GENERAL INFORMATION

Organising committee:

- Giulio Trillò (Trieste, Italy)
- Vincenzo Lanza (Palermo, Italy)
- Bernhard Pollwein (Munich, Germany)
- Wolfgang Koller (Innsbruck, Austria)
- Geza Nagy (Miskolc, Hungary)
- Keith Ruskin (New Haven, United States)
- Andreas Tecklenburg (Eutin, Germany)

Location:

Congress Centre
Stazione Marittima
Molo Bersaglieri, 3

Meeting Secretariat:

In the hall of the Congress Centre
open from Sept. 21 1.00 p.m. to Sept. 23 12.00 a.m.

Working Lunch:

Friday, September 22 at 1.00 p.m.
Restaurant “Savoy Inn”, Savoia Excelsior Palace Hotel in front of the Congress Centre

Social Dinner:

Friday, September 22 at 8.30 p.m.
Restaurant “Al Granzo”, Piazza Venezia 7, Trieste

Airport:

Trieste Airport “Ronchi dei Legionari”

Transfer Service:

No transfer Service is provided by the organisation.
Bus transfer to the airport starts 90 minutes before the time of departure from the Air terminal near the Railway Station.

Language:

Official language will be English

Shopping hours

8:30-9:00 a.m. to 12:30-1:00 p.m.
3:30-4:00 p.m. to 7:00 to 7:30 p.m.
Some shops may be opened throughout lunchtime.

Local Currency:

Italian Lira (ITL)
1 € = 1936,27 ITL

FINAL PROGRAMME
THURSDAY, SEPTEMBER 21

14.30	Opening of the Conference	Page 5
	A. Tecklenburg, G. Trillò	
14.50	**Session 1 -** Technology: anything new?	
	Chair: MJ Bloom, B. Schwilk	
14.50	Introduction	
	B. Schwilk	
15.10	Transpulmonary (arterial) thermodilution continuous cardiac output and derived variables	
	A. Perel	
15.30	Better hemodynamic monitoring through a monitor-ventilator linkage	
	A. Perel	
15.50	New technology in brain monitoring	Page 6
	M. J. Bloom	
16:10	Patient feedback in sedation and anaesthesia	Page 10
	G. N. C. Kenny	
16.30	Discussion	
16.40	Coffee Break	
17.00	**Session 2** - Free Paper presentation	
	Chair: G. Nagy G, P. Ramaya	
17.00	The interaction between Propofol and Fentanyl during ICU sedation: Effects on EEG variables	Page 54
	M. Doi, S. Sato, G. N. C. Kenny	
17.15	Design and evaluation of an ecological interface and an intelligent alarm concept for the anaesthesia workplace	Page 52
	A. Jungk, B. Thull, G. Rau	
17.30	Target Controlled Infusion (TCI) using The "Visualtci" program software.	Page 56
	F. La Mura, F. Cavaliere, M. Pennisi, C. Scarfini	
17.45	Using a Bayesian Belief Network to model interaction of remifentanil and propofol on wakeup time	Page 67
	Ulrich Bothner, Stefan Schraag, Gavin N. Kenny	
18.00	Development and evaluation of a PC-based program for rapid bedside calculation of ten severity scores in the ICU	Page 61
	A. Nierhaus, B. Montag, D. Frings, G.G. Schneider, I. Nielsen, J. Schulte Am Esch	
18.15	Agent based theatre management	Page 63
	M. Sedlmayr, H. Knublauch, T. Rose	
18.30	Non-Invasive estimation of pulmonary gas exchange parameters in 10-15 minutes	Page 65
	S.E. Rees, S. Kjærgaard, P. Thorgaard, E. Toft, S. Andreassen	
18.45	End of session	

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08.30	**Session 3** - Free Paper Presentation *Chair: R Hagenow, G. Trillò*	
08.30	A Micro-Fluid system for accurate drug administration *N. Lutter, M. Richter, B. Kozma, J. Schuettler*	Page 57
08.45	Performance of third-generation pulse oximeters during recovery from anesthesia *N. Lutter, E. Kozma, S. Kroeber, J. Schuettler*	Page 59
09.00	Data import into a patient data management system *M. Benson, A. Michel, A. Junger, C. Fuchs, L. Quinzio, D. Brammen, K. Marquardt, G. Hempelmann*	Page 69
09.15	Differences between manual and automated data collection of vital signs with an Anaesthesia Information Management System (AIMS) *A. Junger, M. Benson, D. Brammen, A. Michel, G. Sciuk, K. Marquardt, G. Hempelmann*	Page 71
09.30	Aspects of user acceptance of patient data management systems (PDMS) *L. Quinzio, A. Junger, M. Benson, D. Brammen, A. Michel, K. Marquardt, G. Hempelmann*	Page 73
09:45	Coffee break	
10.00	**Session 4** - Internet and Intranet *Chair: V. Lanza, K. Ruskin*	
10.00	Finding information on the Internet *R. Hagenow*	Page 14
10.20	Data acquisition, record keeping, remote anaesthesia *V. Lanza*	Page 16
10.40	The videoconference as an instrument of continuous quality improvement (CQI) in a department of Anaesthesia and Intensive Care *L. Guglielmo, V. Lanza*	Page 19
11.00	Electronic Signature *G. Nagy*	Page 22
11.20	Telemedicine Extensions to the Electronic Patient Record *P. Ramaya*	Page 23
11.40	The role of the Internet in medical education *K. Ruskin*	Page 25
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16.20	Optimising Work Processes by PACS (Picture Archiving and Communication System) - a Clinical Evaluation *H. Sander, I. Marsolek, W. Friesdorf, S. Peer, W. Jaschke, W. Koller,, N. Mutz, D. Pappert, J. Hierholzer*	Page 38
16.40	Usability of intensive care information systems: have we found the silver bullet yet? H.-J. Popp, G. Wagener, A. Prause, H.-W. Bause	Page 40
17.00	**ESCTAIC General Meeting**	
19.00	Gala Dinner	

SATURDAY, SEPTEMBER 23

09.00	**Session 7** - Patient Data Management Systems (PDMS) *Chair: B. Pollwein , G. Trillò*	
09.00	Is anybody using a PDMS out there? *G. Trillò*	
09.20	Configuring the anaesthesia LAN as a Intranet *V. Lanza*	Page 42
09.50	PDMS in ICU: the UCSC experience using DIGISTAT *R. Maviglia, M. A. Pennisi, F. Cavaliere*	Page 46
10.10	The business of anesthesia is changing, Agilent Technologies Clinical Information Systems Solutions helps you to take control. *A. Bonalumi*	Page 48
10.30	Artificial Intelligence in Clinical Information Systems *M. Hurrel*	
10.50	Discussion	
11.15	Closing of the Conference	

INTRODUCTION TO THE CONFERENCE

Dr. Andreas Tecklenburg

Chairman of ESCTAIC

Dear Friends of ESCTAIC,

Welcome to our 11th meeting here in Trieste. We are the second time in Italy and I am very thankful to our host Giulio Trillò, who organised our meeting.

It is more and more difficult to have such meetings. The financial budgets in the health care community decrease from year to year. So do the budgets from the industry to support such meetings. We thank all participating companies in making it possible to support our meeting.

Again we have friends from all over the world here in Italy. Thank you for coming. I am sure we all again will have interesting discussions and an excellent information exchange.

NEW TECHNOLOGY IN BRAIN MONITORING

Marc J Bloom MD PhD

Director of Neuroanaesthesia and Neurophysiology Programs
NYU Medical Center

Technologies

Many new technologies have emerged to enhance our ability to monitor the brain. Among them are new advanced processing systems for EEG and evoked potentials, BIS monitors to assess the sedative effects of drugs, TCD to measure flow velocity in major cerebral vessels, Precordial Doppler to detect air embolism, Jugular Venous Catheters to measure $SjvO_2$, Cerebral Oximetry, and Xenon CT scans.

EEG & Evoked Potentials

Continuing developments in electrophysiologic monitoring have lead to improvements in the detection of cerebral ischemia or injury, leading to earlier intervention, and allowing for better assessment of therapy.

Quantitative methods provide a guide to ‘protection measures’.

Motor Evoked Potential Techniques

In particular, new techniques are emerging to monitor the integrity of the Cortico-spinal motor system.

MEP Methods

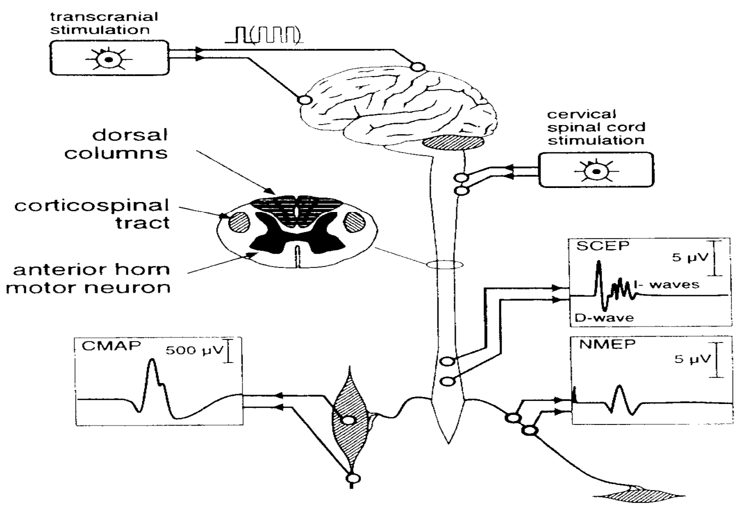
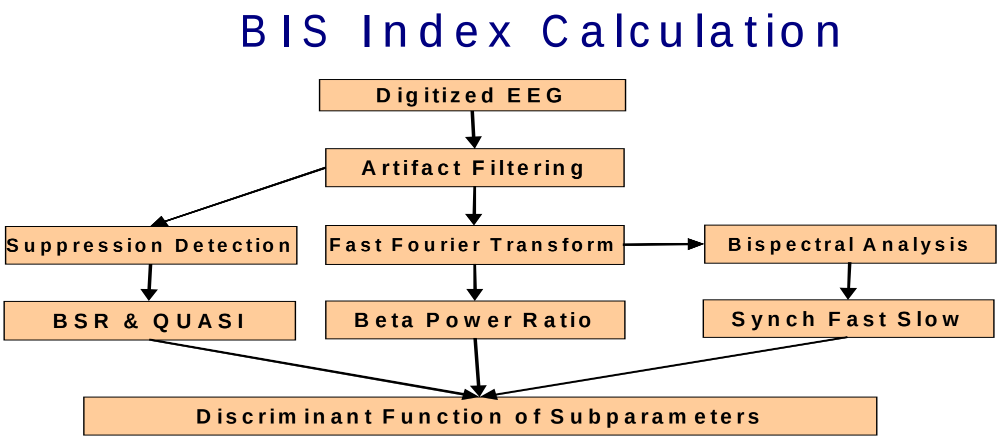


Figure 2: Equipment and electrode positions for motor evoked potential monitoring.
SCEP: Spinal cord evoked potential; NMEP: Neurogenic motor evoked potential; CMAP: Compound muscle action potential.

These techniques use three ways to stimulate the motor tracts: TransCranial Electrical Stimulation (TCES), magnetic stimulation, or direct spinal cord stimulation. The responses to that stimulation are measured as either epidural Compound Action Potentials or, more commonly, peripheral EMG recording.

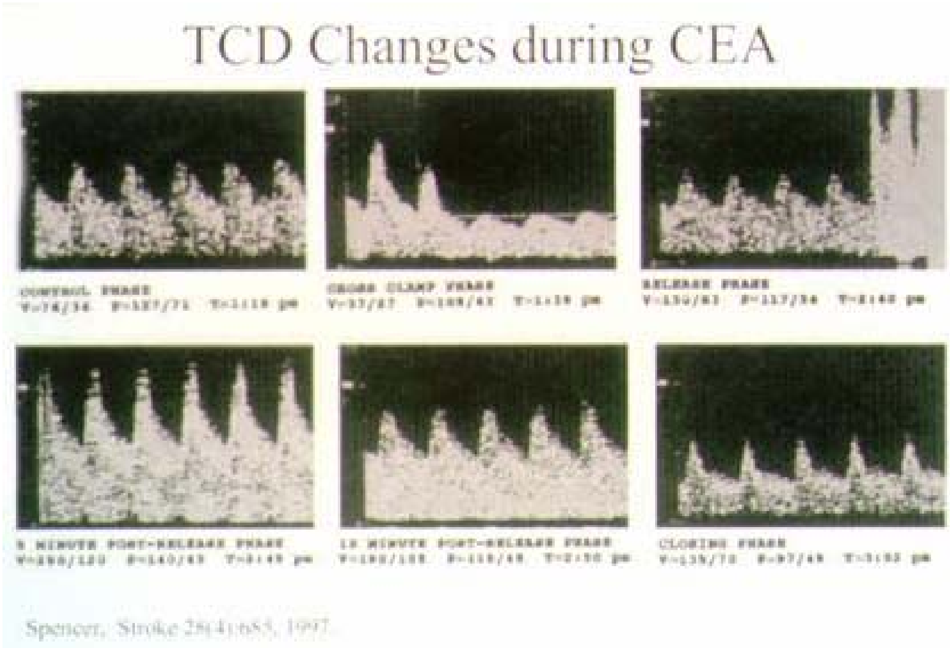
BIS Index

Acceptance continues to grow for the BIS index, an EEG-derived measure of sedative drug effect, calculated by a unique commercial instrument. Use of this technology allows an anaesthesiologist to apply individualised pharmacodynamics for each patient. This helps to determine the lower drug needs of neurologically obtunded patients. On the other hand, some patients may have higher drug needs if their enzyme systems have been induced by drugs such as anti-seizure medications. BIS monitoring also facilitates the rapid assessment of neurologic status at end of surgery. Investigations are ongoing on the conditions that modify or limit the reliability of this technology.



TransCranial Doppler (TCD)

Another technology that continues to develop is transcranial Doppler measurement of cerebral blood flow velocity and the detection of emboli. This technology is finding application in the assessment of vasospasm and in the qualitative comparisons of cerebral blood flow before and after interventions. Transcranial Doppler technology has several limitations. It is not always possible to obtain a reliable TCD signal due to anatomical variations. The TCD



measures velocity, not actual flow making interpretation problematic. Nonetheless, TCD effectively detects emboli in cerebral vessels during carotid endarterectomy and cardiopulmonary bypass procedures. It also shows distinct high velocity patterns in the presence of cerebral vasospasm after subarachnoid haemorrhage. TCD has also been used to assess the degree of vertebro-basilar insufficiency. Significant elevations of intracranial pressure produce a characteristic pattern in TCD showing reduction or elimination of diastolic velocity. In any case, one of the strongest advantages of TCD is that it is completely non-invasive and can be repeated often to allow immediate assessment of therapy.

Precordial Doppler

Precordial Doppler monitoring has been in use for many years. It is a sensitive and early detector of venous air embolism. It is also non-invasive and can be rapidly applied. New technologies are being applied to automate analysis that can quantitate air volume and distinguish between air and particulate emboli.

Jugular Venous Bulb O_2 Saturation

Oxygen saturation of venous outflow from the brain can be measured with a catheter placed in the Jugular bulb. This measurement assesses the balance of supply and demand for oxygen in the brain. When this balance is disturbed by conditions such as elevated intracranial pressure, $S_{jv}O_2$ can be used to assess the improvement in perfusion produced by ICP therapy. It may also be useful to evaluate the effects of hyperventilation on cerebral perfusion. Jugular Bulb Venous Saturation ($S_{jv}O_2$) is usually done by intermittent venous blood gas sampling, but new solid-state technology now makes continuous monitoring possible. The most significant limitation to its use is that the placement is technically demanding.

