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Editors: B. Pollwein, M.D. (Munich) & I. Kalli, M.D. (Helsinki)
Helsinki City Maternity Hospital, Dept. of Anaesthesia, SF-00610 Helsinki, Finland

1. Automated acquisition of smart alarm rules from monitoring data using the polyanalyst machine discovery system

S. Arseniev, M. Kiselev & E. Flerov

Introduction: At the previous ESCTAIC meetings we have reported the development of the SYPAM-i – the integrated anaesthesia monitoring system which is now clinically implemented and used routinely in every day cardiac surgery in several hospitals of Russia [1]. One of the important features of the SYPAM-i is a smart alarm (SA) subsystem. The first version of this subsystem was based on a limited set of rules obtained from experts-anaesthesiologists. First experience with the SA revealed the following major drawbacks of this approach:

1. Expert knowledge is often limited by ideal physiological models and does not take into account real conditions of data acquisition, measurement artifacts, noise, etc.
2. Expert rules usually have qualitative rather than quantitative nature. Meanwhile to implement SA the exact numerical dependencies are required.

Alternative approach to SA rules acquisition – machine discovery: Modern methods of artificial intelligence provide a promising alternative to interviewing an expert. Recently our laboratory completed the first working version of the machine discovery system called PolyAnalyst which is capable of elucidating the numerical interdependencies in bodies of experimental/observational data [2]. We applied this system to the above-mentioned problem of the SA rules formation.

Methodology: During clinical usage of the SYPAM-i monitoring system a huge base of anaesthesia records has been collected. Each record contains more than 30 parameters monitored at 1 minute interval. Among them are continuous cardiac output, consumption of oxygen, mixed venous saturations and others. The monitoring picture is completed by patient data, blood lab data, surgery event, drug and solution comments.

The following dangerous states have been chosen for automated detection: inadequate ventilation, inadequate anaesthesia, cardiac insufficiency, and vascular insufficiency. The experts were asked to mark these episodes in the records. These fragments formed the training examples body which was the input for the PolyAnalyst. We expected the output to be a set of formulae expressing the probability level of the dangerous states from the recorded parameter values.

Results and discussion: At present we obtained only preliminary results related mostly to episodes of inadequate ventilation. The formulae for inadequate ventilation probability levels give their values as real numbers in the range from 0 to 1. A certain value from this range should be chosen as the alarm threshold. This value determines the alarm sensitivity and is a matter of compromise between the reliability of detection and frequency of false alarm occurrence. This work is still in progress and there are a lot of unresolved difficulties. However the present study seems to be a useful stage in solving the complex problem of building a reliable smart alarm real-time expert system.

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2. Hospital Communication based on HL7. Structure, Possibilites and Realisation

J. Dudeck

An intensive care computer system should be understood as an integrative part of an hospital information system, which requires data from administrative and ancillary systems like clinical laboratory, microbiology, pharmacy, pathology and which has to deliver requests and other data to related systems. For the electronic data interchange (EDI) via more and more available hospital networks interfaces have to be established. To diminish the efforts required for connecting different systems standard interfaces are already defined resp. are under development. The currently available most comprehensive standard interface is HL7 introduced in US since 1987 by an engaged consortium of volunteers.

The first really applicable version 2.1 has been delivered in 1990. It includes ADT (Admission, Discharge, Transfer), Order entry, Results Reporting, Financing and Query messages. The following version 2.2 has just been finished and will be published until the end of the year. It includes new messages for drug prescription and management and for accessing master files. Version 2.3 which will include in addition scheduling messages, is expected at the end of 1995.

Within HL7 the messages are defined on the 7th layer of the ISO/OSI communication model (Health Level 7). In the HL7 standard the syntax and the semantics of the messages are defined. The message is the smallest unit to be transmitted. It consists of a sequence of segments which comprise the atomic elements within the message, the attributes. The structure of the messages, the definition of segments and attributes are provided by the standard. The construction of messages and the available definitions will be explained and displayed using examples of messages.

In the US HL7 has already become a quasi standard. The HL7 group was accredited by ANSI to be a "Messages Developing Group". Nearly all HIS and ancillary systems are now providing HL7 interfaces. In Germany and also in Europe the first implementations are already operational but the experiences are still limited. More and more tools and communication servers are becoming available. Tools and servers will be described and first experiences with an HL7 implementation connecting an EMTEK intensive care system with an hospital information system will be illustrated.

