SCATA'S 20th ANNIVERSARY (1987-2007)

JOINT
SCATA
ESCTAIC

Scientific Meeting 2007

21st - 23rd NOVEMBER

THE ROYAL COLLEGE OF ANAESTHETISTS, LONDON

SCATA www.scata.org.uk
SOCIETY for COMPUTING and TECHNOLOGY in ANAESTHESIA

ESCTAIC
European Society for Computing and Technology in Anaesthesia and Intensive Care

Contents

Programme

Wednesday 21st November 2007

08:30 **Registration desk opens**

09:00 – 10:30 **SCATA Committee Meeting**

10:30 – 16:30 **The SCATA Information Technology Life Support (ITLS) Course** (see separate handbook)

12:30 – 13:30 **Lunch**

14:00 – 17:00 **ESCTAIC Tutorials**

1 Telework in anesthesia and the intensive care unit

Dr Vincenzo Lanza, Chief of Department of Anesthesia, Ospedale Buccheri La Ferla, Fatebenefratelli, Palermo, Italy

2 What role can linux play in daily medical practice?

Dr Frank O'Connor, Consultant Anesthesiologist, Operating Theatre & Pain Relief Clinic Amphia Ziekenhuis Breda, Oosterhout, The Netherlands

3 Computerized clinical guidelines

Mr Martin Sedlmayr, Researcher, Fraunhofer Institut für Angewandte Informationstechnik, St. Augustin, Germany

4 Physiological models - from model formulation to clinical applications

Stephen Rees, Associate Professor, Centre for Model-Based Medical Decision Support, Aalborg University, Aalborg, Denmark

This tutorial goes through some of the fundamentals of building physiological models, and is intended to give the inexperienced a feel for how to build such models, and how they can be used to help clinical understanding. It will present different types of models, and their applications in a range of fields relevant to SCATA and ESCTAIC members.

14:00 – 17:00 **SCATA Working Groups**

1 Clinical terminology and document structures

Working Group Leaders: Dr Andrew Norton, Dr Martin Hurrell

SCATA participates in initiatives to develop controlled terminology for anaesthesia within SNOMED CT, the terminology standard adopted for the National Programme for IT within the NHS. Other areas of activity include standards for anaesthetic document structures aligned to the Health Level 7 (HL7) Clinical Document Architecture, input into pre-assessment standards and documentation in the NHS Connecting for Health Do Once and Share pre-assessment project and recommendations for the anesthetic content of the NHS summary care ("Spine") record.

2 Portfolio Project

Working Group Leaders: Dr Grant Forrest, Dr Alan Hope

SCATA has developed web based and PDA based software to support anaesthetists' requirements to document activity for continuing professional development and revalidation. This working group provides an opportunity to contribute to development and testing of this software.

3 SCATA Educational projects

Working Group Leaders: Dr Ranjit Verma, Dr Jim Berrington

SCATA has developed and delivered the ITLS (Information Technology Life Support) Course since 2004. This course delivers an introduction to health informatics designed to cover the necessary trainee competencies outlined by the Royal College of Anaesthetists. SCATA members have also designed and delivered PowerPoint courses at major anaesthetic meetings and are involved in planning content for the Surgery, Theatres and Anaesthesia sub-library in the National Electronic Library for Health. This working group will focus on the content, planning and delivery of SCATA educational courses and resources.

19:00 – Late **River Thames Boat Cruise** (see following details)

Thursday 22nd November 2007

08:30 **Registration Desk Opens**

09:10 – 09:30 **Welcome and Opening Remarks**
Dr Ranjit Verma, Chairman of SCATA, Derby, UK
Dr Giulio Trilló, Chairman of ESCTAIC, Trieste, Italy

09:30 – 11:00 Session I – [Organised by SCATA]
NON-INVASIVE OR MINIMALLY INVASIVE CARDIAC OUTPUT MEASUREMENT
Chairman: Dr Richard Dunnill, UK

a Technologies for minimally invasive cardiac output measurement.
Dr Max Jonas, Consultant in Intensive Care, Southampton University Hospitals, Southampton, UK

b Cardiovascular physiology and algorithms for minimally invasive cardiac output measurement.
Dr Karen Stuart-Smith, Consultant Anaesthetist, Glan Clwyd Hospital, Rhyl, UK

c Cardiac output measurement in goal-directed therapy.
Dr David Bennett, Consultant in Intensive Care, St George's Hospital, London, UK

11:00 – 11:30 **Refreshments & Trade Exhibition**

11:30 – 13:00 Session II – [Organised by ESCTAIC]
eMANAGEMENT, eLEARNING AND eCARE IN THE OPERATING ROOM & INTENSIVE CARE
Chairman: Dr Philippe Mavoungou, France

a HealthGrid: Towards collaborative and on-demand healthcare.
Prof Chun-His Huang, Assistant Professor, Department of Computer Science & Engineering, University of Connecticut, Storrs, Connecticut, USA

b Web-learning: Current and future solutions for web based education.
Mr Marco Sajeva, Department for Software Development, Visioni Network, Palermo, Italy

c Tablet PCs and Pocket PCs in the operating room and intensive care units.
Dr Vincenzo Lanza, Chief, Department of Anaesthesia, Ospedale Buccheri La Ferla Fatebenefratelli, Palermo, Italy

d Computerized clinical guidelines.
Mr Martin Sedlmayr, Researcher, Fraunhofer Institut für angewandte Informationstechnik, St Augustin, Germany

13:00 – 14:00 **Buffet Lunch & Trade Exhibition**

14:00 – 15:30 Session III – [Organised by the Americans]
EXTENDING OUR REACH BEYOND THE OPERATING ROOM
Chairman: Dr Ranjit Verma, UK

a In-flight emergencies: techniques, physiology and epidemiology.
Prof Keith Ruskin, Professor of Anaesthesiology and Neurosurgery, Yale University School of Medicine, New Haven, Connecticut, USA

b Advances in anaesthesia monitoring technology.
Prof Marc J Bloom, Associate Professor and Director of Neuroanaesthesia Program, New York University, New York, USA

c Controlling data flow enhances anesthesiology's role in perioperative care.
Prof David L Reich, Professor and Chair of Anesthesiology, Mount Sinai School of Medicine, New York, USA

15:30 – 15:30 **Refreshments & Trade Exhibition**

15:30 – 17:30 Session IV
FREE PAPERS I
Chairman: Dr Giulio Trilló, Italy

19:30 for 20:00 **Presidential Reception and SCATA Dinner** (see following details)

Friday 23rd November 2007

08:30 Registration Desk Opens

09:00 – 10:30 Session V – [Organized by ESCTAIC]
MEDICO-ERGONOMICS IN EMERGENCY ROOMS, OPERATING ROOMS & INTENSIVE CARE UNITS – WHAT'S STATE-OF-THE-ART?
Chairman: Prof Keith Ruskin, USA

Medico-ergonomics in emergency rooms, operating rooms and intensive care units…….

a …..what's state of the art in medical rescue?
Dr Giulio Trilló, Regional Helicopter Emergency Medical Service University Hospital, "S. Maria d. Misericordia" 33100 Udine, Italy

b …..what's state of the art in the intensive care unit?
Prof Wolfgang Koller – Assistant Professor and Head of the Trauma Intensive Care Unit, University of Innsbruck, Innsbruck, Austria

c …..what's state of the art in the design of medical products?
Prof Wolfgang Friesdorf, Head of the Department for Human Factors Engineering & Ergonomics, Technical University of Berlin, Berlin, Germany

d …..what's state of the art in the design of clinical workflows?
Dr Ingo Marsolek, Staff Researcher & University Lecturer, Department for Human Factors Engineering & Ergonomics, Technical University of Berlin, Berlin, Germany

10:30 – 11:00 **Refreshments & Trade Exhibition**

11:00 – 12:00 Session VI – [Organized by SFIMAR]
INTRAVENOUS ANAESTHESIA (IVA) ~ TARGET CONTROLLED INFUSION (TCI): FROM OPEN LOOP TO CLOSED LOOP
Chairman: Dr Ingo Marsolek, Germany

a Open loop target controlled infusion (TCI).
Dr Véronique Crinquette, Staff Anaesthesiologist, Lille University Hospital, Lille, France

b Semi-closed loop.
Prof Luc Barvais, Professor and Chairman of Department of Anaesthesia, Bruxelles Erasmus University Hospital, Bruxelles, Belgium

c Closed loop intravenous anaesthesia, my clinical experience.
Dr Ngai Liu, Staff Anaesthesiologist, Foch Hospital, Suresnes, France

12:00 – 14:00 Sessions VII
SCATA and ESCTAIC Annual General Meetings followed by **Lunch**

14:00 – 15:00 Session VIII
FREE PAPERS II
Chairman: Dr Alastair Lack, UK

15:00 – 16:30 Session IX – [Organized by SCATA]
INNOVATIVE DEVELOPMENTS IN ANAESTHESIA
Chairman: Dr Tony Madden, UK

a Bilateral brain function monitoring.
Dr Chris Pomfrett, University of Manchester, Oxford Street, Manchester, UK

b What's new in pulse oximetry?
Prof Kirk Shelley, Associate Professor of Anesthesiology, Yale University School of Medicine, New Haven, Connecticut, USA

c My-Anaesthesia-Space – A shared space in which to work, rest and play – a personal view.
Dr Felix Jackson, London, UK

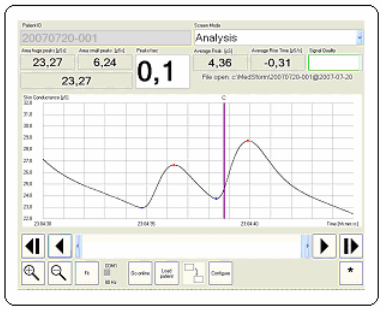
16:30 **Closing Remarks, Refreshments and Depart**

Delegates

Delegate	Organisation
Abdelrahman, Moataz	Manchester Childrens' Hospital
Arnot-Smith, Jonathan	North West Deanery
Aseri, Salmin	Deby City Hospital
Ashford, Peter	Manchester Childrens' Hospital
Avidan, Alexander	Hadassah Hebrew University Medical Centre
Ayorinde, Bolaji	Leicester Royal Infirmary
Barclay, Philip	Liverpool Women's Hospital
Barham, Chris	Queen Victoria Hospital, East Grinstead
Barner, Christoph	Charite
Barvais, Luc	Hôpital Universitaire Erasme
Bennett, David	St George's Hospital, London
Berrington, Jim	Royal Bournemouth Hospital
Bloom, Marc	New York University
Boemke, Willehad	Charité Campus Virchow Klinikum und Campus Charité
Bothma, Pieter	James Paget Hospital, Great Yarmouth
Connell, Henry	Auckland District Health Board
Cooper, Paul	North Tyneside Hospital
Crinquette, Veronique	Centre Hospitalier Régional Universitaire de Lille
Critchley, Lester	Chinese University of Hong Kong
Crowley, Mark	Oxford Radcliffe Hospital
Daniel, Nirmal	
Das, Summit	John Radcliffe Hospital
Donovan, Andrew	Peninsular Medical School
Dunnill, Richard	Retired (Bournemouth)
Emerantia Jacintha, Francis	Stoke School of Anaesthesia
Entwistle, Michael	Princess Margaret Hospital, Swindon
Fernando, Premendra	Luton & Dunstable
Forrest, Grant	Queen Margaret Hospital, Dunfermline
Foster, Susannah	Mayday
Freeman, Robin	STH NHS Foundation Trust
Friesdorf, Wolfgang	Technical University Berlin
Geoghegan, James	University of Birmingham NHS Trust
Hopkins, Chris	Charing Cross Hospital
Huang, Chun-His	University of Connecticut
Jackson, Felix	eBusiness Medical Advisor
Jones, David	Royal Gwent Hospital, Newport
Jordan, Michael	St Peter's Hospital, Chertsey
Jouffe, Lionel	
Kashoulis, George	
Krummreich, Lutz	Dräger Medical
Lack, Alastair	Retired (Salisbury)
Lane, Colm	Cork University Hospital
Lanza, Vincenzo	Journal of Clinical Monitoring and Computing
Lesser, Piers	Calderdale Royal Hospital
Lim, Michael	Llandough Hospital and University Hospital of Wales
Liu, Ngai	Foch Hospital
Lorenz, K	University of Wuerzburg Hospitals
Madden, Anthony	Southmead Hospital, Bristol
Marsolek, Ingo	Technical University of Berlin
Mavoungou, Philippe	Chairman of SFIMAR
Mishra, Amit	Imperial (NW Thames), London

Delegate	Organisation
Moors, Anthony	Russells Hall Hospital, Dudley
Moser, Walter	LKH Klagenfurt
Muirhead, Richard	Rotherham General Hospital
Nagy, Geza	Anaesthesia and ICU
Ng, Chi	University College London Hospital
Nickalls, Dick	City Hospital, Nottingham
Norton, Andrew	Pilgrim Hospital, Boston
O'Connor, Frank	Amphiaziekenuis
Panis, Anastasia	Concord Hospital
Pomfrett, Chris	The University of Manchester
Ramayya, Pradeep	AxSys Technology Ltd
Ramessur, Suneil	East Surrey Hospital
Ray, Dominic	Golden Jubilee National Hospital, Glasgow
Read, Martyn	University Hospital of Wales
Rees, Stephen	Aalborg University
Reich, David	Mount Sinai Medical Center, New York
Reide, Peter	Imperial Hospital
Renna, Maurizio	Ealing Hospital
Ruskin, Keith	Yale University School of Medicine
Sajeva, Marco	Università Degli Studi di Palermo
Sale, Steve	Bristol Rotation
Sathishkumar, S	Bournemouth & Poole Hospitals
Schnekenburger, Marc	ISM
Schrader, Gunther	Aarlius University Hospital
Sedlmayr, Matrin	Fraunhofer FIT
Shelley, Kirk	Yale University School of Medicine
Shewan, David	Lincoln County
Sidwell, Ian	Taunton & Somerset NHS Trust
Smith, Anthony	Stoke
Stuart-Smith, Karen	Glan Clwyd Hospital, Rhyl
Tackley, Roger	Torbay
Thoms, Gavin	Manchester Royal Infirmary
Trillò, Giulio	Regional Helicopter Emergency Medical Service University Hospital
van Dusseldorp, Albert	VU Medical Centre, Amsterdam
van Schagen, Nico	VU Medical Centre, Amsterdam
Verma, Ranjit	Derby City General Hospital
Watt, Jim	University of Birmingham NHS Trust
Wauchob, Todd	Liverpool Women's Hospital
Weaver, Mike	Freeman Hospital
Wilson, Jason	Charing Cross Hospital
Zielke, Hendrik	Charité University Hospital

Trade Exhibitors



MED-STORM innovation

Med-Storm Stress Detector™ or Skin Conductance Monitoring System

A breakthrough solution to monitor pain and pain relief

A unique solution

When patients are incapable of communicating pain or stress themselves another means of monitoring has to be found. Med-Storm Stress Detector™ is a complete stress monitoring solution based on the principles of skin conductance changes, a unique way to easily monitor pain and enable immediate (1-2 seconds) and appropriate responses. The Med-Storm Stress Detector™ directly measures sympathetic nerve activity (acetyl choline acting on muscarine receptors). Output can be used to differentiate pain stimuli or lack of analgesics from awareness stimuli or lack of hypnotics. The technology is covered by patents and patent application assigned to Med-Storm Innovation.

Based on research

Med-Storm Stress Detector™ has been developed based on award winning research with 30 published and 10 other studies carried out within the US, Australia and Europe with 2,500 patients examined. The Stress Detector is more accurate than measuring heart rate and blood pressure. The Stress Detector is unaffected by conditions such as heart disease, hypertension, lung disease, circulatory changes, medications that influence blood circulation or muscle relaxants.

