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Morbidity in anaesthesia in 2009: still need for improvement

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Anaesthesia is frequently identified as an example for its achievements in the field of safety. This statement relies on the results of recent surveys that demonstrated a 10-fold decrease in anaesthesia mortality within the last few decades. This finding was confirmed by the evolution of insurance premiums for anaesthetists that remained stable or decreased in European or North American countries [1]. Anaesthesia can be proud of this achievement. However, anaesthesia mortality does not equal anaesthesia safety, which is to *'ensure that no patient should be harmed by anaesthesia'*, as established by the Anesthesia Patient Safety Foundation. This goal has not yet been achieved since accidents still occur that could be prevented.

Anaesthesia mortality

During the last ten years, anaesthesia mortality has been measured in the Netherlands, France and Australia in three surveys, which found comparable results. Arbous et al showed that in 1995-6 the death rates within 24 h of anaesthesia were 0.8 per 100,000 for anaesthesia-related deaths, and 13.7 per 100,000 for partially anaesthesia-related deaths [2]. Lienhart et al found that in-hospital mortality rates in 1999 were 0.7 per 100,000 for anaesthesia-related deaths and 4.7 per 100,000 for partially anaesthesia-related deaths, 42% of deaths occurring within 24 h of the procedure [3]. In ASA I patients, solely or partially-related mortality rate was 0.4 per 100,000 procedures. When compared with a previous survey performed in 1978-1982 these results demonstrate a 10-fold decrease in the anaesthesia mortality rate. Gibbs et al showed that in the triennium 2000-2002, the death rate within 24 h of anaesthesia was 0.55 per 100,000 for anaesthesia-related deaths, and 1.8 per 100,000 for partially anaesthesia-related deaths [4].

Anaesthesia mortality is difficult to measure because of the loose definition of what is solely or partially attributable to anaesthesia and because of the difficulty in counting during the same period of time both the total number of deaths and the total number of anaesthetics. Nevertheless, most surveys performed in the 1980's reported solely anaesthesia-related mortality rates around one death for 10,000 procedures, while at the end of the 1990's these rates decreased, as described, to 0.6 - 0.8 deaths per 100,000 procedures. Similar results were reported by large institutions, which also found anaesthesia mortality rates of 1 per 100,000 procedures [5]. This result was confirmed in obstetric surveys, which showed that anaesthesia deaths during Caesarean sections had declined from 36 deaths per 100,000 in 1964-6 to 6 deaths per 100,000 in 1982-4, and to 1 death per 100,000 in 2000-2 [6]. In addition to these improvements anaesthesia and surgery have been extended to older and sicker patients during the same period of time [7].

Anaesthesia morbidity

Anaesthesia safety cannot be assessed solely by measurement of mortality. It is important to examine anaesthesia morbidity separately in order to determine the rate of anaesthesia complications and their nature, which may be different from those leading to patient death. In addition, most anaesthesia mortality surveys have restricted their analysis to the first 24h following anaesthesia and surgery, ignoring later complications.

Studies of anaesthesia morbidity show that non-fatal anaesthesia-related complications remain frequent. Bothner et al, as well as Fasting and Gisvold, found an overall incidence of minor anaesthesia-related peri-operative incidents of 18%-22% [8, 9]. More serious peri-operative events, such as those requiring an unplanned transfer to ICU or intermediate care units, were reported at a rate of 0.45%-1.4% [8, 10]. Severe anaesthesia-related complications with permanent damage occur at a rate 0.2 to 0.6% [8, 9]. This rate of anaesthesia complications clearly contrasts with the low rates of anaesthesia mortality. This data suggests that severe peri-operative complications with permanent damage occur in one per 170-500 patients and an unplanned post-anaesthesia transfer to the ICU in one per 70-250 patients, while anaesthesia-related death occurs in less than one per 100,000 patients.

The second point raised by the analysis of anaesthesia morbidity is that it contains specific information on unsafe care, which is not identified in mortality surveys and which may require specific corrective actions. For example, tracheal intubation during general anaesthesia can be associated with very frequent and minor events such as hoarseness, present 24h postoperatively in 14-50% of patients. But it may also be responsible for a traumatic lesion of the larynx or hypopharynx in 6.3% of patients [11], for dental injury requiring further dental interventions in 1 patient per 1,450 [12], or for one death in every 176,000 patients [3]. Drug administration errors during anaesthesia were shown to occur in 1 per 130 anaesthetics, but serious complications after such errors are only observed in 5 in every 100,000 patients [13]. Anaesthetic equipment problems were shown to occur in 0.23% of patients during general anaesthesia and in 0.05% during regional anaesthesia; one-third of these problems were related to the anaesthetic machine, and a quarter to human error [14].

Peripheral postoperative neurological complications were not identified in mortality surveys. If severe and persisting anaesthesia-related complications are extremely rare, moderately-severe complications are relatively frequent. Paraplegia after spinal or epidural anaesthesia occurs at a rate of 0.6-0.9 per 100,000 patients, but neuropathy after peripheral nerve blockade is present in around 3% of patients, most of these recovering after some weeks or months [15]. Ulnar neuropathy after anaesthesia and surgery, consisting mostly of unilateral paresthesias of the ring and little finger, can be present in 0.5% of patients, with residual symptoms persisting 2 years later in 0.2% of patients [16]. After anaesthesia and surgery in the lithotomy positions, lower extremity neuropathies are present in 1.5% of patients, although symptoms resolve in most patients within 6 months [17].