The European efforts supported by CEN and carried out in particular in the Working Group 3 of the Technical Committee 251 (TC 251) will also be explained.

3. Modelling work of breathing: The effects of continuous positive airway pressure, endotracheal tube size and inspiratory flow in normal subjects and test-lung

S.D.R. Homan, J.L. Moran, S.L. Peake & D. Smith

Introduction: Continuous positive airway pressure (CPAP) circuits of demand flow CPAP systems have been assessed in normal subjects, patients and via test-lung methodology. Recent investigations [1] have suggested that the performance of CPAP circuits differs between test lung and human subjects.

Aim: To model and compare the performance of the demand CPAP circuit of a new microprocessor controlled ventilator (Siemens SV300) in both pressure and flow triggering modes using: (i) normal seated subjects, and (ii) Test-lung methodology.

Methods: The inspiratory work of breathing (WI, mJ/l) of 6 seated normal subjects (naso-oesophageal balloon-tipped catheters in-situ) was computed thus: breathing at (random order) 0, 5, 10 and 15 cm H_2O

CPAP with varying target inspiratory (VI) flows (20, 40, 60 and 80 Um) through a mouth-piece (18 mm inner diameter) and mouth-held 23 cm long endotracheal tubes (ETT) of 7, 8 and 9 mm inner diameter via the CPAP circuit of the Siemens SV 300 (flow and pressure, 1 cm H_2O, trigger). WI was calculated from the (oesophageal) pressure-volume (integrated pneumotach flow) product, during inspiration, using an on-line PC-based system. The WI of the CPAP apparatus was also measured at the same VI and CPAP levels using a Michigan Instruments 1600 TL test-lung, driven by a PB 7200a ventilator with sine and square-wave (shape) VI. WI was computed from pressure-volume product; pressure measured at CPAP-pneumotach interface (Pp) yielded Wcir and pressure at the distal end (PD) of ETT yielded Wapp. *Statistical analysis:* WI data from multiple comparisons of Subject and Test-lung interaction of ETT/trigger function/flow/CPAP level were subjected to Analysis of Variance. In both cases trigger was considered to be a blocking factor with a joint blocking factor of subject for the subject data and shape for the machine data. In both cases flow, ETT and CPAP were considered as fully interactive factors.

Results: For the purpose of comparing Subject and Test-lung WI, with respect to flow and ETT, a table of differences (which model the comparisons against ETT 7 and VI 20 l/m, within any level of CPAP and subject/shape) can be constructed:

TABLE I

SUBJECTS: averaged nett WI (mJ/I)					TEST-LUNG: averaged nett WI (mJ/I				
ETT	VI20 l/m	VI40 l/m	VI60 l/m	VI80 l/m	ETT	VI20 l/m	VI40 l/m	VI60 l/m	VI80 l/m
7	0	287	733	1511	Wapp7	0	338	842	1268
8	−60	96	460	934	Wapp8	−29	186	532	936
9	−89	52	297	704	Wapp9	−34	136	440	819
M-piece	−112	−42	112	356	Wcir	−175	−118	30	177

Similarly, a table of comparisons for the CPAP effect upon WI may be constructed; Test-lung versus Subject relative to ETT 7 and VI 20 l/m.

The initial model of: Subject + Trigger × Flow × ETT × CPAP was modified in the stepwise elimination process to yield a simpler model of: WI = Subject + CPAP + Flow × ETT (Multiple R^2 = 0.88). Similarly, for the Test-lung the initial model: Shape + Trigger × Flow × ETT × CPAP was modified to yield a simpler model of: WI = Shape + CPAP + Flow × ETT (Multiple R^2 = 0.97).

TABLE II

CPAP Level (cm H_2O)	Test-lung: sine-wave	Test-lung: square-wave	Subjects
0	0	21	0
5	−101	−80	−105
10	−67	−46	−127
15	−70	−49	−97

Conclusions: The behaviour, in terms of WI, of both Subjects and Test-lung to various levels of CPAP, VI and ETT, may be described by similar statistical models.