Key application areas: Anesthesia, preterm infants, critical care, post operation.

More information: hanne@med-storm.no www.med-storm.com

SPACELABS Healthcare

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Over the past two years Spacelabs Healthcare has been consolidating its business and expanding its portfolio with the acquisitions of Blease Medical (Anaesthesia) and Delmar Reynolds (Diagnostic Cardiology). Our research and development pedigree stretches back sixty years and the Company is now emerging as a major player in the healthcare industry. Renowned for our IT capabilities we continue to develop innovative ways to analyse and distribute data improving information flow, interpretation and ultimately patient safety.

Social Events

Wednesday 21st November – River Thames Boat Cruise

Join us for a boat cruise on the River Thames with buffet dinner and a complimentary drink. A coach will leave the **Hotel Russell at 19:00** and will take us to Swan Pier on the River Thames. Our boat trip starts at 8pm and we will return to Swan Pier at midnight when the coach will return us to the Hotel Russell.

If you would like more information, please visit www.thamesleisure.co.uk and the boat is Miyuki Maru.

Time: 19:00

Location: Hotel Russell, 1-8 Russell Square, Bloomsbury, London

Dress: Informal

Please note: The bar does not take credit cards or Euros.

Thursday 22nd November – SCATA's 20th Anniversary Dinner

This year marks SCATA's 20th Anniversary and we will be celebrating the occasion at our Annual Dinner to be held in the Fitzroy Doll's Restaurant at the Hotel Russell. There will be a presidential reception with a complementary drink, a three course meal with wine and live classical music followed by the obligatory speeches and a short history of SCATA.

Time: 19:30 for 20:00

Location: Fitzroy Doll's Restaurant, Hotel Russell, 1-8 Russell Square, Bloomsbury, London

Dress: Lounge suits

Please note: The bar does not take Euros.

Lobby at the Hotel Russell

Lecture Abstracts

(Thursday Session I Lecture b)

Cardiac Physiology And Algorithims For Minimally Invasive Cardiac Output Measurement

Relevance to the management of sepsis

Dr Karen Stuart-Smith, Consultant Anaesthetist

Glan Clwyd Hospital, Rhyl, UK

Fluid management in septic shock, and the optimisation of cardiac output in sepsis, have been a matter of intense debate-and changes in management fashion-for 30 years. A major advance in the assessment and treatment of septic patient was considered to be the measurement of cardiac output, and derived indices such as systemic vascular resistance, via the pulmonary artery catheter (PAC). Although use of the PAC has not been shown to improve outcome in septic shock[1], cardiac output continues to be considered to be an important index in sepsis management. The perceived problem that the PAC is an invasive monitor with potential complications[1] has led several companies to develop 'minimally invasive' cardiac output monitoring. In general these devices depend on analysis of the arterial pulse wave, measured at either the radial or femoral artery-pulse contour analysis. Individual company algorithims arise from modifications of Wesseling's three-element model of an arterial pressure pulse propagated along a vessel[2].

Cardiac output measurement via minimally invasive devices has been shown to correlate well with the PAC, long considered the gold standard. Unfortunately, like the PAC, these devices have not yet been shown to have a beneficial impact on the outcome in sepsis[3]. This is in contrast to the clinical results in early goal directed therapy, where aggressive early fluid management may improve the outcome in elective major surgery and acutely ill patients. This talk will consider the following:

1 The PAC was originally designed for use in cardiac patients, and so makes assumptions about the quality of the cardiac muscle and arterial tone which may not be relevant to sepsis. This would explain the lack of effect of the PAC on outcome.
2 Minimally invasive cardiac output monitors are designed to make the same assumptions, and may compound the problem by not sufficiently taking into account the greater distensibility of septic vessels and wider recruitment of vascular beds (secondary to nitric oxide production from white cells) that may dampen the pulse pressure signal in endotoxaemia.
3 Early goal directed therapy managed via oesophageal Doppler or pulse contour analysis is of most benefit in the elective patient undergoing major surgery, where the myocardium, vascular endothelium and smooth muscle are still relatively normal. Patients in the very early (within 6 hours) stages of sepsis may also benefit provided cardiac and smooth muscle tone have not yet been compromised by endotoxins and cytokines.
4 Other monitors of cardiac performance may be of greater use in advanced sepsis, such as the ability of the septic myocardium to develop force (i.e. dP/dt), and markers of peripheral perfusion such as imaging of capillary filling may give a more accurate picture of the septic circulation. Research is urgently required in this area.

References

1 Hadian M and Pinsky MR. Evidence-based review of the use of the pulmonary artery catheter: impact data and complications. ***Critical Care*** 2006;**10(Suppl 3):**S8

2 Wesseling KH et al. Computation of aortic flow from pressure in humans using a non-linear, three-element model. *J Appl Physiol* 1993;**74:**2566-2573

3 Uchino S et al. Pulmonary artery catheter versus pulse contour analysis: a prospective epidemiological study. *Critical Care* 2006;**10:**R174

(Thursday Session I Lecture c)

Cardiac Output Measurement in Goal-Directed Therapy

Dr David Bennett, Consultant in Intensive Care

St George's Hospital, London

Oxygen delivery which is principally determined by cardiac output is one of the main factors deciding prognosis in patients undergoing high risk surgery. It has been estimated there are up to 250,000 in the such patients annually in the UK. These are a group of patients who have a 28 day post-operative mortality of greater than 5% with overall mean mortality of more than 12%. Only about 14% of these are admitted to intensive care.

More than 30 years ago Shoemaker and his colleagues having establishes the importance of oxygen delivery in determining outcome showed that the median value for oxygen delivery for 70% of patients who survived major surgery was 600ml/mim/m2 . He suggested that as this was associated with spontaneous survival it should become the goal to aim for in patients undergoing major procedures. He published a paper in 1988 in which a pulmonary catheter was used to measure

oxygen delivery which was increased to the goal of 600ml/mim/m2 the peri-operative period. This led to a more than 25% absolute reduction in mortality.

A substantial series of papers has since followed using a variety of technologies and protocols to achieve the same aims. In the past ten years intra-oesphageal Doppler has been utilised in a series of studies to maximise stroke volume both intra and post operatively and has consistently resulted in significant reduction in post operative complications and length of hospital stay. Other studies using pulmonary artery catheters have produced less consistent results.

More recently calibrated pulse contour analysis has been been applied to high risk post operative patients again to target oxygen delivery resulting in more than a 50% reduction in complication rate a 12 day reduction in length of hospital stay.

Within the last few months an intra-operative study was published that ensured patients were optimally filled by reducing pulse pressure variation to below 10% resulting in significant reductions in hospital stay and complications.

(Thursday Session II Lecture a)

Health-Grid: Towards Collaborative and On-Demand Health-care

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Vincenzo Lanza (lanza@unipa.it), MD, Dept. of Anesthesia, Ospedale Buccheri la Ferla Hospital, Palermo, Italy

Introduction

Health-care related research and practice often produce tremendous amount of data. These data are usually geographically distributed among hospitals, clinics, research labs, radiology centers, etc. For research, training or clinical purposes, physicians and medical researchers often need to consult and analyze medical data from distributed sites. The on-demand integration and automated analysis of these data in a real-time manner will provide significant convenience and is therefore increasingly needed. However, due to the sensitive nature of these data and the lack of an effective integration approach, nowadays medical data are often stored and archived inside each data producer and are usually disconnected from the outside world to enforce security issues. The massive computing power nowadays can be applied to help doctors make diagnoses and treatment decisions. With the advent of the internet, new standard practices could be communicated to doctors within months rather than 15 years, the current lag between discovery and practice. In addition, pharmaceutical companies with access to anonymous health data could improve and speed up drug development. The dynamic networking technology today will have the potential to allow hospitals in rural areas to securely access expensive medical equipment located in peer medical institutes in a real-time manner.

Methods

The Grids represent a rapidly emerging and expanding technology that allows geographically distributed resources (CPU cycles, data storage, sensors, visualization devices, and a wide variety of internet-ready instruments), which are under distinct control, to be linked together in a transparent fashion [BFH03, FK99]. The power of the Grid lays not only in the aggregate computing power, data storage, and network bandwidth that can readily be brought to bear on a particular problem, but on its ease of use. After a decade's research effort, Grids are moving out of research laboratories into early-adopter production systems, such as the Computational Grid for certain computation-intensive applications, the Data Grid for distributed and optimized storage of large amounts of accessible data, as well as the Knowledge Grid for intelligent use of the Data Grid for knowledge creation and tools to all users.

The grid infrastructure, while applied to health-care, will have the potential to, for instance, allow physicians to get secure access to patients' medical image files and send hybrid requests over distributed data bases. Radiologists from geographically dispersed hospitals can also share standardized mammograms, compare diagnoses, and perform sophisticated epidemiological studies across (national) boundaries, all in a real-time and on-demand manner.

Results

Example projects addressing these challenges include sharing datasets to enable a cure for cancer [caBig07, ACGT07], science portals that enable neuroscientists to better visualize the morphology of the brain [BIRN07], and a mobile grid framework to allow heart monitoring and emergency service for participating patients within the virtual health-care organization [AC05]. These and many other projects have begun to demonstrate the power and potential of the grid approach in health-care and in biomedicine.

Conclusion

Health-care research and practice increasingly rely on globally distributed information and knowledge repositories. The quality and performance of future computing and storage infrastructure in support of such research depends heavily on the ability to exploit these repositories, to integrate these resources with local information processing environments in a flexible and intuitive way, and to support information extraction and analysis in a timely and on-demand manner. Modern information technology and grid infrastructure may provide a viable solution. However, a few research issues remain to be tackled.

Ethics The deployment of Health-grid technologies will inevitably foster the sharing of information from

molecular, individual to population levels. Releasing personal genomic data, even with consent, implies a de facto release of information pertaining to related individuals. Protocols generally agreed upon are yet to be worked out. In addition, the uniqueness of personal genotype often renders anonymity of the information source difficult. Strict regulations need to be devised to keep such information from being abused.

Interoperability A fundamental issue for the success of Grid technologies supporting health-care research and practice will be the interoperability at the levels of health-data format, middleware and the system architectures. At present these issues have not been settled, although various solutions have been suggested, such as the Open Grid Service Architecture (OGSA). The compatibility of diverse security models and the translation of different high-level protocols, which specify actions in the Grid, are the critical elements for interoperability. Besides, protocols for building a uniform format/interface for health data are still under heavy development, though medical professionals have been so attempting (e.g. PACS for picture archiving and communication systems, HIPAA for confidentiality and privacy of patient information, etc.).

Liability/Legal Issues The issue in regards to the determination of the person(s)/institute(s) liable in case of medical accidents or errors pertaining to the use of Health-grid while providing health-care to a patient is crucial. For an international virtual organization enabled by the Health-grid, such issues become far more complicated. As an initial step towards the determination of jurisdiction, the European Union has adopted the Council Regulation (EC) No 44/2001 on December 22, 2000 on jurisdiction and the recognition and enforcement of judgments in civil and commercial matters [HG94].

Security Most ongoing Grid developments have emerged from a high-performance computing context. However, a large number of health-care applications rely on the sharing and exploitation of large amounts of globally distributed data and information repositories as opposed to computation resources. Besides, data management and replication mechanisms proposed by the current grid middleware mainly deal with flat files. Data access control is handled at a file level. In certain data-grid projects, user authentication relies on the asymmetric key-based Globus Grid Security Infrastructure layer (GSI) [BE00]. File access is controlled through Access Control Lists (ACL). This infrastructure does not take into consideration metadata. Note that metadata plays an important role in the health-care database management systems, and an effective abstraction of the health-data is essential in its storage, access, organization and authentication in the Health-grid environment.

References

[ACGT07] ACGT Project, http://www.eu-acgt.org

[AC05] The Akogrimo Consortium, http://www.mobilegrids.org

[BFH03] Berman, F., Fox, G., and Hey, T. *Grid Computing: Making the Global Infrastructure a Reality*. John Wiley & Sons (2003).

[BIRN07] BIRN Project, http://www.nbirn.net

[BE00] Butler, R., Engert, D., Foster, I., Kesselman, C., Tuecke, S., Volmer, J., and Welch, V. *A National-Scale Authentication Infrastructure*. IEEE Transactions on Computer, 33(12) (2000), 60–66.

[caBIG07] caBIG Project, http://cabig.nci.nih.gov

[FK99] Foster, I., and Kesselman, C. *The Grid: Blueprint for a New Computing Infrastructure*. Morgan Kaufmann, San Francisco, 1999.

[HG94] Health-Grid Association. *Health-Grid White Paper*. 1994.

(Thursday Session II Lecture b)

Web-learning: Current and future solutions for web based education

Authors: Marco Sajeva, Vincenzo Lanza

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Introduction

The definition of the term *e-learning* is still a work in progress [1]: this is due to the fact that technologies evolve every day and it is difficult to improve teaching methodologies or to adapt traditional ones to a new or already existing educational model.

The European Community does believe in lifelong learning projects and that is why it is funding several research projects to define the new common market place for the tomorrow educational system: this is leading toward new frontiers like virtual Erasmus inter-exchange programs based on e-learning. At the same time, the use of Web based education can help small hospitals and departments [2] to improve the quality of lifelong learning programs reducing the total cost of management. This is possible using open source solutions and brand new methodologies that use low cost technologies, as Moodle, for example. The advanced use of rich multimedia content [3] in distance learning projects can lead to the development of transnational virtual circles of

Universities as it is happening in several European research projects, like e-Report.

Methods

In this paper we will define the use of Web based e-learning programs, also named Web-learning based system, and we will understand it is as "*a learning method based on the mutual interaction of a group of students through a web based LMS (Learning Management System)*".

To build a Web-learning educational program we must focus on two aspects:

1 methodology to build rich multimedia teaching files that can support educational modules;

2 interaction between students, teachers and tutors.

Besides this, a Web learning platform (LMS) must be used to ensure the interaction of the students using the web browser: this system must be based on solid technological infrastructure developed with as many degrees of freedom for the user, but also for the lecturer that, with the help of the multimedia editor, develops his lessons and materials [4]. The introduction of open source solutions can lower the TCO (Total Cost of Ownership) in a very significant way, an this can be a key factor for small hospitals and departments that want to start an homemade Web learning system [5].

Results

The University of Palermo has about 70.000 students, placed along five Sicilian provinces. The educational supply, that consists in 195 educational and training courses, is managed by a central educational pole and 4 provincial decentred poles. The University of Palermo has a consolidated experience in the field of distance learning; this University actually belongs to an Italian consortium between universities and enterprises for the realization of degree courses (Nettuno – Network for the University everywhere). Moreover, three system projects, related to e-learning and distance learning and funded by the EU, are in progress: *Centrico* , aimed at enhancing the supply of scientific and technological tools in the field of ICT and e-learning; *TutorFad* , aimed at realising a network for the distance learning in the five educational poles of the University of Palermo; *e-Report* aimed at setting up an European transnational virtual study circle.

We moved more than 50 courses in full Web-learning and more than 100 courses in blended-learning, that means that part of the teaching is done in traditional classroom and part is done on the LMS platform. At the same time, the *e-Report project* (finished on September the 30th 2007) gave us an interesting feedback on the possibility to move University full Web-learning courses to VET (Vocational Educational Training) centres [6].

It is also interesting to note that the medical community of all Europe has defined C.M.E. (Continuing Medical Education) programs for physicians and trained nurses (in Italy, we have the E.C.M.); however it is well known that this kind of education requires high cost that can be prohibitive for small hospitals and departments. E-learning tools can be used in anaesthesia departments to train qualifying students, to improve the self-learning experience, but also it can be used as an alternative method to fulfil a low-budget C.M.E. program. In Italy, the SIAARTI (*Società Italiana Anestesia, Analgesia, Rianimazione e Terapia Intensiva* – Italian Society for Anaesthesia and ICU) has established an ICT task force to promote the use of e-learning in anaesthesia and ICU long-life learning programs.

