Selected abstracts

Patient Data Management Systems in Intensive Care - 1996

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Ph.G.H. Metnitz (Vienna) & I. Kalli (Helsinki)

1. Knowledge-Based Interpretation and Monitoring in Intensive Care: Application in ARDS Patients

Klaus-Peter Adlassnig[1], Heinz Steltzer[2] & Alfons Hammerle[2]
[1]*Department of Medical Computer Sciences, University of Vienna Medical School, Spitalgasse 23, A - 1090 Vienna, Austria;* [2]*Department for Anesthesiology and General Intensive Care Medicine, University of Vienna Medical School, Waehringer Guertel 18–20, A – 1090 Vienna, Austria*

Introduction

Intelligent on-line monitoring of ICU patients requires mechanisms to detect and interpret significant patterns in the flood of recorded data. Many monitoring methods have been proposed, ranging from simple surveillance of thresholds to complex reasoning about and forecasting of the patient's behaviour based on computational models of the human organism [1].

Methods

From the many components that constitute a comprehensive intelligent monitor we focus on two combinations which result in a workable device capable of mapping collected data onto physiological and pathophysiological states. They are arranged as stages and form the kernel of a bigger, still evolving system called DIAMON-I, which is dedicated to the on-line interpretation of patients' status.

Stage one, which has been more generally described as pre-processing [2, 3], deals with the transformation of incoming data streams into a sequence of events. Here, temporal abstraction is done by fuzzy trend detection. Detected trends are reported to stage two, a fuzzyfied deterministic automation capable of assigning interpretations to the sequences of events.

Results

For the purpose of evaluation, ICU data of an eight month old female suffering from adult respiratory distress syndrome (ARDS) was chosen. The data set contains continuous heart rates, blood pressures, O_2 saturation values, and ventilator settings sampled over a 12-hour period. In addition, continuous data from laboratory tests and the flowsheet was provided.

The application showed the sensitivity of the fuzzy trend detection method: E.g., all sudden increases in SaO_2 were correctly identified.

Discussion

In combination with the fuzzyfied deterministic automation, the input of which consists of the detected trend events, the system was capable of assigning high-level interpretations to the sequences of detected trends.

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2. Can a patient data management system enhance quality of intensive care?

Aarno Kari
Department of Anaesthesiology and Intensive Care Kuopio University Hospital, Finland

The debate on possible advantages and disadvantages of patient data management systems for intensive care (PDMS) has been focused on 'high level' problems. Proponents have said that a PDMS may significantly support both clinical and managerial decision making. All commercial PDMSs comprise options supporting quality management and planning. Although these features may look out attractive, they are of secondary importance when evaluating the impact of the PDMS on the quality of care. The most important functions of a PDMS are the automatic collection of data and the formation of an organised data base. These functions bring along advantages, which obviously improve the quality of intensive care:

PDMS reduces workload

Automatic charting of on-line monitoring data, data from therapeutic devices, data from the clinical laboratory and I/O data reduces the clerical work of the nurses significantly. Prescription and administration of drugs and fluids can be done without repeated writing. The use of default orders for medication, fluid therapy and laboratory tests reduce the workload especially in ICUs with lots of elective surgical patients. Manual collection of data for scoring systems for severity of illness and intensity of care are time consuming. According to our test a nurse spents 10–15 minutes to collect data and to calculate the APACHE-II score. A PDMS produces the score without extra consumption of work. Cost accounting and billing are examples of time consuming managerial activities, which can be performed automatically by a PDMS.

PDMS improves quality of documentation

One of the major concerns expressed by the opponents of PDMS is the quality of the documentation. An automatic charting system cannot identify artefacts but includes them in the trend recordings. In manual system the nurse controls for artefactual values. This argument can be turned, however, upside down: A high quality document of monitoring should show at every moment data, which are available at bedside including all artefacts displayed by monitoring devices. The artefact rejection is the matter of measuring devices and a PDMS just documents what has been measured. Manual recording of haemodynamic and respiratory monitoring, which is usually done on hourly basis, consists limited amount of information compared to trend graphs drawn by a PDMS with high time resolution. There are also studies showing that manually produced documents may be surprisingly inaccurate, which makes their use as a golden standard inappropriate.

PDMS improves quality of care

There are no studies showing convincingly that a PDMS improves the quality of care. Indirect evidence suggests, however, that it does. By reducing the unnecessary workload a PDMS gives to the personnel more time to the direct patient care. The higher the quality of documentation the better are the chances for right decisions. A comprehensive, well organised database makes it possible to develop modern, efficient quality management systems, which has been shown to reduce costs and improve the quality in several types organisations in the service sector.

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3. Beyond Scoring, towards Case Mix Assessment: A new Method

J.R. Le Gall, C. Alberti, E. LePage, G. LeLeu
and the European Consortium, Paris, France

The Severity Scores and Probability Models helped considerably for the description and comparability of patients. Nevertheless the lack of calibration observed either in differents units or different countries outlines the difficulty to describe the case mix [1]. The aim is the Description of the Case Mix by a new method assessed by the inter observer reliability.