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4. Is an individual anaesthesiological profile distinguishable? The variation in anaesthesiological care during routine coronary artery surgery

R. Huet, Af. De Geus & G. Van Deest

Introduction: Characterization of the anaesthesiological profile is important for quality control, training purposes, data validation, and decision support. The anaesthesiological profile can be characterized by the procedural approach, the dose of various drugs (fine-tuning), or by the concept of target points. As we use a standardized anaesthetic technique, we are able to compare the variability in these areas between anaesthetists.

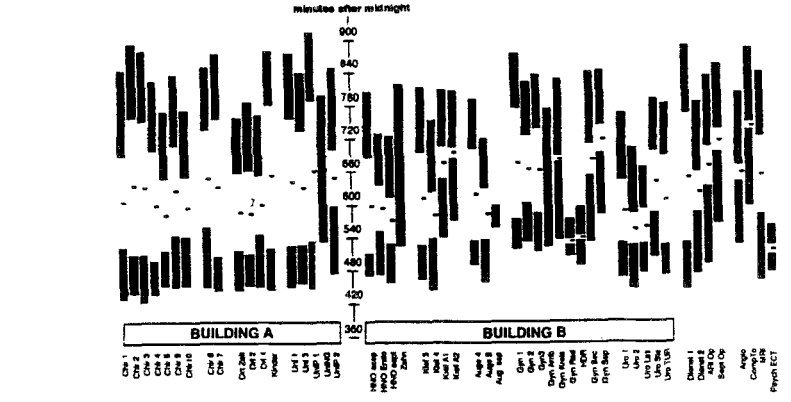
Method: Retrospectively, 391 automatically documented anaesthesia records of routine coronary artery surgery patients were selected from 8 cardiothoracic anaesthetists (range 25–80 records). The anaesthetic technique consisted in all cases of midazolam, sufentanil and pancuronium for induction and insurance of anaesthesia, with 50% air/oxygen ventilation and identical monitoring. Preoperative hyperon hypotension was individually defined but similarly treated. The following variables were chosen:

a) *The procedural approach*: entry of procedure, blood loss, urine output, wedge pressure (PCWP) and cardiac output (CO). The time taken for induction, to wean from bypass, and for transport to ICU.
b) *The use of drugs*: dopamine, phenylephrine, calcium, furosemide, and second dose protamine.
c) *Target points*: 1. haemodynamics: CO. PCWP and mean arterial pressure (MAP) after induction and sternotomy, during and after bypass. Hyper- and hypotensive events in the ICU (defined as systolic pressure above 150 or under 90 mmHg during 15 minute period); 2. control of potassium, haemoglobin, urine output and nasopharyngeal temperature at the end of operation; 3. extubation time.

A t-test was applied to the extubation time extremes. Variation (%) of range was standardized and defined as (max-min/median) $\times$ 100.

Results: The patients were comparable for age, weight and cardiac state. *Procedural approach.* On average the different chosen items varied 94%. (Table 1). Only 3 anaesthetists recorded PCWP in every procedure. Urine output was recorded always, blood loss was not entered in 0–36% of patients. *The use of drugs* varied on average 93%. Dopamine, calcium, protamine, and phenylephrin use varied enormously among the anaesthesiologists. *Target Points.* The variation was small, on average 30%. 1. haemodynamics. The variation in average MAP was within 12 mmHg (15%) among the 8 anaesthetists during the various events. There seem to be however large differences in the occurrence of hypotensive periods in the ICU. In 6 anaesthetists the hypotensive period were usually dominant in the first hours in the ICU, in the 2 others the hypertensive periods were more dominant.

Discussion: The individual anaesthesiological profile seems to be characterized mostly by variation in



legend

finishing time of last operation
starting before 16.00

hands on time of anesthetists
(grouped around MAX of traffic)

maximum of traffic

start time of first operation

workplaces

Building A
Due to shortening of OR time available, the surgical schedule is dense, properly timed and the area is highly organized.
Cancellation rates are high, emergency cases are rather postponed than done immediately. Anesthetists are used very economically, hands on hours per person are high.

