A computer based handbook and atlas of pathology

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A Computer Based Handbook and Atlas of Pathology[1,2]

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SUMMARY

The Diagnostic Encyclopaedia Workstation (DEW) is a computerized handbook of pathology intended for use in diagnostic practice. It consists of a combination of a personal computer (PC), a video disc player (VDP), for which a specially developed disc is used, two monitors, a mouse and software.

The hard disc of the computer contains textual information on diagnoses in categories such as macroscopy, common histology, immunopathology, clinical observations and prognosis and case histories. This information is frequently illustrated by pictures on a video disc which is automatically addressed by the computer software. All pictures, at present some 3000, pertain to case histories which are included in the system. Also integrated are classification aids in two categories: diagnostic criteria and differential diagnosis.

Advantages of DEW over the use of conventional manuals are 1) the extensive volume of text, 2) the large number of high quality illustrations, 3) the immediate access to cross references and 4) the potential for continuous revision.

Introduction

In medicine, computers are used for four different objectives. Firstly, they are used to increase the efficiency of hospital administration, which includes the storage and distribution of patient findings and records and the information relating to hospital management etc. This is at present the most prevalent use of hospital computers. Secondly they can be used in scientific investigations for improved experiment control and at a later stage for compiling data and editing scientific papers. Thirdly, they can be used for distributing medical knowledge. This application is at present mostly restricted to the use of computerized library search systems and some attempts at computer aided instruction. Finally, systems have been constructed and used in an attempt to improve the quality of medical care by computer assisted decision making. Such applications include quantitative pathology, expert systems and treatment planning.

In this paper, the role of the computer for the distribution of medical (pathological) knowledge is discussed. The distribution of pathological data has been previously almost exclusively the province of books and scientific papers in the form of printed text, which, because of the visual nature of pathology, are usually extensively illustrated. However, this function of distributing knowledge can be performed by the combination of a personal computer (PC) coupled to a video disc player (VDP), a storage medium for pictures. This combination (PC and VDP) is highly advantageous for archiving and distributing information and, as will be argued below, has considerable advantages over the use of books.

To the best of our knowledge such a system has only been infrequently used in pathology[2–4]. Thursh et al.[4]

[1] Supported by grant PF-1207 of the "Praeventiefonds".

[2] Many of the cases used for illustration were obtained from the former "Ovarium Tumoren Commissie".

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described the "Expandable Computerized Learning and Inquiry in Pathology" system, evolving from "The Living Textbook of Pathology". The basic task of this device appears to be the training of students in pathology, but it also has an extensive library function. A recent development is the "Pathfinder" system[5], which can be used for producing tentative diagnoses in the diagnostic field of lymphomas. This, too, has a library function.

The Diagnostic Encyclopaedia Workstation, the device we describe in this paper, is however, specially designed for assisting the pathologist engaged in the daily practice by providing textual and pictorial diagnostic information, including support in pathological decision making.

Some of the requirements that such a system has to meet are: It must contain extensive texts to be able to provide comprehensive diagnostic information including many variations and alternative ways of reaching the diagnosis. This must be extensively illustrated and easy to use for a pathologist.

Equipment

A sketch of the configuration is given in Fig. 1. A standard, unadapted personal computer (IBM-PC-AT or a similar model) with a mouse and a monitor is used. It contains a working memory capacity of 640 Kbyte. The hard disc has the capacity to hold 20 Mbyte, the equivalent of four thousand pages of text or ten million numerical data. The capacity of this disc is roughly equal to the verbal contents of half a shelf of manuals on pathology. A new type of disc, the Compact Disk Information (CDI), based on optical technology, containing 200 Mbyte Read Only Memory (ROM), the equivalent of several shelves of books, will probably replace the present magnetic discs.

In the system, pictures are stored on a video disc in a video disc player. This apparatus is the predecessor of the well known Compact Disc Player for audio use, on which images are stored in a partially digital code on a removable video disc. Such a disc contains one colour tv-frame per track with a maximum capacity of 54 000 tracks. They are visualized on a normal colour tv-set.

The textual information of the system is stored in a database written in the language MUMPS, using the fourth generation database toolkit AIDA[6], described previously[7]. The programmes of the user interface are written in C.

The total price of the configuration is about ECU 1300.– (or less) for the computer, including hard disc and monitor, ECU 1500.– (or less) for the laser disc player and ECU 400.– (or less) for the tv-monitor. This is the basic hardware configuration to which the price of the software and contents (the database and the videodisc) have to be added.

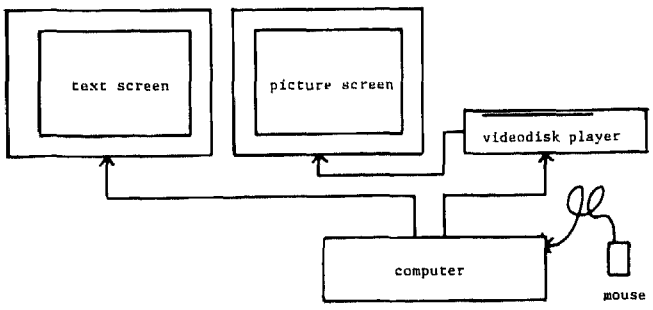

Fig. 1. A mouse, a personal computer, a video disc player and two tv monitors constitute the hardware of the Diagnostic Encyclopaedia Workstation.

