Information technology in anaesthesia and critical care

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The use of information technology (IT) in clinical practice can have clear benefits through structuring actions, reducing medication errors, providing ready access to evidence-based clinical information, improving communication and presentation of data, and enabling patient-centred decision support.

As IT systems become more sophisticated and established, both doctors’ performance and patient safety can be improved.1 Anaesthesia and critical care are specialties inherently involved in new technologies and have evolved with developments in IT. Most anaesthetists, however, are still using paper anaesthetic records, and leafing through large paper bedside charts and folders is still commonplace in critical care.

The NHS recommended the widespread adoption of electronic health-care records in its 1998 Information for Health strategy, and in 2008, the Department of Health Health Informatics Review set out a vision whereby efficient IT systems such as electronic records and point-of-care access to clinical information allow better, safer care and promote quality. The use of computers in hospitals is not new, with some systems already established such as those for administrative use (Patient Administration Systems, PAS) and digital imaging (Picture Archiving and Communication System, PACS); however, bespoke systems for use in anaesthesia and critical care are less common.

The electronic patient record

Being able to access, store, and share health information in a secure electronic format has obvious potential benefits for patient care and staff workflow and is being implemented across the developed world. The National Program for Information Technology (NPfIT), the largest civil IT project in the world, was launched in 2002 to develop and implement a modern, integrated IT infrastructure and systems for all NHS organizations, and installing state of the art EPR systems was one of its aims. To date, the programme is delayed and its degree of funding uncertain.

The detailed care record or electronic patient record (EPR) refers to the record of the periodic care provided by a hospital, specialist unit, or other health-care provider. EPR systems were described in the NHS Information Strategy in terms of a number of core components or ‘levels’ 1–6 of increasing complexity and functionality. The basic levels are integration with clinical administrative data, such as PAS, the master patient index, and other departmental systems. The recording of clinical information, electronic prescribing, and test ordering and reporting of results are examples of clinical activity support, which would be found in a level 3 system.

NPfIT recommended that all hospitals acquire at least level 3 EPRs. Level 4 systems feature clinical decision support and are able to access other knowledge bases. This may be passive, such as providing links or easy access to clinical guidelines and knowledge databases, or active, by comparing live data and trends with established best-practice guidelines and protocols and then giving alerts or even treatment recommendations. For example, when prescribing a drug, patient information such as allergies, weight, and laboratory data can be checked for contraindications or interactions. Signals suggesting deterioration can be highlighted through electronic monitoring in critical care. One of the main advantages of the EPR is electronic prescribing and it has been shown that significantly reduces medication errors, a major cause of patient morbidity and mortality. Errors can be prevented through structured orders and medication checks.

Electronic prescribing provides-legible prescriptions with ready access to a drug database with accurate dosing, administration schedules, and guidelines and access to the patient’s drug history, current medications, and other
information such as allergies, weight, and renal function. The patient safety benefits from electronic prescribing have led to calls for universal adoption and the abandoning of handwritten prescriptions. High-end EPRs also contain specialty-specific modules and access to PACS and imaging. An effective EPR will increase efficiency, reduce clinical errors, and improve cost-effectiveness while facilitating audit and research. One of the challenges of implementing EPRs is in communicating and integrating across different clinical departments each with their individual systems and databases, but this has become easier with the unification of computer coding and defined standards such as standardized clinical terminology.

The most efficient way to integrate all information into an EPR is by having just one master database rather than a variety of different ones associated with each hospital system. There has been little evaluation of EPRs, but one survey showed low-level use, with the systems used mainly for reading data and many functions unused. Possible reasons were the lack of access to computers, the general acceptance of paper records, and a reluctance to change working patterns, which are required when changing to an electronic system.

**Anaesthesia information management systems**

Although there is no legal statute that requires an anaesthetic record to be kept, the General Medical Council states that clear and accurate record keeping is a requirement of *Good Medical Practice*. The anaesthetic record provides information that may be useful to future anaesthetists such as difficulty with tracheal intubation and gives a history of events during the anaesthetic that may be relevant to continuing care, such as prolonged hypotension. In cases of litigation, a detailed and legible anaesthesia record is considered invaluable in determining events and their time course, and a poorly kept or illegible record could potentially be detrimental to an anaesthetist’s defence. The Royal College of Anaesthetists (RCOA) and Association of Anaesthetists of Great Britain and Ireland (AAGBI) stated in a 2008 document *Information Management: Guidance for Anaesthetists* that every anaesthetic machine should ideally be equipped with a computerized anaesthetic record-keeping system, linked with the hospital administrative and clinical systems so that patient information is available at the point of care (Table 1).