Methods

A software has been created with an operating manual for standardisation and definition of each variable and a rule to choose the main diagnosis. Fifty patients from France and United-Kingdom have been coded by three different people. The Kappa coefficient has been calculated to estimate the concordance.

Results

The first day variables are age, co-morbidities [2], Severity Score (SAPS II), type of patient medical, surgical or elective. Besides the patient may be cardiac, traumatic or other (9 types of patients are possible). The main diagnosis at entry is choosen, which is the one explaining at the best the organ(s) in failure or threatened. The diagnoses are classified in three exclusive groups : infections, medical non-infectious, surgical non-infectious. For each group there is a different screen on the software. The appropriate screen is selected according to the preceeding variables. During the stay the number of organ failures. Logistic Organ Failures (LOF) and the occurence of nosocomial infection are noted. For each variable there is a definition on the screen. The results of concordance test are now analysed.

Conclusion

This original system proposes a new solution to the case description and choice of main diagnosis.

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4. The European Intensive Care Database Project: First Results

J.R. Le Gall, C. Alberti, J. Huillard, E. LePage
and the European Consortium, Paris, France

To have a permanent, quality controlled, European data base is useful for epidemiologic studies, performances and costs assessments, therapeutic trials. Sucessive steps had to be reached before getting at an European data base.
1. An European Consortium has been founded in 1994 as an activity of the European Society of Intensive Care. This Consortium is made of (a) a Board in charge of establishing the aims, the plans of action and the rules, (b) a Scientific Committee to guarantee the high quality if data and methodology and (c) an Operating Center to warrant the daily management of data.
2. A minimal common data set has been created by the Operating Center and submitted to the Scientific Committee. This minimal common data base is made up of four mandatory chapters (A,B,E,F) for each patient plus two optional chapters (C,D).

A Demographic data
B SAPS II
C MPM 0 (optional)
D MPM 24 (optional)
E Diagnoses at entry
F Secondary factors (stay events)-therapeutic, outcome

3. The minimal common data set has been computerized in two softwares: PC and Macintosh, with a detailed operating manual giving the definitions of all the items.
4. A special quality control of data is performed. Reliability checks have been built into the computer programs in the form of range checks and logical checks. The primary physician at each hospital will be responsible for repeating data collection on a 5 % random sample of study patients, to determine inter-rater reliability. These data will be entered into froms only (not into the computer). These quality control data collection forms, filled out by the primary physician, will be sent to the coordinating center.
5. A Pilot study is now in progress in 50 units from 10 countries; all the ICUs entering patients are collected for two months.
6. After the analysis of the Pilot Study, the minimal common data set will be altered and the second version submitted to the Scientific Committee.

The preliminary results will be available around March 1996.

5. Vie-Nmed, a computer assisted drug information and prescription facility for newborn infants

Christian Popow[1], Werner Horn[2], Silvia Miksch[2], Thomas E. Young[3], and O. Barry Mangum[4]
[1]*Div. of Neonatology, Dept. of Pediatrics, University of Vienna, Austria;* [2]*Dept. of Medical Cybernetics and AI, University of Vienna, Austria;* [3]*Dept. of Pediatrics, University of North Carolina, Chapel Hill, NC, and* [4]*School of Pharmacy and Medicine, University of North Carolina, Chapel Hill, NC*

Introduction

Drug prescription for sick newborn infants may involve problems of appropriate dosage because in this group of patients immaturity and organ failure may largely influence drug pharmacokinetics, interaction and susceptibility. Moreover, calculation errors, rare untowarded side effects and limited drug monitoring possibilities may cause additional problems.

Some of these problems may be circumvented using computer assisted facilities for information retrieval and dosage calculation. Expert systems and database facilities have been developed for predicting drug interactions and pharmacokinetics, for prescribing antimicrobial therapy, drug dosage and TPN solutions in adult and pediatric patients. Most high-level applications such as MYCIN [1] have not gained widespread use because they do not offer more expertise compared to a real expert, because they are difficult to develop and to keep up to date, and because they may not be time saving. Low level applications offering simple catalogue and calculation functions generally are only of local importance. Recent advances in interface and communications technology enable the development of computer aided systems of supraregional importance and may be integrated within a medical information environment.

We developed a computer assisted facility, VIE-NMed, within the framework of the commonly used WWW shell, in order to help neonatologists in retrieving pharmacologic information from a yearly updated manual, from own tables and therapeutic schemes. The program is also equipped with a drug dosage calculator for newborn infants.

Material and methods

VIE-NMed uses a commercially available reference manual for neonatal drug administration, Neo Fax™ [2] for its information data base. The manual contains structured information about currently used drugs listed under the following headings: doses and administration, uses, recommended monitoring, pharmacology, adverse effects and precautions, special considerations and preparation, and selected references. In addition to the information contained in NeoFax™, we added similarily structured information about drugs not contained in the manual but used at our NICU, and other information such as Austrian commercial drug names.