Building B
Opened in 1990, this ORs allow individual convenient surgical schedules, with low cancellation rates.
The anesthesia work follows passively this schedule leading to many stand by hours

Fig. 1.

the procedural approach and the dose of various drugs. The concept of target points showed less variation, with the exception of urine output, hypotensive events on the ICU and extubation time. The differences in these variables could be caused by the doses of drugs used (fine-tuning) and by volume therapy (not presented). This needs further evaluation. Because the procedural differences are large, these mostly manually entered variables need preoperative validation for completeness. An internal survey revealed that, when the anaesthetists were asked about there performance, not all could characterize their own performance (de Geus, personal communication, 1992). It appeared that those who documented more accurate had a better estimate of their performance and use of drugs. A prospective analysis seems promising to study the anaesthesiological profile and the impact of anaesthesia.

5. Managing a big anesthesia department: Can O.R. data be helpful?

W. Koller, R. Morawetz & D. Schreithofer

During a one year period 24000 "daytime" procedures have been performed in our University Hospital using anesthetists. Starting and finishing times of each action was evaluated from a database. All calculations were done on a minute to minute basis, only workdays of the year were included. All values are averaged for one year and for each workplace. Besides other results, the following figure could be derived from this data (for details see legend):

The surgical schedules are made independent for each subspeciality. The Clinic for Anesthesia has no possibility of coordination on a regular basis for the surgical OR schedules.

Result 1: As all attempts to better intersurgical coordination failed so far, this lack of coordination was accepted by a consulting company, the hospital management and the health authorities as reason to give additional manpower to anesthesia.

Result 2: The highly organized building A will be enlarged for 12 new ORs, dedicated groupwise to surgical specialities. As the new suite will be opened in 1995, we expect a similar pattern than in building B, leading again to disrupted and uncoordinated schedules for anesthesia.

6. An integrative data base concept in anaesthesiology

S. Lindner & N. Lutter

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Subsequent to an analysis of the specific data flow management in the department of anaesthesiology of the University of Erlangen by means of preceding empirical research we started to implement a series of homogeneous applications managing the department's requests in data flow management. These applications should meet at least the following criteria:

- bidirectional connectivity referring to the hospital's information systems (PATIK2, SAP/3) including a computerized anaesthesia billing system;
- a data base server providing a standardized interface that easily communicates with all local applications in the main areas of anaesthetic practice (operating theatre, pain management, peri-operative pulmonary care, emergency medicine);
- considerable surplus of the system's computing and storing resources with respect to increasing networking activities and thus increasing synchronous data base access;
- location-free availability of all facets of the system's features, e.g., a grossly unified graphical user interface, prevention of redundant data input, a reduction in paperwork, etc.;
- substantial protection to data loss and sufficient agreement with the medico-legal aspects of documentation as well;
- integration of pre-existing computer equipment of various different manufacturers.

In attempting to approach these in a way maximum requests we first established a server-client environment based on Unix-based servers (SPARC architecture) and numerous different PCs as front-ends. A relational data base (lNGRES) has been installed for processing and storing data, providing extended scalability, powerful capabilities in backing-up the data base even when data entry or retrieval is performed actually, and detailed access limitations up to the B1-security level. The graphical user interface Windows-4GL provided by INGRES implies full support in various operating systems and different hardware platforms. Centralized storage of all data collected focuses attention to the need for careful backup management, but allows almost instantaneous processing as well.

Representative of the department's data base management miscellaneous applications in peri-operative respiratory care including pulmonary function testing are presented more detailed. The data obtained herein primarily support diagnostic and therapeutic goals but also are utilized as for the billing process, quality assurance and clinical research and may be imported directly into SAS in order to perform the most respectable statistical analysis in addition. Demographic information for each inpatient is downloaded

into our data base from the hospital mainframe running PATIK2, the information for outpatients is uploaded.

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7. Continuous noninvasive blood pressure measurement by means of a contact pressure method (Cortronic 7001)

N. Lutter, F. Fischer, B. Fischer & Ch. Zapf

Introduction: The aim of our clinical study was to approve validity and reliability of a method for continuous noninvasive blood-pressure measurement (cNIPB) by comparison with continuous arterial blood-pressure (cAPB) monitoring. The study was carried through with approval of the university's ethics committee as well as with the patient's written consent.

Methods: We studied 43 neurosurgical patients under standardized anaesthesia, patients with pathological haemodynamics were ruled out beforehand. With the method we tested arterial blood pressure is determined with a specific vascular elasticity and with the correlation of invasive and noninvasive arterial blood pressure on the basis of repetitive oscillometric calibrations. The significant signal is also tracked by means of contact pressure generated via blood pressure cuff; as a reference we took the invasive blood pressure of the homolateral radial artery. Statistical analysis included the events following: recalibration of the Cortronic, laryngoscopy, intraoperative nociceptive stimuli, and different pharmacodynamic effects, in addition the two methods were evaluated by means of Bland-Altmann plotting.

