HAN-FEI BAO, XIAO-WEI NI, SHU LOU: Integratable Relationized Medical Electronic Book(IRMEB)—An Exploration of a New Type of Intellegent Knowledge Medium under the Influence of Pansystems Theory, Inauguration Issue,<Advances in Systems Sciences and Appliacation>, 304-309, 1995

## Integratable Relationized Medical Electronic Book(IRMEB)—An Exploration of a New Type of Intellegent Knowledge Medium under the Influence of Pansystems Theory

## HAN-FEI BAO, XIAO-WEI NI, SHU LOU

## Computer Network Centre. Shanghai University of Traditional Chinese Medicine and Pharmacology, China

ABSTRACT This paper described the backgrounds, structure-characters, aims, advantages and program-development of the Integratable Relationized Medical Electronic Book(IRMEB), which is the research program designed based on the combination of the basic principles and methodology of Pansystems. Theory with medical realities. Its functions for automatic searching and showing the knowledge unit and automatic seeking, linking and deducing of transmissible chain-like and tree-like knowledge flows were also peresentd.

## I. The backgrounds of IRMEB

Though the new techniques and methods for diagnosis continuously come out, the accurate rate of diagnosis does not seem to be improved. As reported on newspaper, in a qualified medical university in China, the nonconsistent rates between clinical and autopsic diagnoses are 28.7%, 29.1%, 36.7%, and 32.5%, respectively in the fifties, sixties, seventies and eighties. The same situations are also seen in other several medical universities. Worriedly, we see that among ten patients about three have been treated with unrelated medicines. People think it is because of the low rate of autopsy. But we know that clinical diagnoses are done based on insufficient information in the sense of Systems Theory, which are naturally different from the visible diagnoses in autopsy. The authors beliebe that one reason is that the amount of medical knowledge which a doctor should master in his or her work is to much to him or her. The conditions may be increasingly serious in coming days.

There are two problems in the usage of medical informations today:

- (1) Though the work of the doctors, professors, researchers has been forced to be more and more specialized, the great "building and apartments" of the scientific information and knowledge of biomedicine, including the levels or "floors" of society, body, system, organ, cell, organell, molecule, etc. are nowadays too big to be red, remembered and linked each other, because their energies and time are limited.
- (2) the pieces of those informations and knowledges of the medical sciences are broken and non-integrated in nature, because so far we have not found an efficient way to help the brain of human beings to link them as an integral knowledge net or system.

On the other hand, the integrated medicine is so vital that the philosophical (not operational yet) discussions of this topic have been never cold historically. Is it possible for the time being to

link and integrate those numberless pieces of medical informations and knowledges together by computer? Is it possible to create a "clever" book which can heop doctors with their reading? Is it bossible that many books in different branches of biomedicine might be integrated into one electronic book? The new exploration of Integratable Relationized Medicine Electronic Book (IRMEB) [1-6] under the influence of Pansystems Theory[7], is looking for the answer, making nothing of hardships.

There are various other types for the time being of the research on medical knowledge media such as hypertexts[8] which can link a concept with its relative texts, hypermedia which combine the texts, pictures, voices and vedio-image together, medical knowledge bases, computer-aided education systems presenting the cases, problems or even high-fidelity patient simulations[9],medical decision support systems with not only knowledge base and search programs, but also reseaner[10].

II. The nature of elements of medical knowledge from the viewpoint of Pansystems Theory

From the most fundamental methodology of Pansystems Theory, we describe the elements of medical knowledge as follows.

The medical knowledge in IRMEB are composed of several sorts of elements attributing to the respective sets.

- Operator Set (S1):The elements (el) of it are e.g. "OR", "AND", "EQUAL"(equal), "DECRS"(decrease), "INCRS"(increase), "COMPN"(company), "CONTN"(contain), "MTHAN"(more than), "CREAT"(create), el∈S1.
- 2. Noun-natured Concept Set(S2):The elements(e2) are those abstract or functional objets such as "symptom", "morbidity", "mortality", "concentration", "oxygen supply", "consciousness", "sensation", "fluid for infusion", etc.  $e2 \in S2$ .
- Noun Set (S3):It contains the concrete elements(e3), for examples, "median nerve", "shank nerve", "CO2", "blood glycose", "blood potassium", "urine glycose" "10% glycose", e3∈S3.
- 4. Measurement Set(S4):Its elements(e4)are "75%, "1g/h", "after 8-12 hrs", "about 500ml", "basically disappear", "light degree", "moderate", "serious" and so on, e4∈S4.
- 5. Process-Situation-natured Concept Set(S5): The elements(e5) belong to the set are the concepts which describe the processes or situations. The examples of them are "abnormality", "dehydration", "be corrected", "dilatation",  $e5 \in S5$ .
- 6. Process-Situation Set(S6):Its elements jointly made fo the elements mentioned above are the basic units of medical information. The examples of the units are "sensation abnormal", "symptoms basically disappeared", "concentration of blood glycose during starvation>=7.8mmol/1", "acidosis corrected", "encephaledema", "dilatiation of encephalic bolld vessels", "pH>7.2", ect.