Drugs were also classified according to their actions on the various organ systems (gastrointestinal tract, CNS, lungs, heart and circulation, kidneys, skin, immune system (including antibiotic tratment)). Drugs acting on various organ systems (such as theophylline) were multiply listed. Within an organ-oriented medication group, drugs were classified according to their kind of action (e.g. antiarrhythmics, GI motility promoting agents etc.) and according to a clinically determined hierarchical order (e.g. first and second line antibiotics). Drugs may thus be selected from alphabetical listings, pharmacologic sections, and organ-specific hierarchical listings (Table).

In order to generate a user friendly environment for information retrieval, we transferred the original WordPerfect™ text file of NeoFax™ including our amendments to the WWW shell using HTML programming language. The whole text file of VIE-NMed can be searched for text strings. The search can be on the whole text file or it can be limited to NeoFax™, to the own medication amendments or to various sections of NeoFax™ such as drug use or drug side effects.

In addition, we included a dosage calculator module to our program in order to facilitate appropriate drug prescription. The dosage recommendations of NeoFax and the added dosage recommendations are displayed on top of the calculator screen. The dosage calculator then asks for the input of body weight, dosage per kg, dosage interval (e.g. q8h), route of administration (iv, po, pr, continuous iv bypass), and if the first dose should be given immediately or according to the routine time schedule (e.g. 8:00, 16:00, and 24:00 for q8h). If the first dose is to be given immediately, the dosage calculator interpolates the time between the following dosage intervals in order to arrive at the scheduled time points after one to three dosages depending on the drug administration time interval and the difference between the actual and the scheduled time. The output of the dosage caculator includes daily and single dose, dose per kg body weight, and drug administration times for the subsequent 24h.

Table. Problem oriented medication. Example, the cardiovascular system - arrhythmia:

Bradycardia	
	→ orciprenaline
	→ adrenaline
	→ atropine
	→ pace maker
	→ consider also hypocalcemia, digitalis overdosage, hyperkalemia
Supraventricular tachycardia	
	→ vagal stimulation, e.g. cold pack
	→ adenosine
	→ propranolol
	→ digitalis
	→ propafenon
	→ consider fluid overload
	(→ fluid restriction, furosemide) drug overdosage (adrenergics, parasympatholytics) hypercalcemia
Ventricular tachycardia with	
- ventricular fibrillation	
	→ defibrillation (1 J/kg)
	→ lidocaine
- no ventricular fibrillation	
	→ lidocaine
	→ propafenon
	→ consider hypovolemia, fluid overload

VIE-NMed has been installed on a UNIX workstation which is connected to the PDMS workstation network of our NICU (Hewlett Packard CareVue 9000). The program can be called at the bedside PDMS monitor from an Access Window. At present, the output of the dosage calculator for reasons of HP-CV9000 system protection cannot be used as an input to the PDMS.

VIE-NMed was technically and clinically evaluated. The technical evaluation consisted of thorough testing of all the program's features. Then, the program was clinically tested by the medical and nurses staff at the bedside of our 18 bed NICU for a period of three months. Critique and suggestions were collected in an electronic mailbox accessible from the program's home page.

Results

During the technical and clinical evaluation, VIE-NMed has been found to work appropriately. Using VIE-NMed in the UNIX network still causes problems of space allocation. Learning to use and using the program was found to be simple. In general, demonstrating the program for approximately 5–10 minutes was sufficient teaching for most potential users.

If the program is running in the background, information about a listed drug can be retrieved using two to three mouseclicks, i.e. usually within less than 5–10 seconds. A context text search will last 5–15 sec depending on workstation performance and extent of the search, restricted e.g. to side effects or search on the entire text.

Suggestions of the test users for a further enhancement of the program included augmentation of the database, and linking the output of the dosage calculator to the PDMS database.

Discussion

We described the development and applicability of VIE-NMed, a useful clinical tool for facilitating medication in neonatal care. The system has successfully been integrated into our PDMS network and can be used at the bedside.

Its main advantages are the simple and rapid retrieval of relevant pharmacological information about dosage, drug interaction, rare side effects, drug monitoring etc. and its dosage calculation functions.

The program uses as its main source of information a yearly updated commonly used manual, therefore information upgrading is simple as there is a special upgrading program which automatically loads the new WordPerfect™ textfile. Thus, the viability of VIE-NMed is somewhat linked to the upgrading of NeoFax™. However, we chose this approach because of the relative safety and popularity NeoFax™ has gained in the last years.

Compared to manual information looking-up, using VIE-NMed is much more rapid if it is installed at the bedside. Moreover, VIE-NMed can easily be customized to the user's needs and standards and offers the possibility of additional searching facilities like disease related search and hierarchical drug listings.

We conclude that VIE-NMed is a useful clinical tool for NICUs. Its concept in the framework of the WWW server could be a standard for other clinical information systems like syndrome databases etc.

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