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Medical Education

Closing the Gap between the Medical Researcher and the Literature

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For about five years in Britain it has been possible to transfer to a computer the formidable task of searching medical literature for articles on a particular topic. The computer searching system is known as MEDLARS and can cover all the medical literature appearing in *Index Medicus*, *Index to Dental Literature*, and *International Nursing Index* after 1963.¹⁻²

Up to the present the complexity of searching by computer has meant that any request for a literature search has had to be channelled through a trained librarian or search editor. This delegation of the task of searching always introduces certain difficulties no matter how the searching is done. The main difficulty is that to make a satisfactory search the librarian needs to know as much about the topic as the medical researcher and to have similar criteria for the rejection of references. Any deficiencies in these respects can be remedied only by constant reference back and consultation.

In addition to the possible misinterpretations resulting from delegation, the use of machine methods introduces further difficulties—particularly (1) the very formal and limited ways of communicating with a machine system; (2) the inability to alter the computer's search instructions, when the deficiencies of the output are seen, without expensive re-searching; and (3) the delay before enough searches can be gathered to make a complete search run economic. This precludes any immediate response to queries.

The difficulties mentioned above have now been largely overcome by a system set up and developed for medical and dental research workers by the Computing Laboratory of Newcastle University with funds provided by the Office for Scientific and Technical Information. Medical and dental research workers can now formulate their own MEDLARS search and see samples of the references it will retrieve immediately printed for them on a typewriter terminal attached to a computer. They can alter the search at any point to improve it as other possibilities occur to them just as they could if searching *Index Medicus* or *Index to Dental Literature* by hand.

Of course, any research worker wishing to use the system has to have some familiarity with the way in which *Index Medicus* treats its references and he also needs to know how to command the computer to do the necessary tasks. We have tried to simplify both these requirements as much as possible and to make the process of selecting a readable number of references from about 1 million on the MEDLARS files as easy as the *Index Medicus* indexing system will permit without sacrificing its great potential for precise searching.

Operation of System

The interaction or dialogue with the computer for an actual search is shown in Figs. 1 to 8. The excerpt in Fig. 1 shows the computer responding to the terminal being connected. The system normally prints in capitals, while entries from the user are in small letters. The user identifies himself to the system using the command "\$signon" and then requests the system to start obeying the programme he wishes to use with the command "\$run *medlars." The computer is, of course, at the same time obeying many different programmes for other users. This initial sequence is probably the least comprehensible part of the process; the remainder of the dialogue on the terminal is with the MEDLARS programme, which is specifically designed for medical users.

```
MTS (LA00-0087)
#$signon dlc4 pw=blank
***LAST SIGNON WAS: 10:03.47 07-07-71
# USER "DLCA" SIGNED ON AT 10:05.21 ON 07-07-71
#$run *medlars
#EXECUTION BEGINS
OPERATOR ASKED TO MOUNT MEDLARS DISK
DONE
```

FIG. 1—Start of terminal session with MEDLARS system.

A complete search done by a medical user as it appeared on the terminal is shown in Figs. 2 to 8. The explanatory comments are interspersed to ease the understanding of the process. In Fig. 2 the user requests help from the programme to ensure that he gets full messages rather than the brief version available to the experienced user. He gives his search a title to provide an identification for him should he wish to return to this search at a later date and amend it or merely run it again on a different file of references.

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* SIGN INDICATES THAT SYSTEM IS READY FOR A REPLY
DO YOU NEED HELP? Y/N
* y
0 SEARCHES HELD
SEARCH NO. 001 NAME, TITLE?
* d.g. lewis ventilation