Let W be Pan-wright Set, then S1, S4, S5, S6 W, S6 (S2 x S5, S3 x S4, S3 x S5). And the essence of medical knowledges (K) might be considered as the relations between the process-situation elements with or without pan-wright elements, i.e. K S6 x S6 x S4. To exemplity, we have

1."fall in pH of cerebrospinal fluid" CREAT (1) "dilatation of cerebral blood vessels" (2)

"increase in volume of cerebral blood flow" (3) "cerebral edema".

2."CO2 in blood" DECRS "pH of cerebrospinal fluid".

3."diabetic ketosis and acidosis" INCRS "ketones in urine".

According to the roles they play in the knowledge units, the elements or their combined forms can be classified into three sorts: the subject-elements, object-elements and condition-elements.

III. The pan-operating attributes of the medical relations

Of course, it is unrealistic to expect that all relations of medicine can be accurately calculated and inferred like those of physics and mathematics. On the whole, the relations of medicine can be divided into three. The first group can be programmed to be calculated and inferred automatically, such as CONTN and CREAT. The second can be calculated and inferred interactively or semi-automatically, such as INCRS and DECRS, and the third can't be calculated and inferred completely, but can be fast searched and shown in IRMEB.

In bio-medical sense, the relations such as INCRS, CONTN, DECRS, TIME-ORDER, DEGREE-ORDER, CREAT, have pan-order properties and through them, the pan-order deductions can be done in interactive way. Generally, those pan-order deductions are carried out jointly by IRMEB and doctors, and in most cases, the former can help the latter with searching the necessary original data, gibing the prompts, elicitations and instructions.

Some medical logical deductions may be formalized. Let I, D be INCRS and DECRS relations, respectively, then we have:

1.(a,b)  $\in I \land$  (b,c)  $\in D \rightarrow$  (a,c) D e, g.

(1). "diuresis" INCRS" lose of potassium ion through urine" AND "lose of potassium ion through urine" DECRS "amount of potassium in body", THEN "diuresis" DECRS "amount of potassium in body".

(2)."osmotic diuresis" DECRS "reabsorption of sodium through renal tubule" AND "reabsorption of sodium through renal tubule" INCRS "amount of sodium in body", THEN "osmotic diuresis" DECRS "amount of sodium in body".

2. (a, b)  $\in \mathbb{D} \land$  (a, c)  $\land \mathbb{I} \rightarrow$  (b, c)  $\in \mathbb{D}$ , e.g.

"diabetic ketosis and acidosisi" DECRS "acetyl coenzyme A enters tricarboxylic acide cycle" AND "diabetic ketosis and acidosis" INCRS "coenzyme A", THEN "acetyl coenzyme A enters tricarboxylic acid cycle" might DECRS "acetyl coenzyme A".

3. (a, b)  $\in I \land (a, c) \in I \rightarrow (b, c) \in I$  e.g.

"hormones regulating contrary to insulin" INCRS "decomposition of fat" AND "hormomes regulating contrarty to insulin" INCRS "free fatty acid", THEN we have "decomposition of fat" might INCRS "free fatty acied".

4. (a, b)  $\in \mathbb{D} \land$  (a, c)  $\in \mathbb{D} \rightarrow$  (b, c)  $\in \mathbb{I} \lor$  (c, b)  $\in \mathbb{I}$  e.g.

"diabetic ketosis and acidosis" DECRS "glycolysis of glucose" and "oxidation of glucose" and "diabetic ketosis and acidosis" DECRS "pyruvate" and "oxaloacetate" THEN glycolysis of glucose" and "oxidation of glucose" might INCRS "pyruvate" and "oxaloacetate".

5. Let R1, R2, R3, R4, R5, be CREAT, CONTN, EQUAL, "TIME-ORDER", "DEGREE-ORDER" relations, respectively and  $F \in (R1, R2, R3, R4, R5)$ , as general knowledge, we habe (a, b)  $\in F \wedge (b, c) \in F \rightarrow (a, c) \in F$ . It means that these relations are transmissible.

Other formalizations of medical logical deduction in IRMEB can be seen in the references [4-6].

IV. The structure designes and program development of IRMEB

The knowledge bases of IRMEB are divided into two parts: \*\*\*\*\*.BOK(the book-file) and \*\*\*\*\*.COD(the code-file). The former contains the coded elements (see Fig.1) and the latter comprises the formalized relations: subject-element-set\*object-element-set\*codition-element-sets, i.e. the three-set units or "bricks" of the knowledge base (Fig.2).

#35 dental lamina<<

#36 tooth bud<<

#37 enamel organ<<

#38 outer enamel epithelium<<

#39 inner enamel epithelium(ameloblast) <<

Fig.1 A part of DIFFN.BOX, incliding a series of coded elements of medical knowledge.

