WebAIRS - A Case Study: How the Multidisciplinarity of IS Can Save Lives

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Abstract

This paper presents a case study chronicling the development of WebAIRS, an Australasian national anaesthetic incident reporting database for health care practitioners. WebAIRS is an example of the multidisciplinary nature of the IS discipline, incorporating IS theories, tools and principles in the creation of an IT artefact with significant real world application. This case study introduces the background of the project and the motivations for its conception including the need for critical incident reporting in anaesthesia, the process of its development using IT students and the problems identified following its national release among the anaesthetic community. The paper demonstrates the evolution of contemporary IS research and the IT artefact, and how each can be crucial foundations for hospitals of the future.

Keywords
Anaesthesia, Case Study, Health Informatics

INTRODUCTION

Avison and Elliot (2006) consider the contemporary Information Systems (IS) discipline as focusing on integrated aspects of technology and its management within organizational and social environments. They cite a definition by the UK Academy for Information Systems, which considers the study of IS to be “a multidisciplinary subject [that] addresses the range of strategic, managerial and operational activities involved in the gathering, processing, storing, distributing and use of information, and its associated technologies, in society and organizations.”

At the centre of IS study is the information technology (IT) artefact, a term used interchangeably with technologies and systems. Leading scholars such as Weber (1987; 2006), Wand and Weber (2001) and Orlikowski and Iacono (2006) have identified the centrality of the Information Technology (IT) artefact in the IS discipline. The multidisciplinary nature of IS research and the broadening distribution of IT artefacts lends itself to a wide variety of areas of study. A field where IS research is expanding is in the medical community, where artefacts are used to assist health practitioners prevent errors and save lives.

This paper illustrates the multidisciplinarity of the Information Systems (IS) discipline by examining the conception, emergence and appropriation of an anaesthetic incident reporting system: WebAIRS (Web-based Anaesthetic Incident Reporting System). WebAIRS provides an illustrative case study suitable for introductory IS courses to help explain the role of IS in society and the importance of mastering multiple concepts, which are often required to establish new ways of working within a professional community. Its development is an example of the multidisciplinary nature of IS integrating tenets of IS education, knowledge management, information and system security, complex adaptive systems, IS appropriation, process management (of critical incidents) and ethics in the creation, use, direction and impact of this system. The length limitations of this paper, however, allow only a brief discussion of the application of these research streams to the story of WebAIRS.

1 http://www.anztadc.net/
WebAIRS demonstrates the key role that IS will play in the hospitals of the future. It is presented as a descriptive case study, drawing from the research and development activities of the participating authors who include practising anaesthetists and information researchers. We will firstly set the scene by describing the role of IT artefacts in the context of anaesthesia. Following a brief discussion of the appropriation of IT artefacts in anaesthesia, the paper explains the knowledge management context and the role of critical incident reporting in this medical field. A brief description of the development of WebAIRS is followed by discussions of the system’s ethical considerations, information and system security and complex adaptive nature. A short example of the system’s contribution to practice is given prior to some concluding comments.

ANAESTHETIC INFORMATION SYSTEMS ARE KEY IT ARTEFACTS

The term *anaesthesia* was first used by Greek philosopher Dioscorides in the first century AD, but the modern usage of the term is credited to Oliver Wendell Holmes in 1846 (Morgan and Mikhail 2006). From the mid 1800’s to early 21st century the responsibilities of the anaesthetist have grown from the administration of anaesthetic gases and vapours to the peri-operative care of patients undergoing anaesthesia for medical procedures. The practice of anaesthesia consists of five main phases: 1) Pre-operative assessment and optimisation of medical conditions; 2) Induction: when the anaesthetic is commenced by administration of drugs; 3) Maintenance and Monitoring: when the anaesthetist maintains a appropriate state of anaesthesia and bodily function during the procedure; 4) Emergence: during which patient recovers from the effects of the anaesthesia; and, 5) Post-operative: the period where the patient recovers from the effects of the procedure and requires ongoing analgesia and physiological management. Each phase involves great complexity and the interaction of multiple rules. A patient’s response depends on the other medications they may be taking, any background medical conditions and the effects of the procedure. It is, therefore, impossible to predict using algorithms the exact response each individual will have when anaesthetised. At each stage human factors such as opinion, beliefs, intuition and errors may also affect the outcome.