Conclusions

The focal point of Web based education is in the quality of the content: only high quality multimedia rich teaching files designed just with clear e-learning educational models (that is, designed with the keywords "cooperative learning" and "tutoring" always in mind) will ensure the success of a e-learning course. The future of e-learning should aim at the creation of guidelines for the creation of content that should be useable by anybody interested in sharing knowledge. This could be achieved by the use of Open Source license, like Creative Commons, or more specific license that could be developed for the occurrence.

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(Thursday Session II Lecture d)

Computerized clinical guidelines - background, technologies and vision

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Clinical practice guidelines are "systematically developed statements to assist practitioner decisions about appropriate health actions for specific clinical circumstances" (Field/Lohr, Institute of Medicine, 1990). Such structured care plans are aimed to reduce variability, to reduce costs and to increase quality of care by describing essential steps in the care of patients with a specific clinical problem. An increasing number of quality management procedures in addition with cost pressures fosters the application of best practices according to evidence-based standards [1]. This body of information about patient care and treatment is constantly growing due to its promotion by organizations around the world: Internet portals such as http://www.guidelines.gov and http://www.leinlinien.de offer access to thousands of guidelines in free text formats, HTML, Microsoft Word or PDF.

Research on the support of medical processes can be traced back as early as the 70s when expert systems offered support in the execution of medical guidelines such as ONCOCIN [2]. At that time, those systems were standalone expert shells requiring manual input of patient data due to a lack of electronic patient records. In addition, as stand-alone tools they were not integrated into the clinical workflow, but external applications that required massive user attendance. Today, recent patient data management systems (PDMS) offer electronic access to the complete dataset of a patient, enabling the development and broad application of online support systems by integration of automated guidelines.

Automating office and production processes has fostered the development of various kinds of workflow systems for many years and numerous standards exist (see e.g. www.ebpml.org or www.bpm-guide.de), which differ by support for different standards, products, vendors or domains [3]. But workflow systems only come to their full potential when standardized and fixed process flows exist: clinical guidelines do not represent process models as required by workflow management tools. They are rather a set of rules that gather knowledge about patient care and medical treatment of which some of them include process fragments.

Therefore, during the last decade a number of methods have been proposed to support the computerization of clinical guidelines [4, 5]. These vary from XML based, semi-structured document formats over rule-based decision support systems to workflow-like execution systems (see http://www.openclinical.org for a comprehensive list).

The intention in which a guideline modeling system has been developed significantly influences the scope of the model: support for different types of guidelines, different modes of use, adaptation of guidelines for local use, integration with institutional systems, revision tracking, and managing complexity. Hence, different representation formalisms and computational techniques, such as rule-based, logic-based, networked-based and workflow-like, are used and each system puts a specific emphasize only on certain aspects, such as specification of intentions, chronic diseases or formal languages [6].

In the end, the models shall be automatically executable by execution engines. However, existing execution engines are mainly proprietary prototypes implemented by the authors of the models as a proof-of-concept and only a few have been commercialized (e.g. PROForma [7]). None of these systems have been adopted on a broad basis in clinical applications.

To sum up, several knowledge and process management approaches have been proposed for capturing the know-how about decision rules and processes and the use of this know-how for automated process guidance. However, formal representations of this know-how are scarce and often limited to well structured processes such as the treatment of chronic diseases [4, 8], but there is little support for complex and dynamic cases. On the one hand, this is due to the still required research in process execution. On the other hand physicians have to be sensitized through education and routine work to be able to deal with formalized guidelines - may they be automated or not.

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(Thursday Session III Lecture a)

Management of In-Flight Medical Emergencies

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Over two billion passengers board commercial airplanes every year.[1] Airline travel is inherently safe and reasonably comfortable, but factors including psychological stress, jet lag, and pre-existing disease cause a small number of passengers to become ill while flying. The average age of airline passengers is increasing with that of the general population, and older passengers may have one or more underlying illnesses that impair their ability to adapt to a potentially stressful environment. New, larger airplanes such as the Airbus A380 may carry as many as 800 passengers – over twice the number of passengers as current aircraft. This may further increase the probability that a medical emergency will occur. The Aerospace Medical Association (ASMA) has created a comprehensive set of medical guidelines for air travel, including a list of contra-indications to flight. [Medical Guidelines for Air Travel]

Members of the flight crew may also become incapacitated during flight. Airline pilots are required to undergo a physical examination every six months that includes a screening test for diabetes mellitus, an electrocardiogram at age 35, and yearly electrocardiograms after age 40. Despite close medical observation, however, members of the flight crew have required emergency medical care during flight. Air France reported that 10 pilots (total 1,800 pilots) were incapacitated between 1968 and 1988. Causes included cardiac dysrhythmias, seizures, and hypoglycemia. In one instance, an entire cockpit crew was incapacitated due to carbon dioxide from improperly packaged dry ice. [Martin-Saint-Laurant]

Most in-flight medical events are relatively minor and can be treated without the assistance of a trained volunteer. The most common in-flight emergencies are fainting, near fainting, hyperventilation, and vasovagal episodes. In one study, neurologic, cardiac, and respiratory problems are responsible for the most serious events during flight, and accounted for the majority of emergency landings. [Cummins RO, Dowdall N] In another study of in-flight medical events, syncope accounted for 15% of complaints, followed by trauma (12%), gastrointestinal disorders (12%), and respiratory events (11%). [Delaune] A separate study found that psychiatric illness accounted for approximately 3.5% of calls to a ground-based consulting service, with the majority of cases diagnosed as acute anxiety. [Matsumoto]

Cabin Environment

Commercial airplanes operate at altitudes between 24,000 feet and 40,000 feet. The environment at these altitudes is lethal to humans, and as a result the passenger cabin is pressurized and heated. The barometric pressure (Pb) inside the passenger cabin of most commercial airplanes is equal to that of an altitude of 8,000 feet (2,400m) above sea level. Pressure changes occur slowly in order to minimize discomfort; the pressure in most commercial jets begins to decrease when the airplane climbs through an altitude of 8,000 feet, and increases when the airplane begins its descent. Everyone on board a commercial flight undergoes specific physiologic adaptations that allow him or her to tolerate this artificial environment. Although the vast majority of passengers passengers suffer no adverse effects, decreased atmospheric pressure, extremely dry air (less than 10% relative humidity) and mild hypoxia (PaO_2 approximately 55 mmHg) that occurs during flight may exacerbate certain illnesses.

Hypoxia

Dalton's Law states that the *partial pressure* of a gas is the pressure that it would exert if it alone occupied the space containing a gas mixture. The composition of air is constant, but Pb decreases exponentially with altitude, reducing the partial pressure of oxygen. According to the alveolar gas equation, at sea level (Pb 760 mmHg), if $PaCO_2$ is 40 mmHg, then PaO_2 is 100 mmHg. At 8,000 feet (Pb 565 mmHg), PO_2 is 118 mmHg, PaO_2 is 55 mmHg, and SaO_2 is 89%, which is well tolerated by most healthy travelers. When PaO_2 falls below this level, however, the affinity of hemoglobin for oxygen decreases rapidly, and a relatively small decrease in PaO_2 produces a large drop in oxygen saturation.

The symptoms of hypoxia are cumulative and time-related. Increased minute ventilation and increased cardiac output maintain oxygen delivery at a safe level despite decreasing PaO_2. Above 10,000 feet, these normal compensatory mechanisms are

[1] IATA Annual Report. Accessed 30 May 2007 at http://www.iata.org/iata/Sites/agm/file/2006/file/annual_report_06.pdf

insufficient to maintain oxygen delivery, and symptomatic hypoxia may occur. Hypoxia due to impaired gas exchange is exacerbated by decreased oxygen carrying capacity. Chronic smokers, for example, may have mean carboxyhemoglobin levels of 5%, which further increases after smoking, and thus significantly decreases blood oxygen content. [Turner] Decreased blood flow (*e.g.*, congestive heart failure) may further impair oxygen delivery. As a result, a passenger with obstructive pulmonary disease who has a PaO_2 of 60 mmHg at sea level and 10% carboxyhemoglobin after smoking may be unable to tolerate decreased barometric pressure during flight.

Gas Expansion

At a constant temperature, the volume of gas in an enclosed space varies inversely with pressure (**Boyle's Law**). As a result, the volume of gas in enclosed spaces can increase by up to 30% during flight. Thus, many passengers experience minor otololaryngologic symptoms such as transient decrease in hearing acuity, or minor ear and sinus pain. [Medical Guidelines for Air Travel] A patient with an upper respiratory illness that prevents him or her from equalizing the pressure between the middle ear and outside environment may experience severe, potentially incapacitating pain. Because gases contained within closed spaces expand during flight, surgical wound dehiscence [Skjenna] and spontaneous rupture of bronchogenic cysts and pulmonary bullae have been reported. [Closon] Medical devices are also affected. Pneumatic splints, feeding tubes, and endotracheal or tracheostomy tube cuffs will expand as cabin pressure decreases.

Dissolved Gases

The amount of gas dissolved in a given volume of liquid is directly proportional to the partial pressure of the gas (**Henry's Law**). If barometric pressure is rapidly decreased, nitrogen can leave solution and form gas emboli. Decompression sickness is caused by nitrogen that accumulates in the body during exposure to high barometric pressure (*i.e.,* during scuba dives). A person with mild decompression sickness may complain of itching or tingling ("the creeps"). Joint or muscle pain ('the bends') is the most common symptom of severe decompression sickness; pulmonary gas emboli ('the chokes') or central nervous system involvement all of which are life threatening. The risk of developing decompression sickness increases with age and obesity, and geometrically with shorter preflight surface intervals and dives to greater depths on the last day. [Freiberger] As a result, the US Federal Aviation Administration and the Professional Association of Dive Instructors recommends a 24-hour surface interval between multi-tank or decompression scuba diving and flying.

Deep Vein Thrombosis

The association between DVT and air travel remains controversial. Asymptomatic DVT was found to occur in10% of individuals who did not wear venous compression stockings on flights lasting at least 8 hours; no thromboses were found in those who wore stockings. [Scurr] Another study of passengers traveling through Charles deGaulle airport (Paris, France) between 1993 and 2000 reported 56 incidents of pulmonary thromboembolism occurred in 135 million passengers. [Lapostolle] The occurrence rate in this study, however, may be less than that of the general population. [Cushman] Lastly, a large, well-designed meta-analysis found that long-distance airline travel does not increase the risk of DVT or pulmonary thromboembolism. [Adi]

DVTs that occur during flight may be caused by factors including venous stasis and increased blood viscosity due to dehydration. Recent studies suggest that the incidence of DVT during commercial air travel is low. It seems reasonable, however, to recommend that passengers on long distance flights walk periodically, drink water frequently in order to avoid dehydration, and consider the use of compression stockings if they are otherwise susceptible to DVT. The diagnosis of pulmonary thromboembolism should be considered in a passenger with risk factors who suddenly develops pleuritic chest pain associated with shortness of breath.

Medical Assistance

The United States Federal Aviation Administration mandates that airline flight crews receive training in the management of in-flight medical emergencies. This training includes coordination among crewmembers, the location, function, and operation of emergency medical equipment, and the contents of the emergency medical kit. Flight attendants are also required to undergo training in the use of automated external defibrillators (AEDs) and cardiopulmonary resuscitation every two years. Although flight attendants are required to demonstrate understanding of the procedures involved, their skills are not required to be equivalent to those of a physician or other medical personnel.

Anesthesiologists receive training in physiology, critical care, and crew resource management, and are uniquely qualified to provide assistance. Almost one third of anesthesiologists responding to a survey had offered their assistance during an in-flight emergency, with almost 10% participating in more than one event. [Booth] The pilot in command of the airplane is the ultimate authority for the safety of flight, including the sick passenger. The flight crew is primarily responsible for responding to a passenger who becomes acutely ill, while medically qualified volunteers may provide assistance when requested. Each airline implements its own policies for management of in-flight medical emergencies, with guidance from the Federal Aviation Regulations. Any member of the flight crew may ask a volunteer to

administer treatment, discuss the case with a ground based medical personnel, or return to his or her seat.

Emergency Medical Equipment

Commercial airplanes with more than 30 passenger seats are required to carry one or more emergency medical kits. These kits are required to contain specific equipment and medications (Table 1). The kits on many airlines exceed the minimum FAA standards. Several airlines have augmented their onboard medical kits to include cardiac medications, sedatives, diuretics, and advanced airway management equipment. In addition to emergency medical kits, US registered aircraft are required to carry between one and four basic first aid kits (Table 2), depending upon the number of passengers for which the airplane is configured. European airlines carry the equipment mandated in the US medical kit, and also include other drugs such as furosemide, oxytocin, and steroids.

Limited supplies of supplemental oxygen are available if needed. Airlines are required to carry at least enough first aid oxygen to supply 2% of the passengers for the entire flight. The cylinders are equipped with regulators that are designed to provide a flow rate of either 2 or 4 L/min. Setting the flow rate to 2 L/min at a pressure altitude of 2400 m provides FiO_2 of 28%, which provides a PO_2 equivalent to sea level. It has been recommended that passengers on commercial airline flights who intend to use pulse oximetry should undergo a pre-flight medical evaluation, carry oxygen with them on the airplane, and have a written plan for monitoring and management of hypoxemia. [Dillard]

Commercial airline flights in the United States have been required to carry an AED since April 2004. AEDs are designed to administer a shock only if ventricular fibrillation or ventricular tachycardia is detected. Some airlines carry defibrillators that include an electrocardiogram display; these devices can also be used as a cardiac monitor to assist in the diagnosis. Cabin crewmembers receive training in the operation of AEDs. Many airlines therefore allow only flight attendants familiar with the operation of the AED, and not a physician volunteer, to attach and operate the device.

Policies regarding requests for medical assistance, access to the emergency kit, and treatment of passengers vary among individual airlines. Most airlines will release the emergency kit only to physicians whose identity can be verified. Non-physician health care providers or a senior flight attendant may, with specific limitations, have access to the emergency kit while under the supervision of a physician in flight or in communication with a ground consultant.

Ground-Based Medical Services

Airlines no longer rely only on the chance that a qualified physician will volunteer to assist a passenger who is ill. Most major airlines provide either internal or contracted ground based medical consulting services with physicians trained in emergency and aerospace medicine. In fact, it is the policy of at least one major airline to contact their ground-based support service first, and only request assistance from a medically trained volunteer if instructed to do so by the consultant. One such company, MedAire® (Phoenix, AZ), provides medical assistance to flight crews of commercial and private jets and ships at sea through a regional medical center in Phoenix, Arizona. These consultants specialize in in-flight emergencies and advise aircrews and physician volunteers as to differential diagnoses and treatment options. MedAire® also provides lists of intermediate airports with access to emergency medical services suitable to a specific emergency. Should a dispute arise between the onboard physician and the ground-based consultant regarding diversion, the captain will usually comply with the recommendation of the ground-based consultant.

General Management Strategies

Given the focus of this lecture, it is difficult to recommend specific management strategies, but it is possible to make general recommendations. Before volunteering to provide medical assistance, physicians should carefully assess their ability to do so. They should not volunteer if they have recently ingested alcoholic beverages or central nervous system depressants. Medical volunteers should be prepared to show a form of identification (such as a medical license or hospital identification card) that verifies their training. The volunteering physician must obey all instructions from the flight crew, who will ensure that caring for the sick or injured passenger does not endanger the safety of others. Medical volunteers should stay well within their level of competence. Good Samaritan laws offer protection only to volunteers who provide treatment that another reasonable physician would have provided.