Results: Over the entire testing period data are different (cNIPB − cAPB) for the systolic blood pressure (3.7 ± 25.8 mmHg), the mean arterial pressure (8.2 ± 18.0 mmHg), and the diastolic pressure (10.2 ± 14.5 mmHg, $p < 0.01$). Immediately after recalibration there is a sufficient correspondence of systolic pressures (p(a) = 129.4 ± 24.6 mmHg, p(cor) 132.1 ± 19.3 mmHg), whereas diastolic pressures differ significantly. Though reduced in particular by recalibration the difference of diastolic pressures increases after a delay. According to well-known pharmacological effects the invasive p(syst) decreases significantly after induction of anaesthesia. The noninvasive p(syst), however, shows a delayed increase. Nociceptive stimuli generate synergistic changes in both methods, but are detected earlier by the invasive device with larger increments as well. Regarding pharmacodynamic effects both methods differ in latency, extent and direction of the blood pressure changes measured: drugs with a directly vasodilating effect (nitroglycerin, urapidil) lead to antagonistic blood pressure changes, indirectly vasodilating drugs (clonidine) generate synergistic data with an initial increase only in the invasive system, however. The HMPE-aminophylline/theodrenaline compound induces an increase in the directly measured pressure which is significantly stronger when compared to the cNlBP. A significant decrease in invasive blood pressure is performed with the application of alfentanil, whereas after a similar response time cNIBP shows a minor increase.

The linear regression curves and correlation coefficients calculated from the scatter plots mainly show that, with increasing invasive pressures an increasing difference between lower noninvasive and invasive pressures is established. The Bland-Altmann plots show that diastolic noninvasive pressures are always measured to high, while systolic pressures have a central tendency towards relatively higher values in the lower, and relatively lower values in the upper range of measurement.

Conclusions: Without regarding abrupt changes in blood pressure the noninvasive and the invasive measurement are remarkably congruent, which corresponds well with the correlations described in other investigations comparing noninvasive to invasive blood pressure measurement. However, despite of good correspondence of invasive and noninvasive data during haemodynamically stable periods, monitoring with the Cortronic 7001 with the algorithms implemented at the time of testing in situations when sudden alterations in blood pressure are to be expected, can only be recommended for a restricted field of application.

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8. Computer assisted data analysis in intensive care

P.G.H. Metnitz & P. Laback

Introduction: Patient Data Management Systems (short PDMS) for Intensive Care are rarely integrated as parts of a hospital-wide information system network, at the moment they are mostly isolated solutions. As long as no ideal system, integrating administrative, medical and scientific data exists, interesting patient data have to be exported for further processing (e.g., for scientific analysis, quality control purposes or cost-benefit reports). The PDMS CareVue 9000 (Hewlett Packard) was purchased for all ICUs at the Clinics of the University of Vienna. This system can be queried only via an "interactive database interface" (IDB) which provides extracted data in up to 22 ASCII files. To communicate with the IDB, a DOS program (DBExport) is needed, which transfers the data onto a PC. For further processing those data must be patient- and event-related reconstructed in a relational database. Our goal was to develop a database system for analysing our patient data.

Methods: First we defined the necessary hard- and software configuration. The client-server principle is today's standard solution for a database system having the described needs. We used the MS SQL-Server for Windows NT® as a server system and MS Windows for Workgroups®-PCs as clients. Reasons for this choice were: the availability of these products on a university-contract basis, which allowed the cheap and easily-serviceable construction of an clinic-wide network, and the powerful features for programming and data analyses which are available in MS Windows®-compatible products. The programming language used was MS Visual C++®

Results: After defining the database structure we automated the daily data import. A filter module was necessary to control the import of the raw data. This program performs certain tasks such as parameter-filtering, reduction of redundancy and data validation and formatting, if necessary. An interactive front-end tool was developed, which allows easy querying of patient data. It can be used to review data of medical importance and to create routine statistics. Additionally we are developing a module to support planning and execution of clinical studies: Inclusion and exclusion criteria may be entered into a form and act as filter sets. Matching data records will be transfered retro- or prospectively into separate "study

tables" from where they can be processed easily (e.g., automatic transfer to ODBC-compliant programs as MS Excel). Incoming data can be reviewed and validated using graphical presentation of the data.