Anaesthetic information management system(s) (AIMS) was first developed at least 20 yr ago, although uptake has been slow. These systems have evolved from automatically recording physiological data to ‘perioperative information systems’ being able to interface with other hospital clinical systems.

AIMS software is now available from many different companies and is capable of running on non-proprietary hardware. AIMS differ from EPR in that the recording, presentation, and application of data are in a format-specific and more relevant to anaesthesia. Most AIMS are currently standalone and are not part of an EPR, which means that data such as allergies may need to be entered manually and may not be automatically populated. Integration of clinical systems is still in its infancy, requiring a powerful computer capable of quickly linking and synchronizing information from a number of different sources; however, AIMS usually link to PAS, the master patient index, and laboratory systems (Fig. 1).

A typical AIMS consists of a central data acquisition computer collecting physiological data and automated measurements from a variety of external sources such as the anaesthetic machine, patient monitors, and infusion pumps. By means of software drivers, interfaces, and cables, these data will automatically populate the anaesthesia record. The anaesthetist can also manually input data, allowing annotations to data (including the labelling of artifacts), records of drugs given, and marking of perioperative events. The hardware usually involves a computer monitor, keyboard, mouse, and sometimes a barcode scanner or touch screen to allow the rapid recording of drug administration and event information at point of care. Drop down menus and customizable templates allow quick selections.
Medications and most of the common entries traditionally made in the anaesthesia record are available as standardized selections allowing ease of input, consistency, and accuracy. Data are stored on remote hard-drives or servers as part of a perioperative database that can be accessed later if required. A hard copy may be printed at the end of the case, or instead, it may remain part of an electronic record.

**Advantages and disadvantages of AIMS**

AIMS provide contemporaneous, clearly structured, legible, and unbiased documentation, which has been shown to be more accurate and complete than handwritten charts. Once saved and backed up, the record is less easily lost than a paper chart. There are significant differences between information such as arterial pressure measurements recorded by handwritten and electronically acquired means, indicating both faulty recollection and bias against documenting less favourable measurements.

AIMS allow more documentation of physiological data and events than manual charting. This may be especially useful when the anaesthetist is busy such as when a critical incident occurs or when performing a procedure, such as during induction of anaesthesia. Procedures such as airway management and regional anaesthesia techniques can be entered in a standardized manner and with reminders to enter specific details such as the method of skin disinfection to ensure more thorough documentation. The software can scan for missing documentation and then alert the anaesthetist through reminders, ensuring a more complete record. AIMS may reduce the time spent on record keeping, which is estimated at 10–15% of anaesthesia time, and consequently improve efficiency and vigilance, although this has not been shown consistently.

Integration with other databases such as blood results should improve efficiency and the anaesthetist’s workflow. One of the major driving factors in developing AIMS was in improving patient safety, particularly related to the administration of i.v. drugs. By having bar-coded syringe labels, a further check is involved in the process of scanning the intended drug into the computer. Once a drug has been administered, it will be clearly documented on the chart. It may be checked against allergies or computer. Once a drug has been administered, it will be clearly documented on the chart. It may be checked against allergies or

Audit and research is facilitated by being able to retrospectively review large numbers of anaesthesia records, for example, one could interrogate the database for episodes of hypotension or oxygen saturation <90%.

The perioperative database can be readily searched and reports generated, used to assess outcomes, and compare results between other departments. Local audit and therefore quality improvement are possible, for example, one could audit perioperative delays or incidences of hypothermia. Other benefits include providing visual or audible ‘smart alarms’ to the anaesthetist, for example, in the timely administration of prophylactic antibiotics or in turning alarms back on after the cessation of cardiopulmonary bypass after recognizing the resumption of pulsatile flow. These are examples whereby compliance with local and national guidelines may be improved. There may be economic benefits, such as accurate evaluation and tracking of anaesthetic drug and disposables use and in electronic billing by improving coding and capture of charges. Operating theatre management may be improved by allowing remote viewing of event logs and AIMS data from individual rooms in real time. A potential benefit and important area of development of AIMS is in rule-based clinical decision support, through automatically turning data into information.

In an age of automation and technology, one may wonder why the uptake of AIMS has been slow. Although IT-based systems such as PACS and laboratory information systems are now commonplace, AIMS is well behind and only installed in a minority of operating theatres (10% in a European survey in 2008 had already implemented or were in the process of implementing an AIMS).