It is essential to collect morbidity data in order to have a better understanding of the situations in which anaesthesia care remains sub-optimal. However, it is difficult to get a clear overview of the incidence of all anaesthesia complications, a necessary step before defining priorities for corrective actions. This is because anaesthesia complications include a broad range of very disparate adverse events, each of them having a different level of severity and frequency, and their occurrence is influenced by the type of anaesthesia, the type of surgery and the patient's co-morbidities.

Lessons for further improvements in anaesthesia safety

If improvements in anaesthesia safety have resulted in a reduction in major complications to very low rates, the same progress has not yet been obtained for moderate or mild complications. Different lessons can be drawn from the analysis of all the epidemiologic data on anaesthesia accidents, which should guide further progress in safety.

The first lesson is that some anaesthesia procedures remain high risk. During the intra-operative period, three procedures have been shown to represent 49% of all anaesthesia-related deaths: control of the airway during general anaesthesia, the intra- and postoperative management of haemorrhage, and the circulatory disturbances associated with regional anaesthesia [3]. In addition to these other activities were identified to be high risk: central venous catheter (CVC) placement, the use of infusion pumps, and the administration of medications [18]. In morbidity studies, five situations were associated with severe complications: intubation, emergence from anaesthesia, arrhythmias, hypotension and anaphylaxis [9].

These studies also demonstrated that the intra-operative period is not the only time of risk since a large number of anaesthesia accidents result from activities performed by anaesthetists during the pre- and postoperative periods. Pre-operatively, sub-optimal care related to inadequate patient evaluation or incorrect pre-operative management, was found to be a major contributing factor in 38-42% of deaths [3, 4]. While respiratory depression has become extremely rare during the postoperative period with the development of PACUs, inadequate postoperative care still contributes to 42-43% of anaesthesia-related deaths. They include sub-optimal management of postoperative blood loss, failure of supervision of care team members or inadequate resuscitation procedures [3, 4]. Therefore, future efforts to improve anaesthesia safety should not only be directed to improving specific intra-operative procedures, but should also address pre- and postoperative care, such as pre-operative patient evaluation and postoperative follow-up.

The second lesson of this analysis is related to the source of the failures within the different layers of the system delivering care: the individuals, team and organisation. Human failures were identified in 51-77% of anaesthesia-related deaths [3]. They mostly consist of lack of experience or competence, observed in 89% of human failures related deaths, and, less frequently, errors of judgment or analysis, detected in 11% of deaths [3]. In addition, the analysis of these accidents pointed out that in 98% of anaesthesia-related deaths there was at least one deviation from recommended practice in patient care, while in 56% more than four deviations from standard practice were observed. Such studies do not establish that the failure to comply with recommended practice was the explanation for the accidents.

However, the low compliance is disturbing, even if this is not specific for anaesthesia, and raises the question of the utility and importance of guidelines within anaesthesia practice.

Teamwork was identified as inadequate in 62% of deaths, consisting of communication breakdown (oral communication in 36% and written communication in 20%), or poor supervision and absence of help when needed (in 44% of failures) [3]. These difficulties in communication were confirmed by Arbous et al, who demonstrated that the risk of anaesthesia mortality was reduced when a senior anaesthetist was available and could be reached (odds ratio (OR) 0.45), when there was no intra-operative change of anaesthetist, reducing the need for transfer of information (OR 0.44), and when two persons were present during the emergence and termination of anaesthesia (OR 0.69). These findings confirm other reports that identified the importance of operating room teamwork, which should not be seen as restricted to the anaesthesia caregivers, but must also include the surgical and operating room nursing personnel. In a large survey, Davenport and colleagues found that the better the communication and collaboration of the operating room care team with the surgeon, the lower the incidence of postoperative complications [19].

Organisational and management factors were identified as having contributed to 26% of deaths. They consisted of inadequate matching between the required resources and the patient's condition seen in 38% of deaths, inadequate surgical scheduling in 31%, production pressure in 20% and inappropriate night call organisation in 11% [3, 4]. This suggests that our efforts to improve anaesthesia safety should not be exclusively directed to improving individual competence but should also address the optimisation of teamwork and of the organisation of care [10].

The third point comes from morbidity data. The high rate of anaesthesia complications addresses the problem of the monitoring of anaesthesia safety. Severe accidents are easy to count but are so rare that at an institutional level they cannot be used as a marker of anaesthesia safety. In contrast, less severe complications are more frequent and could be monitored at an institutional or regional level. However, as described earlier, their extreme variety and the absence of an established taxonomy make such monitoring difficult. Monitoring of anaesthesia complications is probably one of the next steps that should be encouraged to improve anaesthesia safety focusing on specific complications that could be identified, monitored and treated with specific corrective actions.

Conclusion

Previous improvements in anaesthesia mortality have essentially been obtained by the implementation of minimal standards for practice guidelines, by making sure that patients are constantly monitored by qualified anaesthesia personnel and by automated monitoring in operating rooms as well as in PACUs. Current data suggest that the next improvements in anaesthesia safety should consider the following interventions:

- Reduce complications of procedures that remain high risk, such as airway control, intra- and postoperative management of haemorrhage, circulatory consequences of regional anaesthesia, pre-operative evaluation, and CVP placement.
- Improve communication and teamwork among the different caregivers within the anaesthesia team and between anaesthetists, surgeons and operating room nurses.
- Monitor complications, as an initial step in the implementation of a risk management process [20].

Key Learning Points

- Minimal standards of practice have permitted a reduction in anaesthesia-mortality rates to around 1 death per 150, 000 procedures.
- Serious peri-operative events, such as unplanned admission to ICU, remain around 1 %.
- Reduction of anaesthesia complications can be obtained by:
 - *standardisation of procedures that remain high risk*
 - *improving pre-operative patient evaluation and postoperative follow-up*
 - *improving communication and teamwork among caregivers*

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