Assisting anaesthetists in this task are sophisticated monitoring systems that provide early warning of changing conditions within the patient (Calverley 1989). Improved patient outcomes have resulted from monitoring tools such as the electrocardiograph (ECG), pulse oximetry, non-invasive automated blood pressure measurement, end tidal carbon dioxide measurement and ventilator disconnect monitoring devices. These are incorporated into anaesthetic workstations, which in turn shape the roles and expected capabilities of the anaesthetist (Byrick and Cohen 1995; Greenwood 2005). Advanced monitoring technology is now arguably used in anaesthesia and intensive care more than any other area of medicine (Smith et al 2003).

With the advent of the web, anaesthetic information systems have extended to online journals, various professional resources such as crisis management manuals, continuing education and training systems, and now a bi-national web based incident reporting system. The use of IT artefacts in medicine as a whole is increasing rapidly. WebAIRS in particular has only become possible with the advent of the internet and the inter-industry collaboration that is often necessary in the development of technologies incorporating disparate fields of study.

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A study by Delaney et al (2008) found that the technology
anaesthesia was a core process and a central concern of the community. Figure 1 is the resultant model of this study.

In the above model, Delaney et al – following a grounded theory study – determined that a basic social process in anaesthesia is the appropriation of anaesthetic artefacts. This process has been central to the development of the specialty, with examples that include the appropriation of artefacts from the beer and mining industries (Thompson and Wilkinson 1985) in earlier times to the contemporary appropriation of information systems such as WebAIRS. Figure 1 illustrates that supporting the central concern of appropriation are three drivers: namely, why, what and how anaesthetists appropriate artefacts.

The driver for why anaesthetists appropriate is a result of the complexity of their work. To mitigate uncertainty and channel evidence-based decision-making, anaesthetists appropriate artefacts that will assist with their intensively knowledge-directed medicine. Secondly, what they appropriate are artefacts that are complementary to their mental and practitioner models, such as systems and machines that aid in incident mitigation. Thirdly, anaesthetists are able to justify how they appropriate such artefacts through a culture of anaesthesia that is driven by mechanisms of group sharing and mutual benefit rather than individual-level drivers. These drivers demonstrate the initiative of appropriation in anaesthesia and offer explanatory reasons for the appropriation of an artefact such as WebAIRS into their knowledge-based practice.

KNOWLEDGE MANAGEMENT CONTEXT

Anaesthetic communities of practice (CoP) in the region include the Australian and New Zealand College of Anaesthetists (ANZCA), The Australian Society of Anaesthetists (ASA) and the New Zealand Society of Anaesthetists (NZSA). These organisations oversee the entry, qualifying and continuing professional development (CPD), quality control mechanisms, and research, thereby providing a CoP for practitioners to generate and exchange knowledge. This anaesthetic network is a prime example of Wenger’s (1998) three dimensions for a CoP, featuring joint enterprise, mutual engagement and shared repertoire of knowledge.

As part of a review of ANZCA activities in 2004, ANZCA Council formed several taskforces to research a number of issues and suggest solutions to a variety of problems facing anaesthetists in the new millennium. One of these taskforces was the Data Taskforce and Human Factors Research and another was the Quality and Safety taskforce. This led to the formation of the Australian and New Zealand Tripartite Committee (ANZTADC) in 2006 which is funded and supported by ANZCA, the ASA and the NZSA. ANZTADC’s mission statement is “To improve the safety and quality for patients in Australia and New Zealand by providing an enduring capability to capture, analyse and disseminate information about incidents (de-identified) relative to the safety and quality of anaesthesia in Australia and New Zealand” (ANZTADC 2011).

The aims of this organisation include developing a knowledge base of incidents which include methods to prevent these incidents from occurring and methods for managing incidents that do occur in order to mitigate their consequences. Although the concept has been used in anaesthesia since the 1980’s, the current systems in anaesthesia are hospital- or state-based and there is no organised central repository of incident data and knowledge for the whole of Australia and New Zealand. ANZTADC determined that establishing a repository was the highest priority, as many of the incidents were recurrent. Although there were strategies that could be used to prevent the incidents from recurring, the information was contained within local silos and was not being propagated effectively beyond local hospital or state-based systems. So that the information for Australia and New Zealand did not become retained in a bi-national silo, it was decided to communicate with similar international systems such as the Anesthesia Quality Institute in the USA. This will enable information relating to anaesthetic incidents to be propagated and received at an international level at some stage in the future.