The most obvious barriers to adopting AIMS are financial; the cost of acquiring, implementing, and maintaining the technology and training users may be considerable and run into thousands of pounds per workstation or server equivalent to 20–30% of the cost of a new anaesthetic machine per room. Technological barriers may exist, with lack of IT resources and integration with existing hospital databases, systems, and medical devices difficult or impossible. Behavioural and human barriers include reluctance to accept change and concern about the technology and perceived complexity. There may be uncertainty about the clinical value and therefore the return on investment and doubts over maturity of available systems. There has also been fear about the medico-legal implications of automated data collection, although this has been unfounded and most experts believe that the transparency and better documentation afforded by AIMS is far better for risk management and is protective against liability.

Despite these concerns, interest in AIMS is increasing and it is generally accepted that the benefits outweigh the drawbacks and that they will inevitably replace the handwritten chart. One group demonstrated that even in an anaesthetic department comprising around a third of staff with minimal computer experience, the implementation of an AIMS was effective in a short time period and the system was well accepted.

**Clinical information systems in critical care**

Critical care, with its wealth of monitoring and technology, was the logical place to first introduce clinical information systems (CIS), and since first implemented in the 1980s, the technology has evolved considerably.

A typical CIS comprises bedside workstations linked by a network to a central server, each able to capture data from the bedside monitors and other devices such as the ventilator and provide medical and nursing records and electronic prescribing through incorporation or integration with an EPR. A sophisticated CIS can integrate with laboratory, pharmacy, PAS, and other hospital databases such that this information populates the record. Data can be presented on the screen in customizable interfaces and can be archived and retrieved.
Benefits of CIS

Many of the advantages and disadvantages of AIMS also apply to CIS. Better record keeping in terms of legibility, detail, and communication is one of the major benefits of a CIS. A vast amount of data can be stored and accessed, allowing more complete and up to the minute charting with less documentation errors and greater ease of access to information compared with paper charts. Having an electronic database allows easy recollection of clinical information and facilitates audit and research. An electronic record may promote adherence to guidelines, for example, by displaying components of a care bundle, which the user must acknowledge, or by quick access to hospital microbiology policies. Through electronic prescribing, medication errors are reduced.10

Ready access to laboratory data and radiology improves efficiency. One of the perceived benefits that many nurses using CIS have is of improved workflow by less time spent documenting. Clinical decision support may be provided through better presentation of data such as trend analysis or through reminders and alerts, for example, reminders to administer drugs or turn the patient to prevent pressure sores.

Disadvantages to CIS

The high financial cost is the obvious barrier to CIS implementation, and as with AIMS, there must be continued software and hardware support, requiring a significant amount of human resources to implement, train staff, and maintain the system.

A reduction in nursing time spent charting has not been shown consistently in the literature and even when it has, it was not clear whether this translated to increased patient care. Moving away from paper notes to an electronic system on a small computer screen may also have a detrimental impact on the way medical and nursing staff communicate on ward rounds, with less interaction and openness of discussion.11 As with any electronic system, there may be software crashes and faults and loss of data so constant backing up, secondary power systems, and antivirus software are essential.2

One must also be sure that the data entered into the CIS, both manually and automatically, are accurate and for the correct patient.

Implementation of AIMS and CIS

Dedicated personnel should take responsibility for the implementation, software and hardware support, maintaining and modifying the user interface, and developing new functionalities. Usually, a clinician with an interest in IT will be the lead in implementing the system and the ongoing support. Choosing a system will depend upon cost, compatibility with existing hospital systems, and preference to the ergonomics and user interface. AIMS/CIS software should be easily customized depending on each department’s needs but this requires further planning. These systems can only be considered useful if they are able to evolve as clinical practice develops. This may be possible if they were built with open data standards and an interface that is easily extensible and can be customized to suit the department.12

There must be a consideration for data protection, and as such, a range of government and industry standards should be upheld to ensure that information is processed securely and with proper regard for its confidentiality, integrity, and availability.

Conclusion

One may argue that in contemporary practice, especially the information-rich environments of anaesthesia and critical care, the only way of presenting and storing data is electronically.

The NHS is currently committed to implementing EPR systems and electronic prescribing. Systems like AIMS and CIS have many benefits, not just through increased accuracy and legibility but also by being able to search and retrieve data and present it in such a way that it can ultimately improve workflow, quality management, and patient safety. Implementation costs and reservations are reasons as to why their use is not widespread at present.

Conflict of interest

None declared.

References


Please see multiple choice questions 20–22.