FIG. 2—Starting search and labelling it.

```
* across m1b
M2= AIRWAY RESISTANCE      T14      NEW TERM   A, B
M3= ASPIRATION              T261     NEW TERM   A
M4= LUNG COMPLIANCE         T182     NEW TERM   A, B
M5= RESPIRATION             T4543    1962      X A
M6= SNEEZING                T8       1962      A
M7= SPEECH                  T789     1962      X A, B, C
M8= VENTILATION PERFUSION RA T73      NEW TERM   X A, B
M9= VITAL CAPACITY          T0       1962      A, B
M10= VOICE                  T368     X A
M1= RESPIRATORY DEAD SPACE T10      NEW TERM   A, B

* full m8
M8= VENTILATION-PERFUSION RA T73      NEW TERM   X
DN 0      A RESPIRATORY FUNCTION TES (DIAGNOSIS, CLINICAL TEST (DIAGNOSIS
DN 0      B RESPIRATORY TRACT PHYSIO (BIOLOGICAL SCIENCES AND )

* xref m8
M11= PULMONARY CIRCULATION T1411    1962      X A

* across m11
M12= CEREBROVASCULAR CIRCULAT T1180    NEW TERM   A
M13= COLLATERAL CIRCULATION T687     NEW TERM   A
M14= LIVER CIRCULATION T584      NEW TERM   X A
M11= PULMONARY CIRCULATION T1411    1962      X A
```

FIG. 4—Display of related terms from dictionary.

```
* carbon dioxide
M15= CARBON DIOXIDE T4724 1962 X
DN 1 A CARBON (ELEMENTS )
DN 0 B OXIDES (OXYGEN) (ELEMENTS)

* down m15a
C1= CARBON DIOXIDE TT4764
M16= DRY ICE T40 1962 X A, B

* blood
Q1= BLOOD T1763 1962 X
M17= BLOOD
DN 0.0 A CARDIOVASCULAR SYSTEM (CARDIOVASCULAR SYSTEM )
DN 0 B HEMATOPOIETIC SYSTEM (TISSUES, EMBRYONIC STRUC)
DN 0 C HEMATOPOIETIC SYSTEM (FLUIDS AND SECRETIONS (N)
DN 1 D BODY FLUIDS

* physiology
Q2= PHYSIOLOGY T544 1962 ( BIOLOGICAL SCIENCES AND )
M18= PHYSIOLOGY
DN 5 A BIOLOGY

* combine m15 link q1
R1= M15 LINK Q1
EXP 72
```

FIG. 5—Use of combine command to qualify term.

```
* anaesthesia
M19= ANESTHESIA T1884 1962
DN 8.9 A ANESTHESIA AND ANALGESIA

* artificial ventilation
NOT IN DICTIONARY. TRY A SYNONYM OR BROADER TERM

* down m19
C2= ANESTHESIA TT9293
M20= ANESTHESIA, CONDUCTION T333 1962 A
M21= ANESTHESIA, DENTAL T749 1962 A, B
M22= ANESTHESIA, GENERAL T1366 1962 A
M23= ANESTHESIA, INTRATRACHEA T428 1962 X A
M24= ANESTHESIA, OBSTETRICAL T638 1962 X A
M25= ANESTHESIA, REFRIGERATIO T6 1962 A
M26= HYPNOSIS, ANESTHETIC T43 NEW TERM A
M27= NEUROLEPTOANALGESIA T115 NEW TERM A

* down m22
C3= ANESTHESIA, GENERAL TT2951
M28= ANESTHESIA, INHALATION T1109 1962 A
M29= ANESTHESIA, INTRAVENOUS T463 1962 A
M30= ANESTHESIA, RECTAL T13 1962 A

* down m23
C4= ANESTHESIA, INTRATRACHEA TT1080
M31= INTUBATION, INTRATRACHEA T652 1962 X A, B, C

* xref m31
M32= TRACHEA T877 1962 X A

* inspiration
M5= RESPIRATION

* combine m8 and m5
R2= M8 AND M5
EXP 0
sample r2
CIT NUM 00314919
PETERS RM
Coordination of ventilation and perfusion
Ann Thorac Surg VOL 6 570-90 Dec 68
* LUNGphysiology * PULMONARY CIRCULATION * RESPIRATION
AGE FACTORS BLOOD FLOW VELOCITY
HUMAN LUNG physiopath
MATHEMATICS NITROGEN blood
OXYGEN CONSUMPTION REVIEW
SPIROMETRY TIME FACTORS

CIT NUM 00316784
ROSENHAMER G
Pulmonary gas exchange as influenced by G-Induced shifts in central blood
volume.
Acta Physiol Scand VOL 78 404-9 Mar 70
* BLOOD VOLUME * PULMONARY ALVEOLI physiology * RESPIRATION
ADULT CARBON DIOXIDE DIFFUSION
GRAVITATION HUMAN MALE
OXYGEN PARTIAL PRESSURE PULMONARY CIRCULATION
PULMONARY VEINS physiology SPIROMETRY VENTILATION-PERFUSION

CIT NUM 00323984
KATORI R AMORIM D THEYE RA WOOD EH
influence of body position on regional pulmonary arterial-venous shunts in
intact dogs.
J Appl Physiol VOL 29 288 96 Sep 70
* POSTURE * PULMONARY CIRCULATION
* OXYGENblood AIRWAY RESISTANCE ANIMAL EXPERIMENTS
* RESPIRATION CARBON DIOXIDE blood DOGS
AORTA PULMONARY ALVEOLI PULMONARY ARTERY
GRAVITATION THORACIC RADIOGRAPHY VENTILATION-PERFUSION
PULMONARY VEINS

ATTENTION INTERRUPT
* combine r2 or m1
R3= R2 OR M1
EXP 10
* batch r3
10: 23.37 JUL 7, 1971
ASSIGNED RECEIPT # 4
```