If a passenger becomes ill during flight, the immediate priorities are to quickly locate oxygen and medical equipment, ask for and use any help available, delegate responsibility when appropriate, and suggest diversion if it will be of benefit to the patient. The goal of in-flight medical assistance is to stabilize the patient and advise the flight crew as to a diagnosis and treatment. In addition, when appropriate the volunteer should seek consultation from ground based medical support personnel and suggest diversion of the aircraft to an alternate airport. The limited amount of space available makes medical treatment a logistical challenge. If possible, treating the passenger in his or her seat is the safest option. If this is infeasible, the patient may be relocated to an aisle or galley, or to the first or business class section at the discretion of the flight crew. Treating the patient in an aisle should be avoided if possible, since it will impair the ability of the flight crew to perform their required duties. If the passenger and physician do not speak a common language, flight crew, family members, or other

passengers may be asked to assist with translation. Diversion should be recommended if the passenger complains of unremitting chest pain, shortness of breath, or severe abdominal pain.

The patient's initial complaint, medical history, and physical findings, along with treatment administered during flight, should be documented. Many airlines have pre-printed forms for this purpose. Documentation is especially important if the passenger is being transported to a hospital, since the treating physician will not be able to accompany him or her and because symptoms may disappear when cabin pressure is increased.

Providing assistance to an airline passenger who becomes ill during flight is challenging and requires an understanding of physiologic adaptations to flight. Successful outcome requires flexibility and crew resource management skills. Anesthesiologists manage complicated, unpredictable situations as a routine part of their workday, and may be uniquely qualified to ring the call button when a physician is asked to identify him or herself.

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Table 1: Emergency Medical Kit

Type of Equipment	**Contents and Quantity**
Diagnostic	1 Sphygmomanometer 1 Stethoscope
Airway Management	Oropharyngeal airways: 1 pediatric, 1 small adult, 1 large adult 1 Self-inflating manual resuscitation device Cardiopulmonary resuscitation masks: 1 pediatric, 1 small adult, 1 large adult
Intravenous Administration Set	1 tubing set with 2 Y connectors 2 Alcohol sponges 1 Roll of 1-inch adhesive tape 1 Pair of tape scissors 1 Tourniquet 1 500 cc Bag saline solution
Medication Administration	Needles: 2-18 ga., 2-20 ga., 2-22 ga., or other sizes necessary to administer medications. Syringes: 1-5 cc, 2-10 cc, or sizes necessary to administer medications.
Analgesics	Non-narcotic analgesic tablets, 325 mg: 4 Aspirin tablets, 325 mg: 4
Antihistamines and Bronchospasm	Antihistamine tablets, 25 mg: 4 Antihistamine injectable, 50 mg, (single dose): 2 ampules Metered dose bronchodilator inhaler: 1
Resuscitation	Atropine, 0.5 mg, 5 cc (single dose): 2 Dextrose, 50%/50 cc injectable, (single dose): 1 Epinephrine 1:1000, 1 cc, injectable, (single dose): 2 Epinephrine 1:10,000, 2 cc, injectable, (single dose): 2 Lidocaine, 5 cc, 20 mg/ml, injectable (single dose): 2
Heart Disease	Nitroglycerin tablets, 0.4 mg: 10
Protective Equipment	Nonpermeable gloves: 1 pair
Instructions on the use of drugs in the kit	

Adapted from Federal Aviation Regulation 121.803, Appendix A

Table 2: First Aid Kit

Contents	Quantity
Adhesive bandage compresses, 1-inch	16
Antiseptic swabs	20
Ammonia inhalants	10
Bandage compresses, 4-inch	8
Triangular bandage compresses, 40-inch	5
Arm splint, noninflatable	1
Leg splint, noninflatable	1
Roller bandage, 4-inch	4
Adhesive tape, 1-inch standard roll	2
Bandage scissors	1

Adapted from Federal Aviation Regulation 121.803, Appendix A

Legends

Figure 1. The hemoglobin-oxygen dissociation curve. Altitude correlating with a given PO_2 is at the top of the graph.

Figure 2. A large right inferior lobe intrapulmonary bulla that expanded during flight in a transport-category jet, causing a gas embolism. (Reproduced with permission [Closon])

(Thursday Session III Lecture b)

Advances in Anesthesia Monitoring Technology

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TransCranial Doppler
Sites of Examination
Advanced TCD Imaging
MCA Velocity Reflects CBF Changes
TCD Changes during CEA
Correlation between TCD change and Stroke
Doppler MicroEmbolic SignalsDuring CEA

Precordial Doppler
Jugular Bulb Venous Saturation (SjvO2)
Near Infra-red Spectroscopy
NIRS Cerebral Oximetry

Neurophysiologic Monitoring
EEG & Evoked Potentials
Motor and Sensory Pathways Are Separate

Monitoring of spinal cord function
Motor Evoked Potential Techniques
Brainstem and Cervical Surgery
Events Causing BAEP Changes in Retromastoid Craniectomies
EEG Monitoring in ICU

Anesthetic Considerations for Intraoperative Monitoring
Neurophysiologic monitoring and adequate anesthesia must mutually coexist in the OR
Advanced Processing of EEG during Anesthesia
Monitoring cerebral "protection" efforts
Monitoring anesthetic effects
Drug dosing Schemes
Several Components to "Anesthetic Depth"
BIS Index
Control of the opiate infusion
Pitfalls of BIS application
Many ways to assess "depth"
Statistically-derived multi-parametric indices
Consciousness Monitors Comparisons

(Friday Session V Lecture a)

Medico-Ergonomics in ER, OR & ICU – What's State of the Art in Medical Rescue?

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Introduction

There are some well known differences in the out-of-hospital rescue strategies between Europe and the USA, With the former seeing more Physician and Nurses based systems, while the latter rely mostly on EMT and Paramedics.

Nevertheless, the aforementioned differences does not reflect too heavily in the medical equipment and the vehicles used in the rescue efforts.

Basically, the current practice out-of-hospital rescue strategy is mostly based on appropriate approved guidelines (ACLS, ATLS, PHTLS…), that tend to focus the physician efforts on performing on the patient some quite well defined maneuvers, that usually focus on securing an appropriate Airway, supporting the Breathing, controlling the Circulation by stopping any bleeding and/or infusing various physiological fluids, and immobilizing/mobilizing the patient in the most careful way in order to be able to transport him/her to the most appropriate hospital.

Having said that, the problem in today out-of-hospital rescue is that these not so hard to perform maneuvers are indeed usually performed in the most in-appropriate places, in the most different and extreme weather conditions if outside, or in the most unusual, but usually very cramped spaces if in-house.

Rescue materials

Storing, transporting and using the rescue material has seen in the out-of-hospital rescue history different approaches, that were and are mostly

based on the working and transporting environment in which they are supposed to be used.

The aero-medical is mostly based on the use of backpacks, while the ambulance scene use both backpacks and various sorts of boxes and luggage's.

Quite often, these are not especially designed for the rescue world, but are "adapted" from other uses, mostly the trekking and leisure worlds.

All in all, the perfect way of transporting and using the rescue material should still be created.

Medical devices

The 3 most used medical devices used in out-of-hospital rescue are the monitor-defibrillator, the mechanical respirator and the suction unit.

All these devices are battery operated, and therefore quite some problems arise from the strategies chosen by the producers in the battery type, battery recharging and on-board battery power management.

The fact that monitor-defibrillators and mechanical respirators are used in the open, pose some problems in display and indicators visibility in bright sun, as well as device protection from extreme temperatures, rain, dirty.

One of the most well known ergonomic design flaws is the "spaghetti syndrome", with cables of different length messing up on the monitor during rescue and transport. But the overall design of the devices shows that little consideration is given to the out-of-hospital use of these devices, in terms of commands and connectors position, battery accessibility, weight.

Some of these design flaws are probably due to the design being the sum of an in-house design (i.e. the defibrillator) to which other modules (i.e. pulse-oximetry or non invasive blood pressure) added from different vendors.

Ambulance Design

Although in the last years some giant leaps were made in terms of ambulance design, some compromises are still necessary, most of all the dimensions of the van used to build up a rescue vehicles, or the streets in which the aforementioned vehicle is supposed to operate.

The interior of the ambulances shows still some design flaws, with some builders looking more into the layout and color design (mostly appreciated by the managers purchasing them) that the usability of the same (needed by rescue personnel).

Air Medical Rescue

The air medical rescue is mostly based on helicopters use. The design of the aero-medical kits is mostly limited by space and weight considerations, with a friendly war going on between the aeronautic crews (opting for the most small and lightweight kits) and the rescue crews (wishing to carry the equivalent of an Emergency Room equipment with them). In the end, weight, space, regulations (that may vary between different countries) and costs considerations lead the choice.

Much can be done, however, in streamlining the design and equipment of helicopters dedicated to HEMS operations.

Conclusions

Although much has be done in the out-of-hospital rescue ergonomic design, there is still ample space of improvements, and the Authors opinion is that a more close co-operation is needed in the interface between the rescue community and the Industry to solve some of the flaws in the currently available devices.

The ultimate goal, however should be to closely co-operate to design devices specifically oriented for the out-of-hospital market.

(Friday Session V Lecture b)

Medico-Ergonomics in ER, OR & ICU – What's State of the Art in the ICU?

W Koller, Innsbruck

Ergonomics in the ICU tries to find the optimal solution between

Planning and delivering ICU care and treatment at high preset quality

(morbidity and mortality) by means of efficient working processes.

and

respecting limits of physiological and psychological abilities of ICU-healthcare-workers,

to grant a long term working place and "well beeing" on the job.

During the various work processes in the ICU, employees interact in many ways with the basic components:

Architecture of the ICU (location of the ward, internal floor plan)

Permanent installed technology

Mobile technological equipment

Drugs and other materials

Hardware and software

Standards (procedures, goals), Protocols

Organisation

Each component has to be planned carefully, starting with goal definitnions like Planned case-mix, desired level of care, size and location and others. Mistakes or weak communication in the planning period lead to suboptimal processes of care. Subsequently, more

human ressources are needed, to fill up the gaps, turning down the ergnomoc issue. Such typical pitfalls are:

- The location of ICU in the hospital is wrong
- Inadequate floorplan (long distances)
- Fix mounted equipment at the wrong place (med-gases, sinks, wiring)
- Unnecessary mobile equipment, too bulky, no storage room
- Wrong placement of devices around the patient
- Equipment does not match goals (wrong parameters monitored, usability not tested)
- Supply with meds and materials does not run smoothly (Storage, delivery, availabiliy)
- Excess use of materials and drugs (Over-all-machines for renal-replacement-therapy)
- Hardware (Computers, screens, in/output devices) not matching demands, mounted wrong
- Software (weak configuration, not supporting work-flow, too old, and much more)
- No or weak written and trained standards for simple, repeated work processes
- Too detailed procedural standards for knowledgebased processes (Algorhythms ?)
- Use of "procedural standards" instead of goals (lack of motivation) were appropriate
- Weak basic communication behaviour (underdeveloped business culture)
- Processes of communication badly or not defined (admission and other key processes)
- Cooperation between professional groups (doctors, nurses, others) not developed

This list must remain incomplete.

Epidemiologic development in Europe and Northern America foresees shortening of human ressources, especially qualified people will grow older. Influence of ergonomic issues will dramatically increase, when availability of human ressources decreases. Adapting humans to the workplace was the leading issue since industrial revolution. Adapting the workplace to the possiblities of humans, combined with continuous education and training on the work processes could give healthcare-enterprises a chance to recruit and keep qualified staff also in the future. Medico-Ergnomics should provide basic knowledge and solutions to achieve this goal.

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(Friday Session V Lecture c)

Medico-Ergonomics in ER, OR & ICU – What's State of the Art in the Design of Medical Products

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Introduction

Since 2006 medical industry has to fulfil an international usability standard [1], which specifies requirements for the development process to analyse, design, verify and validate the usability of medical electrical devices. Usability takes two points into consideration: the intended use of a product with the patient and the user. The interaction of devices used as combinations within workplaces is still a big safety lack. Medico-Ergonomics, coined by Yoel Donchin [2], is the cross section between medical needs, technical possibilities and ergonomic know-how. To make Medico-Ergonomics successful it has to consider the entire patient treatment and all system layers - including the design of workplaces.

Situation & Problems

Patient treatment in high dependency environments is a complex task. Devices are added and removed according to the individual, dynamically changing patient condition. Nurses and physicians put together stand alone devices (e.g. physiological monitoring, infusion pumps, ventilators, etc.), which have been developed by different companies. Although use and user requirements are considered within the development process of each company, the design and user interface of these devices vary considerably from company to company; the resulting workplace is an ergonomic disaster, errors are pre-programmed. Ergonomic rules are too general (e.g. "self descriptiveness" [3]). Comprehensive concepts are seldom (e.g. the draft of guidelines for alarm systems [4]).

Goal

Medico-Ergonomics needs strategies and methods to ensure the design of system ergonomic workplaces and workplace safety.

Solutions

Quality and efficiency improvements require the data integration within workplaces, which will be the strongest integration power in the future. Monitoring systems need ventilation data, infusion pumps need prescription data, electronic patient records need all data, closed loops are needed for weaning, etc. But who will be responsible for the physical, electrical and data safety of these integrated workplaces?

1 Norms could become so powerful and detailed that all individual devices fit into such system ergonomic workplaces – a rather improbable vision.

2 Technical departments within hospitals could select compatible devices and put them together in a standardized way. But a lot of hospitals will not be able to provide the required competency and capacity.

3 Selected companies could become system providers, so that individual devices will become compatible system-modules within a given physical and logical workplace frame (e.g. infusion pumps within a fluid-system). In our opinion the most likely development.

This development will be not only a chance but also a challenge for the big industrial players. Which one will be taking over the workplace responsibility? In either case such a system provider needs much more clinical process knowledge than today's companies have. Therefore Medico-Ergonomics needs to become the turntable where clinicians, engineers and ergonomists meet and jointly improve the usability of clinical work places.

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(Friday Session V Lecture d)

Medico-Ergonomics in ER, OR & ICU – What's State of the Art in the Design of Clinical Workflows?

Marsolek, I. & Friesdorf, W. – Department of Human Factors Engineering & Ergonomics, Technical University of Berlin (Germany)

Introduction

Complex clinical work systems – such as ER, OR and ICU – are defined by three characteristic developments [Marsolek & Friesdorf, 2006]:

1 A steadily increasing cost pressure resulting from diminishing financial healthcare resources, dramatic demographic changes towards more and more elderly and chronically ill patients and a growing number of innovative and promising (but in most cases also cost intensive) diagnostic and therapeutic treatment possibilities.

2 Increasing quality and customer demands because of the patient's health/life being at risk, a growing number of media reports about medical progresses as well as malpractices, an increasing necessity/willingness within patients to pay for selected services on a private basis and a growing competition among healthcare providers.

3 A growing system complexity resulting from each patient's individual health status, unpredictable treatment dynamics, unavoidable ethical problems and an increasing fragmentation of the entire treatment process.

The necessity for a sustainable optimization of clinical workflows is obvious. But the historically grown organizational structure and complexity of clinical work systems often hinder the establishment of a successful change process from the inside. Therefore, besides the traditional question about "WHAT has to be done with the patient from the medical point of view?" the ergonomic question "HOW can we (re-)design clinical workflows in order to achieve this goal as efficient and safe as possible?" is getting more and more importance, which has already become a key challenge for the newly developing research field of "Medico-Ergonomics" (see also Donchin, 2007).

