SYSTEMY DORADCZE W MEDYCYNIE

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Plan prezentacji

1. Informatyka medyczna i systemy doradcze

2. Proces diagnozy i terapii w medycynie

3. Wybrane przykłady systemów doradczych wspomagających decyzje kliniczne

4. Kryteria diagnostyczne i ocena systemów

5. Uwagi na temat stosowania systemów doradczych w medycynie

Poznań

Informatyka medyczna i systemy doradcze

Podstawowe zastosowanie komputerów w medycynie to zbieranie, przechowywanie i udostępnianie informacji.

"Oczekiwania" - specjalistyczne oprogramowanie umożliwiające wyciąganie użytecznych wniosków na podstawie złożonych danych.

Medycyna: wnioski - ***rozpoznanie*** / ***diagnoza*** , to określa działanie - ***terapia***.

Pasywne vs. Aktywne systemy informatyczne.

Zaawansowane zastosowania:

- nowe techniki pozyskiwania danych, np.:
  - rozbudowane scenariusze zadawania pytań,
  - techniki przetwarzania języka naturalnego,
  - rozpoznawanie mowy,
  - automatyczne zbieranie danych.
- komputery jako część wyposażenia medycznego, np.:
  - automatyczna analiza sygnału cyfrowego,
  - analiza EKG, wykrywanie nieprawidłowości,
  - wspomagana komputerowo diagnostyka laboratoryjna.

Systemy doradcze w działalności klinicznej

Diagnoza

Opis słowny zbioru cech klinicznych, który jest podsumowaniem przypadku identyfikując go z innymi przypadkami mającymi podobną przyczynę w sensie patologicznym oraz odróżnia go od innych przypadków.

Diagnoza - rozpoznanie postawione na podstawie wielu cech (symptomów).

Diagnostyka różnicowa - wielość różnych rozpoznań.

Terapia - na postawie diagnozy podjęcie działań leczniczych.

Proces diagnostyczno-terapeutyczny.

Rozumowanie analityczne a syntetyczne w diagnostyce medycznej.

Analiza: opis zdarzeń -> wnioski

Synteza: hipoteza -> fakty za lub przeciw potwierdzeniem

Podejmowanie decyzji co do diagnozy

Podejmowanie decyzji klinicznych, zarówno dotyczących diagnozy, jak i wyboru rodzaju leczeniam, jest złożonym i trudnym procesem.

Podstawowe rodzaje diagnozy [za Rudowski]:

Diagnoza probabilistyczna – lekarz widząc pewne objawy i wiedząc z dużym prawdopodobieństwem co może być ich przyczyną stawia wstępną diagnozę i kieruje pacjenta na badania specjalistyczne.

Rozpoznanie wzorca – zespół objawów występujących u pacjenta odpowiada „podręcznikowemu" opisowi konkretnej choroby.

Postępowanie przyczyne lub dedukcyjne – ustalenie łańcucha przyczyn i skutków prowadzących do choroby.

„*Medycyna to nauka o nauka o niepewności i sztuka prawdopodobieństwa*" [Osler]

Wspomaganie decyzji dotyczących diagnozy i terapii – dalsze uwagi:

- Nie jest to czynność jednorazowa, lecz raczej proces związany z podejmowanie wielu decyzji.
- Proces iteracyjny i interaktywny.
- Wielość czynników trudnych do formalizacji, np.:
  - Działanie w obecności niepewności.
  - Praktyczne postępowanie oparte jest często na wiedzy eksperckiej, doświadczeniu nabywanemu z czasem i technikach heurystycznych – brak analizy formalnej, trudności z nabywaniem wiedzy od ekspertów,…
  - „Każdy pacjent jest oddzielnym przypadkiem”.
  - Wielość (zbyt wiele) parametrów i kombinacji wartości danych do analizy przez lekarza.
  - Nie zawsze dostępne są definitywne odpowiedzi.

Systemy doradcze w działalności klinicznej

Medyczny system wspomagania decyzji - oprogramowanie zaprojektowane w celu pomagania lekarzowi specjaliście w podejmowaniu lepszych decyzji [Shortliffe].

Trzy podstawowe rodzaje:

1. Narzędzia ułatwiające zarządzanie informacją kliniczną
2. Systemy monitorujące i skupiające uwagę.
3. Systemy wspomagające konsultowanie pacjentów.

Def. AI: Przez pojęcie systemu doradczego rozumiany jest program wykorzystujący wiedzę i procedury rozumowania dla wspomagania rozwiązywania problemów na tyle trudnych, że do ich rozwiązywania wymagana jest pomoc eksperta. Program taki może być traktowany jako model wiedzy najlepszych lekarzy praktyków w rozpatrywanej dziedzinie.

Algorytmy kliniczne

Algorytmy kliniczne, nazywane także protokołami lub ścieżkami postępowania - spis kolejnych czynności wykonywanych standardowo podczas badania lub zabiegu.

Stosowane jako materiały dydaktyczne lub do wspomagania bieżącej pracy personelu medycznego.

Postepowanie przy tworzeniu algorytmów klinicznych:

1. Opracowaie reguł diagnozy lub terapii w grupie specjalistów.
2. Zapis i testowanie koncepcyjne protokołu w formie schematów (np. zapisanych jako schematy blokowe na papierze).
3. Testowanie na danych archiwalnych.
4. Poprawianie podczas ciągłej pracy, np. w oddziale.
5. Przygotowanie do rutynowego użytkowania klinicznego (dokumentacja, prezentacje, podręczniki,…)
6. Wdrożenie do wykorzystywania w praktyce klinicznej.

Motywacje dla stosowania:

1. Zmniejszenie odchyleń od prawidłowych wzorców postępowania, szybkie wykonywanie potrzebnych czynności oraz eliminacja wahania personelu.
2. Przypomnienie o kolejnych czynnościach w opiece nad chorym / standaryzacja postępowania.
3. Pomoc w sprawach formalno-prawnych.

System MYCIN – przykład systemu doradczego

Opracowany w celu wspomagania procesu stawiania diagnoz i ustalania terapii podczas leczenia zakażenia krwi oraz zapalenia opon mózgowo-rdzeniowych.

Powstał na Uniwersytecie Stanford (E.Shortliffe).

Stanowił tzw. „wzorcowy” przykład praktycznego zastosowania technik sztucznej inteligencji. Stał się inspiracją dla rozwoju wielu systemów eksperckich.

Motywacje – błędne stosowanie antybiotyków.

Jednostki chorobowe – częstość ich występowania i potrzeba szybkiego działania zespołu leczącego:

Długi okres oczekiwania na wyniki badań laboratoryjnych (identyfikacja bakterii oraz dobór leków).

Charakterystyka działania systemu MYCIN

MYCIN – wspomaga lekarza w zakresie konsultacji wysoko-kwalifikowanego specjalisty.

Działanie systemu – dialog (ogólne informacje o pacjencie, symptomy choroby, znane wyniki badań laboratoryjnych).

Proces wnioskowania systemu składa się z 4 faz:

- rozpoznanie, czy pacjent jest chory i czy choroba jest wywołana przez bakterie,
- ustalenie rodzaju bakterii, które mogły wywołać chorobę,
- identyfikacja zbioru skutecznych środków farmakologicznych - leków,
- wybór właściwych leków i ustalenie sposobu ich stosowania.

MYCIN – proponuje szczegółowo rodzaj terapii, uwzględniając przy tym mogące wystąpić niekorzystne oddziaływania leków oraz ich uboczne wpływ na pacjenta.

Modele probabilistyczne we wspomaganiu decyzji

Klasyfikacja Bayesowska - wykorzystuje twierdzenie Bayesa.

Wiedza przedstawiona w postaci zbioru prawdopodobieństw.

Oblicza się prawdopodobieństwo różnych rozpoznań na podstawie informacji o zbiorze cech klinicznych:

System de Dombal

Cel: badanie przypadków bólów brzucha, które utrzymują się krócej od 1 tygodnia u pacjentów zgłaszających się na oddział nagłych przypadków.

System rozwijany na Uniwersytecie Leeds.

Informacja o każdym pacjencie porównywana z danymi odniesienia pochodzącymi od 6000 pacjentów z 15 krajów, przy zastosowaniu analizy Bayesowskiej - **klasyfikator Bayesowski.**

Przykładowe diagnozy:
appendicitis (wyrostek robaczkowy),
pancreatitis (choroba wrzodowa),
perforaled ulcer, cholecystitis,
...

Weryfikacja: 8 centrów medycznych, przy udziale 250 lekarzy i kilkunastu tysięcy pacjentów -> trafność diagnostyczna wzrosła o około 20%

Przykłady Polskich medycznych systemów eksperckich

Przegląd w *Informatyka medyczna* (Rudowski, red.) oraz w *Systemy komputerowe i teleinformatyczne w służbie zdrowia* (Kącki, Kulikowski, Nowakowski, Waniewski, red.)

AVES-N opracowany w Instytucie Biocybernetyki i Inżynierii Biomedycznej PAN

Przeznaczenie – wspomaganie leczenie noworodków noworodków zespołem niewydolności oddechowej / niebezpieczna choroba przyczyną do 20% zgonów noworodków.

Leczenie – stosowanie respiratora, lecz konieczny jest właściwy dobór nastaw oraz trybu pracy w zależności od zmian stanu pacjenta.

Cel systemu – udzielanie porad personelowi co do nastaw respiratora w zależności od aktualnego stanu pacjenta i stosowanej terapii.

Konstrukcja systemu – klasyczny regułowy system ekspercki; Baza wiedzy specjalistów specjalistów oddziałów intensywnej terapii.

Przykłady innych systemów eksperckich

System INTERNIST1 / QMR

Cel - praktycznie stosowany do wspomagania diagnostyki różnicowej i szkolenia. Określnienie diagnozy wstępnej na podstawie informacji o objawach/symptomach

Rozwijany w Pittisburgh School of Medicine

Obejmuje ponad 600 podstawowych chorób wewnętrznych opisanych na podstawie różnych 4500 symptomów; Na jedną chorobę przypada średnio 70 symptomów.

Metodyka: Baza faktów i baza wiedzy; dla chorób określa się specjalne wagi ważności na podstawie wiedzy eksperckiej i występowania określonych symptomów.

Dobre doświadczenia praktyczne (lata 80te)

Przygotowania nowej wersji QMR (Quick Medical Reference) dla nauczania studentów.

ONCOCIN

Rozwijany w latach 80tych w Stanford University.

Cel: zarządzanie formularzami chemioterapii dla onkologii.

Aktualna farmakologiczna baza danych i regułami przydziału dawek leków.

HELP

System amerykański zintegrowany z szpitalnym systemem informatycznym (HIS).

Cel: bieżące nadzorowanie stanu pacjena, nowopojawiających się wyników badań i obserwacji z terapii; Generowanie „alarmów” i podpowiedzi dla lekarza.

Metodyka: ramowa reprezentacja wiedzy skojarzona z systemem bazy danych w HIS + baza reguł generujących akcje.

Systemy doradcze w kształceniu i praktyce lekarza podstawowej opieki zdrowotnej.

Część z nich rozwijana w Centrum Medycznym Kształcenia Podyplomowego.

ELSA – wspomaganie lekarza w procesie diagnostyki różnicowej.

AEGIS – konsultacja najczęstszych problemów / zaburzeń przewodu pokarmowego.

HERMES – wspomaganie wyjaśniania przyczyn nadciśnienia tętniczego.

AMIGO – konsultacja najczęstszych problemów ginekologicznych.

Więcej: J.Ruszkowski, Systemy z bazą wiedzy ekspertów w praktyce lekarza pierwszego kontaktu, w rozdz. 2.2. *Systemy komputerowe i teleinformatyczne w służbie zdrowia* (Kącki, Kulikowski, Nowakowski, Waniewski, red.), 2002.