FIG. 6—Use of synonyms in dictionary—for example, "anaesthesia and inspiration."

```
* stop
END SEARCH NO. 001
DONE
# EXECUTION TERMINATED
# $signoff
# OFF AT 10:24.59
# ELAPSED TIME 1178.413 SEC.
# CPU TIME USED 31.587 SEC.
# STORAGE USED 1411.93 PAGE-SEC.
# DRUM READS 2409
# MAX VM PAGES 61
# APPROX. COST OF THIS RUN $ 2.36
# FILE STORAGE 51 PG-HR. .00
```

FIG. 8—Finish of a terminal session with display of cost.

ENTER TERMS. START BY TYPING IN A MEDICAL TERM RELATED TO AN ASPECT OF YOUR SEARCH
* physiological dead space
NOT IN DICTIONARY. TRY A SYNONYM OR BROADER TERM
* dead space
NOT IN DICTIONARY. TRY A SYNONYM OR BROADER TERM
* respiratory dead space
M1= RESPIRATORY DEAD SPACE T10 NEW TERM
DN 0 A RESPIRATORY FUNCTION TES (DIAGNOSIS, CLINICAL TEST (DIAGNOSIS
DN 0 B RESPIRATORY TRACT PHYSIO (BIOLOGICAL SCIENCES AND)

FIG. 3—Location of medical term in dictionary.

The start of the formulation is shown in Fig. 3, where the user is invited to type a medical term appropriate to his search. He may find, as in this case, that the term is not in the thesaurus of medical subject headings (MESH) used in *Index Medicus*. There are only 8,000 of these terms but the addition of about 7,000 synonyms which lead automatically to the appropriate MESH term has eased this problem. Finally, he types an allowable term and the programme labels it with a unique identifier "M1=", prints out the term, the number of times it has been used in indexing, and the names of the more general levels of the categories of associated terms.

The use of the commands provided to enable the user to look at related terms is shown in Fig. 4. He asks for terms at the same level in the tree structure by the command "across" and gets a list of nine terms all labelled with their identifier so that he can easily refer back to them. He chooses one of interest and asks first to see a fuller print out of the details of this term. He can then decide whether to pursue terms within the tree structures listed or whether to move to connected terms in other categories whose presence is indicated by the "X." In this case he chooses the latter and commands "xref m8" and then goes on to investigate terms in this new category.

The user has now seen 14 terms from the *Index*

FIG. 7—Citations retrieved from file of references.

Medicus thesaurus merely by moving around from his original term. He feels he has looked at all the terms of interest to him in this area and so goes on to another aspect. In Fig. 5 the user is shown entering a new term, "carbon dioxide" and displaying the more specific terms below it in the tree structure. The next term he enters, "blood," is not only a MESH term but can be used to qualify the meaning of any main term. This possible use is indicated by assigning it a "Q" code for qualifier as well as its M code; similarly "physiology" can be used in the same way.