Near Infra-red Spectroscopy Cerebral Oximetry

Several new instruments use emitters and detectors of near infrared light, sealed onto the skull to measure the oxygen saturation of tissues several centimetres beneath. While it is still not clear exactly which tissues are being sampled and the relative contributions of arterial and venous blood saturation, the measurement appears to be a sensitive detector of regional ischemia in the limited sample volume under the probe. The technology is completely non-invasive, but its placement is limited by the need to seal out light, which cannot be done over hair. Near Infrared Spectroscopy has been used to detect $CO_{2\ reactivity}$ similarly to techniques employing TCD. NIRS oximetry is also being investigated as a possible non-invasive alternative to $S_{jv}O_{2.}$

Xe CT for CBF

The ability of Xenon gas to absorb X-radiation has been exploited to produce a new technology in Computed Axial Tomography (CAT) scanning to produced high regional resolution images of cerebral blood flow. The high resolution images allow the detection of small localised areas of hyper- and hypo- perfusion. This technology has been shown to be useful to evaluate hyperventilation in Closed Head Injury. The Xenon CT Scan of CBF has the highest resolution of any flow measurement, but is the patient must be able to breath less than 60% oxygen and must be taken to the CT scanner. These requirements may be problematic for severely injured patients.

Summary

New technologies and enhancements to old technologies are giving us new tool to monitor the brain and assess the effectiveness of therapies. While these technologies show great promise, their reliability and applicability to specific pathologic conditions still need to be refined.

PATIENT FEEDBACK IN SEDATION AND ANAESTHESIA

Gavin NC Kenny, BSc(Hons), MB ChB, MD, FRCA, FANZCA

Professor and Head of Department,
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The aim of sedation during regional anaesthesia is to permit the patient to tolerate the procedure with minimal anxiety and discomfort. Safety must not be compromised and the patient must remain responsive to commands. An ideal sedative technique should produce a rapid and smooth onset of action with easy control of the level and duration of sedation. There should be a wide therapeutic ratio with minimal cardiorespiratory depression.

Sedation allows patients to undergo procedures, which they would otherwise be unable to tolerate. The sedation must not contribute any morbidity or mortality to the procedure and ideally should be safe when used by surgeons and physicians as well as anaesthetists. The technique used must allow for rapid alterations in the level of sedation. It should allow the patients to recover rapidly full consciousness without rebound or emergence effects at the end of the procedure to ensure that they are in a safe condition for discharge from the recovery area.

Benzodiazepines tend to have prolonged duration of action and even Midazolam may have prolonged effects. Intravenous anaesthetic agents have been used successfully to provide sedation but the withdrawal of many of these agents has left Propofol as the sole representative of this type of drug. The pharmacokinetic properties and the recovery characteristics of Propofol have encouraged its use for sedation.

Sedation with Target-Controlled Infusions

Propofol is often administered by a continuous infusion but it is difficult to predict the changes in blood concentration and therefore the effect achieved. A solution to the problem of attaining adequate sedation rapidly with minimal risk of under or over dosing is to use a target-controlled infusion (TCI) of Propofol. The first use of TCI for sedation using Propofol was reported in 1991. [1] This study reported 20 patients with a mean age of 52 years undergoing upper gastrointestinal endoscopy. The median blood concentration of Propofol for insertion of the endoscope was 2.5 µg.ml-1 (range 1.5 to 4.0 µg.ml-1). Conditions for endoscopy were good in 15 patients and fair in the remaining 5. Patient co-operation was good in 16 patients and fair in 4. There was a significant reduction in SpO_2 during the procedure from a mean of 94.2% to 89.3%.

Satisfactory sedation was reported with TCI Propofol in patients undergoing orthopaedic procedures under regional blockade.[2] The median blood Propofol concentration required was 0.93 µg.ml-1 (range 0.15 to 2.63 µg.ml-1). The decreased dose in this study compared with the endoscopy study illustrates the effect of adequate analgesia on sedation requirements. The patients in the regional block study spent 88% of the time at a satisfactory level of sedation with sedation scores of 3 or 4. Undesirable oversedation occurred for an average of 2.5% of the total time and was quickly reversed by selecting a lower target concentration.

TCI propofol sedation has been used satisfactorily for 21 hours in a patient undergoing gynaecological radiotherapy. [3] Oversedation was not reported although the patient required assisted ventilation by mask for 5 minutes following the administration of 0.75 mg of Alfentanil. Assessment of snoring has been undertaken using TCI Propofol sedation.[4] Patients were sedated until they began to snore and the degree of airway obstruction was then assessed by nasal endoscopy. The technique could reliably produce snoring in the 25 patients studied.

Patient-Controlled Sedation

Sedative medication has usually been provided by the physician, often delivering single doses or adjusting a continuous infusion of the drug. However, patient-controlled analgesia (PCA) is a well-recognised technique for pain control and patient-controlled sedation (PCS) has been described as a valuable technique for sedation. With this technique, the patient uses a device similar to a PCA system to self-administer single doses of a sedative.[5] In most of the studies which have compared patient-controlled sedation using Propofol or Midazolam, Propofol has been reported to produce a more rapid onset of sedation with faster return to normal following the procedure.[6;7]

Patient-Maintained Sedation

Patient-maintained sedation (PMS) allows the patient to control the target concentration of Propofol using a button push. A study of this technique during surgery suggests that it provides rapid, safe and effective relief of anxiety.[8] The efficacy and safety PMS was assessed also in 20 patients scheduled to undergo day case anaesthesia.[9] They controlled TCI Propofol to provide anxiolytic premedication. A target-controlled infusion of Propofol was started at 1 μgml^{-1} and the patient allowed to increase the target by 0.2 μgml^{-1} by operating a control button. There was a lockout time of 2 minutes and a maximum target concentration allowed of 3 μgml^{-1}. There were highly significant reductions in anxiety scores from presedation levels at 15 minutes post sedation which were remained low until induction. Median target concentration of propofol varied from 1.0-1.2 μgml^{-1}. No patients became oversedated and all remained cardiovascularily stable. Two older patients required low dose supplementary oxygen for mild arterial oxygen desaturation but there were no instances of airway obstruction. Patient satisfaction with the system was high.

Patient Feedback in Anaesthesia

We all practice anaesthesia but as yet we have no specific method by which the level of anaesthesia can be assessed. Some would maintain that anaesthesia is an all-or-none phenomenon and that there is no gradation. Others would support the view that, while the loss of consciousness may well be a single transition, different levels of the subsequent state of anaesthesia allow different levels of responsiveness following stimulation of the patient.

Closed-Loop Anaesthesia

The ultimate proof for a measure of anaesthetic depth is that it should be capable of controlling automatically the delivery of an anaesthetic agent to produce satisfactory anaesthesia in a patient breathing spontaneously during surgery. Closed-loop anaesthesia (CLAN) systems have been developed using blood pressure[10] or median frequency of the compressed spectral array.[11] However, these CLAN systems have only been used in paralysed patients during surgery and required intervention often because of unsatisfactory conditions. A system based on the bispectral index has been reported to have successfully controlled the level of sedation in 10 patients during spinal anaesthesia for elective orthopaedic surgery. [12]

A closed-loop control system based on the auditory evoked response has been used to control the intravenous administration of Propofol in patients breathing spontaneously and also in those who received paralysing drugs during surgery.[13;14] The quality of anaesthesia was judged to be satisfactory as assessed by scores of autonomic activity, cardiovascular stability and minimal movement during surgery. Patients were visited postoperatively and there was no occurrence of awareness during the surgical procedures in any patient.

Hypnosis and Analgesia

CLAN techniques have demonstrated the interdependence of hypnosis, analgesia and stimulation and have illustrated that there is no single concentration of an anaesthetic agent, which results in satisfactory anaesthesia for all patients. Indeed within individual patients, the requirements for anaesthetic vary considerably depending on the degree of surgical stimulation and the quality of analgesia provided at any point in time.

Relatively high concentrations of a hypnotic agent are required when a low dose analgesic technique is used. When a high concentration of analgesic is administered, smaller doses of hypnotic are then required to maintain satisfactory. This is shown most clearly when patients have good premedication and a fully functioning local block in place. In this situation, the requirements for anaesthetic can be reduced to very low values.

Conclusions

With more procedures being undertaken using minimally invasive surgical techniques, there will be increased requirements for conscious sedation. The techniques we employ must be safe and efficacious and may be directed towards allowing the patient to participate more in the drug delivery.

The requirements for a depth of anaesthesia monitor are summarised in the table. We can expect considerable progress in the developments of systems to provide some estimates of the depth of anaesthesia. It is clear, however, that anaesthetists must attempt to define the state of anaesthesia and lay down conditions which these devices must meet.[15]

Table. Requirements of Depth of Anaesthesia Monitor

- similar values for different anaesthetic agents at equipotent doses
- alter its signal appropriately during surgical stimulation
- similar value at induction of anaesthesia to that recorded at recovery
- unaffected by temperature, cardioactive drugs, hypotension or tachycardia
- obvious transition from consciousness to unconsciousness and vice versa with no recall for events during anaesthesia
- able to provide satisfactory anaesthesia by closed-loop control in patients breathing spontaneously during surgery

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FINDING INFORMATION ON THE INTERNET

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Rotterdam, The Netherlands

Finding relevant information on the Internet is possibly the most daunting task an Internet user can undertake. As each new user haphazardly finds his way around the Internet he usually settles on a few key resources and/or search sites early on, and charts the Internet from those key sites. The obvious disadvantage of this strategy is the inherently limited view and the potential large body information hidden from sight.

Indexing and search sites have been around since the beginning of the World Wide Web. They basically come in 2 flavors: content driven or editorial board driven.

The content driven indexing sites scan documents for key words. The main differences between these sites are the number of pages referenced, the 'refresh rate', and the definition and nature of these keywords. Some, like AltaVista and Google, consider all but the most trivial words to be keywords. They also claim the highest number of pages indexed: AltaVista claims 250.000.000, Google more than 1.000.000.000, of which 170.000 are indicated to be related to Anesthesiology (!). These astounding numbers point us to be obvious shortcomings of these sites. As the indexing is largely an automated, albeit smart, process, web authors can influence their rankings by adding more keywords on each page. These keywords need not even be visible to the viewer. As a result, especially the simple searches tend to yield a large number of links with limited usability.

The editorial board driven sites, such as Yahoo and about.com, try to grade sites as to their usefulness. Though this results in fewer and more usable links, the drawbacks are equally obvious: there is an unavoidable editorial bias and these sites typically list less than 1% of the Internet.

Some sites, seeing these limitations, have sought to use additional techniques to enhance the usability of the returned links. Directhit, for instance, tries to monitor which link a searcher selects, and how long he/she stays at that site, and re-ranks it's returned lists accordingly.

Another index site, FindWhat, blandly asks for money, to be collected at 'click through'. It then lists how much money they're getting for the link (the links ar in order of revenue) and has an automated auction engine where web site authors can change the amount they're paying on the fly to change their relative listing.

Medical Information is prominently present on the Internet, and Anesthesiology is well represented. All index sites carry medical sections under the 'health' keyword. Their quality is rather mixed, with about.com providing one of the better listings.

Finding the references to scientific medical articles on the Internet is easy (for once). Medline searches are available at several places. Most of them are free, and the quality of the ones that charge fees is not any higher than the free sites. The most prominent Medline search engine on the Internet is PubMed, run by the American National Institute of Health.

However, once you've found your references, getting the actual articles is rather more difficult. Although the number of Medical journals on the Internet increases quite rapidly, their usability varies greatly as each is basically an experiment by the publisher as how to make money in a world where information is no longer restricted to paper. PubMed also teams up with Loansome Doc, which will deliver a printed copy of the article you asked for (for a fee).

An excellent overview of medical journals, including Anesthesiology and Intensive Care on the Internet may be found at

http://www.sciencekomm.at/journals/medicine/med-bio.html

The full text of this talk, with 'click through' links (at no fee) can be found at:

http://www.gasnet.org/about/staff/hagenouw/trieste2000.html

DATA ACQUISITION, RECORD KEEPING, REMOTE ANESTHESIA

Vincenzo Lanza

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Despite the advantages of automated record keeping, few institutions have adopted its use. Most systems currently in use are an extension of operating room monitoring equipment, and record only vital signs and narrative comments, and do not include information such as a record of the preoperative visit or postoperative printed orders to give to the ward.

The Anaesthetic Workgroup concept

The modern office is the clearest example of how removing repetitive activities improves productivity. Organisations are discovering that computing technology can be used for many applications such as customer support and communication between a group of employees. The term *workgroup* is used to indicate a group of employees that use a network to perform routine tasks. Networked workgroups are popular because they provide an organised way for individuals to share information and ideas with others. Internet implemented the workgroup activities with new software tools (like videoconference, chat, Web server) and opening the transcontinental hospital communications. Using the workgroup technologies the anaesthesia staff is able to control completely the anaesthesia information allowing the anaesthesiologist to have a complete file of the patient and on-line support from other anaesthesia departments.

How to build an Anaesthetic Workgroup

A model of an Anaesthetic Workgroup (AW) is running in the Buccheri La Ferla Hospital from 1986 (1). The model is updated as computer technologies advance. The activity of the AW is planned in 6 steps:

1. Computerised surgery list

The O.R. chief nurse compiles the surgery list utilising the surgery ward advice.

A network connection to the hospital information system allows automatic retrieval of demographic information and permits a unique patient identification. The list is uploaded to anaesthesia network.

2. Preoperative visit

The anaesthesiologist retrieves the surgery list from the anaesthesia network. The anaesthesia software builds the preoperative patient record and checks to determine the existence of a previous anaesthetic record. If one is located, it is added to the new record. The preoperative patient record is transferred to a diskette so the anaesthesiologist can add preoperative data at patient bedside using a laptop computer. After the preoperative data are collected the anaesthesiologist transfers the collected preoperative visit forms to the anaesthesia network by using the floppy diskette at a network desktop computer. A printed surgery list with the anaesthesia advice for the scheduled patients is given to the ward.

3. Day of surgery

On the day of surgery the anaesthesia nurse retrieves the scheduled patient files from the network, prints the surgery list with the preoperative patient's form and calls for the scheduled patients. All the patient treatments performed out of the OR (premedication, venous cannulation, etc.) are entered on-line using a network desktop computer.

4. Data entry and trend collection in OR

In OR the anaesthesiologist enters the procedures and the drugs administered to the patient. The computer in OR, connected to the patient monitoring system by a serial port, provides automatic physiologic data collection and storage. The PC can display the anaesthesia record, data trends, the OR schedule, and by querying the network, anaesthetics in progress in other locations. The same tasks can be performed from a PC in locations outside the OR (*e.g.*, in the recovery room or in the administrative offices) so that any given room can be monitored from a centralised location.

5.Recovery room

The recovery room nurse enters medications given and procedures performed. When the patient is ready to be discharged to the floor, the nurse prints out the postoperative orders that are entered from the anaesthesiologists, using the OR computers.

- The anaesthesiologist on duty enters the 24-hour postoperative report.

Network facilities for the AW.

All anaesthesia activity is monitored on-line. From any computer, including the head anaesthetist’s office, it is possible to determine the status of all anaesthetic procedures. On the computer screen, the status of the case (scheduled or emergency, premedicated, surgery on-going, patient in recovery, discharged) is represented with a characteristic easily distinguished face-like icon (fig.1). All patients trend can be also displayed and analysed. The system uses all the features of telecommuting:

1)Telework

An supervisor anaesthesiologist from home may check the activity status, correct postoperative orders chatting with the anaesthesiologist on duty at same time.

2) Expert remote consultations

An expert may access the system from anywhere, using the INTERNET. During anaesthesia the anaesthetic workgroup can receive support from an expert that by its computer is able to display on-line the trend and the anaesthetic data of the patient currently treated. Videoconference is also supported.

Anesthesia network configuration

10 anaesthesia workstations and 2 portable PCs are used in the B.L.F.H. anaesthesia department. The 10 workstations are networked by an Ethernet LAN (10 Mbytes). The workstation computers are Pentium 300 MHz 64 MB RAM models. The data server computer has a 4GB disk.