Kryteria diagnostyczne i ich ocena

Niech n będzie liczbą przypadków testowych, n_{cor} liczbą poprawnie zdiagnozowanych przypadków.

Miara dokładności zdefiniowana jest jako:

$$\eta_{\text{ov}} = \frac{n_{\text{cor}}}{n}$$

Szczegółowe wyniki rozpoznawania

	Przewidywane klasy diagnozy	
Właśc. diagnoza	Pozytywna	Negatywna
Pozytywna	*TP*	*FN*
Negatywna	*FP*	*TN*

Dla takiej macierzy definiuje się miary:

- czułość (ang. *sensitivity*) =*TP*/(*TP*+*FN*),
- swoistość (ang. *specificity*) =*TN*/(*FP*+*TN*).

Problemy w tworzeniu baz wiedzy dla medycznych systemów doradczych

Jakość wniosków zależy od kompletności i poprawności baz wiedzy.

Metody stosowane przy konstruowaniu baz wiedzy:

1) Wykorzystanie istniejących baz danych.
2) Tworzenie nowej bazy na podstawie lokalnej praktyki medycznej.
3) Tworzenie bazy w trakcie stosowania prototypu systemu eksperckiego.
4) Nabywanie wiedzy bezpośrednio od rzeczywistych ekspertów:
   - prowadzenie wywiadów z ekspertami,
   - wspólna analiza przypadków szkoleniowych.

Trudności w realizacji procesu budowy baz wiedzy.

Kryteria sukcesu i ograniczenia zastosowań

1. Ocena dokładności diagnostycznej (czułości i swoistości) programu; porównanie z działaniem specjalistów.
2. Użyteczność
3. Szybkość działania
4. Autorytet i akceptacja
5. Przenoszalność
6. Integracja ze skomputeryzowanymi systemami zbierania danych klinicznych
7. Prawne aspekty programów wspomagania podejmowania decyzji.

Inne ograniczenia rozwoju zastosowań Med-DSS

Pozyskanie wiarygodnych baz danych i baz wiedzy

„Knowledge acquisition bottleneck”

Opór psychologiczny ze strony środowiska, np.:

- Obawa przed niemożnością kontroli narzędzia
- Brak akceptacji na zbyt zaawansowanych metod (AI i teorii decyzji)
- Ograniczona skuteczność proponowanych narzędzi
- Strach przez nowością i zagrożeniem kompetencji
- Braki w edukacji informatycznej

1) Please enter information about the patient.

Name	Age	Sex	Race
Sally	42 years	Female	Caucasian

2) Are there any positive cultures obtained from SALLY?

No

3) Are there any pending cultures of SALLY?

Yes

4)

site:	date collected:	stain examined?	method of collection: urine, sputum only
CSF	3-Jun-75	Yes	N/A

5) stain of smear: morph:

(type NONE if no organism was seen on the smear)

None

⋮

13) Has SALLY recently had symptoms of persistent headache or other abnormal neurologic symptoms (dizziness, lethargy, etc.)?

Yes

14) Has SALLY recently had objective evidence of abnormal neurologic signs (nuchal rigidity, coma, seizures, etc.) documented by physician observation or examination?

Yes

The CSF cultures will be considered to be associated with MENINGITIS.

⋮

34) Is the meningitis a hospital-acquired infection ?

No

35) Is SALLY's clinical history consistent with EPIGLOTTITIS ?

No

36) Is SALLY's clinical history consistent with OTITIS-MEDIA ?

No

37) Has the patient ever been to an area that is endemic for coccidiomycoses ?

Unknown

38) Is SALLY a burn patient ?

Why

[i.e. WHY is it important to determine whether SALLY has been seriously burned ?]

[4.Ø] This will aid in determining the organism (other than those seen on cultures or smears) which might be causing the infection.

It has already been established that

[4.1] the infection which requires therapy is meningitis, and

[4.2] organisms were not seen on the stain of pending csf culture (CULTURE-1), and

[4.3] the type of infection may be bacterial

Therefore, if

[4.4] SALLY has been seriously burned

then

there is suggestive evidence that Pseudomonas-aeruginosa is one of the organism (other than those seen on cultures or smears) which might be causing the infection [RULE578]

[back to question 38...]

How 4.3

[i.e. HOW was it established that the type of the infection may be bacteria?]

The following rules concluded about: the likelihood that the type of the infection may be bacterial

	Rule	Yes	No
[4.5]	RULE500	(.4)	
[4.6]	RULE501		(.17)
[4.7]	RULE502	(.1)	
[4.8]	RULE524	(.42)	
[4.9]	RULE504	(.28)	

Thus it has been established that the type of the infection may be bacterial.

My therapy recommendation will be designed to treat for organism that either are very likely or, although less likely, would have a significant effect on the therapy selection if they were present. It is important to cover for the following probable infection(s) and associated organism(s):

INFECTION-1 is MENINGITIS
+ <ITEM-1> MYCOBACTERIUM-TB [from clinical evidence only]
+ . . . COCCIDIOIDES [from clinical evidence only]
+ . . . CRYPTOCOCCUS [from clinical evidence only]

43) Does SALLY have a clinically significant allergic reaction to any antimicrobial agent?
No
[Considering ETHAMBUTAL-AND-INH-AND-RIFAMPIN for the use against INFECTION-1 . . .]

44) Is SALLY pregnant or breast feeding?
No

45) Do you have reason to suspect that SALLY may have impaired renal functions?
No

46) SALLY's weight in kilograms (or <number> POUNDS):
51.3

[REC-1] My preferred therapy recommendation is as follows:

Give the following in combination:

1) ETHAMBUTAL

Dose: 1.28g (13.Ø 1ØØmg-tablets)q24h PO for 6Ø days
[calculated on basis of 25 mg/kg]
then 77Ømg (7.5 1ØØmg-tablets) q 24h PO
[calculated on basis of 15 mg/kg]

[The dose should be modified in renal failure.]
I can adjust the dose only if a creatinine clearance or a serum creatinine is obtained.

Comments: Periodic vision screening tests are recommendet for optic neuritis.

2) INH

Dose: 513mg (5.Ø 1ØØmg-tablets) q 24h PO
[calculated on basis of 1Ømg/kg]

3) RIFAMPIN

Dose: 6ØØmg PO q 24h

Comments: Administer dose on an empty stomach.

Although I suspect that fungus may be a possible pathogen, in the absence of definitive evidence I will not recommendet antifungal therapy at this time. Please obtain samples for fungal, TB, and viral cultures, cytology, VDRL (blood and CSF), coccidioides complement-fixation (blood & CSF), cryptococcal antigen (blood and CSF), viral titers (blood and CSF). An infectious disease consult may be advisable.

Przewodnik po Informatyce Medycznej, Internecie i Telemedycynie (w jęz. angielskim)

Systemy Sztucznej Inteligencji rutynowo stosowane w praktyce medycznej

 1 Systemy interwencyjne (acute care), do przypadków nagłych

1.1 ACORN (Przyjmowanie na kardiologię)

Krótki opis: system hybrydowy, oparty na regułach logicznych i wnioskowaniu Baysowskim, doradzający w sprawach bólu klatki piersiowej w sali reanimacyjnej (emergency room ?)

Miejsce stosowania: Accident & Emergency Department Westminster Hospital, London

Kontakt: Jeremy Wyatt jeremy@biu.icnet.uk

Data wprowadzenia: 1987

Przestano stosować: 1990

Opis: Badania weryfikujące stwierdziły, że aż 38% pacjentów z ostrą chorobą wieńcową wysłano błednie do domu, a średni czas przyjęcia na oddział CCU wynosił 115 minut. ACORN, hybrydowy system oparty na regułach i wnioskowaniu Baysowskim, służy do wspomagania diagnoz i leczenia podtrzymującego tych pacjentów. Po okresie próbnym uzywania systemu w praktyce zaproponowano różne zmiany systemu. W nowszej wersji udało się skrócić czas przyjęcia na oddział CCU o 20 minut.
System używano rutynowo w Westminster w latach 1987-90, prowadząc przy jego pomocy kilkaset przypadków rocznie.

Literatura:

Wyatt J. "The evaluation of clinical decision aids: a discussion of methodology used in the ACORN project", Lecture Notes in Medical Informatics 1987; 33: 15- 24

Wyatt J (1989). Lessons learned from the field trial of ACORN, an expert system to advise on chest pain. In: Barber B, Cao D, Qin D, eds. Proc. Sixth World Conference on Medical

Informatics, Singapore. Amsterdam: North Holland 1989: 111-115

Emerson PA, Russell NR, Wyatt JC et al. (1989). An audit of the management of patients attending an accident and emergency department with chest pain. Quart J Med 1989; 70: 213-220

Wyatt J, Spiegelhalter D. Field trials of medical decision-aids: potential problems and solutions. In Clayton P (ed). Proc. 15th Symposium on Computer Applications in Medical Care, Washington 1991. New York: McGraw Hill Inc. 1991: 3-7

Wyatt J. "Computer-based knowledge systems". The Lancet 1991; 338: 1431-1436

Heathfield HA, Wyatt J. Philosophies for the design and development of clinical decision-support systems. Meth Inform Med 1993; 32:1-8

Wyatt J, Spiegelhalter D. The evaluation of medical expert systems. In: Evans D, Patel V (eds), Advanced models of cognition for medical training and practice. MIT Press, 1992 (NATO ASI series F97): 101-120

1.2 POEMS (PostOperative Expert Medical System)

Krótki opis: System wspomagania decyzji leczenia pooperacyjnego.

Miejsce stosowania: St. James University Hospital, Leeds, U.K.

Kontakt: M. J. Sawar, Computer Based Learning Unit, Leeds University, U.K. sawar@cbl.leeds.ac.uk

Data wprowadzenia: 1992

Opis: Opieka pooperacyjna wymaga dużego doświadczenia, dlatego stworzono system wspomagający decyzję w oparciu o monitorowanie symptomów i obserwację oczekiwanych zmian. System ekspertowy POEMS (Post- Operative Expert Medical System) ma na celu doradzanie mniej doświadczonym pracownikom służby zdrowia. POEMS otrzymuje w interaktywny sposób dane o pacjentach zapisywane w bazach: historii choroby, historii operacji, badań i testów pooperacyjnych. Na podstawie tych danych POEMS opracowuje uporządkowaną listę bardzo prawdopodobnych, prawdopodobnych, możliwych i nieprawdopodobnych diagnoz i może odpowiedzieć na pytania, dotyczące sposobu rozumownania prowadzącego do poszczególnych diagnoz, zaleceń terapeutycznych i działań potrzebnych do weryfikacji czy też odróżnianie alternatywnych diagnoz. POEMS zawiera model zmian stanu pacjenta, pozwalając na bieżąco korygować oczekiwania z obserwacjami.
POEMS ma wbudowany mechanizm uczenia się na podstawie oceny jego działania przez ekspertów.

Literatura:

M. J. Sawar, T. G. Brennan, A. J. Cole and J. Stewart "POEMS (PostOperative Expert Medical System)" in Proceedings of IJCAI91 one Day Workshop: "Representing Knowledge in Medical Decision Support Systems", Sydney, Australia, Aug. 1991.

M. J.Sawar, T. G. Brennan, A. J. Cole and J. Stewart "An Expert System for PostOperative Care (POEMS)", in Proceedings of MEDINFO-92, Geneva, Switzerland, Sept. 1992.

1.3 VIE-PNN

Krótki opis: System ekspertowy do określenia składu pozajelitowego odzywiania noworodków na oddziałach intensywnej opieki (ICUs).

