per patient is nearly US$300. \(^2\) Maternal and child health issues have also received significant funding, as exemplified by the Millenium Development Goals which have committed billions of dollars to improve maternal and child health. \(^3\)

Yet, if one examines the burden of disease attributable to surgical complications compared to tuberculosis, the numbers are fairly similar. In 2006, there were 9 million new cases of TB and nearly 2 million deaths globally. Funding for TB therapy exceeded $3 billion in 2008. \(^2\) During that same time period, 7 million people were disabled by surgical complications, and 1 million of these patients died as a result of their operation. \(^4\) To address this challenge, WHO created the Surgical Safety Checklist, which requires pulse oximetry. This safety tool, combined with pulse oximetry, could substantially decrease the number of surgical complications and deaths. It is even feasible that the cost effectiveness of the Checklist and universal pulse oximetry could exceed that of TB treatment.

Poor infrastructure has also contributed to the limited availability of pulse oximetry in many hospitals in the developing world. This has adversely affected general surgical patients as well as pregnant mothers and their unborn children. One survey of more than 500 Ugandan hospitals that offer basic obstetric care revealed that most hospitals lacked a constant supply of electricity, running water, and functioning operating rooms. \(^5\) Another survey of 97 anaesthesia providers in Uganda, who represented nearly one-third of the anaesthesia workforce, indicated that only 25% of providers had the necessary supplies to deliver safe anaesthesia to adults. Only 6% could deliver safe anaesthesia during a caesarean section. Electrical supplies were constant for only 20% of providers and 10% always worked without an oxygen supply. For three-fourths of anaesthesia providers, the item most frequently unavailable was a pulse oximeter. \(^6\) The situation is similar throughout sub-Saharan Africa and much of the developing world.
There are significant inequalities in the distribution of the world’s 59 million health care workers.\textsuperscript{5} For example, 10\% of the global burden of disease exists in the WHO Region of the Americas. However, 37\% of the world’s health workers live there and 50\% of the world’s health finances are spent in that region. This contrasts sharply with the African Region where 24\% of the global burden of disease exists. Only 3\% of the world’s health workers provide care in this region, and less than 1\% of the world’s health expenditures are spent there. This “workforce crisis” has profoundly impaired the ability of resource-limited countries to deliver surgical and anaesthesia care.

While a precise description of the anaesthesia workforce in the developing world is lacking, published data indicate a critical shortage. In Uganda, for instance, there are approximately 15 physician anaesthetists for a population of 27 million.\textsuperscript{6,8} As a comparison, the U.K. has 12,000 physician anesthetists for a population of 60 million – 600 times the number of anaesthesiologists per citizen. Due to the severe shortage of physician anaesthetists in Uganda, the vast majority of anaesthesia is administered by 350 anaesthetic officers in the country. These anaesthesia providers have, on average, only one to two years of anaesthesia training following high school.\textsuperscript{6} The situation is similar in Cameroon, where more than 80\% of surgical cases involve a non-physician anaesthetist.\textsuperscript{9}

Given the scarcity of physician anaesthetists in the developing world, the vast majority of anaesthesia is administered by providers with limited training. While many of these “anaesthetic officers” are technically skilled, they often lack a thorough understanding of the relevant pathophysiology and have not received the training needed to anticipate or troubleshoot difficulties. Without adequate knowledge of the clinical implications of hypoxia, it is difficult to expect these officers to use pulse oximetry effectively for clinical decision making. This knowledge gap has limited the efficacy of pulse oximetry in these settings.

In other lower middle income countries, such as India, anesthesia training has traditionally been limited to physicians. This has changed recently with WHO and WFSA statements supporting anaesthesia administration by medical officers with 1 or 2 years of training. Yet, the vast majority of anaesthesia is still provided by physician anaesthetists. As a result, while the quality of technical expertise is strong, the capacity to adequately treat the population is limited. Seventy percent of district hospitals have at least one physician anaesthetist, but only 22\% of first referral hospitals employ physician anaesthetists.\textsuperscript{10}