Methods

This organizational challenge can only be met with a systematic analysis and sustainable optimization of the underlying clinical workflows based on a systematic staff participation throughout the entire re-design process. That's why a "balanced rationalization" is required, in which the set free optimization potential is not simply used for a correlating reduction of clinical staff members, but for a joint reinvestment of the released resources into further system improvements. As a first step all involved clinical staff members need to be informed as early as possible about the real project objectives and entire project plan with the help of according kickoff meetings. Then the work processes to be improved need to be jointly visualized as so called process flow diagrams in order to achieve a comprehensive process transparency/understanding for everyone. During the entire visualization already obvious process flow strengths and deficits are documented and quantified. In addition to that also classical analysis and optimization tools such as "process data analysis", "process benchmarking", "information flow analysis", "value and output assessment" etc. can be used for their identification. In a next step the analyzed processes need to be improved as systematic as possible by eliminating all unnecessary and redundant work tasks as well as existing deficits and stabilizing all insecure process parts – whenever possible also through learning from good practice examples of other clinical work systems. Before implementing the re-designed

workflow all possible process improvements should be assessed according to their cost-benefit potential together again with the involved staff and concrete realization steps have to be defined for the best process improvements. In addition to that characteristic benchmarks have to be identified for an objective evaluation before and after the introduction of the re-designed workflow as well as for forcing its realization and establishing a continuous process management. [Marsolek & Friesdorf, 2006]

Results

While using such participatory optimization approaches within the last ten years for the re-design of more than 40 clinical workflows, the existing optimization potential proved to be significant within every analyzed clinical work system – regardless of being an ER, OR, ICU or any other clinical division. But furthermore, also the following project obstacles, which need to be overcome for a successful project realization, showed to be characteristic for today's "state of the art" in the re-design of clinical workflows:

1 In most clinical work systems prior optimization approaches (either through the hospital management or professional consultants) have left a negative climate among medical staff members for the initiation of future change projects. Reasons for this often lie within insufficient participation possibilities and the fear of hidden layoff plans.

2 In many clinical work systems not all staff members were informed in time and adequately enough about the underlying project aims by the hospital management. Therefore additional kickoff meetings are essential for a successful staff participation.

3 Most clinical work systems still have yet not even started to analyze and document their momentary clinical workflows – a comprehensive workflow optimization is still far away. If process documentations exist, they often do not reflect the clinical reality.

4 In many cases an optimization of clinical workflows requires also a significant investment of additional financial resources (for new architectural structures, qualified staff members, technological innovations etc.), which many hospitals can not afford. Thus a significant part of the identified optimization potential can not be set free immediately.

5 Often the re-design of clinical workflows requires also a systematic change of historically grown organizational structures and leadership responsibilities, which many hospitals are yet not willing to enforce.

6 In most clinical work systems the close interdependency between the optimization of clinical workflows and the definition of future hospital structures and technological solutions has yet not been recognized. As a direct consequence many architectural changes and technological investments are still planned without any information about the underlying processes resulting in the implementation of sub-optimal solutions.

7 In many hospitals the importance of a systematic re-design and continuous management of clinical work processes is still not understood. Therefore the involved staff members do not have enough timely resources and no professional "process managers" exist.

Conclusion

The optimization potential, which can be set free through a medico-ergonomic re-design of clinical workflows, is still significant due to the historically grown complexity of clinical work systems – especially within such high dependency environments as ER, OR and ICU. But it can only be achieved through a "balanced rationalization" and if the involved clinical experts are being accepted as self-responsible project partners, adequate timely and financial resources are provided and the work system itself is successively transferred into a process-oriented, self-learning organization.

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(Friday Session VI Lecture b)

Semi Closed Loop Control!

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Fatigue is an associated factor in 6% of the critical incidents resulting from human error in anaesthesia and reduced vigilance is shown in deprived sleep conditions (1). Automated general anaesthesia might help to decrease these related risks. Closed loop anaesthesia systems have been developed linking one controlled variable with the automated titration of one anaesthetic drug. The development of electroencephalographic indices of anaesthetic depth has in turn generated interest in automated anaesthesia delivery systems using these as the input variable. Several studies have related the BIS index to the closed loop administration of propofol by TCI.

They demonstrate an adequate control of the depth of anaesthesia, no awareness, good haemodynamic stability and a short awakening time but they were limited to the maintenance period of general anaesthesia (2, 3). These interesting results are challenging and several questions are still unsolved.

1 Is there a best EEG monitoring ? The BIS or the Entropy monitoring seems to be equivalent and both could be recommended as an input variable in an automated propofol TCI delivery system (4, 5).

2 Is 50 the appropriate target for any EEG parameter whatever the anaesthesia technique and what is the influence of the anaesthesia technique on the EEG target figure? Using frontal, central and parietal electrode montages, the corresponding BIS values were simultaneously recorded with a BIS A1000 monitor during 10 minutes at the propofol concentration allowing LMA insertion in 20 ASA I-II, 18-62 yr, non obese patients (6). At the same predicted effect propofol target concentrations, the mean BIS values were 32, 46 and 58 for the frontal, central and parietal leads, respectively. The effects of a bolus of ketamine 0.5 mg kg-1 on BIS, RE and SE during surgery under sevoflurane anaesthesia was associated with a significant increase in BIS, RE and SE (7). This increase is considered as paradoxical in that it is associated with a deepening level of hypnosis. Muscle relaxation may also confound interpretation of entropy monitoring (8). So, BIS values can change according to the location of the EEG recording.

3 Can we close the loop of propofol TCI anaesthesia using other input parameters? Auditory evoked potentials measure different aspects of neural processing during anaesthesia. This gives rise to the hypothesis of Schwilden et al that simultaneous monitoring of the EEG, AEP and SSEP may give additional information compared with the monitoring of each quantity alone (9).

4 Which sensor to monitor analgesia? In contrast to hypnosis, there is no ideal surrogate parameter for analgesia in anesthetized patients. In 13 patients undergoing spine surgery, Luginbühl et al have developed a closed-loop of mean arterial blood pressure during surgery with alfentanil TCI infusion which allows adequate peroperative alfentanil dosage (10). The authors' controller has a similar set-point precision as previous hypnotic controllers and provides adequate alfentanil dosing during surgery. This may be a further step toward a multiple input-multiple output controller.

Today, there is a need of good and multiple sensors to monitor not only the hypnotic component but also the analgesic component. Clinicians are not convinced that general anaesthesia can be simplified for all the types of patient, surgery and moreover for the different phases of general anaesthesia (induction, maintenance and emergence) using only one input linked to one anaesthetic drug output using even a very complex algorithm. Future computer assisted IV anaesthesia systems have to be developed by using several input parameters related to the administration of the simultaneous delivery of the hypnotic and analgesic drugs. A computer system allowing the anaesthetist to control the limits of the input and output parameters according to the selected anaesthesia technique and the intensity of the nociceptive stimulation seems a more logical approach. Adequate clinical judgement, physiological response analysis and selected monitoring tools remain the standard of care to optimize Anaesthesia in 2007.

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(Friday Session IX Lecture a)

Bilateral Brain Function Monitoring

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The human brain exhibits profound asymmetry of certain functions, with handedness, speech and language well-known examples. Less well-known is the potential link between changes in brain asymmetry associated with severe emotional disturbance, autonomic dysfunction, and sudden cardiac death.[1] Studies using functional imaging such as 18-FDG positron emission tomography have revealed asymmetry of function during anaesthesia and sedation.[2] However, current functional imaging techniques have relatively low temporal resolution,

with large size and cost, that render them inappropriate for most studies during routine anaesthesia on patients.

Dolphins demonstrate marked electroencephalograph (EEG) asymmetry during routine general anaesthesia.[3] The EEG has been used to monitor brain asymmetry during human anaesthesia in order to facilitate surgical decisions during carotid endarterectomy and Wada testing. The potential for changes in asymmetry of human brain function during routine hypnotic general anaesthesia have not been extensively studied, although pharmacological challenge with a putative hypnotic agent has shown rapid changes in bispectral index (BIS) asymmetry measured using a multi-channel EEG monitor.[4]

It is suggested that monitoring real-time indices of bilateral brain function using multi-channel BIS or electrical impedance tomography may yield new information for anaesthesia and intensive care specialties, including levels of analgesia.

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(Friday Session IX Lecture b)

What's new in pulse oximetry?

Prof Kirk Shelley, Associate Professor of Anaesthesiology

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Despite the impression that the title of this talk may give, I do not plan on examining the newest breakthroughs in motion resistant pulse oximeters nor the latest substances that can be detected by off the shelf devices (CO & methemoglobin). With this audience, I would like to examine what is around the corner for this device.

At the core of this remarkable technology is **photoplethysmography**. First described by Hertzman (Hertzman and Spielman 1937) this waveform has undergone extensive reexamination by generation after generation of investigators. Encouraged by ever improving computer technology, and breakthroughs in digital signal processing this technology appears once again on the verge of spawning a new wave of non-invasive clinical monitors.

Interestingly, despite all our marvelous technology, we are not much further along than Hertzman in the 1930's when it comes to understanding the underlying physiology that creates the waveform. Like Hertzman, we note the relationship between the **arterial pulse** and the components of the waveform. It was Hertzman who first noted that blood flow effected the waveform (Hertzman 1938) and that the blood flow is related to the **autonomic system** (Hertzman and Roth 1942). Like Hertzman, we still have not figured out a way to calibrate the signal and tend to label changes and fluctuations we do not understand as "artifacts".

Today's presentation will focus on two aspects of photoplethysmography, **rhythm and amplitude analysis**. These are worthy of discussion because they have clinical relevance today using off-the-shelf devices. These two topics are excellent starting points for those interested in beginning their investigations of this extraordinary signal.

Rhythm analysis gives an instantaneous assessment of cardiac rhythm & function. A beat to beat change of the pulse oximeter amplitude and timing is often the first clue that the patient has developed an irregular heart rhythm. Comparing the pulse oximeter waveform to the electrocardiogram is an excellent way to confirm these changes. One of the more useful plethysmographic features is the waveform amplitude. Once a baseline measurement has been established, the pulse oximeter amplitude can be followed as a gauge of sympathetic tone.

With ventilation (spontaneous and positive pressure) there is fluctuation of both the baseline (D/C) and pulsatile (A/C) components of the plethysmographic waveform. The ability to detect the influence of the respiratory system on the cardiovascular system opens intriguing possibilities. Monitoring the respiratory variability, seen in the photoplethysmography waveform, may be a useful method of detecting occult hemorrhage with its resulting hypovolemia

Finally, I would like to invite fellow investigators to submit any interesting photoplethysmography waveform samples they may like to share for a proposed Atlas of Pulse Oximeter Waveforms. I believe it is time to we organize such a document.

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(Friday Session IX Lecture c)

My-Anaesthesia-Space - A shared space in which to work, rest and play - a personal view

Dr Felix Jackson

eBusiness Medical Advisor

The internet has eventually begun to live like we do. It has climbed off the library shelf and into the pocket of every teenager and mobile professional. The internet is no longer simply aligned to our online life, which is mostly spent sitting at a desk, it is now entwining itself around every moment we live.

The internet began as a way for researchers to communicate by email, evolving into a way to store and access information remotely. Now it has become a sophisticated social enterprise. New social media tools (often grouped together as Web 2.0) are fundamentally changing the way we live. The advent of user generated content (UGC) has enabled users to contribute content on a huge scale; shifting power away from traditional corporations and into the hands of the user.

Social networking sites use sophisticated technologies to connect people, allowing them to share content and ideas. One of the most well-known is MySpace, a site that enables members to contribute many types of content, including music, images and video, for friends and the public to view. This is revolutionising the music industry both through the ease record companies can discover new talent but also the ease with which artists can access the marketplace directly.

Another distinct aspect of Web 2.0 is the way in which the internet is now becoming a computer platform in its own right. This is exemplified by Google Apps, an online word processing and document storage site, which allows multiple users to work collaboratively on the same documents. This is moving the use of programs like Microsoft Word off the desktop computer and onto the internet facilitating greater user collaboration.

Collaborative work using social media tools gives doctors the opportunity to improve healthcare through the creation, identification and dissemination of medical expertise. So, what shall we do about it?

Free Paper Abstracts

Thursday Session IV

1 High anesthesia record completeness using Visual Basic in a commercially available electronic anesthesia record keeping system. *Alexander Avidan*

2 Ontology-Driven Preoperative Information Collection System. *Matt-Mouley Bouamrane, Alan Rector, Martin Hurrell*

3 Arterial blood pressure (ABP) wave reconstruction from plethysmography (PPG) signals: combining fourier transformation based transfer functions with the predictability of mean ABP from higher-order harmonics. *P Sämann, M Schnekenburger, R Schneider, Ludwig Auer*

4 Integrating heterogeneous data management systems for clinical outcome management. *M Seeling, F Radtke, M Franck, C Barner, M Schmidt, C Spies*

5 Web Based Management Of Standard Operating Procedures In Clinical Practice. *Zielke, W Boemke, M Kastrup, C. Melzer-Gartzke, C.Spies*

6 Data mining in an intubation database with Bayesian Networks. *V Crinquette, L Jouffe, P Mavoungou, E Kipnis*

7 Drug calculation in pediatric cardiac anesthesia. *Alexander Avidan, Yaacov Gozal*

8 Variation in the PaO2/FiO2 ratio with FiO2 – is it relevant? *Dan S Karbing, Søren Kjærgaard, Bram W Smith, Kurt Espersen, Steen Andreassen, Stephen E Rees*

9 A review of criteria used in recent studies to assess new modes of cardiac output monitoring. *Lester AH Critchley*

10 Leveraging Commercial Software Products. *J Hoyle, R Freeman*

Friday Session VIII

1 A first look at ALERT (Anaesthetic Locator for Equipment, Research and Training). *S Shenoy, MW Lim*

2 Installation free approach to the PC version of Royal College of Anaesthetists logbook. *A Mishra*

3 Wikisthesia. *Tony Smith*

4 Selecting a departmental wiki solution – Cardiff's experience. *S Shenoy, MW Lim*

5 Information Technology - are we in the 21st Century? *C Cook, A Thompson*

(Thursday Session IV Paper 1)

High anesthesia record completeness using Visual Basic in a commercially available electronic anesthesia record keeping system.

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Introduction

Commercially available anesthesia information management systems (AIMS) are gaining wider acceptance into clinical practice[1]. These systems record vital signs automatically and may import data from the hospital information system. Additionally, clinical notes (e.g. anesthesia type, intubation technique, level of conciseness after emergence) are entered manually by the anesthesiologist. Completeness of the manually entered data depends strongly on the workflow and technical features of the system[2].

Metavision™ (IMD-soft, Tel Aviv, Israel), an AIMS installed in the 23 main operating rooms at the two Hadassah University Hospitals in Jerusalem (Ein Karem and Mount Scopus), allows data entry of clinical data through customizable forms. Metavision™ incorporates certain mechanisms to assure data entry by the user. Each data field on these forms can be defined as mandatory field. The form cannot be closed (i.e. save in the system) until all the mandatory fields are filled in. These mandatory fields are absolute and cannot be defined conditionally, that means depending on other data fields. For example on a form with data on airway management, the data field for the laryngoscopic view should only be mandatory if the airway management was endotracheal intubation, but not for mask ventilation. This drawback could be overcome by introducing various forms for each possible airway management technique, which on the other hand makes the workflow of the system very complicated and inconvenient for the user. Unfortunately there is no built-in system to force the user to fill in certain forms. Before completing the electronic chart (which is called "discharge"), Metavision™ allows one form to be prompted to the user. But even if this form contains mandatory fields, the user may just close it without entering any data and have the patient successfully discharged. In fact, the anesthesia chart can be closed by the user without having entered any clinical information.

We developed a system based on the Metavision™ platform making extensive use of the built-in Visual Basic (VB) programming possibilities in the design of the clinical data entering form to assure data completeness. We present in this study the rate of completeness of the anesthesia charts eight months after introducing of the AIMS.