Miejsce stosowania: VIE-PNN (Vienna Expert System for Parenteral Nutrition of Neonates) używany jest w:

- Neonatal Intensive Care Unit, Department of Pedriatics of the University of Vienna, Austria
- Neonatal Care Unit, University of Graz Medical School, Austria
- Pediatric Clinic Glanzing, Vienna, Austria

Kontakt:Silvia Miksch Austrian Research Institute for Artificial Intelligence (OeFAI) Schottengasse 3 A-1010 Vienna, Austria tel: +43-1-5353281-0 fax: +43-1-5320652 email: silvia@ai.univie.ac.at

Data wprowadzenia: 1993

Opis: The aim of the project was to develop an expert system representing the clinical and theoretical knowledge about the composition of parenteral nutrition solutions for newborn infants treated at neonatal intensive care units (NICUs).

Planning of an adequate nutritional support for maintaining the metabolic needs of sick newborn infants is time consuming, needs experts' knowledge and involves the risk of introducing possibly fatal errors. Recent systems used for composing parenteral nutrition solutions mainly support the calculation and the documentation process and cannot easily be adapted for neonates. Computerized expert system technology may help to develop time saving solutions to a given problem and to avoid errors within certain limits. We therefore developed an interactive expert system for calculating the composition of parenteral nutrition solutions (PNS) for newborn infants.

The knowledge base of the expert system consists of the rules for composing the PNS according to heuristic rules used at the cooperating NICU. Applying these rules, the daily fluids, electrolytes, vitamins, and nutritional requirements were calculated according to the estimated needs, the patient's body weight, the age, and the individual tolerance. The requirements were also corrected according to the daily measurements of serum electrolytes, triglycerides and protein if available. Glucose supply was adjusted depending on the type of venous access used (peripheral or central venous line), on the glucose tolerance and on the total fluid allowances. Finally, the PNS was reduced according to the proportion of oral feedings. The program works interactively asking for relevant data, calculating the PNS, and displaying the results. The physician has the choice to adjust calculated values according to special clinical requirements. The final output is a PNS schedule that can be used directly in the case history of neonates. Possible input and dosage errors are eliminated by methods of data validation using body weight and age dependent thresholds.

A knowledge acquisition module supports updating of thresholds, input of medication of new bypass and new oral feeding products. VIE-PNN was developed on an IBM compatible PC. Currently, a practical clinical evaluation of VIE-PNN is performed at the ICU.

The project is a joint cooperation of the Austrian Research Institute for Artificial Intelligence (OFAI), the Department of Medical Cybernetics and Artificial Intelligence (IMKAI), and the Neonatal Intensive Care Unit (NICU) of the Department of Pedriatics of the University of Vienna:

- Werner Horn, IMKAI & OFAI
- Silvia Miksch, OFAI
- Christian Popow, NICU
- Maria Dobner, NICU
- and several students at the IMKAI.

Dalsze szczegóły VIE-PNN Home Page

Literatura:
Dobner M., Miksch S., Horn W., Popow C.: VIE-PNN: Ein Expertensystem für die Berechnung der parenteralen Ernährung von intensiv behandelten Früh- und Neugeborenen, Wiener Klinische Wochenschrift, 107(4)128-32, 1995.

Popow C., Miksch S., Horn W., Dobner M.: VIE-PNN: Ein Expertensystem für die Berechnung der parenteralen Ernährung von intensiv behandelten Früh- und Neugeborenen, Wiener Intensivmedizinische Tage (WIT-94), Workshop: "Patienten Daten Management Systeme auf Intensivstationen", 1994.

Miksch S., Dobner M., Horn W., Popow C.: VIE-PNN: An Expert System for Parenteral Nutrition of Neonates, Ninth IEEE Conference on Artificial Intelligence for Applications (CAIA-93), Orlando, Florida, March 1-5, pp. 285-91, 1993.

Miksch S., Dobner M., Horn W., Popow C.: An Interactive Support System for Neonate-Specific Nutrition Planning at Intensive Care Units (VIE-PNN), AISB Quarterly, 82, pp.24-30, 1993.

Miksch S., Popow C., Horn W., Dobner M.: Struktur und Funktionalität von VIE-PNN: Ein Expertensystem zur Berechnung der parenteralen Ernährung von intensiv behandelten Früh- und Neugeborenen, Austrian Research Institute for Artificial Intelligence, TR-92-17, 1992.

Dobner M., Miksch S., Popow C., Kohlhauser C., Horn W.: Expertensystem für die Berechnung der parenteralen Ernährung von Früh- und Neugeborenen, 30.Jahrestagung der Österreichischen Gesellschaft für Kinder- und Jugendheilkunde, (Abstract), 1992.

Ostatnie zmiany: December 8 1995

1.4 NéoGanesh

Krótki opis: System ekspertowy do zarządania systemem sztucznego oddychania dla oddziałów intensywnej opieki (ICUs).

Miejsce stosowania:NéoGanesh was developed in cooperation with the National Institut for Health and Medical Research (INSERM), the Department of Physiology, and the ICU Department of Hospital Henri Mondor (Créteil, France).

Kontakt: name address email Michel DOJAT INSERM U296 Faculté de Médecine de Créteil 8 av. Gral Sarrail 94010 Créteil France Tel: 33 1 48 98 46 03 Fax: 33 1 48 98 17 77 email: dojat@laforia.ibp.fr

Data wprowadzenia:

CURRENT STATUS: NéoGanesh is in use at Henri Mondor Hospital.

Opis: NéoGanesh is a closed-loop knowledge-based system used for ventilator management in Intensive Care Units. NéoGanesh integrates a distributed model of medical reasoning and an explicit representation of time. The system is based on the representation of physicians expertise. It interprets clinical data in real-time and controls the mechanical assistance provided, in Pressure Support Ventilation mode, to a patient who suffers from a lung disease. NéoGanesh develops a therapeutic strategy to gradually re-educate the respiratory muscles of the patient, and evaluates his capacity to breathe without mechanical assistance. NéoGanesh runs on a microcomputer placed at the patient's bedside, controls a Veolar ventilator (Hamilton Suitzerland) and does not interfere with the usual management of the patients. Our representation paradigm is based on object-orientation and forward chaining production rules. NéoGanesh is implemented in Smalltalk-80. A clinical evaluation of NéoGanesh was performed at Henri Mondor Hospital (Créteil, France). The use of NéoGanesh improves the quality of the patient's ventilation and the prediction of weaning.

Dalsze szczegóły NéoGanesh Homepage

Literatura

1.Dojat M. and Pachet F., An extendable knowledge-based system for the control of mechanical ventilation, in Proc. 14th IEEE-EMBS, Paris, pp. 920-921, 1992.

2.Dojat M. and Pachet F., Representation of a medical expertise using the Smalltalk environment: putting a prototype to work, in TOOLS 7, G. Heeg, B. Magnusson and B. Meyer, Ed., New York: Prentice Hall, pp. 379-389, 1992.

3.Dojat M., Brochard L., Lemaire F. and Harf A., A knowledge-based system for assisted ventilation of patients in intensive care, International Journal of Clinical Monitoring and Computing, vol. 9, pp. 239-250, 1992.

4.Dojat, M. and Sayettat, C. Aggregation and forgetting: two key mechanisms for across-time reasoning in patient monitoring. In ""Proceedings of AAAI spring symposium. Artificial Intelligence in Medicine: Interpreting Clinical Data", (I. Kohane and S. Uckun, Eds.), pp. 27-31. AAAI Technical Report SS-94-01, Stanford University (Ca), 1994.

5.Dojat M. and Sayettat C., A realistic model for temporal reasoning in real-time patient monitoring, Applied Artificial Intelligence, vol. 10, n°2, 1996, (to appear).

6.Dojat M., Harf A., Touchard D., Laforest M., Lemaire F. and Brochard L., Evaluation of a

knowledge-based system providing ventilatory management and decision for extubation, American Journal of Respiratory and Critical Care Medicine, 1996 (to appear).

Ostatnie zmiany: September 29 1995

1.5 VentEx

Krótki opis:VentEx jest systemem ekspertowym służący doradzania i monitorowania urządzeń wspomagających sztuczne oddychania. Zastosowano w nim hybrydowe metody reprezentacji wiedzy oraz system akwizycji wiedzy specjalnie przystosowany do tego typu urzadzeń. System sprawdzano na prawdziwych danych pacjentów a jego ocena przez ekspertów pokazuje dużą zgodność jego rekomendacji z ich zaleceniami.

Miejsce stosowania: VentEx was developed in cooperation with Medical Intensive Care Unit, Sodersjukhuset, Stockholm, Siemens Elema AB and Department of Medical Informatics, Linkoping University , Linkoping, Sweden.

Kontakt: Nosrat Shahsavar, Dept. of Medical Informatics, Linkoping University 581 85 Linkoping, Sweden. Phone: +46 13 227579 - Fax: +46 13 104131 Email: nossh@ami.liu.se

Data wprowadzenia:Currently under evaluation

CURRENT STATUS:VentEx is now being evaluated in the field. A multi-center evaluation phase has just started in which three intensive care units are participating to evaluate the effects of VentEx on patients, users and on the organization.

Opis:The VentEx system is used both for monitoring and decision-support in patients with different kinds of imminent and obvious ventilatory insufficiencies. Decision-support (the system outcomes) is based on patho-physiological state, ventilation functions and patient data, and it covers different phases of ventilator therapy, namely start (intubation), ongoing (treatment phase) and weaning (extubation). The system includes 13 basic groups of diagnoses within the area of ventilator insufficiency.

The VentEx system has been built to support ventilator therapy management using knowledge-based system technology. Development started with an early prototype system called KUSIVAR [I] which dealt with knowledge representation and knowledge acquisition research using the Knowledge Engineering Environment (KEE). A domain specific tool called KAVE [II] was later developed to facilitate the knowledge acquisition process. Then a PC-based on-line system (VentEx) was built [III] as an integrated knowledge-based system in the clinical environment using Nexpert Object. Results of the evaluation work [IV] indicate the usefulness of KAVE, and there was a high consensus between the doctors and VentEx according to a "gold" standard [V].

Literatura

[I] Shahsavar N, Frostell C, Gill H, Ludwigs U, Matell G and Wigertz O. Knowledge Base Design for Decision Support in Respirator Therapy. International Journal of

Clinical Monitoring and Computing, 1989, 6:223-231.

[II] Shahsavar N, Gill H, Wigertz O, Frostell C, Matell G and Ludwigs U. KAVE: A Tool for Knowledge Acquisition to Support Artificial Ventilation. International Journal of Computer Methods and Programs in Biomedicine, 1991, 34: 115-123.

[III] Shahsavar N, Gill H, Ludwigs U, Carstensen A, Larsson H, Wigertz O and Matell G. VentEx: An On-Line Knowledge-Based System to Support Ventilator Management. Technology and Health Care, 1994, 1:233-243.

[IV] Shahsavar N, Ludwigs U, Blomqvist H, Gill H, Wigertz O and Matell G. Evaluation of a Knowledge-Based Decision-Support System for Ventilator Therapy Management. Artificial Intelligence in medicine, 1995, 7:37-52.

[V] Nosrat Shahsavar. Design, Implementation and Evaluation of a Knowledge-Based System to Support Ventilator Therapy Management. Linkoping Studies in Science and Technology, PhD thesis 317, Department of Medical Informatics, Linkoping University, Sweden, 1993.

Ostatnie zmiany: December 12 1995

1.6 SETH

Krótki opis: System ekspercki dla toksykologii klinicznej

Miejsce stosowania: Poison Control Centre, Rouen University Hospital, France

Kontakt: Stefan Darmoni or Jean-Michel Droy

Data wprowadzenia: April, 1992

CURRENT STATUS: In use in the Rouen University Hospital since 1992, and in external evaluation in 3 French Poison Control Centres (Grenoble, Lille, Nancy)

Opis: Zadaniem SETH jest doradzani i monitorowanie pacjentów po zatruciu. Baza danych zawiera 1153 najczęściej zażywanych leków i substancji trujących należących do 78 klas substancji toksycznych. System SETH symuluje rozumowania ekspertów biorąc pod uwagę klasę substancji, czas jaki upłynął od jej zażycia, symptomy kliniczne, i przyjętą dawkę. Dostarcza dokładnych porad dotyczących sposobu obserwacji i leczenia, uwzględniając przy tym oddziaływanie różnych leków i uczulenia na leki.
System używano od 4/1992 przez Poison Control Center do dawania porad telefonicznych innym ośrodkom. W latach 1992 -1994 przanalizowano za jego pomocą ponad 2000 przypadków. System przeszedł przez trzy oceny jego przydatności i jest nadal używany w Poison Control Center.