WebAIRS provides a web-based program enabling users to log in and report the details of an incident. The project does not replace or interfere with existing hospital incident recording and management systems but enables the forwarding of a de-identified subset of the data to a bi-national registry. The bi-national registry will be used to work out strategies at a bi-national level for preventing such incidents in the future. The information is then passed back down the chain to all participating hospitals and also separately to members and fellows of ANZCA, the ASA and NZSA in their official publications and annual scientific meetings.

DEVELOPMENT OF WEBAIRS

In 2007, ANZTADC commenced a review of existing incident reporting systems in Australia and New Zealand. The committee identified the dataset to be collected, the ethical issues associated with the data collection, the design issues of the database, compatibility issues with various web browsers, the outputs desired to produce the knowledge base as well as data security and disaster recovery plans. After comprehensive discussion, a Strategic Plan was developed in early 2008 and then using this plan, the system was designed. The next phase involved evaluating existing systems against the requirements of the system design. It was found by late 2008 that none of the currently available systems met the ANZTADC’s specifications for incident reporting. The system was built
Incident reporting has been used in medicine since the 1950's in areas such as maternal mortality, surgical and anaesthetic mortality. The reporting of unexpected outcomes and incidents in anaesthesia gained prominence toward the late seventies, coinciding with the widening appropriation of computer-based systems and ICTs into the clinical setting (Boelle et al 2000). An incident is defined as “any observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the person performing the act” (Flanagan 1954, p. 1). Heinrich (1959) noted that incidents are precursors to accidents, therefore, the need to gather information on incidents is important for constructing pre-emptive measures to mitigate the occurrence or ramifications of critical events, preferably before harm occurs. A critical incident report is a vital component of many high-risk industries, such as military and civil aviation, and the nuclear power industry (Webster 2005).

Cooper et al (1978) began appropriating the critical incident technique into anaesthesia in an attempt to uncover patterns that lead to recurring accidents. In this study, they reported that the major cause of problems in anaesthesia is human error - that is, error on the part of anaesthetists. Although anaesthetists are trained to react swiftly in their diagnosis of sudden anomalies, there still exists a need to determine the root-causes of incidents and how this knowledge can improve the management of future patients to avoid recurrences of the incidents. An early Australian application of the critical incident reporting principle was in Townsville in 1985 by Dr. John Williamson. This was followed in 1987 by Professor Bill Runciman, who established the Australian Patient Safety Foundation. The Foundation coordinated the first national Anaesthesia Incident Monitoring System (AIMS) (Webb et al 1993). AIMS began as a paper-based system but evolved into a system capable of collecting, classifying, analysing, managing and learning about errors. The intention was for all incidents to be reported, not simply those thought to be preventable or involve human error. This work resulted in the adoption of a number of new technologies and recommendations that are believed to have reduced the likelihood of several anaesthetic mishaps.

WebAIRS is the latest artefact to emerge from the co-evolution of anaesthetic practice and contemporary technologies. It supports a critical incident process lifecycle that can be conceived as a complex adaptive system.

**Incident Reporting as a Complex Adaptive System**

Complex Adaptive Systems (CAS) systems were first studied in biological systems that involve individual agents in an organisation (Holland 1995). Individual agents in these systems adapt competitively to external forces, which in turn results in the whole system adapting. Complex adaptive systems have since been related to human organisations and businesses. Traditionally, business systems have been codified as rigid sets of rules in manuals. In some cases, however, the tasks were too complex to map. When this was the case it had to be left up to humans to make decisions on the basis of their knowledge and experience. It can be argued that the incorporation of incident reporting into anaesthetic practice is an example of a developing CAS.

As noted by Neale et al (2000), the complexity of anaesthesia means that an incident is not often standalone and is often the culmination of multiple errors. Different variables and various diagnostic possibilities can elicit confusion and great stress. An example of this situation is provided by the following vignette.

A patient begins a drop in blood pressure accompanied by a rising pulse rate. The anaesthetist detects this from the monitors and starts to scan for a possible cause. However, there is no apparent cause, so the anaesthetist increases the fluid infusion in case the cause is fluid or blood loss. After a few minutes, with blood pressure still falling and the anaesthetist still uncertain of the cause, he calls for a second anaesthetist. The second anaesthetist notices that the patient is developing a rash and suggests anaphylaxis (severe allergic reaction). The first anaesthetist is surprised as it is 10-15 minutes since any new drugs have been given, but the second anaesthetist indicates that it may have been caused by surgical skin preparation which is slow in onset. A treatment for anaphylaxis is given, to good effect. In this example the first anaesthetist was so fixated on fluid loss, blood loss or cardiac as possible causes that the rash which in turn indicated an allergic reaction was not noticed.