Seven workstations are placed in the operating rooms. The others are in the recovery room and the departmental chief's office. Any of the PC workstations are able to display a complete anaesthesia form and to retrieve the patient's heart rate, blood pressures, CO_2, oxygen saturation trends with updates every minute.

The network is running Windows 98 on the client computers and Windows NT on the server.

The network using a TCP/IP protocol is configured as an INTRANET connected via a router to INTERNET

Symantec pcAnywhere software is used for telecommuting.

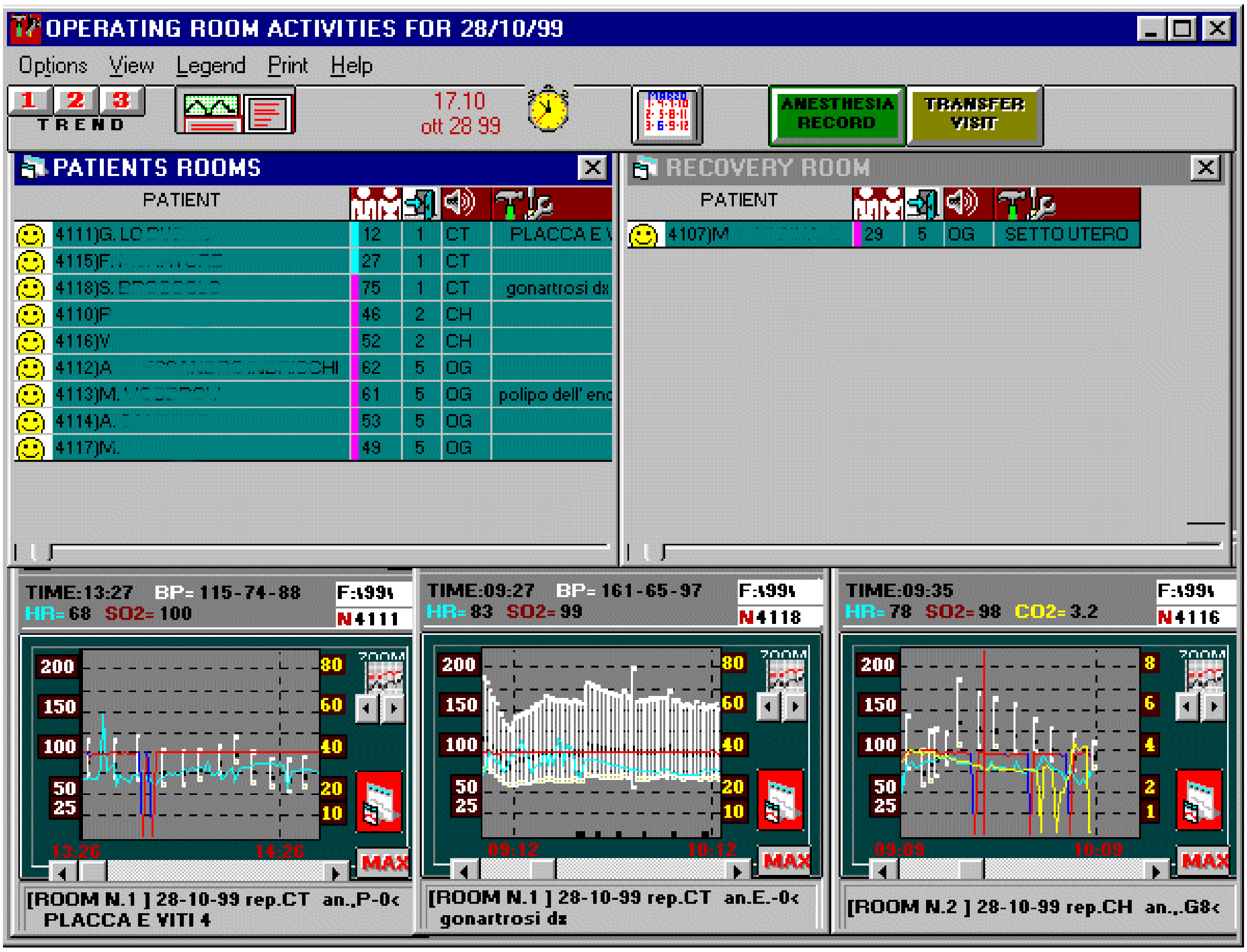

Fig.1. Control panel of anaesthesia procedures. The patients names have been erased

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THE VIDEOCONFERENCE AS AN INSTRUMENT OF CONTINUOUS QUALITY IMPROVEMENT (CQI) IN A DEPARTMENT OF ANESTHESIA AND INTENSIVE CARE

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Introduction

The continuous quality improvement (CQI) in the health field depends on updating the frequency of medical team clinical knowledge. The common method used to update knowledge is the medical staff meeting. However the diffusion of communication and information does not always satisfactorily and effectively reach every single operator (i.e. at the same time engaged in another activity or not particularly attracted by the expressive form of a conference, etc.).

The latest improvements in desktop videoconferencing technology and telecommunication, allow small working groups to deliver interactive seminars to a remote audience by using this communication tool (1) .

Therefore, in this study we made use of videoconferencing (VC) technology during a cycle of refresher meetings to verify the practicality of usage and the effectiveness to update the anaesthetic knowledge .

Methods

We compared a cycle of 10 monthly refresher meetings of the Department of Anaesthesia, presented in a traditional course (TC), i.e. held in a conference room and open to all the medical staff (medical doctors and nurses), vs a cycle of 10 monthly meetings made with a videoconferencing computer camera (VCC) that also provided the transmission of the meeting to three other working units (ICU, OR, OR in the obstetric department) outside the conference hall.

The VC system was a Matrox mystique video capture card connected to a Sony DCR TRV9E camera in the room of meeting and a Connectix Quickcam in the peripheral PCs. All the computers used were powered with Intel Pentium II 300 Mhz processor. The videoconference sessions were divided in 2 parts:

1) The presentation, 2) The discussion

The presentation

The computer screen was displayed to a big screen by using a Polaroid computer projector. The screen was captured with the voice speaker by the digital camera and the frames were streamed by using the Microsoft Windows Media Encoder software. The output from Windows Media Encoder was sent to a Windows NT computer running a Windows Media server for multicasting and storage. The participants were able to join the videoconference by using stream of information that were heard and viewed with Microsoft Windows Media Player software running at peripheral PCs of the network. During the presentation session the participants were not able to enter the videoconference in a interactive way that is to speak with the speaker. The videoconference was also stored on the server as on demand clip so the anaesthesiologists were able to see the presentation again when they want.

2) The discussion

After the presentation the Windows Media Encoder was stopped and Microsoft NetMeeting software was launched on the speaker computer as well as on the peripheral PCs. The participants were able to have a discussion with the speaker.

The presentation of the meeting in both ways was carried out by one of the members of the Anaesthesia Department, with the aid of a personal computer., with a presentation carried out with Power Point or Internet Explorer. The exposition length, as a rule, was expected to last 60 min. and the discussion started only at the end of the exposition. An external observer (with no knowledge of the study) counted the number of the internal and the external (in the case of VC) participants of the meeting, the number of the interventions at the end of the exposition and the length of the conference. To verify the participants understanding of the scientific information, a multiple-choice test (Qs), (20 questions concerning topics discussed during the meeting), was given to all department components (even to those not present for the conference) after a week. Another test (Qt), containing questions concerning the effectiveness of VC as a technical means was assigned to the external attendants. In this case the answers were graduated in a 5 point scale (1=not effective, 5=very effective). Data expressed as a media + S.D. and were statistically compared using the T student Test.

Results

The number of attendants to the refresher meeting was 9 $\pm$ 0.94 in the TC whereas it was 13.20 $\pm$ 1.32 in the VCC ($p<0.05$) (fig.1). The duration of the meeting was 63 $\pm$ 9.49 min. in the TC and 82.50 $\pm$ 9.20 min in the VCC ($p<0.05$). The number of interventions at the end of the exposition was 2$\pm$ 0.94 in TC and 4.1 $\pm$ 1.20 in VCC ($p<0.05$). Analysis of the answers to the Qs showed a percentage of 66.5% $\pm$ 10.29 correct answers in the TC and 80 $\pm$ 8.16 in the VCC. In the Qt medium the score was 3.6$\pm$1.07.

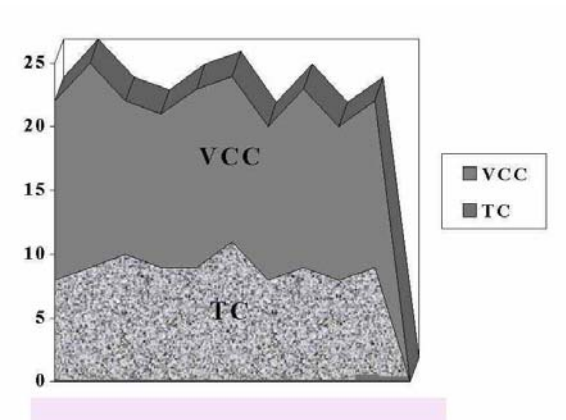

Fig.1 The number of attendants at conferences

Discussion

Current technology has set up telecast techniques with personal computing and low cost technologies that have certainly increased informative and cognitive possibilities. The system of telecommunication (telemedicine) and videoconferencing have also been used in the medical field (2) as a long term back up system and can spread the participation of operators in the process of cultural updating.

The results of this study show, in fact, an increased number of attendants and intervention in the course of the refresher meetings during VCC compared with the traditional meeting cycle.

Anaesthesiologists and nurses engaged in other activities elsewhere could in fact follow and participate in the conference, by using a computer present in the working area.

The video transmission was acceptable and comprehensive as is shown by the multiple choice test answers given by the attendants to the VC meeting. Furthermore this system was particularly appreciated by those shy operators who participated more easily in the discussion when they were in front of a video rather than in the actual meeting room.

The use of the VC system with educational and interactive learning purposes however requires minimum practical training and guidelines (style, length, intervention rules) by whoever leads the VC if he wants his communication to be effective and to help the audience. This is a positive fact because it accustoms the speaker in to taking possession of a simple and synthetic scientific language and to expose his presentation clearly.

Moreover it helps in the collecting of scientific documentation which can be easily utilised and reproduced for popularising aims.

Conclusion

The CQI culture is also formed by means of the improvement of scientific and technical knowledge. The videoconference system can contribute in improving the effectiveness and the quality of anaesthetic meetings.

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ELECTRONIC SIGNATURE

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Introduction

The paper-based word of humanity has grown to huge dimensions continuously in last century. The expectations for solving this problem are obvious. Nowadays we use regularly a large number of electronic documents, which are letters contracts photographs etc. and this documents are generated or stored on the computer.

The word is open with the help of NET and in this way the other applications are connected to electronic environment e.g. e commerce and e mails and information flow on the Internet etc. In this circumstance the safety and personal rights are essential. The dark side of the NET is exists and the solution against this side is electronic signature.

Description

Throughout the presentation the author will explain the details following next steps:

- How digital signature technology works
- What are the digital signature creation and digital signature verification
- What are the public key and private key
- What does a digital signature look like?
- Some FAQ

After acquisition of the information structure of the digital signature the steps of simulated message sending will be demonstrated on slides.

In the final part of the presentation the author will present the actual status of the digital signature in the USA and the EU (as a EU Community framework for electronic signatures).

TELEMEDICINE EXTENSIONS TO THE ELECTRONIC PATIENT RECORD

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It is almost a decade since the Institute of Medicine first issued its report, ‘The Computer-Based Patient Record: An Essential Technology for Healthcare’ (National Academy Press, 1991). The report stated that “Computer-based Patient Records (CPRs) and CPR systems have a unique potential to improve the care of both individual patients and populations and, concurrently, to reduce waste through continuous quality improvements”.

Since the publication of this report there have been many changes in Healthcare and its delivery. The changing demographics of the population are placing greater direct demands on health care providers and indirect demands on their information capabilities. The increasing volume of data collected and the continued growth of medical knowledge have created a dramatic need for information technology to address not only the task of collating and sorting this information, but also of assessing the strength of the evidence, which must be brought to practitioners whenever they need it, most especially when they are making decisions on clinical care.

At the same time there has been an exponential increase in power and capacity of personal computers and comparable improvements in peripheral devices with the result that powerful workstations are now more affordable. Dramatic strides in computer technology have been accompanied by the massive growth of the Internet, linking individuals to information resources around the world.

The need for more effective delivery of healthcare allied to the perceived need to exploit advances in telecommunications, prompted the World Health Organisation (WHO) to publish a report in 1997 entitled ‘Impact of telecommunications in health-care and other social services’ which stated “Integration is the key to effective delivery of care. There cannot be high-technology hospitals in every part of every country, and with telemedicine links there does not need to be. Instead a tier system should be created, with established links between the various levels of the health services, with the peripheral health units seeing the majority of cases and the feeding through to district-level hospitals, which in turn can refer patients to more specialised centres if need be.”

Although, the case for Electronic Patient Records (EPRs) is stronger today than it was 10 years ago, it is clear that modifications have to be made to the original vision of the EPR. Current trends in health care delivery, management and research indicate that EPRs must seek to address two main functions, population-based management of health through computer-based population records and citizen-based management of health through another variant of the EPR - the computer-based personal health record. First, EPRs will play an increasingly important role in supplying data for computer-based population databases. Second, as people continue to become more active consumers of health care and assume greater responsibility for managing their own health, and as information technology becomes available in more homes, individuals will increasingly use elements of the EPR and EPR-related technology to search through the health literature, communicate with their health care professionals, access data on their health care history and manage chronic conditions.

A key factor in determining the success of an EPR will be the extent to which it enables effective communication between the main stakeholders – patients and clinicians. Extending its functionality by the incorporation of Telemedicine technologies is the logical way ahead.

THE ROLE OF THE INTERNET IN MEDICAL EDUCATION

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The Internet can improve the process of medical education, and ultimately, medical decision-making by providing access to high-quality resources and support systems that might otherwise be unavailable. Moreover, the growing use of the Internet for medical education provides new abilities to study the ways in which physicians use information. The Internet is growing at a rapid rate, and new resources, which offer new ways to learn and to communicate, are added almost daily. Medical Internet resources now number in the thousands, and anaesthesiologists routinely use the Internet to exchange information between institutions and across time zones and international boundaries.

Educational Technology

The Internet offers innovative ways to develop new educational programs and to evaluate the information needs of practising physicians. The practice of medicine requires a broad base of knowledge that encompasses theoretical and practical information as well as a variety of manual skills. Although didactic teaching, lectures, journal articles, and textbooks are used most commonly to transfer this information, some ideas may best be conveyed by other means. Electronic publications use video, sounds, and pictures to present some ideas (*e.g.*, subtle anatomic relationships) that may be difficult to convey with printed text. Publication on the Internet offers the added advantages that information can be distributed world-wide and can be easily and rapidly updated to reflect the state of the art.

Electronic publication may help to solve at least one problem facing developers of educational programs for physicians. Physicians may not recognise all of their information needs. Although educational researchers have developed electronic information systems that attempt to solve this problem, very few ever progress beyond the demonstration phase. One possible reason for this is that physicians use information differently than many other groups of people. Because they must convert theoretical information into a series of tasks, simply presenting a list of facts may not be helpful. Moreover, non-physicians, who may not understand how a physician approaches a given problem, often design these systems. For this reason, accurate models of how physicians use information are necessary to ensure continued use of information systems.

The information collected by Web servers and other Internet resources can help teachers to develop better educational materials because Internet users frequently “browse” for information when they recognise a need, but cannot precisely identify it. By analysing log files of a medical Internet resource, for example, it may be possible to determine the information needs of its users. This allows the developer of the resource to add more information on popular topics, or to move important information to a location where it can be more easily accessed. It might ultimately be possible to infer the processes that physicians use to find information by examining how they follow hyperlinks or phrase queries to a search engine.

Internet medical resources may help to improve all forms of medical education by giving teachers a better understanding of the information needs of physicians.