WWW REFERENCE: Seth Home page

Literatura

SJ. DARMONI, P. MASSARI, JM. DROY, E. MOIROT, J. LE ROY. Functional

evaluation of SETH: an expert system in clinical toxicology Proceedings of the 5th Conference on Artificial Intelligence in Medicine Europe, P. Barahona, M. Stefanelli, J. Wyatt (Eds), pp 231-238 (Pavie, Italie, Juin 1995).

SJ. DARMONI, P. MASSARI, JM. DROY, T. BLANC, F. MORITZ, N. MAHE, J. LEROY. From general reasoning in drug poisoning to specific attitudes in human and in SETH. Computer as an aid in poison centres, Lille, Décembre 1995.

P. MASSARI, SJ. DARMONI, JM. DROY, T. BLANC, F. MORITZ, N. MAHE, J. LEROY. Seth, an expert system in drug poisoning: five years later. Computer as an aid in poison centres, Lille, Décembre 1995.

SJ. DARMONI, P. MASSARI, JM. DROY, E. MOIROT, J. LE ROY. SETH: an expert system for the management on acute drug poisoning in adults. Comput. Methods Programs Biomed. 1993; 43: 171-176.

Ostatnie zmiany: June 4 1996

2 Laboratory Systems

2.1 Becton Dickinson Laboratory Systems

Krótki opis: 1. QBC (TM) haematology analyser
2. The Sceptor (TM) MIC interpreter

Miejsce stosowania:

Kontakt: Joan Curry Becton Dickinson Research Centre 21 Davis Drive RTP, NC 27709 Tel. (919) 99010 Fax (919) 549-7572 curry@bdrc.bd.com

Opis: Becton Dickinson, an international health care technology company, has two systems that were developed at the corporate R&D centre and are in routine use by customers.
1. QBC (TM) Reference System. This system is integrated into the QBC haematology analyser product line and provides possible medical interpretations of a patient's haematologic test results. It is used primarily in physicians' office laboratories.
2. The Sceptor (TM) MIC interpreter. This system is integrated into the Data Management Centre for the Sceptor line of microbial detection instruments. The instrument determines the Minimum Inhibitory Concentration values (i.e. the minimum amount of an antibiotic needed to kill bacteria) for a variety of drugs; from these values, the expert system generates a clear interpretation of whether the drugs will be effective against the organism. The rules for this system are based on the National Committee on Clinical Laboratory Standards' guidelines for MIC interpretation. The Sceptor system is used primarily by hospital microbiology labs.

2.1.1 Coulter(R) FACULTY(TM)

Krótki opis:Coulter FACULTY Knowledge-Based System Software functions as a consultant, assists workflow, and acts as an educational tool in laboratory haematology.

Miejsce stosowania:The system has been installed in 5 European hospitals: (1) St. Bartholomew's Hospital, London, UK; (2) Hospital Clinico, Valencia, Spain; (3) Hospital La Paz, Madrid, Spain; (4) St. Antonio's Hospital, Porto, Portugal; and (5) Cliniques Universitaires Mont-Godinne, Yvoir, Belgium. In addition, a Coulter symposium was held in conjunction with the British Society of Haematology meeting at the world-wide introduction of Coulter FACULTY and attendees (from the UK and the Netherlands) received the stand-alone educational version of the system.

Kontakt: For information, interested persons can Kontakt the developers, Dr. Lawrence W. Diamond and Dr. Doyen T. Nguyen, at Department of Haematology, St. Bartholomew's Hospital, West Smithfield, London, EC1A 7BE, UK, Telephone: 44 171 628-4007, Fax: 44 171 601-8200, E-mail 100572.3637@compuserve.com .

Information about the St. Bartholomew's site can also be obtained from Dr. John Amess, Consultant Haematologist, Department of Haematology, St. Bartholomew's Hospital, West Smithfield, London, EC1A 7BE, UK, Telephone: 44 171 601-8204, Fax: 44 171 601-8200.

Information regarding the IZASA-Coulter CITOTECA Workstation and the sites in Spain and Portugal can be obtained from Dr. Ramon Simon, Haematology Division, IZASA, S.A., Aragon 90, 08015 Barcelona, SPAIN, Telephone: 34 3 4010101, Fax: 34 3 4010230.

The Kontakt at PGP (for the site in Belgium) is Renato PROTTI, Product Specialist, Rue Driesstraat 175, Bruxelles B-1200, Belgium, Telephone: 32 2 770 62 22, Fax: 32 2 770 92 25, E-mail: 100653.2230@compuserve.com .

Data wprowadzenia:The five installations described above took place between October, 1995 and April 1996. Coulter FACULTY was released as a stand-alone product on April 26, 1996.

CURRENT STATUS:The system is operational in all of the above sites. Three different interfaces are in use:

(1) At St. Bartholomew's, FACULTY is running on a five computer network with a bi-directional interface to the laboratory's LIS using a custom Coulter haematology communications server (HCS). Specimen orders are passed from the LIS to the HCS. The HCS filters the haematology specimens as they are run on a STKS. Normal specimens are routed directly to the LIS. Abnormal specimens artion, to the PGP system which downloads STKS data to the LIS. Abnormal specimens are stored in Professor Petrushka's database. Peripheral blood film review is performed using Professor Petrushka and the results are passed back to the LIS. Flow cytometry immunophenotyping results are stored in Professor Fidelio's database. We are currently setting up Professor Belmonte to process bone marrow reports;

(2) At the three sites in Spain and Portugal, FACULTY is installed on the IZASA-Coulter CITOTECA (R) Workstation which includes a mini-LIS (Modulab Plus),

instrument interfaces, and a facility for capturing images from a video camera/microscope attached to the workstation. The FACULTY Paradox databases are interfaced to the dBase tables maintained by Modulab Plus;

(3) At Cliniques Universitares Mont-Godinne, FACULTY is interfaced, via a network connection, to the PGP system which downloads STKS data to the LIS.

Opis:FACULTY is available on CD-ROM. The package consists of: (1) Two KBS modules, Professor Petrushka for peripheral blood interpretation, and Professor Fidelio for flow cytometry immunophenotyping and DNA content analysis; (2) A complete electronic textbook of peripheral blood interpretation with over 240 photomicrographs (Diagnostic Hematology: A Pattern Approach, Volume 1) which serves as the explanation facility for Professor Petrushka; (3) Database and printing utilities; and (4) Eight case studies, in a hypertext format identical to that used for the textbook, featuring Professor Petrushka, Professor Fidelio, and the next module to be released, Professor Belmonte for bone marrow interpretation. The system runs under the Windows (TM) operating system and requires a video card/monitor with a resolution of 800 x 600 x 64K colors. An interface to Coulter STKS 2B instruments is available from Coulter Corporation.

WWW REFERENCE: Coulter(R) FACULTY(TM) Homepage

Literatura

(1) Diamond LW, Nguyen DT: Expert systems in laboratory haematology. In: Lewis SM, Koepke JA (eds), Haematology Laboratory Management and Practice. Butterworth-Heinemann, Oxford, 1995, pp.43-51.

(2) Diamond LW, Nguyen DT, Andreeff M, Maiese RL, Braylan RC: A knowledge-based system for the interpretation of flow cytometry data in leukemias and lymphomas. Cytometry 17:266-373, 1994.

(3) Diamond LW, Mishka VG, Seal AH, Nguyen DT: Multiparameter interpretive reporting in diagnostic laboratory hematology. International Journal of Biomedical Computing 37:211-24, 1994.

(4) Nguyen DT, Diamond LW, Priolet G, Sultan C: Expert system design in hematology diagnosis. Methods of Information in Medicine 31:82-9, 1992.

2.2.0 DoseChecker

Krótki opis: To assist the staff pharmacists at Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with monitoring drug orders for a set of drugs which must be carefully dosed for patients with possible renal impairment. CLIPS, Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box

8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Used in production since September 1994

Opis: ertain types of drugs require careful quantitative dosing, particularly in patients with renal impairment. In these patients, drug concentrations can build to toxic levels. Drug dosing decisions should focus, then, on maintaining concentrations which maximize therapeutic effects while controlling the risk of toxicity.

Renal function varies over time and can be estimated as a function of calculated creatinine clearance. DoseChecker is an expert system which monitors patients with active orders for drugs known to require careful dosing. Using parameters such as patient weight and serum creatinine, DoseChecker calculates creatinine clearance and applies a set of dosing guidelines developed by pharmacokinetic experts to determine if the dosing is appropriate. If it does not fall within established guidelines, an alert is generated for a pharmacist, who then consults with the patient's attending physician to determine whether the dosage should be adjusted.

DoseChecker uses a relational database containing patient demographic information and clinical data such as serum creatinine measurements and drug orders. Suspected dosing violations are stored so that trends can be detected.

Ostatnie zmiany: October 27 1995

2.2.1 GermAlert

Krótki opis: To assist the Infection Control Departments of Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with their infection control activities. These activities include surveillance of microbiology cultures data. Languages/Shells Used: Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box 8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Used in production since February 1993 p>
Opis: Most hospitals have infection control programs which are aimed at the early detection and aggressive treatment of infections. The earlier an infection is discovered and treated, the less likely it is to spread to other patients and hospital staff--and the less likely it is to prolong the infected patient's stay in the hospital. We have developed an expert system called GermAlert, which applies local hospital culture-based criteria for detecting "significant" infections, which require immediate treatment. GermAlert has been deployed at Barnes Hospital, a large tertiary-care teaching hospital, since February 1993. It was later deployed at neighboring Jewish Hospital in July 1995. Microbiology culture data from the hospital's laboratory system are monitored by GermAlert. Using a rulebase consisting of criteria developed by local infectious diseases experts, GermAlert scans the culture data and generates an "alert" to the Infection Control staff when a culture representing a "significant"

infection is detected.

Ostatnie zmiany: October 27 1995

2.2.2 Germwatcher

Krótki opis: To assist the Infection Control Departments of Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with their infection control activities. These activities include surveillance of microbiology cultures data. Languages/Shells Used: CLIPS, Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, Jewish Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box 8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Used in production since February 1993

Opis: Hospital-acquired (nosocomial) infections represent a significant cause of prolonged inpatient days and additional hospital charges. We have developed an expert system called GermWatcher, which applies the Centers for Disease Control's (CDC) National Nosocomial Infection Surveillance (NNIS) culture-based criteria for detecting nosocomial infections. GermWatcher has been deployed at Barnes Hospital, a large tertiary-care teaching hospital, since February 1993. It was later deployed at neighboring Jewish Hospital in July 1995.
Microbiology culture data from the hospital's laboratory system are monitored by GermWatcher. Using a rulebase consisting of a combination of the NNIS criteria and local hospital infection control policy, GermWatcher scans the culture data, identifying which cultures represent nosocomial infections. These infections are then reported to the CDC.

Literatura:

1. Kahn MG, Steib SA, Fraser VJ, Dunagan WC. An expert system for culture-based infection control surveillance. In: Safran C, ed. Proceedings Symposium on Computer Applications in Medical Care. New York, NY: McGraw Hill, 1993:171-5.