The complexity of this particular scenario, whereby an anaesthetist fixates on a particular line of diagnosis or prognosis, is known as fixation error. A related phenomenon is called confirmation bias (Reason 1990; Runciman et al 2007); once a particular diagnosis has been made, there is a strong tendency to interpret new information as confirmatory, rather than to appreciate that it may be pointing in quite a different direction. During the course of managing an incident, it is normal practice for an anaesthetist to call for assistance from a colleague. The colleague will enter the OR, review the situation, consult with the principal anaesthetist and suggest alternative diagnosis and management strategy from their own observations and experience. If necessary the colleague will also begin thinking about possible resolutions, perhaps using the web-enabled personal computer that is a feature of the modern OR. One advantage of using this consultative process is its potential to overcome the occurrence of a fixation error. A second is to broaden the base of expertise and experience.
available to resolve the problem. A third is reducing the cognitive and technical load on the single anaesthetist. The role of a second doctor broadens the scope of possible interventions and assists with managing the problem.

Underlying this process is the strong human tendency to operate by pattern recognition. Particularly when under pressure of time, humans are less good at working things out from first principles than at recognising patterns within events and situations, and fitting pre-formulated solutions to these patterns. This is why incident reporting is particularly valuable. It disseminates information and allows analysis of complex situations with the advantage of hindsight and the absence of time pressure. In effect, as Webster (2005) explained, incident reporting increases the known system states and thereby increases the likelihood of practitioners averting disaster when similar events occur in the future.

WebAIRS aids Anaesthetists, as a body, to react to the environment in the fashion of a CAS. Each time a new incident occurs, it is put into the system and analysed so that the group as a whole can learn from individual experiences. With this model, if the occurrence of a particular event results in an incident, the system should then react to allow this event to be handled more effectively in the future.

Audit systems in anaesthesia have previously been shown to be capable of improving safety and quality of care (Grant et al 2008). Anaesthetic incident reporting is important to detect incidents which are then analysed and solutions developed. These are then fed back to the anaesthetic community with the intent of improving clinical practice. The result of this change in practice is continually monitored using the system allowing any problems to this new solution to be reported and then further improved. This has a short feedback loop and thus has some of the characteristics of a complex adaptive system, although it is not completely self-organising (as it requires analysis and solution development as interventions) (ANZCA ASM 2008).

Data and System Security

System security issues were addressed prior to developing the system. Security provisions include secure login through an encrypted connection and a dedicated server in a secure location. The database is duplicated using two separate database programs and the server is backed up regularly. In addition, sensitive fields within the database are also encrypted. One issue that was considered low risk was damage to the building; however when the building was flooded during a so called “once in 30 year event” in Brisbane, in January 2011, the server was moved to high ground ahead of the flood and the program rapidly relocated to another server. This was a good test of how rapidly the system could be redeployed in an emergency. There are plans in motion to have servers running permanently in both Brisbane and Melbourne with constant replication. If any similar events bring down either server in the future then all traffic will be directed to the remaining server. This should reduce or eliminate any downtime in future and provide greater security against possible loss of data.

Using Students to Develop the Artefact

The principal developer, anaesthetist Adjunct Professor Martin Culwick, completed a part-time Masters of Information Technology during the period 2005-2007 studying both technical programming and information systems courses such as knowledge management, information management and technology management. As part of the information systems curriculum at QUT, final year students are required to engage in an industry project, employing the skills that they have acquired during their course. On completion, the principal developer mentored both undergraduate and postgraduate students, employing them on the WebAIRS project. Students extended their skills through working on challenging problems within this mission-critical system, closely monitored by the principal. Each student was given a specific piece of separate functionality to complete in accordance with their ability and work rate. Given the nature of the system, students were required to have specialised in software development and achieved high grades in their programming subjects.