@ (\$35) \* (&36)-0!

@ (\$36) \* (\$37)-0!

@ (\$37) \* (&38 &39)-0!

Fig. 2 A part of DIFFN.COD, including a series of formalized relations, represented by the three-set units or "bricks" of medical knowledge

The programs of IRMEB include the editing program (GENEDT15.EXE), the reading program (IRMEB26.EXE), and the operating programs, such as the automatic linking and deducing programs for chain-like and tree-like knowledge flows, CHAIN9.EXE and TREE24.EXE.

The form of knowledge base thus characterized has at least the advantages as follows: (1) It is readily "understood" by computer and, consequently, the knowledge units the users desire can be quick picked up from a large-scale knowledge base and shown on the screen, cmissionlessly. (2)Just like variously shaped and different sized buildings in the cities can be simple built of the uniform bricks, the integration of many medical fields or macro-to-microlevels could be done based on those uniform knowledge units or knowledge "bricks". (3)Through the pan-operating attributes of the knowledge units many different knowledge relations (or units) can be linkied and integrated, e.g. the simple knowledge chain and knowledge tree with mathematical transitivity can be automatically sought out, linked and some new knowledge (not described in the book) can be deduced (see bellow).

Traditional books are "dead" books, which are onluy the "store houses" of knowledge. Any intelligent reasonings are done by the readers. Whereas IRMEB is a "living" book, which helps doctors in their reading, seaching, remembering, deducing etc. The investigatoers of IRMEB expect that: a clever book + na clever doctor = a super-doctor, who has the largest memory, most detailed analysis, widest knowledge-integration or -linking, most correct diagnosis, and most efficient medical treatment and so on.

V. The automatic seeking, linking and deducing of transmissible knowledge tree by IRMEB

The knowledge tree is composed of a scries of one-to-many generation-by-generation relations. The mission of complete inference is accomplished by the program TREE23.EXE of

IRMEB. On running, TREE23.EXE found and linked relations together (as a bunch of grapes) and, further, resulted in new relations or understandings.

Here we will present one practical examples, which are most easily understood. When reading the DIFFN.BOX and DIFFN.COD by IRMEB26, we acquired the screen text in Fig.3, telling us the differentiation directions of mesenchymal cell. After transitivity-reasoning by TREE23, the new relations on the differentiation directions of mesenchymal cell was outputted in Fig.4.

lateral mesoderm
 can develop into→
parietal mesoderm, intra-embryonic coelom
visceral mesoderm

Fig. 3 The screen text when reading DIFFN. BIX and DIFFN. COD with IRMEB26 to show the differentiation directions of lateral mesoderm

lateral mesoderm can develop into → skeleton, skeletal muscle, connective tissue mesothelium, peritoneal cavity, pleural cavity pericardiac cavity, mesothelium, smooth muscle cardiac muscle

Fig. 4 The new understandings on the differentiation directions deduced by TREE23. EXE through the transitivity of the relations

References

- 1. 包含飞(1991).QMSOC与计算机辅助教学,医学教育,(6), 21-23
- 2. 刘少纯、耿京汉、包含飞(1992). 多学科整合性计算机医学辅助教学系统人体分化模 块(DIFM)——QMSOC 与计算机辅助医学教学(I),计算机应用研究 1992 专集,137-138
- 3. 包含飞(1993). 整合性关系化电子医学书(IRMEB)——QMSOC 与计算机辅助教学(II).中国高等教育研究论丛.成都:成都科技出版社

4. 包含飞,王 奕, 敖竹君(1994).整合性关系化医学电子书(IRMEB)的单纯性传递性 知识链的自动推导——QMSOC 与计算机辅助教学(III),医学教育,(8),17-23

5. 包含飞,王 奕, 敖竹君(1994). 医学知识的编码化关系化以及自动提取和推导——整 合性关系化医学电子书(IRMEB)研究进展, CMIA94 论文集, 678-683

6. 包含飞,王 奕,刘少纯(1995). 整合性关系化医学电子书(IRMEB)的背景,结构,程序研制及功能——QMSOC 与计算机辅助医学教学(IV),计算机应用研究(1995年第2号增刊), 37-40

7. 吴学谋(1990).从泛系观看世界,北京:中国人民大学出版社

8. Timpka. T, Hedblom P, Tibblin G(1990). A hypermedia document collection for primary care: why, what and how? Arti. Intell. Med. 2, 179-92

9. Mahy I, Jones S, Steadman J, Kriegeskotten-Theide I, Godfrey R(1988). The Mac series of medical and physiological. Lancet 1,444-45

10. Spiegelhalter D, Knill-Jones R(1984). Statistical and knowledge-based approaches to clinical

decision support systems, with an application in gastroenterology, J Roy Stat Soc A, 147, 35-77