2. Kahn MG, Steib SA, Spitznagel EL, Dunagan WC, Fraser VJ. Improvement in User Performance Following Development and Routine Use of an Expert System. In: Greenes RA, Peterson HE, Protti DJ, eds. MEDINFO '95. Edmonton Alberta, Canada: International Medical Informatics Association / Healthcare Computing & Communications Canada, Inc., 1995:1064-67.

Ostatnie zmiany: November 15 1995

2.3 Hepaxpert I, II

Krótki opis: Automatic Interpretation of tests for Hepatitis A and B.

Miejsce stosowania: Hepatitis Lab University of Vienna Medical School

Kontakt: Klaus-Peter Adlassnig Dept. of Medical Computer Science University of Vienna Garnisongasse 13 A - 1090 Vienna Austria

Data wprowadzenia: 1989

Opis: Automatic Interpretation of tests for Hepatitis A and B. Developed using a rule based representation on the RULEMASTER shell the system consists of over 100 rules. The system has been in routine at the Hepatitis Lab of University of Vienna Medical school since Sept. 1989. Prior to use the system was tested with about 25,000 cases and the acceptance by the doctors has been found to be quite high.

Literatura:

KP Adlassnig, W Horak, Routinely-used, automated interpretive analysis of hepatitis A and B serology findings by a medical expert system, Proc. Medical Informatic Europe `90, R. O'Moore et al. (eds), Lecture Notes in Medical Informatics, 40, Springer-Verlag, 313-318.

KP Adlassnig, W Horak, Hepaxpert I: Automatic interpretation of Tests for Hepatitis A and B, MD Computing, 8,2,(1991),118-119.

2.4 Interpretation of acid-base disorders

Krótki opis: Expert system for interpretation of acid-base disorders

Miejsce stosowania: University Hospital

Kontakt: Dr. Pince Hilde Department of Medical Informatics University Hospital Gasthuisberg Herestraat 49 B - 3000 Leuven Belgium EARN address: feeee03@blekul11.bitnet email: FEEEE03%BLEKUL11.BITNET@pucc.Princeton.EDU

Data wprowadzenia: 1989

Opis: In routine use in the intensive care unit and the emergency department of the university hospital since end 1989 producing about 7500 reports per year Hardware: SUN 3/160 Software: BIM-Prolog Input: Blood gas data and serum electrolytes Output: a single, double or triple acid-base disorder. Two versions were developed: an interactive version (with explanation facilities, requested lists of causes...), and a version integrated in the Laboratory Information System (this version is in routine use)

Literatura: Pince H, Verberckmoes R, Willems JL, Computer aided interpretation of acid-base disorders, Int. J. Biomed. Comp. 25:177-192, 1990.

2.5 Liporap

Krótki opis: Automatic Phenotyping of dyslipoproteinemia

Miejsce stosowania: University Hospital Gasthuisberg

Kontakt: Dr. Pince Hilde Department of Medical Informatics University Hospital Gasthuisberg Herestraat 49 B - 3000 Leuven Belgium EARN address: feeee03@blekul11.bitnet email: FEEEE03%BLEKUL11.BITNET@pucc.Princeton.EDU

Data wprowadzenia: 1987

Opis: In routine use in central laboratory since July 1987. Outputs about 1000 reports per year Hardware: IBM-PC Software: LPA-Prolog Input parameters: Total cholesterol, TG, HDL,LDL,VLDL, Phospholipids, Interpretation of the serum lipoprotein electrophoresis Interpretation of the "standing plasma test" Output:- classification of the lipoprotein pattern as a Frederickson type or as a more rare disease (Tangier, LP-X...) -background information: chronic diseases and drugs which might explain the lipoprotein pattern of the patient

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2.6 PEIRS (Pathology Expert Interpretative Reporting System)

Krótki opis: Interpretative reporting of chemical pathology reports

Miejsce stosowania: Department of Chemical Pathology, St Vincent's Hospital, Sydney

Data wprowadzenia: May 1991.

Przestano stosować: 1994. PIERS is out of use while a new hospital information system is settling in. Once this is stable, PIERS will need to be interfaced into the system.

Kontakt: Dr Glenn Edwards Department of Chemical Pathology St Vincent's Hospital Sydney, New South Wales AUSTRALIA Telephone: (612) 361 2156 glenn@cse.unsw.edu.au

Opis: PEIRS (Pathology Expert Interpretative Reporting System) appends interpretative comments to pathology reports. The knowledge aqusition strategy is the Ripple Down Rules method, which has allowed a pathologist to build over 2300 rules without knowledge engineering or programming support. New rules are added in minutes, and maintenance tasks are a trivial extension to the pathologist's routine duties. PEIRS commented on about 100 reports/day. Domains covered include thyroid function tests, arterial blood gases, glucose tolerance tests, hCG, catecholamines and a range of other hormones.

Literatura:

Edwards G, Compton P, Malor R, Srinivasan A, Lazarus L. PEIRS: a pathologist maintained expert system for the interpretation of chemical pathology reports. Pathology 1993;25:27-34

Compton P, Edwards G, Srinivasan A, Malor R, Preston P, Kang B, Lazarus, L. Ripple down rules: turning knowledge acquisition into knowledge maintenance. Artificial Intelligence in Medicine 1992;4(6):463-475

Compton P. A philosophical basis for knowledge acquisition. Knowledge Acquisition 1990;2:241-257.

Ostatnie zmiany: October 27 1995

2.7 Puff

Krótki opis: The PUFF system diagnoses the results of pulmonary function tests.

Miejsce stosowania: Pacific Presbyterian Medical Center

Kontakt: John Kunz kunz@cive.STANFORD.EDU

Data wprowadzenia: 1977

Opis: PUFF went into production at Pacific Presbyterian Medical Center in San Francisco in 1977. Several implementations and many thousands of cases later, it is still in routine use. The PUFF technology was originally developed in the late-1970's by researchers from and Pacific Presbyterian Medical Center and Stanford. The PUFF basic knowledge base was incorporated into the commercial "Pulmonary Consult" product. Several hundred copies have been sold and are in use around the world.

Literatura:

Kunz, J.C., R.J. Fallat, D.H. McClung, et. al., "Automated interpretation of pulmonary function test results". Proceedings of Computers in Critical Care and Pulmonary Medicine, IEEE Press, 1979.

Aikins, J.S., Kunz, J.C., Shortliffe, E.H., Fallat, R.J., "PUFF: An expert system for interpretation of pulmonary function data", Computers in Biomedical Research, 16, pp. 199-208, 1983.

Snow, M.G., Fallat, R.J., Tyler, W.R., Hsu, S.P., "Pulmonary Consult: Concept to Application of an Expert System", Journal of Clinical Engineering 13:3, pp. 201- 205, 1988.

2.8 Microbiology/Pharmacy Expert System

Krótki opis: dBase based ES utilizing downloads of Laboratory and Pharmacy data to detect patients whose antibiotic therapy is not consistant with pathogens detected by culture.

Miejsce stosowania: North Carolina Baptist Hospitals

Kontakt: Robert Morrell North Carolina Baptist Hospitals Clinical Microbiology

Medical Center Blvd. Winston-Salem, N.C. 27157 (910)716-2646 bmorrell@isnet.is.wfu.edu or BL Wasilauskas at bwasilau@isnet.is.wfu.edu

Data wprowadzenia: 9/91

Opis: PC based, rule based, dBase IV, utilizing flat file downloads from laboratory and Pharmacy mainframes. Operates daily, output evaluated by pharmacy. Spinoff output used to monitor aminoglycoside and renal active antibiotic dosing.

Further Information: A detailed schematic of the system is avialable

Literatura:

Morrell RM, Wasilauskas BL, Winslow RM. Personal computer-based expert system for quality assurance of antimicrobial therapy. Am J Hosp Pharm. 1993;50:2067-73.

Morrell RM, Wasilauskas BL, Winslow RM. Expert Systems, A Primer. Am J. Hosp Pharm. 1994;51:2022-2030

Ostatnie zmiany: January 2 1995

2.9 SahmAlert

Krótki opis: To assist the Microbiology Laboratory at Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with identifying organisms that have unusual patterns of antibiotic resistance. Languages/Shells Used: CLIPS, Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box 8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Used in production since October 1995

Opis: To test the efficacy of antibiotics, microbiologists apply clinically approved drugs to bacterial cultures. Drugs which are effective against the microorganisms in the culture may then be considered therapeutically useful in treating a patient with the same type of microbial infection. However, bacteria are developing resistance to existing antibiotics, making previously routine infections difficult or even impossible to treat. This makes the task of developing new antibiotics difficult. It also complicates the work of the health care provider, who must stay abreast of these changes. Microbiology culture data from the hospital's laboratory system are monitored by SahmAlert. Using a rulebase consisting of criteria developed by local epidemiologists, SahmAlert scans the culture data, identifying which cultures contain organisms with patterns of unusual antibiotic resistance.

Ostatnie zmiany: October 27 1995

2.10 Pro.M.D.-CSF- Diagnostics

Miejsce stosowania: Frankfurt am Main, Germany

Kontakt: Prof. Dr. Chr. Trendelenburg ; Institute for Laboratory Medicine, Staedtische Kliniken Frankfurt a.M.-H"ochst, 65929 Frankfurt a.M.;

CURRENT STATUS: in routine use along with a variety of other Pro.M.D.-Systems

Opis: The system for interpretation of CSF findings was developed several years ago using Pro.M.D. (Prolog System supporting Medical Diagnostics) and is now in routine use. Other Pro.M.D.-systems have been developed by our group or by other groups and are also in routine use : EBV-serology (distributed by BIOTEST), thyroid hormone diagnostics (Thyrolab, distributed by Boehringer Mannheim), interpretation of alkaline phosphatase isoenzyme patterns, interpretation of lymphozyte subpopulations, interpretation of urine protein findings, interpretation of lipoprotein patterns .

WWW REFERENCE:

Knowledge-Based Systems in Laboratory Medicine

Routine use of interpretative knowledge based systems in the interchange between clinic and laboratory

An overview on all Pro.M.D.-publications

Literatura

C Trendelenburg, B. Pohl, Pro. M. D.: Medical Diagnostics with Expert Systems An introduction with diskettes to the expert system shell Pro. M. D. Publisher: MEDISOFT 1995, 4. edition 180 pages with 3,5' diskette ISBN: 3-931296-04-0 145,-- DM

December 94 issue of the Journal of laboratory medicine (LaboratoriumsMedizin) contains 6 papers on Pro.M.D.:

Chr. Trendelenburg: Interpretation of special findings in laboratory medicine and medical responsibility. Lab.med.18:545-582,1994

five additional papers on Pro.M.D. (alkaline phophatase isoenzymes (in English), interpretation of thyroid hormone measurements, Pro.M.D.-shell Opis etc.)

Ostatnie zmiany: January 26 1996

3 Educational Systems

3.1 Cancer, Me??

Krótki opis: Expert system for automated delivery of personal advice on how to reduce risk of cancer.

Miejsce stosowania: Videotext trial in Montreal, Canada, (1,000 Users); Disk based trials in Calgary, Alberta, Ongoing

Kontakt: Ivan H. Zendel, Ph.D. izendel@cadvision.com Paradigm Solutions, #420, 910-7th Ave. SW. Calgary, Alberta, Canada, T2P 3N8

Data wprowadzenia: 1989

Opis: Has been used by approx. 2,000 people `Cancer, Me??' provides users with personalized cancer prevention information. It addresses concerns such as: "What aspects of my lifestyle increase my risk of getting cancer?"; "What can I do to reduce that risk?"; and "How do I improve chances for early detection?". `Cancer, Me??' engages the user in an interview. It begins the consultation by asking the user introductory and demographic questions, then asks about the user's motivation for using `Cancer, Me??'. The main consultation is divided into four sections (Smoking and Smoke Exposure, Diet, Sun Exposure and Health Practices) which the user can choose in any order, and an Evaluation section. In each section the user is asked questions having to do with lifestyle, medical and personal background and family health history. Information gathered from the user's answers, either directly or by inference, is subsequently used throughout the consultation. Thus, the user is addressed by his/ her name; data such as the user's sex and age affect the inclusion as well as the content and phrasing of various sections.