This experience enabled these students to engage in a real-world complex system development and add this experience to their curriculum vitae. To ensure the future ownership of the intellectual property, the ANZTADC required each student to complete a legal release prior to working on the system. The combination of paid

2 Also one of the authors.
contractors, student efforts and the underlying design provided by the principal developer, based on his long experience in anaesthetic practice resulted in an operational system that is now implemented across 29 hospitals in Australia and New Zealand. Importantly, the drive for the appropriation and development of this system emerged from the community of anaesthetists and not hospital administration, chief information officers or policy officers, in accordance with the grounded theory model by Delaney et al (2008) shown in Figure 1.

Implementation and Future Directions

Because this system was designed to fulfil a need identified by the original ANZCA Quality and Safety Taskforce in 2005 and it is supported by ANZCA, the ASA and NZSA, which are the three major professional anaesthetic organisations in Australia and New Zealand, it greatly assisted the initial uptake by willing participants. In Continuing Professional Development in Anaesthesia (CPD), each anaesthetist must complete Quality Assurance activities each year. The system provides a means to complete these activities and is available online which makes this system attractive and encourage “buy in”. Feedback from participants indicates a need for integration electronically into the hospital system and this function is being currently developed with selected hospitals. This will mean that in the future the anaesthetist will be able to enter the information into both systems simultaneously. One subset is stored at the hospital and a non-identifiable subset forwarded bi-nationally.

RESPONDING TO INCIDENTS – SOME BASIC CONCEPTS

In Figure 3, there are nine major incident categories that have so far been accumulated in WebAIRS. The reporting period is from near the end of 2009 to the 21st of July, 2011.

![Figure 3: Incidents in the database by category](image)

The most commonly reported events for this period were in the categories of Respiratory/Airway (21.46%), Medication (18.05%), Medical Device/Equipment (17.54%) and Cardiovascular (14.99%). Many incidents in anaesthesia (as in essentially all complex human endeavours) can be attributed to human error. The things that predispose to these errors are often considered under the term ‘human factors’. Reason (1990) described a General Error Model, and introduced the concept of latent factors in the system which increases risk. Disaster seldom follows a single failure, whether active or latent, but rather requires the juxtaposition of several in quick succession. This has lead to the well known analogy of Swiss cheese, in which the holes in the slices of cheese are thought to represent latent factors, and the accident trajectory is understood to have to traverse all the slices to actually cause harm. To achieve the objective of WebAIRS of preventing the recurrence of incidents, or more specifically to prevent harm from such recurrences, the first step is the timely notification to the members of the danger. After this has been done, an analysis can be undertaken of the system factors and other causes of the event, and of possible ways of dealing with these through actions leading to a change to the established system.

AN EXAMPLE OF AN INCIDENT REPORTED TO WEBAIRS – AND OF A MULTI-PRONGED RESPONSE

WebAIRS enables users to report the details of an incident. Figure 4 shows the data entry screen; the example being entered concerns an incident arising during the infusion of insulin. The data entry pages are navigated using the yellow tabs seen about a quarter of the way down the screen. The yellow tabs are awaiting completion, the grey tab is currently being completed and the tabs turn green once that section is completed. The mainstay of the initial data entry seen below is a narrative section, followed by the user providing a self analysis of what happened and self-coding of the classification of the incident, then the details of the anaesthetic, the procedure, contribution factors and finally a quality assurance section. This report is checked by a data analyst to remove any identifying data such as a patient or hospital name and to ensure that the coding matches the narrative. An analysis committee consisting of peers then scrutinises the incident to check the initial coding and look for root
causes of the problem. The results are then used to construct reports and are recommendations for management included in the web-based management tool.

During an emergency orthopaedic case in an insulin dependent diabetic, the insulin infusion from the ward was running out. A new infusion was prepared by the anaesthetic registrar. I was the anaesthetic specialist supervising the registrar. When I checked the insulin ampoule it was empty. The intended dilution was 2 units per ml and the syringe used was 50 mls, so it was expected that 9 mls would remain in the insulin ampoule as the insulin was 100 units per ml in 10mls. When the registrar was challenged he replied that this was the first time he had made up an insulin infusion and he thought there was 100 units per ampoule so he drew up all 10 mls and added it to the syringe. When he checked the ampoule after this challenge he noted that it did say 100 units/ml 10mls but added that this is really misleading as all other ampoules have the dose per ampoule, not dose per ml. I said this was the exception to the rule but thought I ought to report it as it may be misleading to other junior staff who might not have made up this infusion previously.