Material and Methods

We designed and programmed forms for four detailed data sets: 1)demographics, 2)name and site of surgery, name of anesthesiologists and surgeons, 3)details on anesthesia techniques, 4)clinical data after emergence. Data on IV access was not defined as mandatory. On each form, a VB routine checked the data entered and prompts a message box informing the user about missing data depending on the data entered. Ease of use was another cornerstone in the development of the system. Depending on the data entered, data field were hidden or shown to facilitate data entry (for example when mask ventilation was chosen, all data fields for endotracheal intubation were hidden). The anesthesiologist may enter these data any time during the anesthesia, but with this workflow the patient cannot discharged from the system without having completed all of these four forms. However, Metavision™ does have a built-in form to discharge patients directly. This feature cannot be disabled and was not presented to the users.

Data was extracted from the Metavision™ database (based on SQL server 2000, Microsoft, Redmond, WA) using the Metavision™ Query Wizard and exported to Microsoft Access 2003 (Microsoft, Redmond, WA) for further data compilation. Statistical calculations were performed with Microsoft Excel 2003 (Microsoft, Redmond, WA).

Results

During the eight months after introducing Metavision™, 10024 anesthesia charts were recorded by more than seventy anesthesiologists (residents and attendings). 9961 (99.4%) of all charts were completed without any data missing from the four mandatory forms and so only 63 (0.6%) charts had missing data. 34 (54.0%) of these charts had only missing data on emergence, in 29 (46.0%) charts various data were missing. In 30 (47.6%) of the uncompleted charts the anesthesiologist did not discharge the patient at the end of the anesthesia and in 33 (52.4%) cases, technical problems (network and hardware failure, learning curve) were the reason for record incompleteness. Data on IV access (which are not mandatory) were entered in 94.1% of all completed records.

Conclusion

An AIMS based on Metavision™, designed with a user-friendly environment/workflow and combined with extensive VB programming assures practically an almost hundred percent (99.7% without the cases with missing data due to technical problems) completeness of mandatory data entered through customizable forms. With such a system, completeness of non-mandatory data is also very high (in our system 94.1%).

The need for experienced VB programming knowledge (which is not necessary if using only the built-in functionality of Metavision™), increased development time and higher maintenance needs are the major drawback of a system such as ours.

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(Thursday Session IV Paper 2)

Ontology-Driven Preoperative Information Collection System

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Abstract

A thorough documentation of a patient's medical history is widely recognised as providing good indicators of potential intraoperative and postoperative complications. As preoperative assessment can be time consuming, computer-based Information Collection Systems (ICS) can help free up precious and limited resources, leaving clinicians with more time for fulfilling their primary mission of administrating medical care. ICSs are well accepted both by patients and clinicians, they collect information in a structured manner which can then be used by other applications (e.g. decision support). In addition, medical histories collected by ICSs have proved to be more complete than traditional pen-and-paper questionnaires or face-to-face interviews. One challenge faced by ICSs however lies in how to design a questionnaire which is both general enough to suit the majority of patients, while being able to capture critical individual information at the same time. In this paper, we propose a solution to this problem with an adaptive questionnaire in which dependencies between potential questions are asserted in an ontology. As a result, patients are prompted certain questions only when these are consistent with previous information they have provided. We argue that this method is robust, scalable, flexible and highly configurable. In addition, because the method is ontology-based, it results in questionnaires which are coherent and well structured.

(Thursday Session IV Paper 3)

Arterial blood pressure (ABP) wave reconstruction from plethysmography (PPG) signals: combining fourier transformation based transfer functions with the predictability of mean ABP from higher-order harmonics

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Introduction

Arterial blood pressure (ABP) is a most informative physiological parameter in critical care and emergency medicine. Due to the availability of miniaturized sensors, photoplethysmography (PPG) has gained new attention for a number of application fields [1]. PPG allows to gain a continuous volume pulse that is indirectly related to ABP. The main problem lies in calibrating PPG signal due to the many unspecific optical, biomechanical and physiologic influences on this optic technique. Therefore, algorithms are needed that relate wave shape features of the PPG to arterial blood pressure key variables (as mean or systolic ABP) or the full arterial blood pressure waveform. Millasseau et al. (2000) reported that shape features of the ABP and PPG signals can be related to each other by transfer functions (TF) built from the first 10 harmonics that emerge from a fourier transformation of the original signal ($TF = FFT_{PPG}/FFT_{ABP}$). TFs were conferrable between individuals and robust towards experimentally induced changes of vascular compliance. The approach, however, is only applicable to predict shape features, but not absolute amplitudes of the ABP signal. Various other PPG waveform features have been investigated for their correlation with central hemodynamic parameters [6-8], yet with limited clinical translation.

Goal

To develop an algorithm that reads out arterial blood pressure key variables or allows the reconstruction of the absolute arterial waveform from PPG recordings.

Methods

Data acquisition: Data were obtained during ergometer experiments in 12 healthy adults (resting state, stepwise dynamic load up to 200 watt, relaxation phase; total duration 15 minutes), with simultaneous recordings of a PPG (Nellcor/Mallinckrodt Inc., USA, with RS-10 reflectance [forehead] sensor) and the digital ABP waveform (Portapres, Biomedical Instrumentation, Netherlands). *Preprocessing:* After (i) digitilization, (ii) standard low pass filtering for denoising and high pass filtering to remove respiration related components, waveforms

are (iii) segmentated (automated steps, manual refinement) and (iv) stored in a database. *TF application on normalized ABP and PPG:* Ensemble averages of PPG and ABP waves at different dynamic load levels are calculated and load-specific and general (across the whole experiment) TFs calculated from the first 10 harmonics of a fast fourier transformation (FFT) as described [2-5]. For this purpose, wave cycles are normalized to 1000 ms and amplitudes normalized to a pressure pulse of 1. For cross-validation, TFs are applied to PPG waves from all load levels of the same individual and other individuals. The agreement between (normalized) ABP waveform and TF-based PPG transform (referred to as reconstructed ABP wave [rABP]) is quantified by calculating the sum of root mean square (RMS) differences between the two signals. *Reconstruction of absolute ABP waveform:* As proof-of-concept step we explored if the mean ABP can be estimated from a linear combination of about four of the higher (up to 10^{th}) harmonics. For each individual, regression coefficients of four harmonics with the largest contribution to explain mean ABP variance are estimated for later reconstruction of the absolute ABP. A general TF is generated from artefact free sections of the original ABP and PPG, and re-applied on representative PPG waves of the same individuals. Eventually, the estimated harmonics are used to reconstruct the wave shape (by applying inverse FFT) and estimating the mean ABP of the respective wave. Reconstructed absolute ABP waves (raABP) are compared with the original APB waves using the RMS methods.

Results

TF application on normalized ABP and PPG waves: Close agreement could be demonstrated between amplitude normalized measured ABP and rABP waves. Within all subjects, lowest RMS errors were observed for load specific TFs (about 40 AU [arbitrary units]), with higher RMS errors for the general TF (about 70 AU [arbitrary units]). Significantly larger RMS errors were found for most subjects at the highest dynamic load (about 200 AU [arbitrary units]). Across subject application showed that the general TF of an individual is suited for application on a different individual while the benefit of a load specific TF could not be retained. *Reconstruction of absolute ABP waveform:* Analysis of FFT transforms of the ABG signals normalized to period duration of 1000 ms but with original amplitudes demonstrated that variance of the mean blood pressure can be estimated from the amplitudes of four harmonics to a high degree (adjusted Nagelkerke R^2 between 96.3% and 98.5% in six analyzed individuals) with marginal improvement gained by adding more harmonics. However, regression models (combination of harmonics, coefficients and constant) differed between individuals.

Conclusions

Findings of Millasseau et al. [2] showing that normalized ABP and PPG signals can be transferred into eachother using FFT based transfer functions are extended in two ways: first, the method is also useful for a wider blood pressure range as enforced by an ergometer experiment in this study. Second, load specific TFs are superior to general TFs within an individual. The re-calibration problem has been approached by demonstrating that the mean blood pressure of an ABP wave is highly predictable from higher order harmonics. Conjoining both approaches is promising to predict absolute ABP values from PPG signals.

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(Thursday Session IV Paper 4)

Integrating heterogeneous data management systems for clinical outcome management

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Introduction

Data management systems increasingly assist in controlling and advancing clinical processes. Complexity of health care interactions give rise to heterogeneous systems often hindering analysis and consecutive outcome improvements. Undocumented process quality is often a major drawback in judging health care resources.

As a first step towards the implementation of a comprehensive routine outcome quality system we developed a way of using the already existing albeit heterogeneous data management systems. We merged data from several different input systems by entering them into one single database. In order to tests the practical analytical value of the newly formed system we retrieved data comparing patients with and without cardiac disease with regards to their length of stay in the postoperative recovery room.

Methods

Routinely we use several different data monitoring systems, such as Medlinq, SAP and OpDIS. Here we extracted data from all of these sources, reuniting them in one single format (MySQL) for further analysis.

Statistics: Mann-Whitney-U Test

Results

We analyzed data of 16,943 patients passing through our postoperative recovery room (RR) between January and June 2007 during regular working hours. Of these 7,495 patients showed signs of cardiac disease. For both groups length of stay in the RR differed signficantly between using volatile or intravenous anesthetics, the effect, however was considerably stronger in the cardiac disease group ($p < 0,01$). Interestingly the in-hospital length of stay was almost equal in the non-cardiac disease group for the two different anesthetics (TIVA vs. Volatile: 5.91 (1.0 – 6.0) vs. 5.92 days (1.0 – 7.0)), whereas length of stay for patients treated with volatile agents was markedly greater for patients with cardiac disease (TIVA vs. Volatile: 6.44 (2.0 – 8.0) vs 9.36 days (3.0 – 12.0)).

Conclusion

The example of length of stay in the RR dependent on type of anesthesia and premorbidity produced significant data supporting the anesthetist in choosing the appropriate anesthetics in our department.

This holds true despite the lack of a comprehensive decision support system. This first laborious step gave proof of the significance and the potential benefit that could lie in a routine and homogeneous outcome system. Arising from this analysis, as a next step we will implement a more complex and focused patient data management system.

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(Thursday Session IV Paper 5)

Web Based Management Of Standard Operating Procedures In Clinical Practice

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Introduction

Standard operating procedures (SOP) have been used increasingly to improve quality and reliability of medical care during the last years. Unfortunately, barriers to actually implement these evidence-based guidelines are often high. [1] Nevertheless, in our department, SOPs became an important tool to help especially our younger colleagues with their daily work by setting standards and providing a tool for quick reference.

The primary substructure of this reference work was based on a series of about 265 Microsoft Word files, each detailing one SOP out of a total of 13 subspecialties, including for example anaesthesiology, intensive care medicine, emergency medicine and pain management. The articles then were combined by subspecialty in larger Portable Document Format (PDF) - files and stored on our department's fileserver for easy retrieval. In addition, printed folders were distributed among the various workplaces, including operating theatres (OT), wards and examination rooms. A book version was published by Springer in April 2005 [2].

At present we are in the process of implementing a more convenient system to maintain, develop and present our SOPs. The new framework should allow concise access, comfortable handling of changes and the possibility to export for printing and publication.

In order to implement the system with a minimum expenditure of time, costs and manpower, we favoured an existing open source software solution over a proprietary development of an own platform or the licensing of a commercially available platform.

Methods

After careful deliberation we decided to use the web-based MediaWiki platform for our purposes. MediaWiki provides a complete solution to store and display formatted text, tagged images and other files, allows quick and easy interlinking, categorization, full text search, and basic user management, all with an intuitive user interface. We run our system on a Windows 2003 server with Apache HTTP Server 2, PHP 5 and MySQL 5.

Although MediaWiki originally is intended for a much more liberal way of distributing and entering information, sufficient configuration options and integrable extensions were available for tailoring the systems to our specific needs. With our installation, the platform is configured to differentiate general access for reading, discussing and/or editing on a user or group basis. It is assured that only authorized users are able to publish or update SOPs.

Articles follow a specific outline, guaranteeing fast access and easy readability. One key feature of the (extended) MediaWiki is its ability to transclude data between different articles, which effectively enables the editor to use defined parts of a text in any number of other articles and allows him to implement updates on all affected pages simply by changing the source text.

Certain inbuilt maintenance functions enable us to selectively dump the articles for printing and export them to other data formats, noticeably PDF versions for publication via the SOP database on the homepage of the German Association for Anaesthesiology and Intensive Care Medicine and for use on handheld devices.

Results

The SOP-system is now functional. Analysis of a sample of 665 anesthesia protocols between January and June 2007 revealed that the implementation rate is 77.9 %. In total, 143 (20.9 %) of the interventions were performed with deviation from the SOPs, only 4 (0.006 %) with serious deviation.

Conclusion

MediaWiki is a convenient tool for providing quickly retrievable and easily manageable reference data in a various environments. Its development as open source software by a large international community allows for a high degree of customizability. Especially in scenarios with limited personal and financial resources MediaWiki can be deployed with reasonable time and effort. Our experience shows that this system - which was originally developed as an encyclopaedial framework - provides a number of tools and characteristics particularly useful for publishing and maintaining Standard Operating Procedures in a hospital.

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(Thursday Session IV Paper 6)

Data Mining In An Intubation Database With Bayesian Networks

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Introduction

Prediction of difficult intubation (DI) is a crucial issue before anaesthesia. Unexpected DI may be catastrophic for the patient. Different clinical signs are used to predict DI with a more or less good performance including Mallampati classification (1). "Lille difficult intubation Score" (LDIS) based on a combination of predictors, was developed in order to improve the predictability of DIs (2). An intubation database was since created, using AREA™ record keeping system (Mexys S.A©, Mons, Belgium), and including several predicting factors of DI, patient demographics, and the ease of the intubation or not. The Bayesian networks learning algorithms allow indeed to mine such database and then to quickly discover unknown probabilistic relationships between variables (4). The aim of this study was to mine a patient database of intubations in order to find more consistent predictors or confirm the pertinence of the LDIS

Patients and Methods

The database , including 1 653 patients having been intubated for anaesthesia in the department of plastic surgery of Lille University Hospital, was submitted to data mining using BayesiaLab™ software (Bayesia©, Laval, France). 18 characteristics were present for each patient. We first used unsupervised learning to discover all the probabilistic relations that hold between the characteristics. Then, we used supervised learning to characterize the target variable INT diff (DI).