Ostatnie zmiany: August 19 1997

4 Quality Assurance and Administration

4.0 ADE (Adverse Drug Event) Monitor

Krótki opis: To assist the staff pharmacists at Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with monitoring patient clinical data for potential adverse drug events (ADEs). Languages/Shells Used: CLIPS, Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box 8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Development prototype running since June 1995

Opis: This expert system is currently under development, although a prototype has been running since June 1995. It monitors patient clinical data including demographics, drug orders, lab results, and drug allergies, for evidence that a patient has suffered an adverse drug event. If the event is detected early enough, intervention can occur. Whether or not the event is detected in time to intervene, some types of ADEs must be reported to external agencies in order for the hospital to maintain its accreditation status. The criteria for determining the signs that signal a potential ADE is being developed by local physicians and pharmacokinetic experts. The final version of the system will include a software application through which these experts can specify and modify the expert system rules. The system will also automate the process of reporting certain types of ADEs to government agencies such as the FDA.

Ostatnie zmiany: October 27 1995

4.1 Apache III

Krótki opis: Acute Physiology and Chronic Health Evaluation

Miejsce stosowania: 1/ Ann Arbor Catherine McAuley Health System Ann Arbor, Michigan 2/ Beaumont Hospital, Royal Oak, Michigan 3/ Ford Hospital, Detroit, Michigan

Kontakt: Sherrie Jones, VP of Marketing APACHE Medical Systems sjones@apa.com or Alicia Saia asaia@apa.com

Opis: The APACHE III system was designed to predict an individual's risk of dying in the hospital. It compares each individual's medical profile against nearly 18,000 cases in its memory before reaching a prognosis that is, on average, 95 percent accurate. There are 16 hospitals in the U.S. where APACHE III is in use or in the process of being installed. There are approximately another 40 hospitals worldwide where the APACHE III Methodology is used to generate reports which compare their actual average ICU outcomes to ones predicted by the APACHE III Methodology.

The system was developed by William A. Knaus, an intensive-care physician at George Washington University. In 1978 he and several colleagues at GWU began collecting and computerizing the experience of intensive care patients from dozens of hospitals. The computer considered each patient as a complicated sum of several variables: diagnosis and physiological abnormalities on admission to the ICU, age, pre-existing medical problems, etc. The system was designed as a way to judge how the hospitals were doing in terms of the mortality rate of its patients.

A physician can give the computer system 27 easily obtained facts, and the program would predict that patient's risk of dying in the hospital. The system is also useful in answering the question: Is treatment making a difference? Studies have shown that about half the deaths in American Intensive Care Units now occur after a deliberate decision has been made to stop "heroic" measures. While APACHE does not make such decisions, its advocates say it helps those who must make them ponder the issues in the fairest and most realistic way.

Ostatnie zmiany: November 7 1995

4.2 Colorado Medicaid utilization review system

Krótki opis: An expert system which performs quality review of drug prescribing for Medicaid patients.

Miejsce stosowania:Dept. of Preventive Medicine and Biometrics, Section on Medical Informatics, University of Colorado Health Sciences Center Denver, CO 80262, U.S.A.

Kontakt:TED D. WADE UNIV. COLORADO HEALTH SCIENCES CENTER tedwade@tropiq.colorado.edu

Data wprowadzenia: 1990

Opis: The system has been in continuous operation since 1990. It reviews thousands of patient medical histories per month, looking for temporal patterns of events which indicate scenarios of either hazardous or unnecessarily expensive prescribing. The reviews are retrospective, based on clinical information extracted from billing data. The output reports are reviewed by a peer review panel before a decision is made to intervene in writing to the doctors or nursing homes involved in the problems. The panel agrees with the computer about 70% of the time overall, although for some problem scenarios agreement is virtually 100%. This contrasts with commercial systems, not using ES technology, who are lucky to get 10% agreement.

Medicaid (the Colorado agency for indigent medical care) loves the system. It at least pays for itself in various kinds of savings, including some serendipitous discoveries of fraud and/or billing errors. We have a randomized trial which indicates that our intervention significantly changed prescribing behavior to less expensive non-steroidal anti-inflammatory drugs.

The program cost $500,000 and 7-person-years to develop. It runs on about $200,000/year. Two physicians, one pharmacist and three informatics specialists were the development team. The operational director now is Patricia Byrns, MD, an internist and one of the developers.

The local medical society and the American Medical Association believe that the program provides useful information to health-care providers about fragmentation of care, about the patient's drug-taking and care-seeking behavior, and about current standards of care. We have numerous testimonial letters to that effect.

Literatura:

P.J. Byrns, D.C. Lezotte, and J. Bondy, "Influencing the cost- effectiveness of prescribing using claims-based information: a randomized trial", submitted to J. Am. Med. Assoc.

T.D. Wade, P.J. Byrns, J.F. Steiner, and J. Bondy, "Finding temporal patterns -- a set-based approach", submitted to Artificial Intelligence in Medicine.

4.3 Geriatric discharge planning system

Krótki opis:

Miejsce stosowania:

Kontakt:Laurence Moseley Computer Science UC Swansea SA2 8PP UK cslaurie@pyramid.swansea.ac.uk

Opis:
We have had a geriatric discharge planning system working, plus several training programs for nurses, plus a pressure area care one (which has a fascinating knowledge acquisition history).

Literatura:

4.4 Managed second surgical opinion (MSO) system

Krótki opis:

Miejsce stosowania:

Kontakt:Tod Loofbourrow loofbour@husc.harvard.edu

Data wprowadzenia: 1989

Opis: Developed by Foundation Technologies, Inc. and Medical Intelligence, Inc. for Aetna Life and Casualty. The system has been in routine use since 1989. The expert system provides an automated second surgical opinion for areas where surgery is often overprescribed. That automated second surgical opinion is send to a second opinion physician, who can review both attending physician and expert system based comments to adjudicate several opinion and make the clinically best decision. The system has had a major impact on reducing the incidence of unnecessary surgery, and is helping its user to provide more consistent and higher quality care in its managed care networks.

Literatura: presented at the Expert Systems in Insurance Conference in Boston in October of 1991 by Irene Scheibner of Aetna. You can obtain a copy of the proceedings from IBC at 508- 60-4700 or Fax them at 508-653-1627.

4.5 Reportable Diseases

Krótki opis: To assist the Infection Control Departments of Barnes and Jewish Hospitals (teaching hospitals affiliated with the university) with their infection control activities. These activities include surveillance of microbiology cultures data. Languages/Shells Used: Sybase ISQL scripts, Bourne shell scripts

Miejsce stosowania: Barnes Hospital, St. Louis, Missouri

Kontakt: Dr. Michael Kahn kahn@osler.wustl.edu or Sherry Steib sherry@osler.wustl.edu Washington University School of Medicine Department of Internal Medicine Division of Medical Informatics 660 South Euclid Campus Box 8005 St. Louis, Missouri 63110 USA. Phone: (314) 454-8651.

Data wprowadzenia: Used in production since February 1995

Opis: Most hospitals have infection control programs which are aimed at the early detection and aggressive treatment of infections. The earlier an infection is discovered and treated, the less likely it is to spread to the community. For that reason, the Public Health Department requires that hospitals report certain types of communicable diseases, some of which can be detected through microbiology culture surveillance.

We have developed an expert system called Reportable Diseases, which applies state Public Health Department culture-based criteria for detecting "significant" infections, which are required to be reported to the state. Reportable Diseases has been deployed at Barnes and Jewish Hospitals, tertiary-care teaching hospitals, since February 1995.

Microbiology culture data from the hospital's laboratory system are monitored by Reportable Diseases. Using a rulebase consisting of criteria developed by the state Public Health Department, Reportable Diseases scans the culture data and generates an "alert" to the Infection Control staff when a culture representing a "reportable" infection is detected.

Ostatnie zmiany: October 27 1995

4.6 Clinical Event Monitor

Krótki opis: Based on clinical events and a centralized patient database, the clinical event monitor generates alerts, interpretations, screening messages, etc. for health care providers throughout the medical center.

Miejsce stosowania:Columbia-Presbyterian Medical Center

Kontakt: George Hripcsak hripcsak@columbia.edu

Data wprowadzenia: March 1992

Opis: The Clinical Event Monitor is a automated decision support system that is based on the Arden Syntax for Medical Logic Modules. The system is triggered by clinical events throughout the medical center, including admit-discharge-transfer events, the storage of laboratory results, the storage of reports from ancillary departments, the processing of pharmacy orders, etc. The system reads a centralized patient database that includes coded registration information, laboratory results, radiology findings (via natural language processing), medication orders, and text reports from most ancillary departments. Based on the events and data, the system generates emergent alerts (about 50 per day), informational interpretations

(about 2000 per day), and screening messages for clinical research, quality assurance, and administration (eg, billing rules). The system runs for all the medical center's patients, and all health care providers have access to the generated messages. The system has been in clinical use since March 1992. There are about 100 MLMs (rules) at present, which concentrate on laboratory alerts, lab-drug interactions, health maintenance protocols, tuberculosis follow-up, administrative rules, and screening messages for research and quality assurance. There is anecdotal evidence of success, and formal studies are in progress.

Literatura: George Hripcsak, Paul D. Clayton. User comments on a clinical event monitor. In: Ozbolt JG, editor. Proceedings of the Eighteenth Annual Symposium on Computer Applications in Medical Care; 1994 Nov 5-9; Washington, D.C. Philadelphia: Hanley & Belfus, Inc., 1994; 636-40.

George Hripcsak, Peter Ludemann, T. Allan Pryor, Ove B. Wigertz, Paul D. Clayton. Rationale for the Arden Syntax. Computers and Biomedical Research 1994;27:291-324.

T. Allan Pryor, George Hripcsak. Sharing MLM's: an experiment between Columbia-Presbyterian and LDS Hospital. In: Safran C, editor. Proceedings of the Seventeenth Annual Symposium on Computer Applications in Medical Care; 1993 Oct 30-Nov 3; Washington, D. C. New York: McGraw-Hill, Inc., 1994; 399-403.

George Hripcsak. Monitoring the Monitor: Automated Statistical Tracking of a Clinical Event Monitor. Computers and Biomedical Research 1993;26:449-66.

George Hripcsak, James J. Cimino, Stephen B. Johnson, Paul D. Clayton. The Columbia-Presbyterian Medical Center decision-support system as a model for implementing the Arden Syntax. In: Clayton PD, editor. Proceedings of the Fifteenth Annual Symposium on Computer Applications in Medical Care; 1991 Nov 17-20; Washington, D.C. New York: McGraw-Hill, Inc., 1992; 248-52.

G. Hripcsak, P.D. Clayton, J.J. Cimino, S.B. Johnson, C. Friedman. Medical decision support at Columbia-Presbyterian Mecial Center. In: Timmers T, Blum BI, editors. Software Engineering in Medical Informatics. Amsterdam: North-Holland, 1991, pp. 471-9.

Ostatnie zmiany: December 5 1995

5 Medical Imaging

5.1 Perfex

Krótki opis: expert system for automatic interpretation of Cardiac SPECT data

Miejsce stosowania: Emory University Hospital

Kontakt: Norberto Ezquerra norberto@cc.gatech.edu, Rakesh Mullick

rakesh@cc.gatech.edu, Levien de Braal levien@cc.gatech.edu

Opis: At Georgia Tech., we have developed a rule based expert system called PERFEX , for automatic interpretation of Cardiac SPECT data. This system infers the extent and severity of coronary artery disease (CAD) from perfusion distributions, and provides as output a patient report summarizing the condition of the three main arteries and other pertinent information. The work on this project has been done in collaboration with Emory University Hospital.