Quality of Educational Resources

Users of medical Internet resources require of high-quality, secure publications, with clearly identified authors and references. External enforcement of editorial policies or quality control of Internet resources is impossible, however. Individuals are therefore able to distribute information that may be inaccurate and that has not undergone peer review. Leading authors are also reluctant to publish electronically until this activity is recognised by academic institutions. This leads many individuals to distrust information obtained on the Internet, and limits its usefulness as a clinical tool. Accountability is another problem unique to electronic publication on the Internet. The author and affiliation of nearly every article published in printed media is identified. Many Internet resources are maintained by anonymous authors, however, and may sometimes even deliberately mislead the reader as to the author's true identity.

Resources on the Internet can be added, changed, or removed without external peer review, and may therefore be more likely to contain inaccurate or unsubstantiated data. One recent study of WWW sites pertaining to fever in children found a large variation in both the definitions of "fever" and the treatment that was recommended. Although parents or other lay people maintained many paediatric fever resources, web sites at many academic medical centres also offered incorrect advice. Another study found that even academic institutions well known for their expertise in management of paediatric patients offered advice that was no more accurate than that which came from alternative medicine WWW sites. This information suggests that, although many medical Internet resources are reliable, they must be critically evaluated prior to use in a clinical setting.

One recent study proposed that the number of printed publications written by contributors to unmoderated discussion groups be used as an indicator of the quality of the posting. Most physicians discover that unpublished, but highly experienced, colleagues can also be excellent teachers, however. Although recognised experts frequently participate in mailing lists, anaesthesia professionals who do not publish in traditional journals also post regularly, and are frequently well informed and helpful. Posts from well-published authorities may indicate that the overall quality of these lists is high, but users should evaluate each author on the merit of his or her ideas, and not only on how many papers the author has written.

These problems make a rating system for electronic information that incorporates some form of peer-review essential. Services which been developed to evaluate medical Internet resources usually provide some indication of relative value by awarding stars or medals or offering a review. Some rating sites, such as LookSmart, evaluate Internet resources of all categories, and award a "medallion" to sites that they have selected. This medallion is then displayed on the site, and a link to reviewed sites is provided from the rating service. One Internet directory service, About.com (http://www.about.com), employs experts in a large number of fields, who review Internet resources for relevance prior to including them.

The reviewers that some sites use are not identified, and may not have expertise in the field for which they review Internet resources. Popular rating services often do not publish the criteria that they use to rate sites, and the ratings themselves are frequently based on subjective evaluation. Even reviews of Internet resources by health rating services tend to vary widely in quality. Independent medical rating organisations may help to solve these problems by reviewing sites according to specific criteria such as authorship information, use of references, ownership of the resource, and conflicts of interest. The Health on the Net Foundation (http://www.hon.ch/) is an organisation that promotes and evaluates health-related Internet resources. This organisation offers a voluntary code of conduct (HONcode) that specifically describes how medical resources should be created and maintained. It also undertakes other initiatives such as monitoring medical use of the Internet, creation of specialised search engines, and hosting WWW sites for other related organisations.

ISI, the publisher of *Current Contents*, and the National Institutes of Health, both organisations with recognised expertise in evaluating the quality of printed resources, have begun to rate Internet medical resources. ISI has chosen to evaluate Web Sites on the basis of eight points: authority, accuracy, currency, navigation and design, applicability and content, scope, audience level, and quality of writing. Perhaps the evolution of external rating systems such as this will help the practitioner find relevant medical information on the Internet. The National Institutes of Health has started a project called Pubmed Central that will index, archive, and distribute information from traditional printed journals as well as medical Internet resources. This initiative will hopefully resolve the problems of archival and permanence in addition to that of quality control.

Relatively few academic institutions regard electronic publications as equivalent to paper publications. Moreover, there is not as yet a method of measuring the “impact” of an electronic publication. Although promotion committees can use references such as *Science Citations* to determine how many times a given article has been cited by other authors, no such system currently exists for Internet publications. This problem is compounded by the fact that many printed journals consider electronic distribution to be equivalent to prior publication when determining whether an article will be accepted for publication. Academicians are therefore reluctant to publish original research or review articles electronically if there is a possibility that may be published in printed media. This problem may be resolved as electronic publication is better understood and becomes more widespread.

Developing activities which award continuing medical education can be simplified by using the Internet. The regulations of the Accreditation Council for Continuing Medical Education (ACCME) do not exclude Internet-based medical education. In fact, they offer potential content creators the opportunity to use the Internet not only to disseminate their information, but also to design the course. The ACCME requires extensive documentation of how a course is developed, including the use of broadly distributed surveys and mailing lists to assess needs, monitoring which information a person is actually accessing, including flow through a web site, and finally evaluation. Moreover, it allows an author to offer a course that has a very narrow focus because the Internet would make it accessible to a large number of individuals.

The Internet is becoming increasingly important in medical education, research, and clinical practice. It offers developers of educational programs new ways of finding the information physicians really need. Pictures, sound, and video allow educators to make difficult concepts easier to understand. The Internet has become an important tool for all physicians.

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SITUATION-AWARENESS: THE PRE-CONDITION FOR DECISION MAKING IN HIGH DEPENDENCY ENVIRONMENTS

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Situation

Today's High Dependency Environment is characterised by large complexity, time pressure and a high degree of interlinking. Computers are going to replace jobs of human experts more and more. A task shift between men and machines dominates the current image of complex workplaces and organisations. Additionally, this process derives new structures of teamwork. More inter-disciplinary work occurs, which sometimes might be even spatially distributed (e.g. via Tele-Medicine). However, one of the main targets of work in High Dependency Environments is still patient-safety.

But, in which way patient-safety is acquirable considering these new work conditions? Is it still possible to recognise critical situations and derive adequate behaviour?

As a result of new work structures, efficient communication and co-ordination processes are even more necessary than ever. Aspects of an optimal fit of ICU-staff expectations and qualifications with technology requirements come to the fore to support human decision-making.

A basic theoretical approach in this field is the theory of ”Situation Awareness” (SA), originated in aeronautics. A well known and often cited definition comes from Mica R. Endsley [1]: SA is ”the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.” In the context of complex work design SA becomes more and more important, particularly if a user or a team has to react very fast on critical incidents that are not predictable but need efficient and correct decisions. A good communication, particularly the exchange of mental schemata/models, is necessary to achieve an efficient and safe team co-ordination as well as efficient decisions [c.f. 2,3].

But, how can a single team member/or the team itself achieve a high level of Situation Awareness?

Approach

The CITE-project [Critical Incidents and Teams] at the department of human factors engineering/TU Berlin has started to develop design guidelines for a task-oriented, flexible safety concept exemplarily for Surgical Intensive Care Units. The concept that will be developed is supposed to enable future users (nurses and doctors), co-operating in a team, to recognise critical incidents as early as possible with a maximum safety. Therefore it contributes to built up a good situation awareness, at first. The development of such guidelines will need different analysis and design steps.

In addition to the search for typical critical incidents and the task analysis, an analysis of potential future developments will be conducted by means of a Delphi-Study. The Delphi-Study is a structured, indirect, interactive judgement method [cp. 4] which allows to take a lot of different factors into account influencing the development of SA and Team-SA. Potential changes in the medical environment, medical methodology and technology as well as organisational aspects such as dispatching of responsibility and strategies of communication will be analysed. The design of the study will be oriented at the Delphi-Study of Friesdorf et. al. [5] and Delphi´98 [6]. In this presentation the methodological approach of the Delphi–Study used by CITE will be presented and discussed.

Disucssion/perspectives

Designing work systems today requires the analysis of the momentarily existing system such as process analysis and information flow analysis as well as futurology. Both should be examined with clinical experts. The results of the Delphi-study are only a single, but important step in the process of developing a user-centred safety concept. The results should help to estimate future changes on work places and organisational concepts influencing the Team Situation Awareness and therefore their team performance as well. The whole analysis process (status analysis and futurology) will result in guidelines, which certainly need to be validated in a next step.

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QUALITY OF INFORMATION - THE CLINICAL REQUIREMENTS

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The tasks of the medical staff in modern high dependency environments (HDE) comprise clinical care for individual patients (focus: management of vital functions), organisation of daily routine, co-ordination and logistics, quality assurance and other related activities.

Information handling is one of the main activities particularly in intensive care.

Situation

Even for the pure clinical care of individual patients we spend hours a day to process information which is already available, we are busy to create new data and we give orders to gather additional information. By tradition we are used to have sources of information which are structured according to technical methods (monitoring devices, fluid pumps), to departments in the hospital (X-rays, lab-results, pathology, administration), to the technique of data acquisition (handwritten patient file from admission to hospital), to authors (typed letter of the family doctor).

Problem

The inherent characteristics of clinical situations in HDE is mostly the complexity of physiologic phenomena. Therefore we are mostly not at the end of the job to know a blood pressure or a X-ray image to perform then just one action. The clinical logic of the patient´s state will require that we open a lot of files and look to various devices. But we are often busy to ignore a lot of redundant or irrelevant information and we try to focus on particular items. The relevant items are spread on many sources of information. The technical structure of information storage has nothing to do with the logic structure of a certain order or sequence of information we are looking for.

Requirements

Clinical information has to be complete, valid and principally available. Most of these pure physical or technical requirements are fulfilled nowadays.

The next steps are to provide information structured according to the logic characteristics of our essential tasks:

the patient data model: chronic health state, acute problem leading to ICU admission, course of the vital functions, performed recent interventions and current therapy.

the workflow model: repeated update of the care plan, detection of critical tendencies, changes of shifts including transfer of information (nurses and doctors), admission and discharge routines, triage situations, preparation of particular activities including intrahospital transfers etc.

For these purposes the technical predominance of data storage and presentation of information (which has grown historically) has to be opened for a redesign of information access. When we care for our patient with pulmonary edema we are used to search for a recent echocardiographic finding in typed files, we look at the monitor for the oxygen saturation, we calculate the fluid balance, we look for older findings and letters where a congestive heart failure is described, we look at the trend of CVP, search for the last chest X-rays, former and recent medication of diuretic and inotrope drugs.....

A data management sytem which „has learnt something“ about our complex pattern recognition way of working could help us to get the information in a quicker and more appropriate way.

But at the end we ourselves have to give up to insist on our traditional rituals: Up to now we want to have lab results or monitoring data or X-rays. But in reality we are looking for cardiovascular problems, for respiratory disfunction or acute renal failure. It is unlikely that our basic procedures in Manchester, Berlin or Rome are very different. A case for the software industry?

COMMUNICATION AND CO-OPERATION IN HDE

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Cooperation between the ICU and partners

Cooperation means common usage of ressources from two indepentend units (profit centers, companies, business units...). It is absolutely necessary, that both units are not related to each other in terms of hierarchy or command structure.

The borderlines between the partners have to be definded clearly. The cooperation should not give any reason, for unfriendly annexions.

The result of cooperation must be added value, bigger than simple addition of the ressources.

(Results of a win-win-strategy).

At all levels of management are parts of the cooperation process to plan and to perform:

Normative level:
- Purpose and goal of the concrete cooperation project have to be defined.
- There must be consensus that the necessary ressources are available.

Strategic level:
- Values and Policies (Standards, Procedures) are to be fixed here.
- How and when, under which circumstances to cooperate

Operative level:
- Cooperation is performed and added value is obtained here,
- Cooperation must obey the basic rules of communication.

In the ICU-environment, 2 main types of cooperation takes place:

- function-centered processes
  - One process is performed for more patients (example: X-ray meeting once a day for all X-rays of that day), date and time is preplanned, content is planned
- patient-centered processes:
  - A complex situation is solved with the partners for one patient
  - Indication for emergency diagnostic procedures, operative procedures ....
  - ad hoc, partner must be planned, found and contacted in time

At the end of a cooperation process there should be:
- Consensus about the result with written documentation
- Fixed protocol for the next steps that will follow.
- Tell the partner, that with his help you could solve a problem, or even come closer to a solution. Invite her or him for coffee.

WORK PROCESS ANALYSIS AND PROCESS BENCHMARKING IN HDE

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Introduction

An increasing cost pressure, rising quality demands and growing requests for customer orientation define the future requirements for optimised clinical work processes [1]. In contrast to that most of the existing workflows within the hospital are defined by a historically grown complexity. Especially in high dependency environments an enormous improvement potential can be identified through the creation of process transparency. Furthermore not only this transparency deficit but also individual restrictions and management goals are the main reasons for the existence of hospital specific clinical workflow. Therefore the basis for a systematical improvement of every process flow has to be its hospital specific analysis [2]. Within the process flow optimisation all analysed process alternatives from other hospitals should then be used by systematically integrating the knowledge about their already experienced deficits and strengths.

Method

For this reason a “participatory process flow analysis” and “process benchmarking” build the basis for a method called *TOPICS - Together Optimising Processes In Clinical Systems*.

Within the “participatory process flow analysis” the process flow is visualised together with the involved staff as process flow diagrams [3; 4]. Then for each process module (a defined process flow segment that is common to all similar work processes) all process determining and influencing factors are documented. In the same manner process deficits as well as strengths are identified describing the basis for the process redesign. This participatory procedure ensures that the experts’ experience and improvement ideas are systematically integrated into the process modelling. Even more important it supports later on the successful implementation of such redesigned work processes by increasing their acceptance throughout the staff [2].

The comparison of process flows from different work systems is already known as “benchmarking” [5] within industry and some health care systems. Using a specific process parameter (mainly the duration or cost) this method helps to identify one “best practice”, which is then implemented within all other work systems [1; 3]. A typical “benchmarking” between different hospitals would therefore not consider hospital specific restrictions or management goals. Even worse this method would risk that the entire process flows of nearly all hospitals are rejected as “worse practices”, while they still might contain partly excellent process alternatives. For this reason “process benchmarking” concentrates only on those process segments, where deficits have been identified. Furthermore the comparison itself is not reduced to one specific process benchmark but bases on all identified process deficits and strengths as well as process determining and influencing factors. The systematical analysis of all identified process flow alternatives and reflection of their already experienced deficits and strengths is then used for a process flow optimisation together with the involved staff, in which the most promising solution has to be adapted again to the individual requirements of each hospital.

Evaluation

As an example for other complex clinical work processes in high dependency environments the “Patient Admission Process to the ICU” has been analyzed in a joint research project together with five international hospitals (Charité Campus Virchow Hospital Berlin - Germany, University Hospital Innsbruck - Austria, University of Hokkaido Hospital Sapporo - Japan, Kaplan Medical Center Rehovot - Israel, Palo Alto VA Health Care System Stanford - USA). The compared analysis results then built the basis for a workshop at the Department for Human Factors Engineering in Berlin. At this workshop the representatives of the five clinical project partners were introduced to all within the “process benchmarking” identified process flow alternatives, while the methodical combination of “participatory process flow analysis” and “process benchmarking” was evaluated using standardized questionnaires for all involved clinical staff.

Discussion and conclusion

The evaluation of the “participatory process flow analysis” by the involved clinical staff showed, that not only a short term optimisation was achieved but also a continuous quality improvement process started within all hospitals. The evaluation of the “process benchmarking” allowed the conclusion, that this systematically improvement tool produces an enormous number of previously unknown process alternatives, but which potentials for a realisation then have to be carefully discussed again together with the involved hospital staff (“participatory process flow optimisation”). For the better usability of the “process benchmarking” a structured database has to be designed, which will allow the search for specific process alternatives by certain characteristics. Those characteristics will either result from the need for the process optimisation (e.g. quality improvement, cost reduction or customer orientation) or from the process requirements (process determining or influencing factors such as involved staff, environment, technical equipment, management, measurements or methods).

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INFORMATION SYSTEM DESIGN – AN INDUSTRIAL VIEW

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The challenges of designing commercial systems for clinical information management are very different from those associated with in-house developments. Commercial systems must aim to be acceptable to a wide range of customers and must be suitable for use, and capable of being supported, internationally. Some of the most important design considerations for industrial systems are categorised and discussed with some practical examples.