Discussion: The construction of a database system for intensive care is a complex process, where many factors have to be recognized and evaluated. They include: amount of data, security, as well as performance aspects. The database structure, once defined, influences the quality of available information. To get the information required by the users, this structure – including e.g., indices, time-event relationships and sort orders – has to be discussed exactly with the experts, defined and accurately implemented before starting any import process. Once the database is defined, a querying tool is necessary for clinicians to handle data analyses with a minimum of informatics support. For this purpose we designed an interactive front end, which supports different views of patient data: single patients, defined groups or the complete ward. For each of these views different kinds of query mechanisms and analyses are needed. The described scientific database represents the prototype of a powerful analysing system, which can be easily adapted to local demands.

9. Computer supported management of patient data in a preanesthetic unit – extra effort or facilitation of routine procedures

C. Preis, R. Berger, H. Gilly & H.G. Kress

Computer supported patient data management systems are established in many operating theatres, intensive care units and recovery rooms [1, 2]. To evaluate the patient's fitness and risk for anesthesia and surgery and to handle demographic and biometric data, handwritten reports are used in most cases. To decide whether or not computer support would facilitate the preanesthetic data management, we designed, developed and tested a software package for preanesthetic patient data management.

For preanesthetic evaluation a large amount of data is collected, e.g., demographic and biometric data, results of electrocardiography, assessment of pulmonary function, chest X-ray, physical examination and also preoperatively determined laboratory parameters. Written down in paper reports, these data can hardly be arranged according to their importance. At the end of patient's evaluation, however, each patient should promptly be classified according to ASA physical status. Moreover, if the criteria of the Goldman Cardiac Risk Index and the New York Heart Association Risk Index are fulfilled, these data have also to be considered in the patient's prospective risk evaluation. As the risk indices can only be determined after completion of the patient's examination, and, on the other hand, these indices are known to be very important for the assessment of the patient's preoperative risk, we used different layouts for data input and data output. The data input facilitates compiling the information in a time shortening way. In addition, the output subroutine creates a printed report with the most important topics (e.g., ASA, Goldman, NYHA, Mallampati index) at special positions on the chart record according to the wishes of the anesthetists working with the report in the operating theatre.

To allow a hospital-wide network comprehensive solution, the system was based on OS/2 under MS Access 2.0 running on an IBM network (Token ring, Lanserver 3.0). 62 patients undergoing elective surgery were evaluated so far. The experience with our software showed that our approach data dividing into input and output does not cause any extra effort.

Designed by anesthesiologists for the use of anesthesiologists, the computerized preanesthetic protocol seems to facilitate the preoperative risk evaluation in patient's undergoing elective surgery. In the future, all patient data collected in the preanesthetic unit will be available within the entire hospital as our network is accessible from every operating theatre and recovery room.

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10. Simulator for training the use of medical equipment in anaesthesia and intensive care

A. Rettedal & S. Freyer

Simulators are often used in training personnel when the consequences of inappropriate action could be dangerous or expensive. In the medical field, however, simulators are not very common. Mishaps and accidents in connection with the use of biomedical instrumentation are frequently a result of technical malfunction and improper use of the equipment.

This paper gives details of a "hands-on" simulator for training anaesthesia and intensive care operatives. The simulator consists of a mannequin on a operation table or in a typical critical care unit bed. The mannequin is controlled from a PC and can be ventilated by a respirator or an anaesthesia machine and supported by IV-pumps. Parameters such as ECG, blood pressure (invasive and non-invasive) ETCO2, and airway pressure can be picked up by any ordinary electrodes/transducers and displayed on any appropriate monitor or workstation, and there is no need for modification or special adaption of the medical equipment going to be used in the simulation scenario.

Several other parameters may be controlled from the PC; some digitally, others continuously. They can all be varied during the simulated treatment. Parameters are: Laryngospasm, lung compliance, airway resistance, pneumothorax, cuff leakage, blocking of the breathing sounds from one lung, secretion, gastric regurgitation and diuresis. The mannequin is capable of spontaneous breathing. An event log is produced continuously for analysis and evaluation.