The overall goal is to assist in the diagnosis of coronary artery disease. The approach employs knowledge based methods to process and map the 3D visual information into symbolic representations, which are subsequently used to infer structure (anatomy) from function (physiology), as well as to interpret the temporal effects of perfusion redistribution, and assess the extent and severity of cardiovascular disease both quantitatively and qualitatively. The knowledge based system presents the resulting diagnostic recommendations in both visual and textual forms in an interactive framework, thereby enhancing overall utility.

At present, PERFEX is implemented in an object oriented environment using Neuron Data's Nexpert Object). This object oriented framework provides a some advantages, including inheritance properties and C code. This software, however, has been extensively modified to incorporate the CF Model (which is intimately linked to inferencing) and to allow for a dynamic user interface.

The system is undergoing extensive evaluation - Specially multi- centre testing, which will be followed by filing for FDA approval. The system itself has been already ported to a commercial clinical system.

Literatura: N. F.Ezquerra and R. Mullick and E. V. Garcia and C. D. Cooke and E. Kachouska, PERFEX: An Expert System for Interpreting 3D Myocardial Perfusion", Expert Systems with Applications, Pergamon Press, (1992)

R. Mullick and N. F. Ezquerra and E. V. Garcia and C. D. Cooke, A Knowledge-Based System to Assist in the Diagnosis of Coronary Artery Disease, Proceedings of the Tenth Southern Biomedical Engineering Conference, 107-9, 1991

R. Mullick and N. F. Ezquerra, Research in Medical Informatics at Georgia Tech.: An Overview, Proceedings of the 1991 IEEE Region 10 International Conference on Energy, Computer, Communications, and Control Systems - TENCON `91 New Delhi, INDIA, 2, 63-70, 1991 N. F. Ezquerra and E. V. Garcia, Artificial Intelligence in Nuclear Medicine Imaging, American Journal of Cardiac Imaging, 3, 2, 130-41, 1989

E. V. Garcia and M. D. Herbst and C. D. Cooke and N. F. Ezquerra and B. L. Evans and R. D. Folks and E. G. DePuey, Knowledge-based Visualization of myocardial perfusion tomographic images, vbc90, 157-61, 1990

Ostatnie zmiany: March 13 1996

5.2 Phoenix

Krótki opis: Radiology Consultant

Miejsce stosowania: University of Chicago

Kontakt: Charles Kahn ckahn@post.its.mcw.edu

Opis: The PHOENIX Radiology Consultant was developed at the University of Chicago to help referring physicians select the most appropriate radiologic procedures. The system saw quite frequent use during a two-year clinical trial, and appeared to help improve the process of selecting imaging procedures. The system was taken off-line because some of the knowledge has become out- of-date. PHOENIX is to be superceded by a system called ISIS (Intelligent Selection of Imaging Studies), now under development at the Medical College of Wisconsin, Milwaukee, WI. ISIS uses case-based reasoning to help primary-care physicians select imaging procedures.

Literatura: Kahn CE Jr. Validation, clinical trial and evaluation of a radiology expert system. Methods of Information in Medicine 1991; 30:268-274.)

Ostatnie zmiany: October 24 1995

5.3 Thallium diagnostic workstation

Krótki opis: TDW learns to diagnose thallium myocardial scintigraphy from a training set of examples.

Miejsce stosowania: USAF School of Aerospace Medicine.

Kontakt: Rin Saunders RSAUNDER@opus.starlab.csc.com

Opis: The Thallium Diagnostic Workstation is an AIM application deployed at the USAF School of Aerospace Medicine. TDW learns to diagnose thallium myocardial scintigraphy from a training set of examples. Digitized images are acquired by a gamma camera and send to TDW via ethernet. TDW performs considerable low-level vision processing, then extracts features of diagnostic significance using template-based techniques. The physician can view the images and TDW's findings simultaneously on-screen.
TDW uses induction to learn diagnostic rules. A rule learned from 150 cases diagnosed by cardiac catheter outperforms the best human diagnostician at the school by a few percentage points. Users can view imagery, enter their own findings and diagnosis, select a rule from a catalogue of rule sets (each rule is accompanied by performance statistics), and perform automated diagnosis.

Literatura: TDW was published in SCAMC `89 and in IAAI-3.

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6 Decison Support Systems

6.1 Iliad

Krótki opis: medical diagnosis in internal medicine

Miejsce stosowania: University of Utah School of Medicine's Dept. of Medical Informatics

Kontakt:Omar Bouhaddou, Director, Knowledge Engineering at Applied Medical Informatics - 74763.2532@compuserve.com or Dean Sorenson, PhD at the University of Utah - dsorenson@m.cc.utah.edu

CURRENT STATUS: Iliad V4.5 is scheduled for release at the end of 1995. It's an update on CD-ROM with a library of digitized pictures.

Opis: At the University of Utah School of Medicine's Dept. of Medical Informatics, an Expert System program called Iliad has been under development for several years. Iliad uses Bayesian reasoning to calculate the posterior probabilities of various diagnoses under consideration, given the findings present in a case. Iliad which was developed primarily for diagnosis in Internal Medicine, now covers about 1500 diagnoses in this domain, based on several thousand findings. The Iliad shell has also been used to develop knowledge bases for diagnosis in other domains. Iliad was developed initially for the Apple Mac; a version for the PC-AT running windows has also been released. Current use: primarily as a teaching tool for medical students. Particular cases can be simulated thru' this program and the students have to "diagnose" the case (i.e. extract all relevant useful information to make the diagnosis from the computer in the most efficient manner possible). This helps the students sharpen their skill in differential diagnosis. It is anticipated that in the coming years, the Iliad program will become a widely used adjunct for clinical diagnosis and patient data documentation in the setting of the physician's office or clinic (at least in the USA).

Literatura: Journal of Medical Systems 15(1):93-110 1991

Dalsze szczegóły http://www.ami-med.com

Ostatnie zmiany: October 23 1995

6.2 DXplain

Krótki opis:A diagnostic decision support system in general medicine

Miejsce stosowania:

Kontakt:Octo Barnett MD Lab of Computer Science Mass General Hospital Harvard Medical School 50 Staniford St Boston MA 02114 USA obarnett@warren.med.harvard.edu 617-726-3939

Opis:DXplain is a decision support system which acts on a set of clinical findings (signs, symptoms, laboratory data) to produce a ranked list of diagnoses which might explain (or be associated with) the clinical manifestations. DXplain provides justification for why each of these diseases might be considered, suggests what further clinical information would be useful to collect for each disease, and lists what

clinical manifestations, if any, would be unusual or atypical for each of the specific diseases. DXplain does not offer definitive medical consultation and should not be used as a substitute for physician diagnostic decision making.

DXplain takes advantage of a large data base of the crude probabilities of over 4500 clinical manifestations associated with over 2000 different diseases. The system uses a modified form of Bayesian logic. It was developed at the Massachusetts General Hospital over ten years ago and has been used by thousands of users since then, both as a stand-alone version and over the Internet. The database and the system is continually being improved and adapted as a result of comments from the users. DXplain is in routine use at a number of hospitals and medical schools mostly for clinical education but also for clinical consultation.

DXplain has the characteristics of both an electronic medical textbook and a medical reference system. In the role of a medical textbook, DXplain can provide a comprehensive Opis of over 2,000 different diseases, emphasizing the signs and symptoms that occur in each disease, the etiology, the pathology, and the prognosis. DXplain also provides up to 10 recent Literatura that have been selected as being appropriate reference material for each specific disease. In addition, DXplain can provide a list of diseases which should be considered for any one of over 5,000 different clinical manifestations (signs, symptoms, and laboraory examinations).

DXplain is owned by Massachusetts General Hospital and access is provided only after executing a license with MGH. Access is limited to hospitals, medical schools, and physicians. A stand-alone version of DXplain for MS-DOS or Windows may be licensed from MGH for a modest cost. Internet access over WWW is now in beta test.

Ostatnie zmiany: November 7 1995

6.3 Epileptologists' Assistant

Krótki opis:A cost effective expert system used by nurses to produce preliminary progress notes for physicians in epilepsy follow up clinic.
Miejsce stosowania:Dallas VA Medical Center, Dallas, Texas, 75216
Kontakt: Herbert J. Doller, Laboratory of Artificial Intelligence - doller@cse.uta.edu.
Data wprowadzenia:1989
CURRENT STATUS: Przestano stosować 1995 because system could not easily be integrated into existing HIS, and the eventual reorganisation of the epilepsy clinic. A project is being developed to update and integrate the system into a generalized software framework for medical expert systems.
Opis:Epileptologist's Assistant is an expert system designed to cost effectively handle routine care in epilepsy follow up clinic. Our strategy is to aid paramedical personnel to be better assistants to physicians. The system guides nurses in gathering patient histories and then generates preliminary progress notes along with a personalized patient information sheet.

Around 300 questions could be asked of the patient; however, the system guides the nurse to ask 20 to 40 questions relevant to a particular patient. The progress note, organized in the SOAP format, is reviewed by the physician with the patient. The

physician could also review the clinical data, weigh the suggestions from the system, and modify the Assessment or Plan sections. The Subjective and Objective sections could also be modified but rarely needed to be. Without the system a physician spent 21.35 min (+/- 0.95 sem, N=140) with the patient. With the system, the nurse spent 14.95 min (+/- 0.81 sem, N=27), and the physician spent 7.4 min (+/- 0.68 sem, N=27). Physician time was cut by about 66%. Using 1994 VA salaries for nurses and physicians, we have shown that the system reduced cost by about 40%.

We have compared the quality of the progress note generated by physicians to the computer generated note. Using a scoring system that divides the note data into essential and bonus categories, we found that the computer note quality was higher (95.5, +/-8.19 sd, N=12) compared to a physician's hand written note (85.2, +/-9.11 sd, N=24; $p < 0.01$).

Our informal assessment of the system is that it was well accepted by our physicians, nurses, and patients. Our physicians were willing to give up time on routine cases in exchange for more time on more difficult cases. Nurses liked the system because they could work at a higher level of expertise and spend more time with the patient. Patients seemed willing to accept the system even though they were waiting for two interviews (nurse and physician).

The system uses an object-oriented architecture and is divided into modules which contain both rules and data, and communicate with each other by passing conclusions. We organized the objects by physiological system. The system runs on a PC under Windows 3.11 and was constructed using ToolBook (Asymetric) for the user interface, Nexpert Object (Neuron Data) for the inferencing engine, and DBase III (Borland) for data storage. The system contained about 25 screens, 250 rules, and 300 data fields in about 30 files.

WWW REFERENCE:
Literatura

Doller, H. J., Hostetler, W.E., Krishnamurthy, K., and Peterson, L.L., Epileptologists' Assistant: A Cost Effective Expert System, SCAMC 17:384-388, 1994.

Doller, H. J., Hostetler, W. E., and Peterson, L. L.: Expert Systems Decrease the Cost While Increasing the Quality of Out Patient Clinical Encounters AMIA 1995 Spring Congress, Cambridge, MA, June 24-28, 1995.

Doller, H. J., Hostetler, W., Krishnamurthy, K., and Peterson, L.L.: Expert Systems: Cost Effective Patient Data Gathering Tools for the Electronic Medical Record. AAAI Spring Symposium, St Louis, May 9-15, 1993.

Hostetler, W.E. and Doller, H. J.: Epileptologists' Assistant: an Expert System for Epilepsy Clinic Improves Progress Note Quality While Decreasing Visit Cost, Epilepsia 35:(supp. 8) 45, 1994.

Hostetler, W., Doller, H. J., Krishnamurthy, K., and Peterson, L.L.: Epileptologist's Assistant: A Cost Effective Expert System for Clinical Medicine. First World Conference on Computational Medicine, Public Health and Biotechnology, Austin, Texas., April 24-26, 1994.