Results

129 difficult intubations were present in the database. The supervised learning algorithm allows us to improve the performance of the model, from 47% to 71% (Relative Gini Index). Marginally, the most important nodes (predictors of DI) in the Bayesian

network were: LDIS, OB (mouth opening), Mallampati, Retrognathism and ASA classification. Here are the probabilistic profile of DI (Fig 1) and the combination of the 4 characteristics that implies the highest DI probability (Fig2)

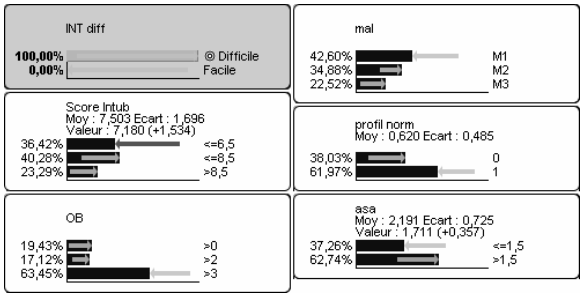

Fig. 1

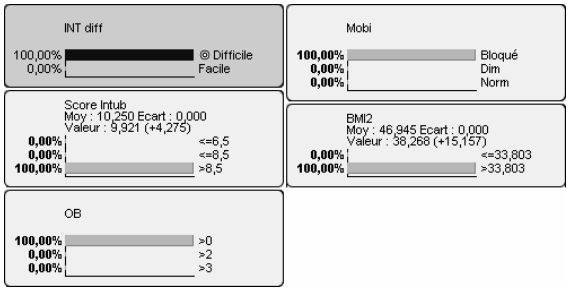

Fig. 2

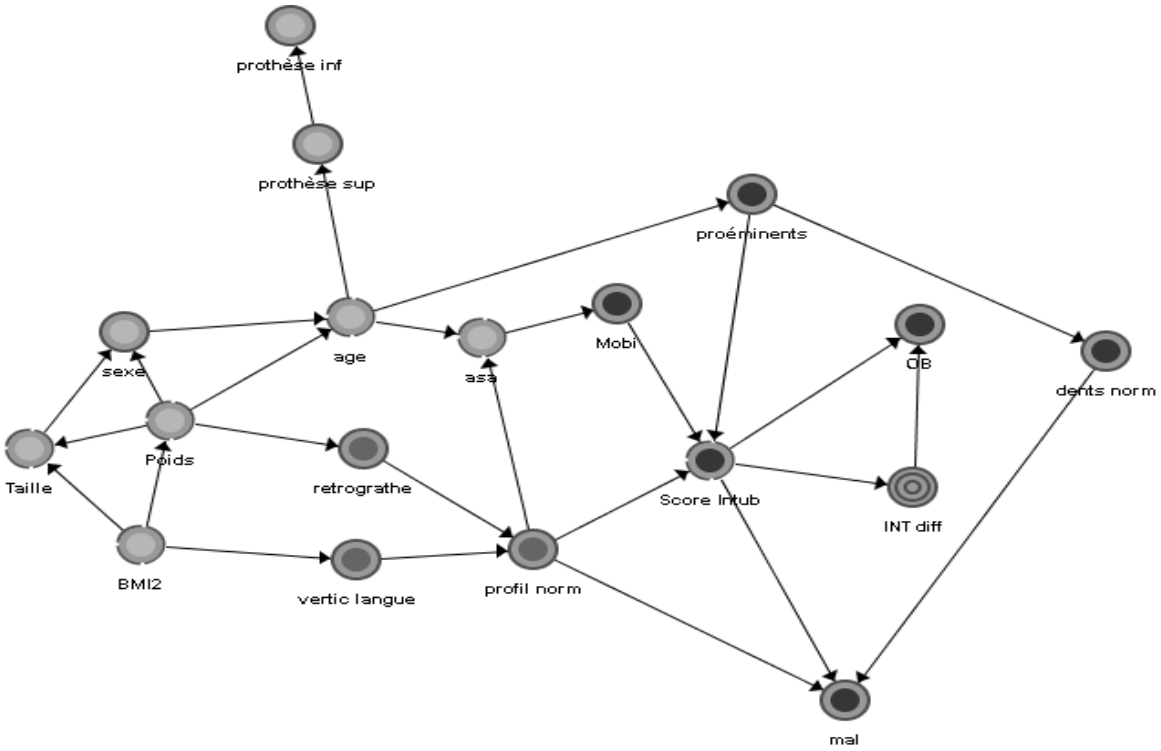

Fig. 3: Bayesian network representing all the direct probabilistic relations between the characteristics. The colors associated to the nodes correspond to the automatic clustering of the variables.

Conclusion

Data mining by Bayesian network has shown that the most important features predicting DIs were OB, Mallampati, ASA, Retrognathism, and confirmed the pertinence of the combination of some features, like in the LDIS. Possible bias may due to the specificity of the patients included in the database being as they come from one surgical department and speciality. It makes sense to apply the same data mining on a larger database including more surgical specialities and hospitals. Thanks to the graphical representation of Bayesian networks, data mining with BayesiaLab™ software allows to quickly discover the knowledge that is hidden in the database. The probabilistic inferences available on these networks can then be used to carry out what-if scenarios, and to build powerful decision support system to update the probability of a difficult intubation as information about the patient arrives.

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(Thursday Session IV Paper 7)

Drug calculation in pediatric cardiac anesthesia

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Introduction

Iatrogenic adverse events occur frequently in hospitalized patients and have often serious sequelae[1]. Complications of medication administrations are very common[2]. Although serious adverse evens in anesthesia are very rare, the number of wrong medication administrations in anesthesia is probably higher than previously thought. The anesthesiologist is almost certainly the only physician who prescribes, prepares and administered under stress highly potent drugs to patients in critical situations without being checked by another medical personnel[2]. Medication errors in pediatric care are very high[3]. The calculation of drugs for pediatric patients may be prone for medication errors attributable to weight-based dosing. This may be even more difficult for anesthesiologists not being familiar with pediatric dosages. These errors highlight the importance of developing, testing and implementing effective error-prevention strategies in pediatric cardiac anesthesia.

In the present study, we evaluated the impact of a computerized form to calculate dosages and infusion rates on the medication error rate in the setting of pediatric cardiac anesthesia in a tertiary-care university hospital.

Methods

We developed a Microsoft Excel (Microsoft, Redmond, WA) based form to calculate dosages and continuous infusion rates based on the patient's body weight for a various lists of inotropes, vasodiliatators, antiarrhytmics and other drugs specific for pediatric cardiac anesthesia (figure 1). The program also calculates the exact amount of drug that has to be added to a 50cc syringe with normal saline to get the exact concentration needed for that specific drug. The program also calculates the exact volume that has to be drawn from each ampoule of drug to reach the desired concentration. This Microsoft Excel form was installed on the computers in the operating room and was also made available on the Internet (http://www.dripomat.info).

Figure 1

Drip-o-Mat for Pediatric Cardiac Surgery (1.0)

Developed by Dr. Yaacov Gozal and Dr. Alexander Avidan, Department of Anesthesiology/CCM Hadassah

Patient's weight	4.5				
Drug	mg/cc	mcg/kg/min	13.5	mg/50cc: 1cc/hr =1 mcg/kg/min	
Dopamine	40	2-10	0.3375	cc	
Dobutamine	12.5	1-10	1.08	cc	
Phentolamine	10	1-2	1.35	cc	
Sodium Nitroprusside	10	0.5-8	1.35	cc	
Sodium Nitroprusside	6	0.5-8	2.25	cc	If diluted to 10 cc
Nitroglycerin	1	0.25-5	13.5	cc	
Drug	mg/cc	mcg/kg/min	0.68	mg/50cc: 1cc/hr =0.05 mcg/kg/min	
Adrenaline	1	0.05-1	0.675	cc	Bolus 4.5 - 45 mcg
Noradrenaline	2	0.05-1	0.3375	cc	
Isoprotenerol	0.2	0.05-0.5	3.375	cc	
Milrinone	1	0.25-0.75	0.675	cc	Loading 225 mcg
Prostin	0.5	0.05-0.4	1.35	cc	
Phenylephrine	0.1	0.15-4	6.75	cc	Bolus 4.5 - 9 mcg
Drug	mg/cc	mcg/kg/min	270	mg/50cc: 1cc/hr =20 mcg/kg/min	
Procainamide	100	20-80	2.7	cc	Loading 13.5 - 22.5 mcg
Lidocaine	10	20-50	27	cc	Bolus 4.5 - 45 mcg
Esmolol	10	50-300	27	cc	Bolus 2.25 - 4.5 mg
Esmolol	250	50-300	1.08	cc	Bolus 2.25 - 4.5 mg
Drug	mg/cc	Bolus mg			
Calcium	100	45 - 90			
Hydralazine	25	3.375	Divided in 4 doses		
Verapamil (not for < 1 year)	2.5	0.45 - 1.35 mg	Repeatdose 0.45 - 0.9 mg		
Adenosine	3	0.45 - 0.9 mg			
Atropine	1	0.045 - 0.09 mg			
Ephedrine	50	0.045 - 0.09 mg			
Labetalol	5	1.125 mg			
Defibrillation					
Defibrillation	2 W/kg	9 Watt			
Coarctation	mg/cc	mg/kg	cc	mg	
Dexamethasone	4	0.25	0.28	1.13	
Mannitol 25%	250	250	4.50	1125	
Heparin	50	1	0.09	4.5	
Lidocaine 1%	10	1	0.45	4.5	

We also asked senior anesthesiologists and residents to calculate for a baby weighing 3.5 kg the amount of two specific cardiac drugs that have to be added into a 50 cc-syringe with normal saline to obtain the following concentrations: 1 cc/hr represents 1µg/kg/min for drug 1 and 0.5µg/kg/min for drug 2. Additionally, we measured how long it took to perform both calculations.

Results

Eleven senior anesthesiologists (group S) and 14 residents (group R) participated in this study. In group S, 42% had 2 correct answers and in group R

46% (P=NS). One correct answer was found in 33% of group S and 8% in group R (P<0.01). No correct answer were found in 25% of group S compared with 46% in group R (P<0.05). The time it took for the calculation was in group S 340 (± 22) seconds and in group R 450 (± 34) seconds (P<0.05).

With the computerized form, there was of course no error and it took only a few seconds to get the perfect result for more than twenty different drugs.

Conclusion

This study demonstrates that the use of a computerized form for preparation of medications in the setting of pediatric cardiac anesthesia is easy and eliminates the errors of calculations (as long as the patient's weight is entered correctly). It is of importance especially for anesthesiology residents who usually prepare the drugs to be administered to the patient. With this form, the time to perform calculations for multiple drugs is negligible and error related to the calculation of dosages and drug preparation can be reduced.

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(Thursday Session IV Paper 8)

Variation in the PaO_2/FiO_2 ratio with FiO_2 – is it relevant?

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Introduction

The ratio of partial pressure of oxygen in arterial blood to inspired oxygen fraction (PaO_2/FiO_2) has been used both to quantify pulmonary gas exchange status before and after interventions [1] and in the definition of acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) [2,3]. Recently the usefulness of the PaO_2/FiO_2 ratio has been questioned by Aboab et al. [4], who analyzed the variation in the PaO_2/FiO_2 ratio with FiO_2 using model simulations. Aboab et al. used a mathematical model including effective shunt, which is known to vary with FiO_2 and as such may not accurately describe measured variations in the PaO_2/FiO_2 ratio with FiO_2. The purpose of this study was to evaluate the variation in the PaO_2/FiO_2 ratio with FiO_2 both theoretically and experimentally by comparing model simulated variations with variations measured in a range of different patient types.

Methods

The study was performed retrospectively using data from 36 mechanically ventilated and 57 spontaneously breathing patients studied on one or more occasions. On each occasion patients were studied by using 4-8 different FiO_2 levels to achieve arterial oxygen saturations covering the range 85-100 %. At each level of FiO_2 measurements were taken of ventilation and arterial blood gases. Two mathematical models of pulmonary gas exchange were fitted to the data: a one parameter effective shunt model [4]; and a two parameter shunt and ventilation/perfusion model [5]. The two models and patient data were used to evaluate the variation in PaO_2/FiO_2 ratio with FiO_2 within a relevant range of FiO_2 defined as the range of FiO_2 resulting in an SaO_2 range of 92-98 %.

Results

Figure 1 illustrates model fits for both models to measured values of FiO_2 versus SaO_2 (A), and FiO_2 versus PaO_2/FiO_2 (B) for a patient presenting in the intensive care unit. The effective shunt model gives a poor fit compared to the two parameter model. This was the case in general, the average root mean square (RMS) error for fitting the two parameter model to patient data was 0.5 % ± 0.4 % (± SD), whereas the RMS for the effective shunt model was 1.4 % ± 1.0 % (± SD). An F-test showed that the two parameter model gave a statistically better fit to the data than the effective shunt model ($p < 0.005$). The effective shunt model simulated an average variation in PaO_2/FiO_2 ratio of (mean ± SD) 11.5 kPa ± 6.6 kPa with a range in variation of 0.9-27.5 kPa. Using the two parameter model the average PaO_2/FiO_2 ratio variation was 6.1 kPa ± 4.1 kPa with a range of 0.9-19.6 kPa.

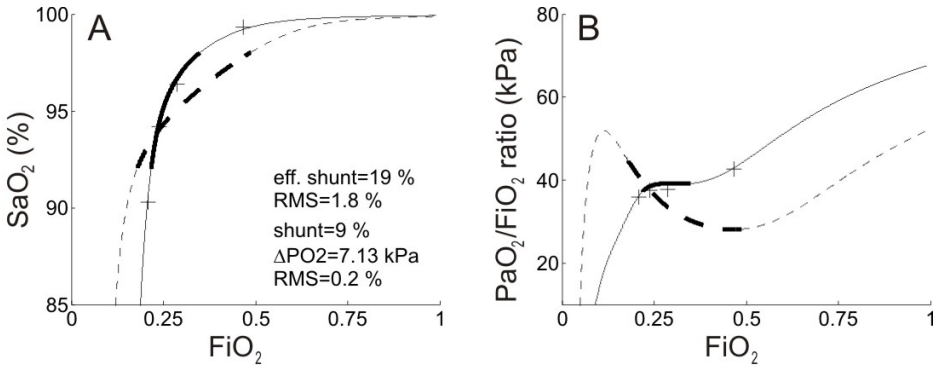

Figure 1

Measured data (+) from a patient presenting in the intensive care unit and model fitted simulations (curves) of: A) FiO_2 versus SaO_2; and B) FiO_2 versus PaO_2/FiO_2 ratio. Curves, parameter values, and RMS is given for the effective shunt model (dashed lines, eff. shunt parameter) and for the two parameter model (solid lines, shunt and ΔPO2 parameters). The thick part of the lines represent the range of FiO_2 giving an SaO_2 range of 92-98 %.

Conclusions

The results show that a two parameter model describing shunt and ventilation/perfusion mismatch is sufficient to accurately describe measured variation in the PaO_2/FiO_2 ratio with FiO_2. In contrast, the effective shunt model overestimates the variation in PaO_2/FiO_2 ratio with FiO_2. Using the two parameter model, the mean (±2 SD) variation in PaO_2/FiO_2 ratio over the SaO_2 range (92-98 %) was 14.3 kPa. This is a significant variation being higher than the range of PaO_2/FiO_2 ratios used to define ALI (27-40 kPa) [2,3]. As such the scientific and clinical usability of the PaO_2/FiO_2 ratio seems doubtful.

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(Thursday Session IV Paper 9)

A review of criteria used in recent studies to assess new modes of cardiac output monitoring.

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Background and Aims

In 1999 we published criteria [1] for comparing methods of cardiac output measurement when using the Bland and Altman approach [2]. These have become widely quoted and include mean cardiac output, bias, limits of agreement (±2SD) and percentage error (2SD/mean). Based on a reference method error, usually thermodilution, of ±20% and combining variances, we set a limit of <±30% for accepting a new method. Since its publication a number of new methods cardiac output measurement have been developed and evaluated. Our aim was to determine how well our criteria have been accepted by these investigators and what were the deficiencies.

Methods

We performed a search of the medical literature for all recent publications (years 2006-2007) in which two or more cardiac output measurement techniques were compared. Papers were reviewed for use of our criteria and their correct application.

Results

Seventeen publications in reputable anaesthetic journals were identified. Thirteen were clinical studies, including two in children, and four were animal studies. Methods under evaluation were pulse contour (n=10), partial CO2 rebreathing (3), bioimpedance (3) and continuous thermodilution (1). Bolus thermodilution was the main reference method (n=15), others being Doppler and lithium dilution. Twelve articles quoted our paper [1]. All but one study used Bland and Altman and eleven included regression analysis. However, only nine studies correctly applied our criteria of <±30% and most papers used multiple data points from each subject. Thirteen studies also addressed ability to follow changes in cardiac output. There was no consensus on statistical approach and several methods of analysis were used.

Conclusion

Bland and Altman and our criteria are now well accepted, though not always applied correctly. However, they do not address ability of data to follow changes in cardiac output. A consensus on the most appropriate statistical evaluation method is needed.

