"I would have every man write what he knowes and no more."—Montaigne

BRITISH JOURNAL OF ANAESTHESIA

VOLUME 64, No. 3

MARCH 1990

EDITORIAL

AN INTERNATIONAL CONSENSUS ON MONITORING?

The Association of Anaesthetists' document Standards of Monitoring during Anaesthesia and Recovery [1] has brought patient safety to the forefront in the U.K. Many of the same issues were raised at a College of Anaesthetists' symposium on Safety and Standards, November 1988.

Guidelines on minimal standards of monitoring originated at the Harvard Medical School [2] and have been adopted by the American Society of Anesthesiologists (ASA) [3]. In 1987, a forum of Australasian anaesthetists reached a consensus on minimum monitoring, critical incident reporting and organization of mortality and morbidity studies. That meeting also inaugurated the Australian Patient Safety Foundation (APSF) [4].

The recommendations of the Association of Anaesthetists reflect, but go beyond, the Faculty of Anaesthetists' criteria on monitoring resources in training junior staff [5]; the Australasian Faculty [6] similarly preceded the Australian consensus conference.

Doctors are traditionally resistant to "standards" for medical care. They fear loss of freedom for clinical judgement in the individual case. Some argue that guidelines and rules are necessary only when common sense and sound principles for practice are lacking. Others take a more rigid approach. In the state of New Jersey, for example, an in-circuit oxygen analyser, an exhaled gas spirometer, ECG and continuous monitoring of body temperature are all required by law as a hospital licensing standard [7]. The wide range of monitoring devices available nowadays appear to offer "safer" anaesthesia, but with pressures for efficient use of finances in health care, what exactly is a reasonable standard of care?

Common to all the reports is the view that the most important safety feature is the presence throughout the case of an appropriately experienced anaesthetist. An Australian study [8] claimed that 80% of anaesthetic mishaps were associated with the absence of such a person.

The level of monitoring required in each case should be decided at the initial preoperative assessment. Checks before commencing—the cockpit drill [9]—should include electro-medical and other monitors. These should be calibrated, with alarms functional and appropriate limits set and sensors appropriately situated.

Although there are many common features in the various recommendations, there are differences in emphasis (table I). For example, the Association of Anaesthetists emphasizes beginning electro-medical monitoring before induction and continuing into the recovery room.

In both Australasia and the U.K. "minimal" monitoring is taken to imply continuous cardiorespiratory and oxygen supply monitoring. In practice, this suggests an oxygen failure alarm on the anaesthetic machine, continuous observation of the reservoir bag and a finger on the pulse. The ECG seems to have slipped in priority. The oxygen analyser, warning of an hypoxic gas mixture as distinct from oxygen failure, is not yet standard in the U.K. It is listed without comment by the Association of Anaesthetists.

For artificial ventilation, a pressure alarm warning of disconnection within the breathing system, still the commonest cause of equipment related death [10], is considered essential. Ideally, alarms should be incorporated in the ventilator, although ventilators are still manufactured without this facility. Further, "pressure accidents" could be avoided by the greater use of pressure manometers and pressure limiting devices in the breathing system.

As technology improves, "minimum" monitoring criteria change. Current guidelines emphasize carbon dioxide monitoring and pulse oximetry. The former provides a monitor of many problems in which other monitors fail, or detect too slowly. Of 35 life-threatening incidents detected using capnometry, only two could be detected independently with a praecordial stethoscope [11]. Carbon dioxide is regarded as an
TABLE I. Comparison of the recommendations of the four groups mentioned in the text. + = Essential; — = not mentioned; NIAP = non-invasive arterial pressure monitoring

<table>
<thead>
<tr>
<th>Method of monitoring</th>
<th>Harvard</th>
<th>ASA</th>
<th>Australia</th>
<th>AAGBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous presence</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>of appropriately</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>qualified anaesthetist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen supply failure alarm</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Continuous monitoring</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>of cardiac output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation of reservoir bag and chest excursion</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ventilator disconnect alarm</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oxygen analyser of inspired gas</td>
<td>+</td>
<td>+</td>
<td>Essential by 1990</td>
<td>+</td>
</tr>
<tr>
<td>Spirometry</td>
<td>Optional</td>
<td>Recommended</td>
<td>Where required</td>
<td>Available</td>
</tr>
<tr>
<td>ECG</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>NIAP</td>
<td>at approp. intervals</td>
<td>at approp. intervals</td>
<td>at approp. intervals</td>
<td>at approp. intervals</td>
</tr>
<tr>
<td>Pulse oximeter</td>
<td>Where required</td>
<td>Recommended</td>
<td>Where required</td>
<td>Strongly recommended</td>
</tr>
<tr>
<td>End-tidal carbon dioxide</td>
<td>Strongly recommended</td>
<td>Recommended</td>
<td>Where required</td>
<td>Strongly recommended</td>
</tr>
<tr>
<td>Temperature</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
</tr>
<tr>
<td>Invasive haemodynamic monitoring</td>
<td>Where required</td>
<td>Where required</td>
<td>Where required</td>
<td>Available</td>
</tr>
<tr>
<td>Neuromuscular block</td>
<td>Available</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

almost immediate monitor of oesophageal intubation [12], disconnection, inadequacy of the pulmonary circulation, air embolism and malignant hyperpyrexia. In the last example a rapid and substantial increase in $P_{CO_2}$ precedes the non-specific tachycardia, cyanosis, tachypnoea, etc. End-tidal carbon dioxide warns of a non-functioning valve and the exhaustion of soda-lime in the circle system and disconnection of the inner tube of a Bain System. Carbon dioxide monitoring, airway pressure and expired volume, for routine use in both spontaneous and artificial ventilation, are now “strongly recommended” by the Association of Anaesthetists.