Hostetler, W., Krishnamurthy, K., Peterson, L.L., and Doller, H. J., The Physician's Interface to Epileptologist's Assistant - A Cost Effective Expert System, SCAMC 17:944, 1994.

Entry : September 23 1997

6.4 Help

Opis:HELP is a complete knowledge based hospital information system.

Miejsce stosowania:HELP is currently operational within 6 major hospitals in Utah and at several sites in the United States supported by the 3M Corporation.

Kontakt: Allan Pryor, 36 South State Street, Suite 800, Salt Lake City, Utah 84111, apryor@ihc.com

Krótki opis:HELP is a complete knowledge based hospital information system. It supports not only the routine applications of an HIS including ADT, Order Entry/Charge Capture, Pharmacy, Radiology, Nursing documentation, ICU Monitoring, but also supports a robust decision support function. The decision support system has been actively incorporated into the functions of the routine HIS applications. Decision support has been used to provide alerts/reminders, data interpretation, patient diagnosis, patient management suggestions and clinical protocols. Activation of the decision support is provided interactively within the applications and asynchronously through data and time drive mechanisms. The data driven activations is instantiated as clinical data is stored in the patient's computerized medical record. Time driven activation of medical logic is triggered at defined time periods. The HELP system supports an integrated database structure which facilitates the decision support fucntions of HELP. The database structure also lends itself to design of application independent patient reports.

Data wprowadzenia:1980

CURRENT STATUS:Operational

Literatura: The HELP System, Kuperman GJ, Gardner RM, Pryor TA, Springer-Verlag New York, 1991

Ostatnie zmiany: January 2 1995

6.5 MDDB

Krótki opis: Diagnosis of dysmorphic syndromes

Miejsce stosowania:Kinderzentrum, Munich, Germany

Kontakt: Prof. Dr. Lothar Gierl , Institut fuer Medizinische Informatik nd Biometrie , Universitaet Rostock, Rembrandtstr. 16/17, D-18055 Rostock. tel. +49.381.494.7360 fax. +49.381.494.7203

Data wprowadzenia: 1988

CURRENT STATUS: routine use

Opis:We have designed MDDB using case-based reasoning in a medical domain with poor medical knowledge but rich information: the diagnosis of dysmorphic syndromes. Dysmorphic syndromes are rare. Approximately 1000 different diseases are known, but even experienced pediatrists encounter most diseases only in the literature. The documented signs of a case may be numerous (between 40 and 130).

We have built an expert system and a knowledge acqusition component which is routinely applied to more than 200 prototypical Opiss of dysmorphic syndromes. Prototypes consist of simple feature lists. The catalogue of features has 823 entries. The patient data management component of the system supports the handling of all clinical data.

We evaluated our approach using 903 patients and 229 different prototypes of dysmorphic syndrome which have been collected over many years in a pediatric clinic at the University of Munich. As a result we observed good sensitivity for the system, comparable decisions to the involved physicians and more precise and enhanced knowledge on dysmorphic syndromes. One of the major advantages of case-based systems is that the semi-automatically and incrementally generated prototypes are highly site-specific i.e. are adapted to the set of diseases specific for the patients seen in this pediatric clinic.

Up to now the system has been used on about 3000 patients. All knowledge about these patients is integrated into the knowledge-base. Up to three physicians have been used MDDB since 1988 daily.

Literatura: Gierl L., Stengel-Rutkowski S.: Integrating Consultation and Semi-automatic Knowledge Acquisition in a Prototype-based Architecture: Experiences with Dysmorphic Syndromes, Artificial Intelligence in Medicine, Vol. 6, 1994, 29-49

Dalsze szczegóły MDDB Homepage

Ostatnie zmiany: March 29 1996

6.6 Jeremiah

Krótki opis: A rule based /fuzzy logic system to provide dentists with orthodontic treatment plans for cases suitable for treatment by general dental practitioners with a knowledge of removable orthodontic techniques (see also Orthoplanner)

The program was designed and written through joint cooperation between the Department of Engineering Mathematics and the Department of Child Dental Health, University of Bristol. Development was funded by an MRC Grant.

Miejsce stosowania: Package is currently available commercially from Team Management Systems, Unit 14, Triangle Business Park, Quilters Way, Stoke Mandeville, Aylesbury, Buckinghamshire, HP22 5PL. UK. Tel: +44 1296 616612 Fax:

+44 491 613754

Kontakt: Professor CD Stephens Department of Child Dental Health Bristol Dental Hospital Lower Maudlin Street Bristol BS1 2LY - C.D.Stephens@bristol.ac.uk

Data wprowadzenia:The program became available commercially in 1992.

CURRENT STATUS: The program is being updated from DOS to a Windows environment. (Surprisingly, until very recently, most dental practice management software was DOS based)

Opis: Fifty per cent of the orthodontic treatment (treatment to correct teeth which do not fit together as they should) which is undertaken in the United Kingdom is carried out by general dental practitioners whose only experience in orthodontics was a basic training during their undergraduate curriculum. Nevertheless there are a significant proportion of cases (25%) which are suitable for treatment by such practitioners using removable orthodontic appliances. The latter have the advantage that they can be removed from the mouth for adjustment and cleaning but have the disadvantage that the range of tooth movements they can carry out to correct dental malocclusion is restricted to simple tipping of teeth.

Whilst the mechanical side of treatment is relatively straightforward, success depends upon adopting an appropriate treatment plan. Studies have shown that less that half the treatment plans adopted by practitioners are ideal and this considerably compromises the standard of result which is obtained. Jeremiah has been shown to improve on the ability of practitioners to select cases for suitable for treatment with removable orthodontic appliances and to identify those requiring referral for more specialised treatment.

Literatura: Brown ID, Erritt SJ, Adams SR, Sims-Williams JH, Stephens CD, (1991) The initial use of a computer controlled expert system in the planning of Class II division 1 malocclusion. British Journal of Orthodontics, 18: 1-7.

Mackin N, Stephens CD, (1997). Development and testing of a fuzzy expert system - an example in orthodontics in proceedings of fuzzy logic: applications and future directions, pp61-71. Unicom Seminars Ltd, Uxbridge, Middlesex.

Richmond S, Shaw WC, Stephens CD, O'Brien KD, Brooke PH, Roberts C, Andrews M, (1993) Orthodontics in the General Dental Service of England and Wales: a critical assessment of standards. British Dental Journal, 174: 315-329.

Sims-Williams JH, Brown ID, Matthewman A, Stephens CD, (1987) A computer controlled expert system for orthodontic advice. British Dental Journal, 163: 161-169.

Sims-Williams JH, Mackin N, Stephens CD, (1994) Lessons learnt from the development of an orthodontic expert system in Neural networks in medicine and healthcare. Ifeachor CD, Rosen KG (eds), pp410-414, University of Plymouth.

Stephens CD, Drage KD, Richmond S, Shaw WC, Roberts CT, Andrews M, (1993). Consultant opinion on orthodontic treatment plans devised by dental practitioners: a pilot study. Journal of Dentistry, 21: 355-359.

Stephens CD Mackin N, Sims-Williams JH, (1996) The development and validation of an orthodontic expert system. British Journal of Orthodontics, 23: 1-9.

Ostatnie zmiany: November 19 1997

6.7 Orthoplanner

Krótki opis: A knowledge based system to provide dentists with orthodontic treatment plans for cases where fixed orthodontic appliance techniques must be employed (see also Jeremiah).

Orthoplanner was developed by cooperation between the Department of Engineering Mathmatics and Department of Child Dental Health, University of Bristol and Team Management Systems, Aylesbury, Buckinghamshire, with support from 2 SMART Awards (Small Firms Merit Award for Research and Technology).

Miejsce stosowania: Package is currently available commercially from Team Management Systems, Unit 14, Triangle Business Park, Quilters Way, Stoke Mandeville, Aylesbury, Buckinghamshire, HP22 5PL. UK. Tel: +44 1296 616612 Fax: +44 491 613754

Kontakt: Professor CD Stephens Department of Child Dental Health Bristol Dental Hospital Lower Maudlin Street Bristol BS1 2LY C.D.Stephens@bristol.ac.uk or Pharding@tmsdental.co.uk

Data wprowadzenia:The commercial launch of Orthoplanner took place in September 994.

CURRENT STATUS: Orthopolanner is in use in a number of practices in the United ingdom.

OpisWhilst the mechanical side of treatment is relatively straight forward, success depends upon adopting an appropriate treatment plan. Studies have shown that less that half the treatment plans adopted by practitioners are ideal and this considerably compromises the standard of result which is obtained. Orthoplanner has been shown to provide treatment plans which have the same peer support as those produced by an average NHS Consultant Orthodontist with 10 year postgraduate training and experience (Stephens and Mackin,1998)

Orthoplanner is a Windows based program. It uses a number of techniques including rulebase reading, but forward and backward chaining and fuzzy logic based representations of orthodontic knowledge (Mackin 1992). Extensive use is made of interactive graphics to input clinical data. In addition to treatment planning advice, the program provides extensive clinical support including instructions to patients, pre-formed letters and a 200 page hypertext manual with 1000 supporting Literatura.

Literatura: Mackin N, Stephens CD, (1997). Development and testing of a fuzzy expert system - an example in orthodontics in Proceedings of fuzzy logic: applications and future directions, pp61-71. Unicom Seminars Ltd, Uxbridge, Middlesex.

Mackin N, (1992). The development of an expert system for planning orthodontic treatment. PhD Thesis, University of Bristol.

Stephens CD, Mackin N, (1998). The validation of an orthodontic expert system rulebase for fixed appliance treatment planning. European Journal of Orthodontics (accepted for publication).

Ostatnie zmiany: November 19 1997

6.8 RaPiD

Krótki opis: Knowledge-based system for designing Removable Partial Dentures (see also Jeremiah).

Miejsce stosowania:School of Dentistry, The University of Birmingham, Birmingham, UK in conjunction with Dept of Computer Science, Brunel University.

Kontakt: Peter Hammond p.hammond@eastman.ucl.ac.uk or John Davenport DAVENPJC@novell2.bham.ac.uk

Data wprowadzenia: 1994

CURRENT STATUS: In regular use by JCD and dental students at Birmingham

Opis: RaPiD is a knowledge-based assistant for designing removable partial dentures (RPDs). It uses techniques from logic databases, declarative graphics and critiquing, together with expert design knowledge, to provide a CAD-style graphical interface for both instructional and professional use, the latter offering some design automation.
An RPD is a prosthesis for replacing missing teeth and related tissues. It restores the patient's appearance, improves speech, assists mastication and maintains a healthy, stable relationship between the remaining natural teeth. RPDs remain a major treatment modality for oral rehabilitation in partially dentate patients who form a large proportion of the adult population (40-60% in Europe). In England and Wales provision of RPDs increased from 228,000 in 1949 to 682,000 in 1994 at a cost in that year of $75M.

Literatura

Hammond P, Davenport JC & Fitzpatrick FJ. Logic-based integrity constraints and the design of dental prostheses. Artificial Intelligence in Medicine 5 (1993) 431-446.

Davenport JC, Hammond P & Fitzpatrick FJ. (1993) Computerised partial denture design - a knowledge-based system for the future, Dental Update, June, 221-226.

Hammond P, Davenport JC, Fitzpatrick FJ, Randell DA, de Mattos M. The RaPiD project: knowledge-based design of dental prostheses, Expert Systems with Applications, 9 (2) (1995).

Davenport JC & Hammond P. The acquisition and validation of removable partial denture design knowledge I - methodology and overview, Journal of Oral

Rehabilitation (1996) 23, to appear.

Davenport JC, Hammond P and de Mattos MG The acquisition and validation of removable partial denture design knowledge II - design rules and expert reaction, Journal of Oral Rehabilitation (1996) to appear.

Ostatnie zmiany: December 16 1997