Definition of workflow

As a first step it is necessary to describe an accurate process model of the clinical workflow. In practice this involves identifying and modelling workflow in a variety of settings including small, medium and large hospitals and general versus specialised units. It is also necessary to account for variations in clinical practice not only between institutions but also between countries. There is a need to balance flexibility and configurability with standardised designs, which can be effectively supported in the field.

Identification of mandatory requirements

Because of the international dimension it is important to identify special requirements which may be enforced (or strongly recommended) by national professional governing bodies or by government. Examples of these will be discussed including specialised data sets such as the German DGAI and clinical classifications such as the UK National Clinical terms.

Administration and Billing

Increasingly clinical information systems are seen as feeder systems to the enterprise-wide IT environment. This means that clinical systems must be designed to provide the information required for administration and billing and again this must be related to national norms and practice. Support for national and international schemes for clinical coding and classification is an important component.

Robust technology

The architecture and foundation technologies of industrial systems require to be robust, widely accepted and above all, supportable. Choices concerning platforms crucially affect these goals.

Interfacing to external systems

Systems, which are designed for Anaesthesia and Intensive Care Information Management, will normally be required to collect data directly from patient monitors and other devices. In addition interfaces will generally be required to the PAS / HIS and possibly to other systems such as clinical laboratories. In addition the close inter-working of AIMS, ITU systems and Theatre Management Systems is logical and expected. Currently the growth of hospital intranets means that there is increasing demand for ‘Web-enabled’ products. These requirements create special challenges, which are discussed.

Forecasting future trends

One of the most interesting and difficult tasks is to forecast future trends and to ensure that current designs can evolve to embrace these. The example of decision support based on artificial intelligence is used as an illustration.

OPTIMISING WORK PROCESSES BY PACS (PICTURE ARCHIVING AND COMMUNICATION SYSTEM) - A CLINICAL EVALUATION

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Introduction

Every implementation of a process supportive technology should result directly in a measurable work process optimisation: either cost reduction, quality improvement or customer orientation [1]. Therefore also an evaluation of a Picture Archiving and Communication System (PACS) for the Radiology Department should not only end up with a statement about the reduction of radiological film material. Also considering the growing customer orientation within hospitals the evaluation of a process optimisation by PACS has to exceed the boundaries of the Radiology Department – much more essential are the changes caused by its clinical customers: especially within the ICU as an example for other high dependency environments. Here, radiological pictures and findings are often needed currently after their assignment and may result in life saving medical decisions [2]. In this context specific process benchmarks are needed for a systematical evaluation of the work process optimisation within hospitals caused by the introduction of PACS.

Methods

Participatory process flow analysis are normally used as a helpful instrument for the analysis as well as optimisation of clinical work flows by the creation of process transparency and staff motivation [3]. In this research context this methodical procedure is used for the participatory visualisation of existing work processes either using the analysed process supportive technology or not. Again together with the involved clinical staff the process strengths and deficits are then identified, that are symptomatic for both work processes. Afterwards all analysis results are systematically compared by using a common hierarchical process flow structure: identified common process modules and their exact quantification (involved men, machines, materials, methods, management, measurements and environment). The discussion of existing process deficits and strengths along the two different process flows then results in benchmarks for an evaluation of PACS, that is much more customer and process quality orientated than only comparing the durations and costs for specific process modules.

Results

In a first project phase the analysis and comparison of the work process „radiological diagnosis for the ICU" took place within two different hospitals: University Hospital of Innsbruck, Austria (representing the work system with PACS) and the Klinikum Ernst von Bergmann in Potsdam, Germany (representing the work system without PACS).

Major differences within the two work processes were especially found for two process modules: “the first access to the new radiological pictures” (which is limited to one user at a time within the traditional work system but absolutely unlimited using PACS) and “the access to previous radiological pictures and findings” (where PACS reduces durations and workload as well). Besides process durations and costs particularly the deficits and strengths along the information flow (for example for the registration as well as for the acute and final radiological findings) resulted in important benchmarks concerning the process quality: e.g. the information’s percentage of losses, the information’s availability and relevance as well as its quality.

Later on in a second project phase those identified process benchmarks will be documented in both participating hospitals for the actual comparison and evaluation of the process optimisation caused by PACS within the “radiological diagnosis for the ICU”.

Discussion and conclusion

Already the first identified process deficits and strengths within the two different work systems showed, that PACS alone can not optimise the clinical work system by itself. Furthermore an efficient integration into the whole clinical data management system has to support the entire work process “radiological diagnosis for the ICU”. Besides that a customer orientated organisational work flow optimisation has to accompany or better precede every PACS implementation. The major goal within this customer orientated organisational optimisation will be the implementation of a Picture Archiving and Communication System actually supporting the medical communication instead of totally replacing it: for example insisting on radiological consultations either by phone or person to person instead of replacing them by the ICU physician interpreting the radiological pictures without any help of the radiologist at all.

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USABILITY OF INTENSIVE CARE INFORMATION SYSTEMS: HAVE WE FOUND THE SILVER BULLET YET?*

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Overview:

Although addressed in several industrial and scientific projects the design of intensive care information systems has not lead to satisfying solutions during the first decade of the development history of this domain. The reasons can be seen in a) the fact that developers had to concentrate on the technical constraints of "contemporary" IT, b) the lack of knowledge about the extreme boundary condition of the application domain on the IT architects´ side and c) the missing awareness of the importance of human factors engineering issues in the design of the user interfaces to these systems. More recent approaches take more advantages on proper analysis of the workflow and modern GUI features. A critical review of past approaches, the special requirements and appropriate methodology for supporting continuous enhancement of clinical applications is presented and discussed at the example of the specially instrumented multi-user-system "Intensive Care Manager", a 3rd generation point-of-care information system provided by Dräger.

Methods:

Methods derived from systems ergonomics where used to analyse the special workflow of the application domain ICU. Current and past approaches to information processing in intensive care where examined with respect to usability and human factors engineering. Derived from this, the event-log instrumentation of a commercially available intensive care information system was designed and data capturing was carried out in an ICU environment, including 30 graphical workstations used by a total of 174 users working on 1275 cases for 57 weeks. A total of 4,9 Billion of user-evoked actions where captured, including time-stamped begin and end of each action, log-in/out-events as well as system response and system availability times. Data where analysed using encryption methods, fully respecting user privacy and data security at all times. Focus of the in-depth analysis was set on order entry, modification and confirmation as the most interactive and most intensively used functional area. Raw data where condensed using n^{SQR}-mean value extraction (loop-averaging).

Results:

186.000 entries of medical orders entered by 174 different users where detected in the log file consisting of 48 different modes of application, dosage schemes and type. 81% of these had been entered using complete pre-configurations, 11 % used parameter values taken from pre-configured pick-lists (average number of items in each list: 1.5). Learning curves where derived from this data using the model of undo-actions. The curves show a reduction of undo-actions to under 40% of initial values after approx. 4 weeks of user experience. Intensity of system

usage showed extreme peaks generated by the work organisation in the ward, especially in the co-operation between doctors and nurses. Whereas physicians show a 24h work cycle, nurses show sub-maxima at cycles of 6-8 hours (work shifts) as well as 1 hour (checking rounds). The performance and availability analysis shows clear increase of response times due to rising data volumes in the first months of usage as well as reduction due to database adaptations carried out by the manufacturer. Net measurements of system availability showed to be at 99,6% where downtime periods measured had a duration of between 4 (min) and 89 (max) minutes at an average of 19 minutes.

Discussion and Conclusion:

The detailed analysis of work- and information flow in the target environment shows that close adaptation of the data entry channel can enhance both quality and speed of record keeping dramatically. This is evidently confirmed by the captured event-log data sequences. The system design of the tested information system shows reasonable learning curves for the core functions and can be considered as a close match to the workflow requirements in ICUs. However, potential for optimisations is also revealed by the probe data, with respect to both information presentation and data entry dialogues. The method of full event-instrumentation has proven to be a valuable tool for analysis of human factors issues in the addressed environment, given the special psychological conditions of users and the stressful work situation which biases all other methods of investigation in this research field.

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CONFIGURING THE ANAESTHESIA LAN AS A INTRANET

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Introduction

A network installed in the Operating Rooms is a critical point to improve the anesthesia workflow and the patient care. The anesthesia network is better running if the software used to connect the OR PCs to the other PCs in the anesthesia department may configure an Intranet, that is a local area network using Internet software.

By using this technology these goals are achieved:

1) Anesthesia record keeping
2) Data monitoring acquisition.
3) Exhaustive and fast audit
4) Use of videoconferencing technology for staff meeting
5) Remote support during anesthesia

A system with these features was developed at the Buccheri La Ferla Hospital in Palermo (Italy).

The OR network development	
1986- a PC local area network was built in the Buccheri La Ferla Hospital (B.L.F.H.) and the first clinical use of the in-house record keeping software was started.	**1988**- a new software module was added to the system. It made the first serial connection to the patient monitoring system possible.
1993- a major new feature was implemented, when a remote control supervisor mode was added. This allowed for real time monitoring of the anesthesia activities in the operating rooms.	**1994**- an option for a modem connection to the system was implemented to share anesthetic activity with out-hospital workstations. The anesthesia service was modem connected with the anesthesia service of the Benevento hospital where a similar anesthesia system is running.
1995- a module that allows an automatically compiled surgery list was introduced .This last module also performs a gateway to the hospital information system and it is the completion of the "computerized anesthesia toolkit".	**1996** The anesthesia network was connected to the ICU network. Any pc may show anesthesia records as well as ICU records.
1997 The network was connected to the Internet backbone building the “Buccheri.unipa.it” domain. The anesthesia network became an Intranet. The ANESTIT website was created as continuos tool to spread to Internet the anesthesia protocols	**1998** Videoconference sessions was used to increase the audience of the anesthesia meetings. The meetings are also stored as streaming on demand clips so the anesthesiologist can attend the meeting even at home.

The modules of the “Anaesthetic software toolkit”

Computerized surgery list

Specialized software produces a more effective turnover of the scheduled patients. In addition a network connection with the hospital information system permits an automatic introduction of demographic and after surgery , selected OR discharge data (date, anesthetist name etc.) are then transferred to the hospital information system.

Anesthesia workstation

An anesthesia record keeping (AARK) allows on–line data entry to patient records

In addition the PCs connected to the monitoring system allow automatic collection and storage of monitored patient data . The OR PCs may display on line the patient's record sheet, the trend of monitoring data, the scheduled patients list and a table of anesthesia in progress in other ORs.

Anesthesia control panel

All anesthesia activity is monitored on-line. At any workstation, including the head anesthetist's office, it is possible to display a status list of all anesthetic procedures. On the computer screen, the status of the case is represented with a characteristic easily distinguished face-like icon.

scheduled or

emergency

premedicated

surgery going on

patient in recovery, discharged

Furthermore, each individual patient’s trend can also be displayed and analyzed from a remote location using INTERNET or a dial call.

Technical references

The software and the codes were designed by an anesthetist (the author).

Anesthesia network configuration. (Fig.1)

10 anesthesia workstations and 2 portable PCs are used in the B.L.F.H. anesthesia department. The 10 workstations are networked by an Ethernet LAN (10 Mbytes). Six workstations are placed in the operating rooms. Any of the PC workstations are able to display a complete anesthesia form and to retrieve the patient's heart rate, blood pressures, CO_2, oxygen saturation trends with updates every minute.

A single patient record needs 7,942 bytes to store a file for the text data. The largest possible vital sign trend is ten hours in duration and its file size is 9,607 bytes. If the surgery takes more than ten hours or if all text entries are not included in one single form, another record is created automatically for the same patient. The network runs the Microsoft Windows 98 TCP/IP software. The anesthesia workstation software is written using programming language Microsoft Visual Basic 6.0, which uses a SQL database that runs on a Microsoft Open Database Connectivity (ODBC) Windows NT server. The modem or INTERNET remote control is based on a PCAnywhere for Windows (1). The estimated cost of the complete in-house designed system (including network and PCs) is approximately $20,000 US.

Remote controlling the system

The possibility to remote control the system offered two important advantages:

Installation and maintenance of other similar systems

Obviously the use of this system in a Hospital other than the BLFH needs installation and maintenance by expert personal. This task would be expensive adding unacceptable costs. Instead, by using the remote control program the introduction of the anesthesia network remains a simple and affordable task. The experience of the installation in the Benevento Hospital shows how cloning of the system is simple. In 1994 in a Hospital of Benevento (a city 800 Km from the BLFH) the BLFH anesthesia system was introduced. The server computer was connected to a modem running at 28,800 Baud with V34 protocol. The modem is usually off and it is turned on by an anesthesiologist when a connection is requested by a normal telephone call. This task prevents unauthorized access to the system. Software and hardware installation took 10 hours of work and a BLFH anesthesiologist was in Benevento a week to teach the software use to the anesthesia staff. In the first 8 months after the installation, only 10 connections were necessary to solve problems due to improper use of the system. After, the connection was used only to exchange documents. The Benevento anesthesia database now contains 20,000 records.

Anesthesia meetings and anesthesia support

During anesthesia meetings the system is entered by remote with a direct dial or by Internet. Due to the fact that the anesthesia system is directly connected to INTERNET, it is enough to start the PCAnywhere software as host to enter the anesthesia network. The connection between the host and a remote is allowed only using a digital ID.

This feature is very effective to show on line patients trends, audit etc. during a meeting far from Palermo. It is possible to have a real time scenario from the Palermo O.R. and to receive suggestions on a case from an anesthesiologist of a foreign hospital. At the 28,800 b/sec the use of this feature is stable and sufficiently fast. The longest distance tested was Newyork-Palermo.

Conclusion

The use of the same file by the components of anesthesia service determines a very rapid growth of the working experience of both the single anesthesiologist and the whole staff achieving a constant improvement of services, a reduction of complications and negative events. In a word, a better outcome for the patients.