Pulse oximetry is accurate to 2% in the range 7–100% Hb saturation [13]. In a critical incident study [14], it drew attention to a life-threatening problem in 5% of all anaesthetics in which the technique was used. Oximetry is especially useful when patient access and ambient lighting are poor, for example in x-ray rooms. It offers second-line monitoring of oesophageal intubation and ventilator disconnection. Its limitations include reliance on adequate pulsation at the sensing site and failure to detect histotoxic hypoxia or hypoxia. There remains a need for oxygen analysers in the gas supply [15]. Pulse oximeters are still relatively expensive. Their introduction to routine use appears to be almost complete in the U.S.A.; in Australia it will be phased to 1991. Their use is “strongly recommended” by the Association of Anaesthetists. The Australians consider that those available should be reserved for procedures in which oxygen delivery may be compromised: ENT, thoracic, head and neck surgery, the pregnant woman, the grossly obese, and patients with circulatory or respiratory failure.

Up to 30% of perioperative deaths occur during the recovery phase, mainly from cardiovascular or respiratory problems [16]. That percentage has remained fairly constant in recent years and is considered to be largely preventable. Recovery rooms should be purpose designed, within the theatre complex. The main purpose is to monitor the unconscious patient and his vital signs, each patient benefitting from the skills of a nurse specially trained in postoperative recovery. It is
common sense that electro-medical monitoring be maintained during this period. In the U.K., however, some hospitals still deny patients the benefit of recovery rooms while the majority of recovery facilities are open for only a limited time, 08:00-21:00 on weekdays.

An increase in the number of monitoring devices often leads to haphazard arrangement of equipment around the patient and anaesthetic machine. Ergonomic ("man-machine interface") considerations have had a low priority, with the anaesthetist frequently positioned amongst an array of controls and monitors extending to 270° in the horizontal plane and 120° in the vertical plane. Data collected from these monitors are rarely co-ordinated. The layout of controls has been implicated in aircraft accidents [17], and this has implications for anaesthesia. Westhorpe [18] has revived the idea that information should be on one monitor. This might be a single screen placed alongside the patient, displaying eight lines radiating from a central point, each representing one variable, with lines of equal length covering the numerical range of the variable, the starting (normal) value positioned at the middle of the line and data points joined to form a circle. With this arrangement, any change in a variable leading to distortion of the circle would be immediately apparent.

Anaesthetists have led the medical profession in auditing mortality, morbidity and "critical incidents" [19],—an idea first utilized by Flanagan in the United States Air Force in 1954 [20], which led to a dramatic improvement in aviation safety. The Adelaide forum proposed the establishment of a National Australian Anaesthetic Incident Database. Central to such a system is the ease of collection of data—ideally by means of computerized anaesthetic records. Incident reporting must be voluntary and legal immunity is essential.

The Australians have also established the Australian Patient Safety Foundation (APSF) to promote, organize, fund and research established processes for patient safety. It is analogous to the Anesthesia Patient Safety Foundation in the United States [21].

APSF will evaluate clinical equipment, along the lines of the Emergency Care Research Institute (ECRI) based in Philadelphia, the organization of workshops and educational activities, and publication of handbooks on certain procedures (e.g. care of arterial cannulae). It will advise on the computerization of anaesthetic records to enable convenient logging and retrieval of information.

Thus there is intense activity, over a wide range, for patient safety. The motives of the protagonists are high, and the consensus advice admirable. The scientific training of the anaesthetist must point us to the realization that mere acquisition of additional electro-medical equipment may contribute less to safety than the optimists believe. We have no significant research on the ergonomics of monitoring and it can be argued that more "information" might, by distraction, pose greater danger.

It is reassuring to learn that American malpractice insurance premiums are reaching a plateau. Is this really a consequence of more equipment? Or does the repeated airing of safety issues bring safety in itself? Two recent studies have attempted objective evaluation. An ASA study of closed insurance claims [22] included prediction of the likely value of additional monitoring including instruments available now but not necessarily at the time of the event. It was concluded that about 30% of the cases could have been prevented by better monitoring, these including a greater preponderance of the more serious insults and expensive settlements. The pulse oximeter and carbon dioxide monitor would have made the greatest contribution to prevention.

Eichorn [23] has published an elaborate analysis of outcome in 1.3 million anaesthetics given in nine hospitals affiliated to the Harvard School (1976-1988). In the past 3 years (in which monitoring standards have been imposed) there was one accident reported to the insurers and no death, compared with 10 accidents and five deaths in the preceding 9 years. On the face of it, this looks good, but even such a large database is inadequate in the examination of rare events and we would underline Orkins' robust critique [24] of Eichorn's conclusions. While we all seek greater safety and must applaud the current efforts directed towards it, it would be an expensive mistake to make assumptions on inadequate evidence.

A. Winter
A. A. Spence

REFERENCES