1.3 Pulse oximetry as a monitoring standard during anaesthesia

Initial efforts to establish pulse oximetry as a mandatory standard for patient monitoring during anaesthesia originated in the United States during the 1980s. Prior to that, standards for intraoperative patient monitoring did not exist. As a result, anaesthesia providers used intraoperative monitoring techniques in an inconsistent manner. These practice pattern variations likely led to an unnecessarily high number of preventable deaths related to anaesthesia. Though precise data describing anaesthesia mortality rates prior to the establishment of monitoring standards are sparse, at least three large studies were published in the 1960s and 1970s. More than 1.5 million patients were included in these studies which reported anaesthesia death rates ranging from 1 in 2,000 to 1 in 7,000 in the developed world.\textsuperscript{13,14,15}

Citing concerns regarding this seemingly high death rate, Eichhorn and colleagues systematically reviewed all anaesthesia-related claims from nine teaching hospitals in the Harvard system from 1976 to 1984. Of the 15 intraoperative “accidents” or deaths, most were preventable with improved clinical vigilance and monitoring. From these efforts, the “Harvard standards” emerged, which represented the first set of formal guidelines for intraoperative monitoring.\textsuperscript{3} The most important component was the continuous presence of an anaesthesia provider throughout the course of anaesthesia. Monitoring blood pressure, heart rate, ventilation and oxygenation were the other primary areas of focus. Pulse oximetry was one proposed method for providing continuous circulatory monitoring.

After publication of the “Harvard standards,” professional societies from around the world developed monitoring standards of their own. In 1986, the American Society of Anesthesiologists (ASA) adopted the “Standards for Basic Intra-Operative Monitoring,” which encouraged the use of pulse oximetry and capnography.\textsuperscript{16,17,18} Three years later, the International Task Force on Anaesthesia Safety was formed to create an international set of anaesthesia standards. For the next two years, anaesthesia experts from around the world systematically analyzed the standards set forth by countries with established guidelines. Four levels of recommendations were outlined: “minimum” standards were applicable to any preplanned anaesthetic; further standards were to be implemented as resources and training permitted, starting with those that were “highly recommended,” and followed by those which were “recommended,” and then “encouraged.”

One of the principles espoused by the groups was the mandatory monitoring of tissue oxygenation; the use of pulse oximetry was “highly recommended” for this purpose.\textsuperscript{19} In 1992, these “International Standards for a Safe Practice of Anaesthesia” were adopted by the World Federation of Societies of Anaesthesiologists (WFSA). When these standards were updated in 2008, the terminology was revised to provide only three levels of recommendation, which was consistent with those used by WHO. Standards that would be expected in all anaesthesia care for elective surgical procedures were termed “highly recommended,” which was the equivalent of a “mandatory standard.” Pulse oximetry was one of them. This was an upgraded recommendation to
the equivalent of “minimum” standards in the original document. These new standards imply that pulse oximetry is now expected in all anaesthesia cases for elective surgical procedures.20

While it has been difficult to demonstrate a causal relationship given the multitude of changes in anaesthesia during the 1980s, the anaesthesia death rate fell significantly after widespread implementation of monitoring standards. A recent review of anaesthesia deaths in Australia from 1980 to 2002 confirmed that anaesthesia-related mortality fell significantly at the time of guideline adoption. The death rate is currently around 1 per 50,000 anaesthetics administered.2 Another study from France documented a ten-fold decline in mortality since the 1980s. A death rate of 1 in 145,000 cases was cited by these authors.21 In the US, Harvard investigators found a three-fold decrease in anaesthesia mortality after implementation of the standards. From 1985-1988, there was only 1 intraoperative accident and no deaths following administration of 244,000 anaesthetics.16 Today, most anaesthesia experts would agree that the death rate attributable solely to anaesthesia in the developed world is between 1 in 50,000 and 1 in 200,000.1,2

Despite the adoption of these standards in the developed world and the subsequent decline in the anaesthesia death rate, there are still a disproportionate number of deaths from anaesthesia in the developing world. Death rates in some developing countries are 100 to 1000 times higher than in the developed world. In Zambia, 1 in 1900 patients die from anaesthesia-related complications.6 In Togo, 1 in 150 surgical patients have anaesthetic complications which result in death.4

At the inception of the Safe Surgery Saves Lives project, the World Alliance for Patient Safety established a “Safe Anaesthesia” working group. Its technical paper states that “the most important monitor is the presence of the trained anaesthesia professional whose expertise is augmented by physiological information displayed by monitoring devices. Pulse oximetry is mandatory for every general or major regional anaesthetic.”22 Pulse oximetry was subsequently established as a “highly recommended” standard for anaesthesia monitoring in WHO’s Guidelines for Safe Surgery.23 As noted above, successful completion of the WHO Surgical Safety Checklist requires pulse oximetry during surgery.