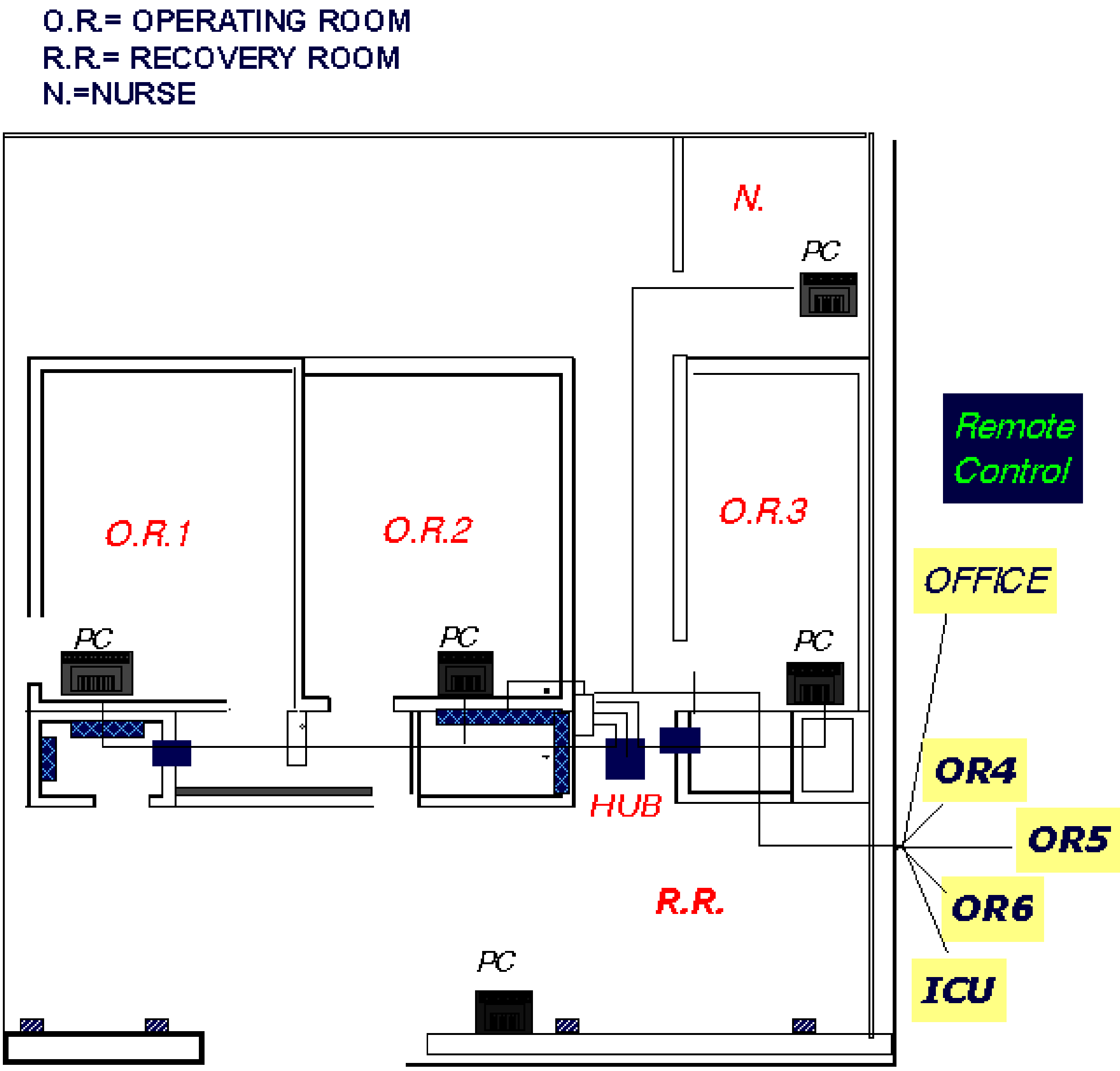

Fig.1. The Buccheri La Ferla hospital anesthesia network

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PDMS IN ICU: THE UCSC EXPERIENCE USING DIGISTAT

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Introduction

Modern management of patient records in Intensive Care Unit (ICU) is more and more a matter of choosing the best tool available from the software market in terms of data relyability, cost/effectivness, data output capability, integration with standard desktop utility/production software, easy end-user interface, low administrative costs vs the higher user satisfaction. Several commercial solutions are available and there is a wide spread need for information at different levels of the information flow (local administrative needs, scientific esigencies, infectious diseases monitoring, etc). DIGISTAT^{tm}, a Patient Database Management System (PDMS) with high user self-configuration level, has been adopted as a solution to the information-flow management need in the ICU of the Catholic University of Sacred Heart - Rome. The 6 months use experience is reported.

Methods

The PDMS used was DIGISTAT^{tm} (Unterberger Medical Software – Alaris Medical Software), running on a Ethernet 10/100 MbpS LAN with 4 Intel PII/III based – 128 Mb RAM - pc working as central stations, 1 Compaq Proliant file server (PII dual processor, 256 M RAM, 7 IBM 9.2 SCSI-II HD working in RAID 0-1), 1 Intel PIII based pc with Touch-Screen monitor working at a bed-side. Operative system was Microsoft WinNT 4.0 Workstation and Server version. LAN communication protocol was NETBeui for local network and TCP/IP for the Intranet connection to the hospital digital data sources and for Internet connection using the hospital Gateway. Patient admitted to our 23 bed ICU since last March have been recorded and assigned to a bed, in the department view of the software program, following the standard analogical procedures. In order to preserve data integrity with the hospital archiving methods, special attention was payed in the fullfilling the field for the standard numerical ID coming with the hard-copy record. Non automatic input of data was reserved to daily clinical notes and for admission anamnestical reports. Admission diagnosis, pharmacological anamnesis and dismission diagnosis and procedures have been recorded using standard encoding (ICD9-CM, ATC, etc.) by means of multichoice configurable lists using the Codefinder tool coming with the program. Therapy planning, and therapy execution scheduling at the bed-side for one experimental station, have been electronically performed by trained users from the ICU staff. Connection to the central hospital laboratories for chemical, haematological and microbiological results and to the radiology department has been performed using the hospital Intranet and with local duplication of information archiving and management.

Clinical scoring (SAPS-II, GCS, SOFA) were calculated for each patient and archived in the database.

Standard SQL (Structured Query Language) queries to the local patient database have been performed using both DIGISTAT^{tm} tools and ad-hoc software application developed using Microsoft VB 5.0 or Access applications.

Results

Use of an open PDMS gave us the ability to be in continuos and sensible touch with the ICU admission and patient condition trends by means of easy to perform statistical reports. Standard information's archiving methods was not in contrast with our current forensical needs for ordered and clear hard-copy documentation outputs.

Intuitive, clear and easy-to-use interface helped the not informatics-skilled end user to archive and retrieve collected data. High level configuration steps have been made by a trained ICU staff, without need for specialistic know-how. With the exception of the external consulting (more often long distance consult) provided by the DIGISTAT^{tm} software vendor, all configurations and specific applications have been developed using local resources.

Discussion

Documentation in ordered, reliable and unique forms of multisource patient information lead to a rational and standard protocol for data input by means of predefined codes. Diagnosis codes are the first step for clinical population studies. Users are more confident in informatic data archiving as long as statistical output data are provided about the ICU management (drugs administered per patient, admissions per month per bed, etc) or patient clinical trends (haematological values, SOFA graphical shaped trends, etc.). Automation in digital data input (central laboratory network connection, etc) saved more man-time for different assistential purposes.

THE BUSINESS OF ANESTHESIA IS CHANGING, AGILENT TECHNOLOGIES CLINICAL INFORMATION SYSTEMS SOLUTIONS HELPS YOU TO TAKE CONTROL.

Alberico Bonalumi

Program Marketing Manager
Agilent Tecnologies

How is Anesthesia business changing?

- Intense pressure to reduce overall costs
- Pressure to increase productivity
- Increasing number of documentation audits
- Need to document staff presence during critical parts of the case
- Need to demonstrate an effective continuous quality improvement program to accreditation agencies
- Hospital administrators and third party payers expect hard data to support your contract negotiations

How can a clinical information system help you?

- Drug cost awareness program educates practitioners about costs and promotes conservation
- Patient tracking alerts personnel to the status of all ORs to improve room turnover time and maximize staff resources
- Electronic signature of key events documents staff presence
- Quality reports help demonstrate a continuous quality improvement to the accreditation inspectors
- Management reports, ranging from personnel productivity to case costing per procedure per practitioner, help track the business of running an anesthesia department.

Total PeriOperative Solution

- Merges pre-operative, intra-operative and post-operative data, documenting every phase of the procedure to produce a comprehensive patient record
- Support your clinical path to standardize procedures and improve effectiveness
- Interfaces to your patient monitors and anesthesia machines
- Instant access to previous cases

As Configurable as You Need it to Be

- Easily and locally configurable

A Good Citizen in the IT Infrastructure

- Built on industry standards, networking, hardware and databases
- Runs on non-proprietary hardware, giving you total purchase control

Scalable solutions tired to your financing plans

- From the standalone workstation to the comprehensive network integrating computing system

Smooth Transition to Your New System

- Our experienced training and implementation team guides youthrough the start up process

PreOperative: Patient Evaluation Module

- Structured format promotes consistent quality interviews
- Automatic test prescription helps control costs
- Patient Readiness reports identify patients with missing or abnormal test results to determine whether they are ready for anesthesia

This module can help you minimize delays and cancellations, for a significant cost savings.

PreOperative: Case Browser

- Enables retrieval of previous case records by patient name, medical record number, date of service and other heather information (department, status, referring physicians, etc.)

Immediate access to previous anesthesia records means better informed users, which translates to improved quality of care.

IntraOperative: Intra-operative Module

- Optimized for both short and long cases
- Automatically gathers and records data from physiological monitors and ventilators
- Touch screen user interface for ease of use
- Unique rapid entry event keys guide the anesthesia provider through the case documentation

Charges are automatically captured from clinical documentation and are used to build accurate cost reports.

PostOperative Module

- Auto enter feature guides the clinician through the post-operative documentation
- Allows for post-operative comments and transport notes
- Prompts for completeness of data before the record is printed

Provides an easy, efficient and organized method of ending the record in real time and documenting your patient's condition at the end of your care.

PeriOperative Module

- Provides a real-time "map" of a patient's progress through pre-, intra-, and post-operative care units
- Alerts clinicians and technicians to the status of all anesthesia related locations
- Presents a graphical display of any case for clinical review from outside the OR or any desired location on the network

Supports better utilization of personnel and physical resources by providing information on wait times, turnover times and real-time physician concurrency.

Improves public relations by providing patient's families with constant information on patient progress through the PeriOperative process.

Provides a real time, security protected look into the operating room to see how a case is progressing. It can also be used as a teaching tool to review completed cases.

Drug Reports

- Complete drug charge captured directly from clinical record
- Builds patient drug cost reports and department usage summary reports
- Generates drug cost comparison reports per procedure per practitioner

By providing comparative information on the drugs consumed during a procedure, reports help you target areas for improvement.

Professional Charges Billing

- Generates patient charge vouchers from system database
- Generates concurrency reports
- Reconciles cases performed and billed

Some billing services have reduced the cost of their services to customers who use electronic transfer of professional charges information.

Supplies Reports

- Complete supply charge captured directly from the clinical record

- Builds supply charge reports and department usage summary reports from charge capture data

Once true costs are identified through the supplies software, cost per case and per practitioner reports can help improve practice patterns and accelerate cost reduction programs.

Research

- Researchers have a complete data dictionary
- ODBC compliant database tables can be used by your favorite front-end reporting tool
- Research projects are separated from the departmental database to avoid contamination of clinical data

Supports your clinical research.

Management Information Services

- Uses system database to create a series of reports to facilitate anesthesia department management

A series of management reports ranging from personnel productivity to room utilization enable you to appraise anesthesia department performance, targeting opportunities for productivity improvement.

Communications Gateway Interface

- Interface the System with other hospital information systems
- Exchanges real time and batch information, both single and bidirectional

Enables your department to easily exchange data with other hospital systems such as admissions/discharges/transfers, lab, pharmacy, billing, etc.

HealthCare Professional Services

- The mission of Agilent Healthcare Professional Services (HPS) is …"To help our clinical customers effectively use and manage clinical information throughout the care process".

Professional Services are the Key Success Factor.

DESIGN AND EVALUATION OF AN ECOLOGICAL INTERFACE AND AN INTELLIGENT ALARM CONCEPT FOR THE ANAESTHESIA WORKPLACE

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Introduction

Biomedical engineering research has improved anaesthetists' monitoring tasks and patients' safety by providing technical devices to measure large numbers of vital parameters. However, the visualisation and alarm techniques have not yet been appropriately adapted to the physicians' decision making behaviour. This may lead to high cognitive load during critical incident management. Our preliminary studies [1, 2] have shown that an ecological interface (EI) [3] as well as intelligent alarms assessing parameter constellations using a fuzzy-logic process model [4] may better support the anaesthetists' concept of decision making than do traditional techniques. The idea of the alarm concept is to infer abstract state variables such as 'Contractility' or 'Preload' relevant during critical incident management. The principle of EI design is to display all information on the screen according to the anaesthesia decision making model: i.e. measured vital parameters, physiological background knowledge, and patient dependant context.

Methods

Based on our previous intelligent alarm concept [4] we developed a new approach. Not only cardiovascular state variables such as 'Contractility' were integrated in the inference process, but also state descriptions for the ventilation, the respiration gases and the oxygen supply. Trend information as well as knowledge about the parameters' behaviour due to events such as 'Increase of the tidal volume' were also considered using temporal reasoning techniques. The alarm concept was implemented in a re-designed EI by colour- and form-coded profilograms for each above mentioned subsystem (s. [1, 4]). The eye-tracking results of our last experiments presented in [1] were used to re-design the EI. To validate the inference engine and the new EI an anaesthesia simulator (BODY Simulation™) was used. Eight anaesthetists performed at least two trials working with the simulator's monitors in combination with the EI. A 'blood loss' was simulated for a 'healthy' and a hypovolemic patient and a 'cuff-leakage' was simulated for a 'healthy' patient and a patient with severe respiration problems (COPD). Further, every minute the anaesthetists were asked to evaluate our intelligent alarms.

Results

Statistical significance for 'cuff-leakage' was more quickly identified (11 of 13 cases, 62 $\pm$ 87s) than in the experiments with the conventional monitors (CM) (6 of 8 cases, 222 $\pm$ 187s) in [1]. Similarly the incident 'blood-loss' was more quickly identified in all cases (136 $\pm$ 67s) than in CM (all cases, 217 $\pm$ 72s) and with our old EI approach (5 of 8 cases, 215 $\pm$ 76s) (s. [1]). The evaluation of 1532 assessed parameter constellations yielded a sensitivity of 96%, a specificity of 95%, and a predictability of 87%.

Conclusion

The results have shown that appropriately designed EIs and intelligent alarms may improve the anaesthetists' decision making and focus attention on specific problems. The alarm validation yielded very good results. However, regarding the latter item it must be taken into account that a *simulated* environment was used and the alarms were assessed in a fuzzy way (e.g., 'The alarm is good/too red'). Now, the findings have to be tested in future studies by widening the scope using other simulated scenarios and actual conditions in the OR.

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THE INTERACTION BETWEEN PROPOFOL AND FENTANYL DURING ICU SEDATION: EFFECTS ON EEG VARIABLES

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The objective of the present study was to evaluate the interaction between propofol and fentanyl with respect to the effects on EEG variables; the auditory evoked potential index (AEPindex), the Bispectral index (BIS), 95% spectral edge frequency (SEF) and median frequency (MF) in intensive care patients.

Methods

After obtaining approval from the Ethics Committee and informed consent, we studied 15 patients undergoing positive pressure ventilation. Fentanyl infusion rates were set at 0.5, 1.0 and 1.5 µg/kg/hr. Each infusion rate was maintained at least for 120 min before the start of the study. Using a TCI system, target blood propofol concentrations were set at 0.5, 1.0, 1.5 and 2.0 µg/ml at random. After at least 15 min had elapsed after achieving the target concentration, the Ramsay sedation score was evaluated and the EEG variables were recorded. The BIS, MF and SEF were measured using an EEG monitor (A-1000, Aspect Medical Systems). The AEPindex was obtained using a similar system to that described in our previous study [1]. Each variable was recorded simultaneously and values averaged over 15 sec intervals. Statistical analyses were performed using the Sperman’s correlation coefficient and the Kruskal-Wallis with Tukey’s tests. $P<0.05$ was considered statistically significant.

Results

The Ramsay sedation score increased with increasing target blood propofol concentrations but was not affected by fentanyl infusion rates. The AEPindex and BIS correlated well with the Ramsay sedation score. With increasing propofol concentrations the AEPindex and BIS decreased (figure) but SEF and MF did not change. The fentanyl infusion rate did not affect any cortical EEG variables; the BIS, SEF or MF. The AEPindexes at a fentanyl infusion rate of 1.5 µg/kg/hr were smaller than those at the rate of 0.5 µg/kg/hr when target propofol concentrations were 0.5 and 1.0 µg/ml.

Discussion

Propofol is a sedative agent and fentanyl mainly has analgesic action. This study revealed that the BIS indicated level of sedation and did not represent level of analgesia, and was superior to SEF and MF. The AEPindex was the only variable that was affected by fentanyl.

Conclusions

The BIS well indicated level of hypnosis and the AEPindex reflected not only hypnosis but also analgesia.

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TARGET CONTROLLED INFUSION (TCI) USING THE "VISUALTCI" PROGRAM SOFTWARE.

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Introduction

In Target Controlled Infusion (TCI), a drug is administered at an infusion rate controlled by a Computer on the ground of a pharmacokinetic-model, in order to obtain a precise blood drug concentration (target). We therefore developed a program software, "VisualTCI", provided with full Infusion-pump control capabilities.