This incident was classified as attributable to both a human factor and a systems factor. It was, in fact, one of several incident reports associated with the administration of insulin. It was evident that the label was misread. Although this is a human error, there was a latent factor in the system which probably predisposed to this error. Many (if not most) drugs used in anaesthesia are labelled with the dose shown as the total amount of the drug in the ampoule. For example, midazolam ampoules are labelled as “5mg in 5ml”, which is readily understood as implying 1 mg per ml. Figure 5 shows an image of the insulin ampoule and the box in which it is supplied on the left, and on the right is the hospital-assigned infusion kit.

The insulin label in the image on the left shows the dose as 100IU/ml 10ml (IU is the abbreviation for International Units). Even an experienced practitioner accustomed to seeing the dose as the total amount per ampoule might easily misread this as 100IU per 10mls which would be 10IU/ml. An additional point is that many anaesthetists only occasionally need to make up insulin solutions and a new trainee may never previously have made up this infusion at all. Focussing on the human error might well reduce the chance of the particular trainee making the same mistake again, and it is certainly worth making sure that the lesson has been taken on board. However, failing to address the system factors would set the stage for the same thing to happen in the future to another practitioner, particularly an inexperienced one.

Having identified a risk, there are three possible responses: accept the risk, manage (or mitigate) the risk, or eliminate the risk. Actions to address a risk may be strong (e.g., introducing a change in design, or a forcing function), intermediate (e.g., introducing a process tool such as a checklist), or weak (e.g., providing a warning sign or notification). Whatever is done must be not only possible but practical and affordable. Typically, as in this case, more than one action may be appropriate. The first step in this event was to notify WebAIRS...
anaesthetists by sending them an alert. This is demonstrably a weak action (people often fail to read alerts, or to remember them if they do read them), but it is nevertheless important and has some value.

Addressing the problem with the label would have the potential to be more effective. However, it is unlikely that persuading the manufacturer to change the label will be possible in a reasonable time frame. Writing to the manufacturer about the incident and asking for consideration to be given to solutions including a change in labelling is, important, but in the meantime something local is needed. In this case, at the hospital concerned, a kit is provided by the hospital pharmacy (the image on the right in Figure 5). This involves providing insulin in a prefilled syringe containing 3mls rather than 10 (limiting the potential for overdose) and carrying large, clear labels. The format of the label is 300 units per 3mls and so is in the format normally used by anaesthetists.

This kit has the additional advantage that it contains all the items required to make up the infusion. Normally these items would have to be collected from various drawers in the anaesthetic trolley or the anaesthetic store room, which is time consuming and probably increases the opportunities for error. Simplification of process is generally considered to be a strong action to improve safety. The kit shown in Figure 5 was a pilot kit with hand written labels but the final version will have pre-printed custom labels.

This is not a complete solution because it is, at present, confined to the hospital concerned. Further work is needed to devise a solution that will apply more generally across Australia and New Zealand. The College Document, PS51 (ANZCA PS51 2009) represents an attempt to promote better practice in relation to drug administration in general, but more active promulgation of it is needed, and that too is planned as part of the response to this incident. Advocacy with the manufacturer, as stated above, may in time solve the labelling problem altogether. The communication on this should ideally come from the Presidents of all three parent organisations of ANZTADC, and should be followed up with an emphasis on engagement, discussion and ultimate resolution of the problem rather than necessarily predetermining what the ideal resolution should be from the point of view of the manufacturer.

CONCLUDING COMMENTS

In this WebAIRS case study, we have illustrated how the adoption of incident reporting by anaesthetists can lead to a CAS. We have also outlined the multidisciplinary nature of information systems and the different skills and knowledge needed to develop, secure, introduce and optimise an IT artefact within a professional community. We have shown how the skilled IS practitioner needs to understand and manipulate multifaceted issues and contexts including knowledge management, information and system security, complex adaptive systems, IS appropriation, process management (of critical incidents) and ethics in the creation, use, direction and impact of this system. The vignette regarding insulin dilution demonstrates the potential for IT artefacts such as WebAIRS to save lives by alerting its target community to critical issues leading to the adoption of new processes. Finally, it shows that solutions to problems that occur in anaesthesia are not simple, and that a multi-pronged approach is often needed to genuinely improve safety throughout a region. As with any CAS, the expectation is that the process will be self-improving and that over time the gains in safety for patients undergoing anaesthesia will be substantial. The case also introduces some anaesthetic concepts such as fixation error, human and system factors and critical incident reporting, which may be employed by the IS community to improve user outcomes.

REFERENCES


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