Before going on to investigate further possible terms a qualifier is attached to one of the main terms by the "combine" command, and the user can then refer to the group "carbon dioxide link blood" by the label R1; he is also given an estimate of the number of articles satisfying this statement since 1968.

Some of the synonyms in the dictionary are shown in Fig. 6. "Anaesthesia" is used to provide the English spelling of the MESH term, whereas "inspiration," which is not a MESH term, points to "respiration," the term used by the indexers for this concept.

A further grouping of terms by the "combine" command is shown in Fig. 7, and finally the user decides to see what articles are in the file with the combination of terms "ventilation perfusion ratio" and "respiration." The programme prints the references it finds, giving the author, title, journal, and the index terms with their qualifiers, if any, in lower case. The user can stop the printing by hitting the "attention" key on the terminal if he is satisfied that the references the statement is retrieving are correct or if they are so wrong that he wants to alter it. In this case the search statement is about right but he adds another term to it before submitting it to be run at a later date on the file back to 1968 with a batch of other searches.

Finally, the search is complete and Fig. 8 shows the user terminating the programme and disengaging himself from the system. The statistics of cost and time used during this session are printed after the "\$signoff" command.

Many of the apparent complications disappear when the terminal is actually being used, since only a small part of the printed output need be considered at any time. Certainly medical and dental workers who have used the system were not overwhelmed by it; they were far more concerned with the medical aspects of the meaning of the terms used.

Comment

Our main interest so far has been to compare searches formulated by the research workers themselves with those formulated on the same topic by the MEDLARS searchers at the National Lending Library. There is some American evidence that the transmission and translation of search requests is a weak link in the MEDLARS searching process.³ Our investigation can provide more evidence on the point.

At present the system is working with an immediate sample file of about the past five months' *Index Medicus* and *Index to Dental Literature* English-language references (50,000 in all). We are not necessarily limited to this and a full MEDLARS search, of course, can go back to 1966. We felt that for immediate references users would prefer the English-language restriction to a shorter time span. Medical and dental research workers using the system have shown great interest in being able to search quickly the new references added to the sample file.

The medical school at Newcastle already has a typewriter terminal installed, and we hope that many medical and dental research workers will use the system to search the sample file on their own informally. The system has great potential as a regular literature-searching method in addition to its use for formulating full-scale MEDLARS searches. Medical and dental research workers in other areas could readily use the system by connecting an I.B.M. 2741 computer terminal to the Newcastle computer via the G.P.O. telephone system.

The use which research workers make of this literature-searching system and their comments on it will be valuable when we consider modifications. Our main interest during the remainder of the research project is to collect the experiences and opinions of the medical and dental research workers using this method of searching the medical literature.

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Any Questions?

We publish below a selection of questions and answers of general interest

Investigation of Azoospermia

A 38-year-old man in an infertile marriage was found to have complete azoospermia on two occasions. Would further investigation such as testicular biopsy serve any useful purpose?

The first further investigation is, of course, to take a history and make a physical examination. There might, for example, have been mumps with orchitis, gonococcal epididymo-orchitis, or bilateral cryptorchidism as causes of azoospermia. If the testicles are small and soft the likelihood of effective treatment will be very small unless there is also evidence of hypogonadism due to pituitary gonadotrophin deficiency. Some men with small testicles have Klinefelter's syndrome and most of these would have chromatin-positive buccal smears and duplication of the X chromosome in the karyotype. If the testicles are of normal size and consistency, full testicular exploration rather than biopsy alone might be of greater help diagnostically since many men with azoospermia

and without obvious explanation are found to have congenital defects either of the epididymis or vas deferens. Testicular biopsy in these cases shows normal spermatogenesis; otherwise it might reveal germinal aplasia or arrest of maturation.

It is not possible in a short space to discuss fully the investigation of azoospermia but it may fairly be stated that though testicular biopsy greatly increases diagnostic precision, it rarely offers much help in choosing an effective form of therapy.

Castor Oil in Coronary Thrombosis?

Is castor oil contraindicated in a patient with coronary thrombosis?

Yes, for it may give rise to considerable abdominal griping, which is very undesirable soon after a myocardial infarction when the patient's heart should be protected from stimulation by catecholamines.