Because the resident should be exposed to a lifelike situation, we are able to place the simulator mannequin either in a room which resembles an intensive care unit or an operating theatre.

The algorithms of a person's normal physiological behavior are not all known, or are algorithms of the patient's responses to all given treatments. It is thus difficult at the moment to develop a computer programme which automatically causes the simulation mannequin to respond appropriately to all possible different steps in a treatment. To ensure a partial and flexible solution to this problem, we include an instructor with medical knowledge in the system. The instructor is able to control the patient mannequin by the computer and duplicate a variety of pathological states in the mannequin of the kind that are likely to occur in response to the treatment determined by the resident, or alternatively, to duplicate less common or predictable states.

The simulator has so far only been used for training 6 upcoming nurses in anaesthesia. It is thus not possible to give any quantification of the fitness for use in a training program. But the subjective comments from the residents concluded that the simulator and scenarios were feeling lifelike, and that the simulator contributed positively to their learning process without risks for any real patient.

11. Automatically readable anaesthetic paper records for quality assurance: Experiences from a three-year period

B. Schwilk, U. Bothner & W. Friesdof

Problem: According to the stipulations in the Social Code, the German Society for Anaesthesiology and Intensive Medicine has elaborated recommendations for quality assurance in anaesthesia. These recom-

mendations are comprising aspects of procedure (method of documentation) as well as the standardization of risk factors as well as pitfalls, events and complications (PECs).

We have studied the following questions:

1. Which problems are resulting from the requirements of a complete documentation?
2. Which are the PECs occurring at a University Hospital, and what is their relation to pre-existing diseases and particular surgical fields?

Methods:

1. Introduction of an automatically readable anaesthetic record (ARAR) and analysis of documentation mistakes as well as of the additional effort of time. Distribution of questionnaires among anaesthetists concerning the design of an ARAR.
2. Utilization of the ARAR for the documentation of standardized items, and application of a sophisticated system of control and corrections.

Results:

1a) After being filled in by the anaesthetist and before being scanned, 60%–90% of the ARAR documents need a – mostly formal – correction.

b) The additional effort of time to be made by the documentation personnel amounts to 2 minutes approx. for every record; almost an additional full-time physician is needed for handling and evaluating the data.

c) Particular demands are made by anaesthetists for the design of the preanaesthetic evaluation record (classification by organ systems and items of severity).

2a) During 23598 anaesthesias (July '92 – Sept. '93) 7417 PECs occurred in 5354 patients (22.7%). The most frequent PECs were hypotension (1998), hypertension (732), arrhythmia (573), bradycardia (458), tachycardia (417), nausea/vomiting (375), bronchospasm (252), hypoxemia (238), and other respiratory disturbances (233).

b) The rate of PECs was closely related to the risk class (ASA), the urgency and kind of intervention as well as different risk factors such as smoking, excess weight, and age.

Conclusions: 1. The comprehensive documentation for the purpose of quality assurance can be made by using an ARAR system. This requires, however, an interdisciplinary group for data control and system maintenance, as otherwise the data are useless.

2. The PECs reporting principle is useful and can serve as a quality parameter only if pre-existing diseases and clinical circumstances are recorded in detail as far as possible, because the frequency and severity of PECs in different big groups of patients differ by a factor of 5.

12. First clinical experience with a prototype to link the Siemens Servo 300 ventilator to the Hewlett and Packard monitoring system

Ch. Sitzwohl, M. Holzer, F. Sterz & A. Laggner

Study background: Monitoring of flow and pressure curves is essential for adequate mechanical ventilation. Until now users of the Siemens Servo 300® ventilator did not have this facility. A new linking system is able to transmit flow, pressure curves and various numeric data from this ventilator to the Hewlett and Packard Component Monitoring System® (HP-CMS).

Purpose: To determine adequate function of the interface in the daily clinical use.

Setting: Department for Emergency Medicine of the General Hospital, Vienna; University Clinic.

Methods: Prospective surveillance of the interfaces correct function by simultaneously comparing shown values on the monitor with displayed values on the Servo 300. Values of interest were: Fraction

of inspired oxygen (FiO2), Minute Volume (MV), Mean Airway Pressure (MnAWP), Peak Inspiratory Pressure (PiP). Tidal Volume (TV) and Total Respiratory Rate (TotRR). Furthermore flow and pressure curves were observed and problems that occurred were noted. For statistical analysis descriptive statistics and Analysis of Variance were used.