Program Features

"VisualTCI", written in MS Visual Basic 3 as an alpha version and under further development , controls a Vial Pilot Anaesthesia Pump throught an RS323C interface; it generates a script handling the pump's bundle MSDOS software (Vial Pilot) via a keyboard-buffer software. "VisualTCI" accepts patient's antropometric data and any 2 or 3 compartement pharmacokinetic model. The program interface was thought to be user friendly, hence no specific computer knowledge is required to users. Drug Target concentration can be modified by simply typing the new value in the proper input box, and calculated parameters, including drug compartement contents and estimated awakening time are shown. A full log (report) of the whole session is generated in a non-proprietary format (ascii txt file) and can be saved upon user request, thus allowing data importation in statistic or database software. Many security systems have been implemented.

Conclusions

To date, no particular problems have been encountered during the sessions, and the security system guaranteed a good overall functionality of the system. The powerpoints of "VisualTCI" basically consist in its open architecture, multiple pharmacokinetic models implementation capabilities, full handling of the Infusion-pump, full session report generation.

A MICRO-FLUID SYSTEM FOR ACCURATE DRUG ADMINISTRATION

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Medical advantages have posed specific challenges on the administration of insuline, glucocorticoides, cytostatic drugs, analgesics etc. at very low flow rates (1). Additionally, for portable and programmable drug delivery systems specific demands regarding to weight, energy consumption and dosing accuracy must be taken into account.

Utilizing silicon micro-channels (2) for drug and fluid delivery systems approaches these requirements. The micro-channels represent key components in micro-fluid devices with drug delivery applications, if continuous and accurate delivery of a liquid is strongly demanded. The micro-channel acts as a high-precision flow resistor, which is arranged at the fluid outlet of a pressurized drug reservoir. Basically, it operates on a linear relation between pressure (as is exerted on the drug reservoir) and flow, and thereby allows for easy and accurate adjustment of the dosing rate required. The high geometrical accuracy of the micromachining technologies used to produce these components allows for superior device-to-device reproducibility when compared to conventional technologies. Moreover, very low dosing rates in the sub-µl-range can be achieved due to the high miniaturization potential as provided by this technology. The micro-channels are realized as straight flow channels located on the front side of a silicon chip. The channel is covered by a pyrex glass sheet, which is mounted by anodic bonding. The chip size is 1x1x8 mm^2, within this area the channel is folded up to a length of 84 mm (width = 50µm, depth = 21µm). Fig. 1 depicts a front view of a part of the meander-shaped micro-channel. As for fluid delivery standard Luer adapters are attached to either side of the silicon chip.

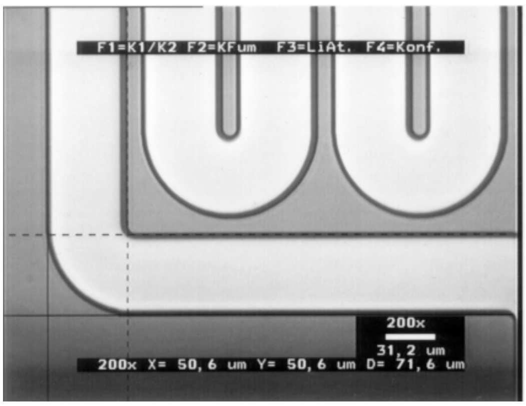

Fig. 1: The microchannel is located on the front side of a silicon chip and covered with a pyrex glass wafer (sectional microscope view, 200x)**.**

However, the dosing rate is predominantly influenced by the temperature dependence of the fluid viscosity, and therefore drug-specific viscosity changes with temperature have to be considered. Given a very small continous water flow of 1.3 µl/min over four days, temperature variations of only 3.5 °C in the laboratory lead to an dosing error of about 6 % if not compensated, but can reliably corrected for by means of an appropriate control system continuously detecting the temperature of the fluid and subsequently modifying the driving pressure on the drug reservoir (Fig. 2).

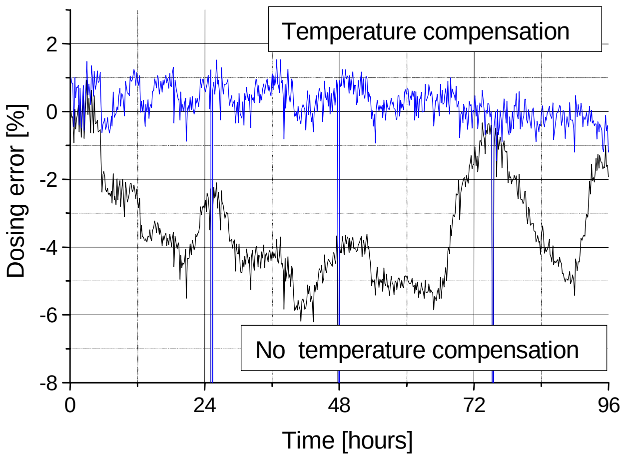

Fig. 2: Compensation for the dosing error of water due to temperature variation.

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PERFORMANCE OF THIRD-GENERATION PULSE OXIMETERS DURING RECOVERY FROM ANESTHESIA

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Introduction

The alarm rates for SpO_2 and pulse of three different third-generation pulse oximeters were studied: *Agilent Viridia CMS 2000*, *Masimo IVY 2000* and *Nellcor Symphony N-3000*. These three pulse oximeters differ from the pulse oximeters of earlier generations by having various sophisticated methods of signal processing; these methods lead to a reduced rate of false alarms (1,2), allow one to calculate more precisely the measured values - even when signals are distorted or weak - and increase the reliability of the calculated SpO_2 values. This study also included the clinical comparison of *Agilent's new algorithm* (analysis of the Fourier transformation spectra), the *Oxismart Technology of Nellcor* (signal shape analysis and alarm management) and the *Masimo SET* (signal extraction technology).

Methods

The reusable sensors of the three pulse oximeters were placed in arbitrary sequence at fingers II, III and IV of the same hand of the patient. The data simultaneously measured by the three pulse oximeters were continuously recorded by a PC. Using the same PC, a clinically experienced examiner documented quasi in real-time the classification of alarm incidents into technical/physiological alarms and into false/correct alarms. Evaluation of data was based on documentation and classification of the alarms (after additional revision of questionable cases). Eventually specificity and sensitivity for each of the above-mentioned pulse oximeters were calculated.

$$\text{Specificity} = \frac{TN}{TN + FP} \qquad \text{Sensitivity} = \frac{TP}{TP + FN}$$

TN true negative alarms, *FP* false positive alarms, *TP* true positive alarms, *FN* false negative alarms

Measurements were performed in ASA I-III patients of age 18 to 75 following emergency and general surgical interventions under general anesthesia, during the postoperative phase in the recovery rooms of the General Hospital, University of Erlangen-Nuremberg.

Results

In 80 patients (corresponding to approximately 120 hours of measuring) with a total of 180 alarm incidents, pulse oximeter alarms were rare: *Agilent*, 120 alarms; *Masimo*, 123 alarms; *Nellcor*, 120 alarms. The specificity calculated from the alarms (see formula) was 0.6 for both

Agilent and *Masimo* and 0.59 for *Nellcor*, while the sensitivity (see formula) was 0.98 for *Agilent*, 0.99 for *Masimo* and 1.0 for *Nellcor*, with both parameters yielding very similar values for all three pulse oximeters (3). The periods for which data were unavailable for technical reasons (dropouts) were pleasingly short with all three pulse oximeters: it was shortest for *Masimo* (1.3% of the measuring time), followed by *Agilent* (2.1%), and it was longest for *Nellcor* (2.6%).

Alarms due to movements were registered in 5% of the patients, alarms due to deficient perfusion in 5% of the patients, and alarms due to dislocation of the sensor in 22% of the patients (4,5). Dislocation was twice with *Agilent* (6.9%), 11 times with *Masimo* (37.9%) and 16 times with *Nellcor* (55.2%), indicating superiority of the *Agilent* sensors (an important secondary aspect).

Discussion

The results suggest (in agreement with our observations) that the three pulse oximeters and the three different signal processing technologies show only negligible differences in their clinical efficiency. As for displacement the *Agilent* device provided for the most reliable sensor instrumentation.

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DEVELOPMENT AND EVALUATION OF A PC-BASED PROGRAM FOR RAPID BEDSIDE CALCULATION OF TEN SEVERITY SCORES IN THE ICU

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Introduction:

Scoring the severity of illness has become routine in daily ICU practice. APACHE II, SAPS II and TISS-28 are the most widely distributed score systems. Apart from being used for research purposes, severity scores serve as a tool for quality management and as an indicator during economic assessments. Due to their complexity, computerization and modularisation of multiple scores in use seemed appropriate to facilitate data entry and score calculation. This paper presents program features and user-specific results of HICAST®, the Hamburg Intensive CAre Scoring Tool, version 1.72 (1).

Methods:

The software platform used was Windows95/98/NT based VisualDBase 7® (Borland, USA), a 32 bit application. A relational database with activeX graphics was created. The runtime module's size is 3.6 MB. Files have the *.dbf format and can be exported into spread-sheet-type software with the ODBC interface. Plausibility and data integrity checks are incorporated. The application was tested by 12 physicians on two anesthesiological ICUs over a period of 3 months in 58 consecutive patients with an ICU stay of > 3 days. Scoring was performed daily on laptop computers. When appropriate, data were transferred from the existing patient data management system (CliniComp, Intl., USA) or entered manually. The scores incorporated according to the original publications consisted of Acute Physiology and Chronic Health Evaluation (APACHE II + predicted death rate), Simplified Acute Physiology Score (SAPSII + probability of mortality), Elebute, Mortality Prediction Model (MPM II), Multiple Organ Dysfunction Score (MODS), Sequential Organ Failure Assessment (SOFA), Sepsis Severity Score (SSS), Therapeutic Intervention Scoring System (TISS28), Injury Severity Score (ISS) and Polytrauma Schluessel (PTS).

Results:

92% of the users found the system to be practical and easy-to-use. Multiple entry of identical data was avoided by the modular structure of the software. Thus, for trained users, the average time needed for daily completion of all ten scores was 12.4±4 min. per patient. The maximum period of time scored for a single patient was 80 days. The problem of incorrect or missing data was successfully approached by an on-line help system and by prompt-based plausibility checks at the time of data entry. According to user requests, a graphical module was added to the software to display daily score values over time. Also, an export feature was added to statistically process selected data sets.

Discussion:

The new score acquisition system effectively enables the clinician to rapidly aggregate patient data on a day-to-day basis. Diagnostic and prognostic evaluation of patients, the assessment of disease progression and the recognition of responders to therapy are made available. Further studies will concentrate on the potential impact of clinical decision making of such a system. Finally, the tool presented here may be valuable in the process of validating and reevaluating physiology- or risk-based severity models that has been called for recently (2).

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AGENT BASED THEATRE MANAGEMENT

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Theatre Management is the complex process of organising patients, personnel and resources within medical, technical and administrative constraints. Although an initial time schedule is prepared in advance, it is very likely that changes occur while carrying out this plan. Adjusting a schedule to these changes requires the awareness of the current situation and its constraints.

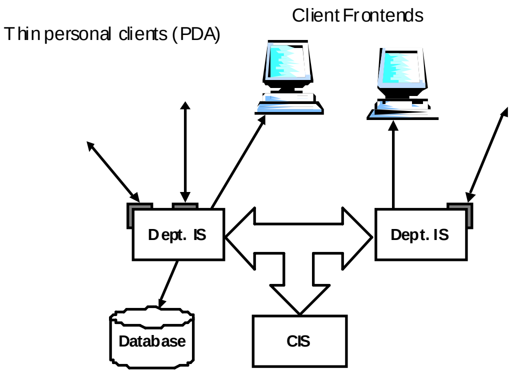
The processes in this scenario depend on a high amount of communication and require information from various sources. Many things happen in parallel and the actual outcome of an action cannot be foreseen in any case. Therefore, involved personnel have to cooperate and react in a flexible manner.

We aim at the development of a system to support the information sharing between the personnel during all work-related tasks. In the beginning, our focus is on the attending anaesthetist in his role as theatre manager.

Our vision is to provide the attending with an intuitive interface to access various kinds of information, e.g. about the status of running operations or the status of a patient still on the ward. With one touch he can call this next patient from the ward, with no further phone call required. If any change to the schedule is required, the attending anaesthetist can enter an update and immediately this change is reflected on all other terminals.

The technical requirements of this complex, dynamic and highly communicative environment can be met by intelligent software agents. Agents act as a virtual representative on the user's behalf. Our system uses different types of agents. Within the clinical information space, *information agents* automatically collect and communicate medical and administrative data. *Task Agents* use this data to execute and monitor user tasks, e.g. a watchdog might monitor an operation to notify others that this operation is about to end. All interaction with the user is done by *interface agents* which notify changes and enable the user to initiate tasks such as calling a patient from the ward. Interface agents could work on thin personal clients such as PDAs

We expect the system to be a great help to the user. At first, pro-actively provision of context specific information supports medical reasoning and planning. Secondly, agents can autonomously perform routine tasks or even analyse incoming data to detect potentially critical situations. Both decrease the information and workload of the staff and shorten communication paths.



Acknowledgements

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NON-INVASIVE ESTIMATION OF PULMONARY GAS EXCHANGE PARAMETERS IN 10-15 MINUTES

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Introduction

Pulmonary gas exchange abnormalities such as pulmonary shunt or ventilation perfusion (V/Q) mismatch are common in different patient groups and may cause hypoxaemia. In the experimental setting estimation of parameters describing these abnormalities is possible using the Multiple Inert Gas Elimination Technique (MIGET) [1]. In clinical practice however, the clinician usually relies on simple measures to describe the abnormality such as arterial oxygen saturation (SaO2) or estimation of “effective shunt”. A more detailed clinical picture of pulmonary gas exchange can be obtained non-invasively by varying inspired oxygen fraction (FiO2) (to achieve SaO2 in the range 90-100%), and estimating the parameters of models of oxygen transport [2,3]. This procedure takes approximately 40 minutes to complete, but with automation of data collection and parameter estimation can be reduced to 10-15minutes.

Methods

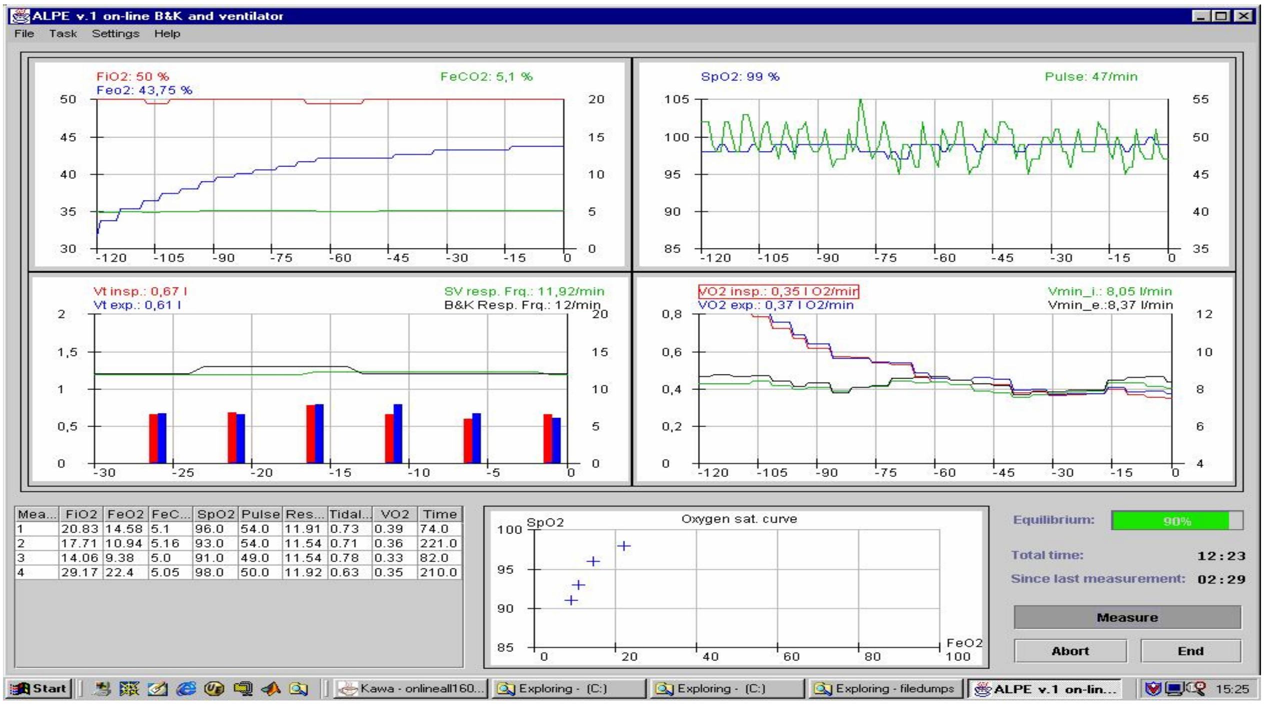
A system has been built for non-invasive, Automatic, Lung Parameter Estimation (ALPE), in 10-15 minutes. This system combines a ventilator (Siemens, Servo 300), a gas analyzer with pulse oximeter (Brüel and Kjær, BK104), and a PC. Air, oxygen and nitrogen are supplied to the ventilator to achieve FiO2 both above and below 21%. The system includes software to control the experimental procedure, for collecting data from the ventilator and gas analyzer, and for estimating the parameters of models of oxygen transport, including parameters describing V/Q mismatch and pulmonary shunt. Pulmonary gas exchange parameters have been obtained for five normal subjects using the ALPE system. In each subject FiO2 was changed in 4-5 steps, oxygen equilibrium achieved, and measurements of ventilation and pulse oximetry recorded automatically.