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(Thursday Session IV Paper 10)

Leveraging Commercial Software Products

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Abstract

From 1994 the Sheffield Hospitals collected theatre episode demographic, surgical and anaesthetic data on paper forms entered into Access databases by coding clerks retrospectively. The anaesthetic department received copies of these databases on an ad hoc basis and used them to provide theatre service data to authorised users via a web application. In 2004 this simple application began to be replaced by a commercial product, ORMIS, currently supplied by ISoft. The anaesthetic department let it be known from an early stage that it wished to use the ORMIS generated data with its existing and future applications to meet its information needs.

The Sheffield Teaching Hospitals version of ORMIS uses the client server database product Microsoft SQL Server 2000 as its data storage tier, the data structure being relational with over one hundred tables. It soon became clear that to reconstruct the data into a useful form for anaesthetic use queries would have to be written and stored within the database. It is not good practice to place third party queries within a production database and we did not expect to be granted the necessary permissions.

The hospital's information technology department offered an alternative. The production database has been set up to back up in the traditional way, and to replicate itself over the hospital network to a separate machine. Replication is an industry standard client server database technology that can be set to give a working copy of an original database either as a snapshot from a set time, or as a per transaction copy. The information technology department set up and gave us necessary permissions on a separate database upon this server.

Because client server relational database products store information about the databases, tables and queries that comprise them within their own system databases, they are unconcerned about one database using the contents of another providing the user has appropriate permissions. It is therefore perfectly feasible to write and store queries in the database made for anaesthesia on this backup server, which in fact processes and returns data from the replicated ORMIS databases.

By working to understand this product, and with the cooperation of other interested departments, anaesthesia has been able to restore its information systems, and can look to a future in which this data can be used as foundation upon which to build new applications. The methodology described should be applicable to other commercial software products similarly set up.

We acknowledge the help of the ORMIS Implementation Team, Mr. P. Sawford, Analyst and Mr. T. Saul, Database Administrator, all of Sheffield Teaching Hospitals.

(Friday Session VIII Paper 1)

Selecting a departmental wiki solution – Cardiff's experience

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Introduction

In "An organisation with a memory", the NHS is set the goal of learning from previous mistakes in order to reduce future risks. However, the feedback structures set up are cumbersome and remote. We suggest that exploiting "wiki" technology is a better way of institutional learning and feedback, not just of adverse incidents, but also of optimal practice.

Wiki, by making internet content creation easy, empowers individuals and groups to create and edit information into an internet database. Departments can therefore put together, over time, a comprehensive and locally-relevant set of induction information, clinical guidelines, audit results, personal recipes *etc*. Wiki is also useful for project coordination, as important milestones and roadblocks can be documented for future reference. We reviewed a range of wikifarms for suitability for our department's needs.

Methods

We referred to the list of wikifarms as listed in Wikipedia. By trial and comparison, we identified the features necessary for a departmental wiki. We selected a wikifarm based on these criteria. We describe our initial 6 month experience using our departmental wiki.

Results

The features we deemed essential for a departmental wiki are: 1. user-friendliness – so as to engage normally IT-reluctant doctors, 2. privacy – in order to secure sensitive (though not patient-confidential) information such as audit results, 3. Ability to backup – so that data is not lost if and when the wikihost is changed; 4. Cost – essential consideration in the modern NHS. The desirable but non-essential features: 1. a complete hosted solution – to minimise installation and maintenance logistics; 2. domain-mapping – to retain familiarity in the event of web-host change.

From these criteria, we selected wikispaces.com. It is user-friendly in that it uses WYSIWYG and format is uncluttered, it allows download of current wiki contents for backup, it is hosted and ready-to-go, and it costs US$ 50 / year for access privacy. Viable alternatives include Stikipad and Netcipia. Smaller groups (< 5 users) may find SocialText suitable as well.

In the first 6 months, our departmental wiki has grown to 95 pages primarily in clinical guideline, teaching and research categories. Our attempts to use it as a departmental calendar were unsatisfactory and more specialised software is needed.

Discussion

In the six months since our departmental wiki was set up in Apr 2007, there is slow penetration. This is partly due to Cardiff's policy of restricting internet access in theatre and partly due to limited publicity in the pilot period. Future work will explore the use of Web 2.0 widgets within Wikispaces and conduct user-acceptance studies for this e-resource.

(Friday Session VIII Paper 2)

Installation free approach to the PC version of Royal College of Anaesthetists logbook

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Introduction

The Royal College of Anaesthetists logbook can be installed on various platforms (PC, Mac, Palm OS, Pocket PC, Windows Mobile). Installations on PC / Mac are user-friendly but not portable. Using the RCA logbook on mobile devices requires use of third-party software (HandDBase from DDH Software) [1]. The process of software installation and importing data from mobile devices is fraught with problems. I describe here a method whereby the PC version of the RCA logbook software can be carried on a USB flash drive and run on any PC, without the need for installing it on the specific machine, thereby providing ease-of-use and portability in the same solution.

Methods

The method described requires a PC running Windows 98 - Vista with minimum 128MB RAM, and removable memory media with 15MB free space. Install the PC version of the RCA logbook in its default location. This will install the program to C:\@logbook7 (or C:\@logbook6 or C:\@logbook5 or C:\@logbook4) depending on the version of RCA logbook used. Copy the respective folder from the C: drive to the removable memory media. Transfer the removable media to another PC that does not have the RCA logbook installed. Access the logbook folder on the removable media and open the file Logbook6.rca In the 'Open with' dialogue box, click browse and navigate to the logbook folder on the removable media. Select RCA Logbook v7.exe (or corresponding version file) to open the .rca file

Results

The method described achieves a number of objectives. Firstly, it uses the PC version of the software, which is the most user-friendly interface of the logbook so far. The PC version is also the final interface for generating reports and summaries.

Secondly, there is no need to install two different interfaces, or to buy and configure third-party software. Thirdly, it is ultra-portable on a flash-drive, which weighs and costs considerably less than a PDA / mobile. Finally, it does not require installation of any software on the host machine. As a result, it can be run on any PC where software installation privileges may have been revoked.

Conclusion

The RCA logbook by Hammond and McIndoe has served many generations of anaesthetists and innumerable RITA processes. However its use has not always been smooth and easy. Many hours have been spent in front of the computer screen and on internet forums trying to achieve a stable and hassle-free installation of the PC and PDA versions, and the intervening HandDBase software. The problem was so endemic and serious that a PC Auto-Installer[1] was released with version 7 of the logbook.

The method described here can work as an alternative to the PDA version, by doing away with the tricky and cumbersome process of transferring data from the PDA to the PC version via the HandDBase conduit. The PC version can be used as the single interface where all data is entered. Using the method described, the software can be used on any PC anywhere in the NHS and elsewhere, irrespective of restrictions imposed by local IT departments.

References

1 Website of RCA logbook - http://www.logbook.org.uk

(Friday Session VIII Paper 3)

Wikithesia

Dr Anthony Smith

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Introduction

Whilst preparing for the Final FRCA I wrote reams of notes, referenced information that I would probably never read again. It made sense to me to develop a website to store my notes online and to access them easily. This project quickly evolved into the development of a website, in essence a wikipedia specifically tailored for anaesthesia.

Methods

The project development process of Wikithesia can be deconstructed into 4 specific steps:

Define: Identified that a content management system was required that provided ease of access, ease of use, low budget and ability to allow multiple contributors that could be identified.

Design: Wikithesia was chosen as the site name and the relevant domains purchased. Mediawiki was identified as the ideal software application and installed. MediaWiki is a web-based wiki software application used as a content management system. It was originally developed for the Wikipedia encyclopedia. MediaWiki is written in the PHP programming language, and can use either the MySQL or PostgreSQL relational database management system.

Develop: Following successful installation of MediaWiki, the site was tailored to the specific needs of an educational tool for the field of anaesthesia and intensive care medicine. Initial development focused upon the site structure and page layout. The site was divided into the main categories of intensive care medicine, clinical anaesthesia, basic sciences and equipment. These main categories were then further subdivided and pages specific for problems, drugs, conditions, techniques etc were assigned to appropriate categories. Individual pages were given templates for content to aid navigation. Beta-testing allowed refinement of the structure and templates.

Deploy: Once the structure was laid out the site was publicised locally in the Stoke and Mersey Schools of Anaesthesia. Further modifications were made as part of an ongoing evolutionary design process. To gain access to a wider audience the site has been promoted on AnaesthesiaUK. This increased numbers of registered members and subsequently increased user contributions to the site.

Results

The website has been well received amongst the anaesthetic community. To promote the website I have held trainee prize competitions to encourage user contributions and ran a workshop at the Midlands society of anaesthesia annual meeting. Following deployment, the site has evolved further with the addition of an IPB discussion board and integration of the board into the wiki using IPBwiki. I have recently concentrated upon the graphic design of the site, developing logos, banners and skins for the site to improve the professional appearance of the site.

Conclusion

This website was initially intended as a personal tool for my own educational development but it has evolved way beyond this. Wikithesia has the potential to become an encyclopaedia of anaesthesia. A definitive resource for information about anything relating to anaesthesia and intensive care medicine.

(Friday Session VIII Paper 4)

A first look at ALERT (Anaesthetic Locator for Equipment, Research and Training)

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Introduction

The reduction of clinical training time due to the New Deal and the European Working Time Directive has detrimentally affected speciality training. One audit showed an 18% decrease in the number of cases done and an 11% decrease in the number of weekly training lists [1]. Together with the increasing emphasis on "competency", it becomes imperative to optimise technical training efficiency. Currently, however, many technical training opportunities are lost in the theatre environment. This is partly due to trainees not being aware of the procedures being planned day by day. This may be addressed by the use of a centralised and accessible procedure information point. We describe the construction of such a system.

Materials and Methods

ALERT consists of three parts: a HTML-Javascript front-end where anaesthetists edit and view data, a MySQL back-end where the data is stored in an internet database, and a PHP interface that translates HTML form data into SQL data and SQL data into HTML tables (see embedded graphic). HTML form and table design is refined based on pilot group feedback.

Discussion

ALERT is designed to maximise training efficiency, by showing trainees the list of procedures planned by location. With the planned extension of ALERT to incorporate a trainee queuing system, trainees can then book themselves in for the appropriate training. Updates would be by RSS and SMS.

Besides training benefits, ALERT may improve theatre efficiency by communicating equipment requirements from anaesthetists on pre-op rounds, to their anaesthetic assistants the next morning. It may also help track assets such as the fibreoptic stack or the ultrasound machine, during the operating day. Finally, ALERT can also be used to audit equipment usage and training opportunities, and for other research.

Future work includes user-acceptance studies. In view of ALERT's many benefits, we propose that this project should be developed into a UK-wide anaesthetic e-resource.

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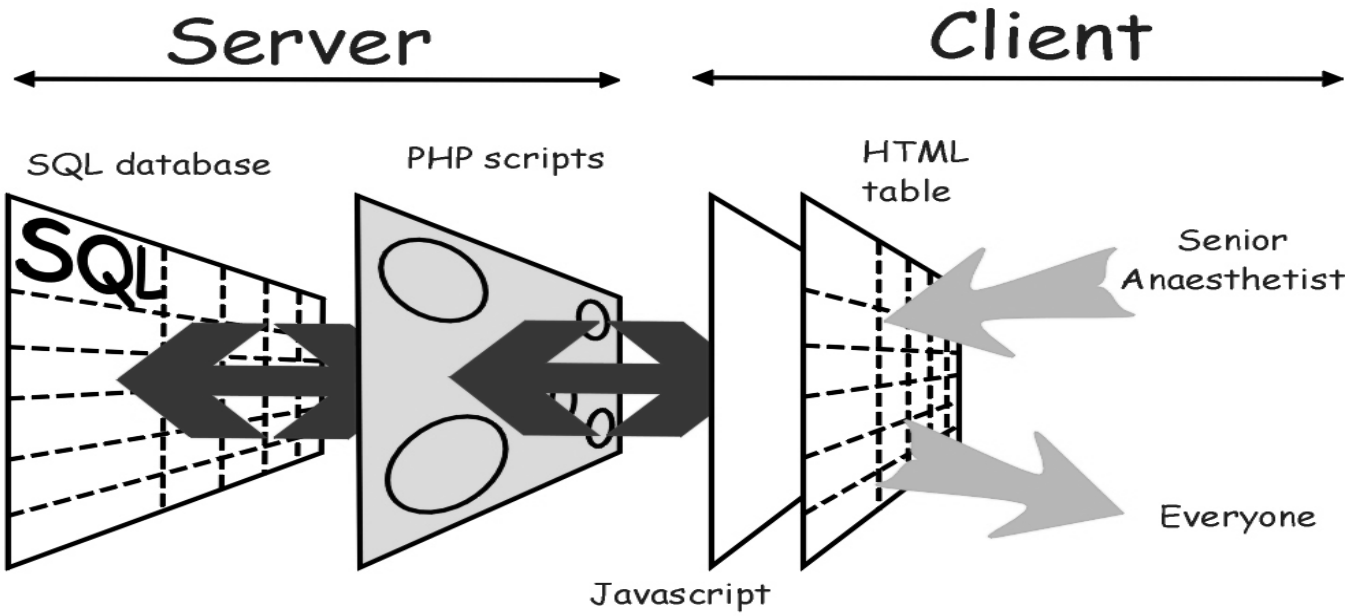

(Friday Session VIII Paper 5)

Information Technology - are we in the 21st Century?

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Introduction

With the implementation of the National Information technology programme, the NHS aims to provide advanced technology systems to support clinical activities and ensure high quality patient care. We report the results of an on-line survey to assess current perceptions of IT facilities available to anaesthetic Specialist Registrars (SpRs) in the Wessex Deanery.

Results

Results are based upon a 58% response rate from 8 of the 9 trusts within Wessex.

6% SpRs solely relied upon IT facilities within the workplace. 54% had IT access in the ITU, on-call room and departmental office, 34% in the library and 30% in theatre.

11% had no access to a computer whilst at work, 29% to 1-2 terminals, 40% to 3-5 and 20% to 6 or more. 56% of these responders thought this was acceptable given that 68% spent between 3 and 10 hours per week on computer based work activities.

100% used this time for email (departmental communications), Internet searches and on-line diary monitoring, and clinical governance activities requiring Word and PowerPoint. 75% used them for accessing clinical databases of which only 32% of responders claimed their department held subscriptions.

34% of responders believed that poor IT facilities had significantly impaired their enthusiasm to undertake audit and clinical research activities.

30% felt the need to purchase further hardware and software to compensate for a lack of facilities at work and 50% had taken their own computer to work.

64% of trainee's were found to have received formal IT training (ECDL, City and Guilds or ITLS) and 33% of the departments have designated IT leads, but 43% of respondents felt this did not adversely influence the IT facilities in their departments.

Conclusions

The NHS is currently implementing the National Programme for IT[1,2]. The Wanless reports have highlight the importance to future UK healthcare[3]. Inequality in facilities and training exists across the NHS[4] with primary care facilities being more advanced.

Our survey of Wessex suggests that further investment in work and home IT facilities is required from both already financially stretched Trusts and a small minority of trainees. This does not bode well for implementing the more complex IT systems of the future.

IT is a non-clinical competency of the CCT in Anaesthesia and 64% of respondents have undertaken further IT training. This, along with a recommendation of minimal standards by a body such as The Royal College of Anaesthetists or Association of Anaesthetists may add substance for departments to improve their IT budget. This would hopefully allow trainees to deliver an even higher and up to date level of care for their patients as well as improve productivity in research, audit and publication.

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Next SCATA Meeting

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20th – 21st November 2008

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By Car

If you are coming by car, consider the Park and Ride facilities. Alternatively, the recommended car park is in Charlotte Street.

Assembly Rooms (for the Meeting)

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