Results: The system was used on 16 patients during a total of 235 hours, monitor and ventilator data were compared (n = 104). Longest continous use was 43 hours. No changes in ventilator or monitor function were induced by the module. No problems with flow and pressure curves were noticed. In contrast to this we observed differences of the numeric values on the monitor with shown data on the ventilator. Frequencies and amounts of these deviations are shown in Table 1.

TABLE I

Frequencies and amounts of differences between ventilator and monitor values during 104 comparisons.

	PIP	MnAwP	FiO_2	TotRR	TV	MinVol
Frequency (number of observed differences (%))	31 (29.8)	33 (31.7)	37 (35.6)	56 (53.8)	66 (63.5)	75 (72.1)
Amount mean ± SD in %	1.6±3.2	4.1±7.4	1.4±3.3	4.9±5.9	3.1±6.4	2.1±3.5

The monitor tended to show a lower than actual respiratory rate. Out of 56 wrong data points 49 (87,5%) were false low, and 43 (76,8%) of these were 1 breath/minute to low. The other parameters had equal deviations to the positive and negative side. The differences for some monitor values were statistical significant larger when pressure support or SIMV was used compared to pressure – or volume – cycled mode. This was true for MinVol ($p < 0,01$) and TV ($p < 0,0001$). For the other parameters only tendencies in the same way were found.

Conclusions:

1. The interface transmitted flow and pressure curves adequately during all ventilator modes.
2. The interface delivered correct numeric values during volume and pressure cycled ventilation.
3. Values for MinVol and TV on the monitor differ sometimes severely from ventilator data. This difference was statistical significant larger during pressure support and SIMV compared to volume or pressure-cycled ventilator modes. For adequate monitoring during weaning periods these values have to be transmitted more accurately.
4. In 41,3% of our observations total respiratory rate was one breath/minute less than actual rate shown on the ventilator. This observation was not linked to ventilator setting.

As none of our observations were noted during test series in the technical labs we conclude that clinical testing of prototypes is necessary to guarantee correct function of the final product.

13. European database for extracorporeal lung support in adult

M. Van Wickern, W. Holtermann, M. Kramer, P. Lukasewitz & H. Lennartz

In 1980 Gattioni gave the first presentation of extracorporeal lung support (ELS) for treatment of ARDS and severe pulmonary dysfunction in Europe. Since this first presentation ELS has undergone many modifications, i.e., different oxygenators were tested, changes in cannulation techniques, modified

circuit management, indications for bypass treatment were reevaluated. Until now more than 400 adult patients have been treated by this method in more than 10 centers in Europe.

A central register for extracorporeal lung support has now become necessary. It enables all participating centers to compare the different forms of treatment and allows them to utilize this large data-pool for the benefit of their patients. In addition a central register will support further standardisation of bypass treatment and implementation of quality standards.

We have initiated this central register with the "European Database for Extracorporeal Lung Support in Adult" in Marburg, in April 1994.

Some technical details of the database: It is programmed in Microsoft Foxpro for Windows V2.5. The databases are fully x-base compatible and supports SQL (Structured Query Language). DDE (Dynamic Data Embedding) and OLE (Object Linking and Embedding) techniques allow a direct data transfer to the most common statistic and calculation programs. Microsoft MS-GRAPH, which is linked to the program allow a direct graphical presentation of queries. The program requires as a minimum an IBM-compatible computer with a 386SX processor and 4 MB RAM DOS 3.3 and Windows 3.0 or higher versions were the software predictions of the program.

In this database for each patient relevant data regarding physical and cardio-pulmonal status before and during extra-corporal lung support, technical details of the bypass and the oxygenators, complications during bypass and outcome of patients are collected.

During the initial phase of the project, we offer an off-line data transfer between the different participating centers. During the second phase of the project we are planning an on-line data transfer for the different participating centers to the database with the possibility of direct evaluation of their own data and a comparison of their data with the data of the other centers.

With this database we intend to build up a knowledge-based system for improved information transfer between the different European centers. This will support standardisation of ELS-treatment and enable further progress in extracorporeal lung support.