Results

Figure 1 illustrates the data collection screen of ALPE for one of the normal subjects. The 4 top panels illustrate continuous collection of data from the ventilator and gas analyzer. After a change in FiO2, ALPE notifies the user when oxygen equilibrium is achieved. Clicking the measure button then records a point in the measurements table and on the plot of FeO2/SpO2. At the end of an experiment mathematical models of O2 transport are automatically fitted to this data, giving a simulated FeO2/SpO2 curve. For the five normal subjects, estimation of pulmonary gas exchange parameters took a mean of 13min 46 s, giving pulmonary shunt mean 4.2%, and V/Q mean 0.99.

Discussion

This abstract presents the ALPE system, which may provide a useful non-invasive estimation of pulmonary gas exchange parameters in 10-15 minutes. The ALPE system could have application in monitoring pulmonary gas exchange abnormalities in the ICU, assessing postoperative gas exchange abnormalities [2,3], or in titrating diuretic therapy in patients with heart failure.



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USING A BAYESIAN BELIEF NETWORK TO MODEL INTERACTION OF REMIFENTANIL AND PROPOFOL ON WAKEUP TIME

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Introduction:

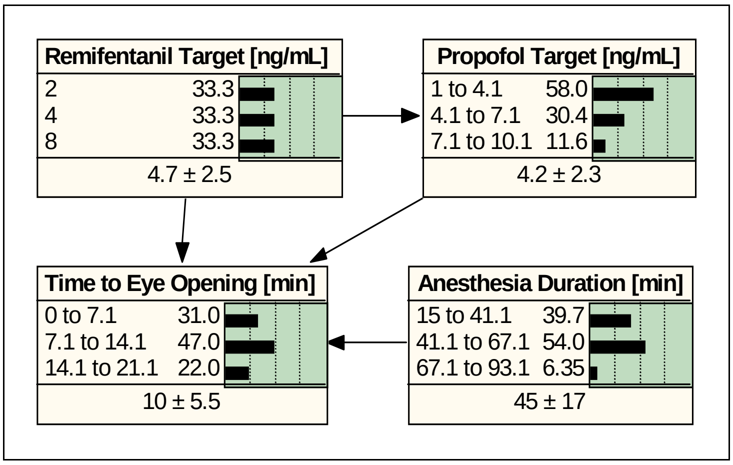
Up to date, the knowledge of combining anaesthetics to obtain adequate depth of anaesthesia and to economise wakeup time has been empirical and difficult to represent in quantitative models. Short acting drugs such as remifentanil and propofol offer exciting new possibilities to measure and control the plasma concentration of anaesthetics. The application of anaesthetics in closed-loop systems where depth of anaesthesia is rendered comparable with surrogate parameters (e.g., the auditory evoked potential index – AEPI) allows collecting of empirical quantitative data. Since there is no reason to expect that action of propofol and remifentanil can be modelled in a simple linear manner, we will demonstrate the use of a new computational approach with Bayesian belief network software.

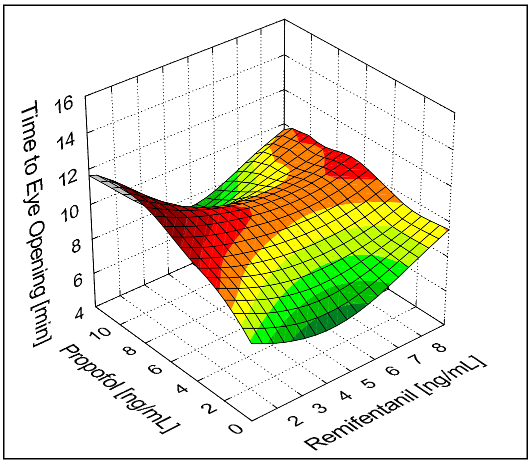
Methods:

We used data collected for other study purposes at the Glasgow University Department where remifentanil was randomly applied in three fixed target concentrations (2, 4, and 8 ng/mL) to 62 subjects. Target concentration of propofol was controlled according to the closed-look system AEPI feedback. Time to open eyes was measured to represent wakeup time after surgery. The NETICA version 1.12 software (Norsys Software Corp., Vancouver, Canada) was used on a custom personal computer for model building and prediction. The Bayesian network was constructed with one node for each variable (Fig. 1). Variables were discretised in few categories (e.g., low, medium, high). Links between nodes were then connected to represent conditional dependency between remifentanil and propofol interacting on the outcome of the wakeup time. Duration of anaesthesia was linked as a confounding variable to the outcome.

Results:

After the learning phase, the network was used to generate a series of random cases whose probability distribution matches that of the compiled network (Fig. 2). These cases can be used as example scenarios of what can be expected if the network represents reality. The sampling algorithms used are precise, so that the frequencies of the simulated cases will exactly approach the probabilities of the network and that of the data learned.





Discussion:

Bayesian belief nets are increasingly used for medical knowledge engineering. Model building and evaluation do not depend on underlying linear relationships. Bayesian relationships represent true features of the represented data sample. Variables may be uncertain, stochastic, or imprecise. Variable attribute values may be on a binary, nominal, ordinary, or continuous scale. Interpreting effects from a compiled Bayesian network may be difficult for the user who is not familiar with the concept of Bayesian methods. The techniques involved are new and still developing. They build on a less established theory as compared to standard statistics. Especially the concept of conditional probability and conditional dependence may not be easily understood by the clinical decision-maker. However, multiple platform software that is easy to learn and use is increasingly available for the novice clinical user. Bayesian nets promise to be versatile tools for building valid, nonlinear, predictive instruments to further gain insight into the complex interaction of anaesthetics.

DATA IMPORT INTO A PATIENT DATA MANAGEMENT SYSTEM

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Introduction

A major advantage of digital patient charts is the data import from other computer systems in a hospital, thus avoiding redundant data entry. A basic requirement is the comprehensive integration of the system enabling the data import from the overall communications architecture of the hospital. With the example of a patient data management system (PDMS) installed at the operative ICU of the Giessen university hospital, a concept for the integration of such a system will be presented and its advantages demonstrated.

Methods

Since 01/01/1999, the patient chart at the operative ICU (14 beds) is recorded with the patient data management system (PDMS) ICUData((Imeso GmbH, H¸ttenberg). The highly modular client-centered approach of ICUData(is founded on a message-based communications architecture. In order to open this communication channel to its broadest possible scope, all messaging between ICUData(components is based on TCP/IP and the emerging Health-Level-7 (HL-7) standard for medical data transfer [1]. Communication between ICUData(components and other data management systems also takes place exclusively through HL-7. Additionally, to enable the transfer of yet undefined messages, ICUData(has placed extensions to the standard. This happened in accordance with the philosophy of HL-7. The developer team participates actively within the German HL-7-Group, and these special definitions will be replaced as soon as widely accepted messages become available. All vital signs and ventilation readings are gathered via RS232 interfaces with a specific driver directly at the local computer. Blood gas analysis readings are also transferred directly into the PDMS data base with a RS232 interface connected to a specific terminal. Patient data and results from the clinical information system (CIS), the central laboratory and the departments of radiology and microbiology are imported via a HL-7 communication server. An anesthesia data set from the anesthesia information management system NarkoData((Imeso GmbH, H¸ttenberg) [2], written as a set of HL-7 messages with the help of the application "NarkoBatch" (Imeso GmbH, H¸ttenberg), is imported into the equivalent fields of the PDMS data base using an additional server service.

Results

From 01/01/1999 until 06/30/2000, data of 2160 patients have been recorded with ICUData(. The above mentioned import mechanisms could not all be installed at the same time, but followed within six months after system implementation. The following amount of data has been imported into the PDMS data base in the respective time period: 615.579 vital sign readings, which means 92,1 % of total, 427.767 ventilation readings (97,9 % of total), 338.876 blood gas analysis data (96,4 % of total), 189.740 laboratory parameters (97,4 % of total) since 01/01/1999, 365 results of X-ray examinations (45,0 % of total since 03/03/1999) and 860 microbiological data sets (52,1 % of total since 03/04/1999). From 06/30/1999 until 06/30/2000, data from 1.218 anesthesia records have been automatically sent to the PDMS and were available upon admission of the patient. In addition to diagnoses, type of surgery and patients' medical history data, the anesthesia record comprises drugs used during anesthesia, intravenous and other catheters, fluid balance and adverse events. Integration of the blood bank and the hospital pharmacy are on their way.

Discussion

Patient data management systems may offer comprehensive and dynamic information at the workstation if they are integrated into other clinical subsystems [3, 4]. If a communication based on standard protocols in a heterogeneous computer environment exists, data of various origin may be integrated into a comprehensive patient chart with relatively little effort. Automated data import from the anesthesia record also improves data quality and supports personnel at the ICU avoiding redundant data entry.

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DIFFERENCES BETWEEN MANUAL AND AUTOMATED DATA COLLECTION OF VITAL SIGNS WITH AN ANAESTHESIA INFORMATION MANAGEMENT SYSTEM (AIMS)

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Introduction

Differences in manual documentation on paper and computerized record- keeping have already been already investigated [1, 2]. There has been so far no report so far about the comparisoncomparing of automatic data- gathering with manual data entry into an AIMS and the effects this may have on the documentation of vital -sign readings. In order to evaluate the influence of automatic data -gathering on the documentation of vital- sign readings within an online anesthesia documenting software, we compared manually entered blood -pressure readings with automatically gathered data. In this study, we focused on the variability of readings and the occurrence of non-plausible readings in particular.

Methods

In 1997 and 1998, data of all procedures, including vital- sign readings, were recorded with the documentation ing software, NarkoData 4 (Imeso GmbH, H¸ttenberg). This data was stored in a relational data base and subsequently evaluated and analyzed with the SQL -based program, Voyant (Brossco Systems, Espoo, Finland). Automatic data- gathering from primary monitors is doneis performed via an RS232-interface serial connection of the RS232-interface of the individual machine with connected to the client computer. Blood- pressure readings could be entered (also parallel or supplementary as well in case of automatic data -gathering) usingvia a pop-up menu with keyboard or per via mouse click directly onto the graphic surface of the anesthesia record. During automatic data- gathering, readings of systolic, diastolic and mean arterial blood- pressure were recorded every 3 to 5 minutes when using noninvasive measurement and every 3 minutes during invasive measurement. In case of manual data-entry, blood- pressure readings were usually entered usually every 5 minutes. The sets of data were split into two groups (, automatic and manual,) based on the method of data collection. These groups were further subdivided according to pre-, intra- and postoperative periods, becausesince anesthesia care is given atdependant on workstations equipped with different types of monitors. Subsequently, we evaluated the influence which automatic data- collection has on the need to correct data, on data validity and variation.

Results

In 37,726 patients, 1,365,282 blood- pressure readings were recorded. This is equivalent to an average of 36 readings per patient, with a standard deviation of 25 readings per blood -pressure parameter (diastolic, mean and systolic blood -pressure). In each investigated period, the incidence of corrected blood- pressure readings gathered automatically was significantly higher than that of manually entered values. During the pre- and postoperative period, values were corrected more often than during the an operation in both groups. The predominant share of non-plausible values are zero values. These were recorded with a higher incidence during automatic data -gathering. A higher incidence was also found for zero values which appeared more often during the pre- and postoperative period. We found a higher incidence of non-plausible (non-zero values) readings during the pre- and postoperative period for automatic data -gathering. However, this was significant for the postoperative period only. During the preoperative period, a higher incidence of non-plausible constellations was recorded with both types of documentation. The variability of automatically collected systolic blood- pressure readings was higher in each period in patients of ASA class I and II as well as in patients of class > III. Regardless of the ASA class, variability decreased from the pre- to the postoperative period. Generally, patients of higher ASA classes showed a higher variability of their systolic blood- pressure readings.

Discussion

An influence of the type of documentation on the quality of data was found. The question of Ifwhether the increased need to correct data during automatic data gathering was caused by artifacts or by the anesthesiologist, who tends to document a smoothed trend, could not be settled sufficiently in this study. But the fact that , despite exclusion of all non-plausible data, automatically gathered blood- pressure readings showed a higher variation, despite exclusion of all non-plausible data, supports the latter hypothesis.

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ASPECTS OF USER ACCEPTANCE OF PATIENT DATA MANAGEMENT SYSTEMS (PDMS)

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Introduction

Patient data management systems (PDMS) are used increasingly in intensive care medicine for computerized record keeping. For an evaluation of the user acceptance of such systems a questionnaire was developed and sent to a number of intensive care units. Results of this survey highlight different aspects of user-friendliness.

Methods

In 1999, 50 questionnaires were sent to 4 different German hospitals and handed out to the ICU staff. The surveyed hospitals are major regional health care facilities with an operative ICU and a minimum of 15 PDMS workstations. PDMS systems used at these hospitals had to be provided by different suppliers. In each hospital the department of Anesthesiology is responsible for the ICU. The questionnaire consisted of 207 items concerning the following aspects: sociodemographic variables, hard- and software, the user interface and special questions on the influence of the computer system on nursing, medical and administrative work.

Results

A total of 84 questionnaires was evaluated. The return of completed forms varied strongly among the hospitals (22-70 %). 60.2 % of all questionnaires were completed by men and 39,8% by women. The question whether the users' general expectations of a documenting system were fulfilled received an overall negative response. Participants of the survey found PDM systems necessary and easy to learn. Efficiency, facilitation of work, clarity of presentation and time saving were judged rather negatively. Questions about the workstation and hardware received a positive response. All those asked were satisfied with stability of the software and data entry via mouse and keyboard, but not satisfied with program performance. The survey showed that the users expect of a new PDM system above all a simple presentation of results, a faster correction of errors, increased user-friendliness, better support during work and time saving. Computerized data import of various parameters and automatic data transfer from different devices was judged very positively by all participants.

Discussion

Despite being generally disappointed by the existing PDM systems, users give a detailed judgement of the different features and performances of these systems. Contrary to other prospective studies [1] and surveys [2] that reports a reduction of documentation time, this was not relevant in our survey. The often-mentioned efficiency and the aspect that work is made easier for the user are not reflected in our results [3, 4]. One reason for this negative attitude is the incomplete connection of PDM systems, and thus data transfer, to other subsystems in the hospital. This is certainly one of the main aspects that has to be improved when new PDM systems are being installed in the near future.

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