Contents

The information in the encyclopaedia, which is structured according to the tumour classification of the WHO, consists of diagnosis descriptions, case histories, captions, structural information and pictures.

Describing information on diagnoses is provided in maximally 18 categories, each describing in a quick reference text the same diagnosis when viewed through the different categories (see Table 1). The primary category is the microscopy description. It describes the common histopathological diagnostic characteristics. Other categories are macroscopy, electron microscopy and immunopathology. Also available is the clinical information and information regarding treatment and prognosis, as far as relevant for making a diagnosis. The page "clinical questions" gives suggestions about the questions to be anticipated from the clinic. Prescriptions are available for the processing of the tissues.

Two categories contain information which gives additional support in diagnosis making. These categories are "diagnostic criteria", i.e. the criteria which must be met in

Table 1. List of potential categories of textual information of a diagnosis description

Clinical data:	clinical data clinical chemistry radiology demography prognosis treatment staging questions to the pathologist
Macroscopy:	macroscopy
Microscopy:	common histology immunopathology electron microscopy quantitative pathology
Decision rules:	diagnostic criteria differential diagnosis
Prescriptions:	macroscopy/immunopathology/quantitative pathology/etc.
Literature:	references
Comments:	all necessary items
Pictures:	caption texts
Cases:	case histories

order to make the diagnosis, and "differential diagnosis", i.e. a list of diagnoses which might cause confusion together with sets of rules required for differentiation.

For each diagnosis one, and for the more important diagnoses two or three case histories, are available with data on clinical and pathological observations, treatment and follow-up.

Many categories, e.g. macroscopy, common histology and immunopathology are illustrated by colour pictures, which are also part of an illustrated case history. Pictures are, however, only included if they form part of a case history.

The system contains data on about 80 diagnoses on ovarian and related pathology, which are illustrated by about 150 case histories and 3000 pictures.

Using the machine

The two screens and the mouse are placed on a desk next to a microscope (see Fig. 2). After turning the system on, the text screen shows a menu (Fig. 3). Options can be selected by touching the desired (sense) fields on the text monitor with the mouse. For example one can select an organ ("ovary"), a diagnosis group (e.g. "common epithelial tumours") and a diagnosis (e.g. "serous adenofibroma"). The text (quick reference type) on common histology (see Fig. 4) is then immediately displayed on the text monitor. The first illustration appears simultaneously on the picture monitor.

In the text (see Fig. 4) three different types of sense fields appear. Some indicate the presence of a picture illustrating the statement. When the sense field is touched with the mouse the corresponding illustration is immediately shown on the picture monitor. In this way it is possible to have access to all illustrations within this category of information. Literature references and screens with comment on histological features are represented by two other, different types of sense fields. They are shown on the text monitor when the appropriate sense field is touched with the mouse.

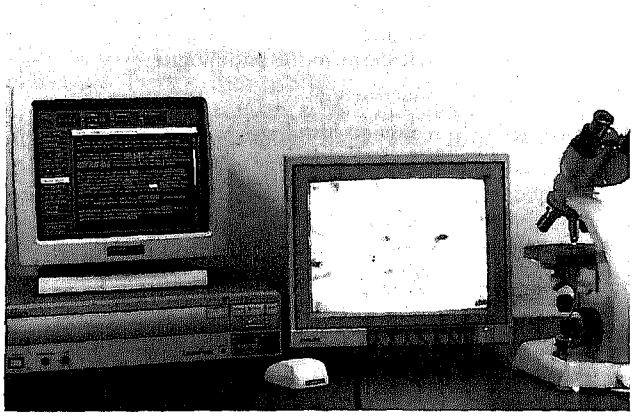

Fig. 2. DEW assembled on the desk of a pathologist. Personal computer and video disc player do not necessarily have to be placed in the same room.

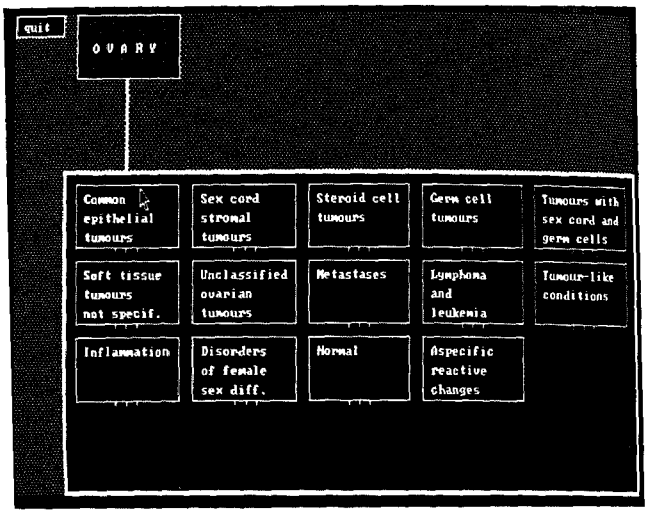

Fig. 3. A menu for choosing between diagnostic groups within the organ "ovary".

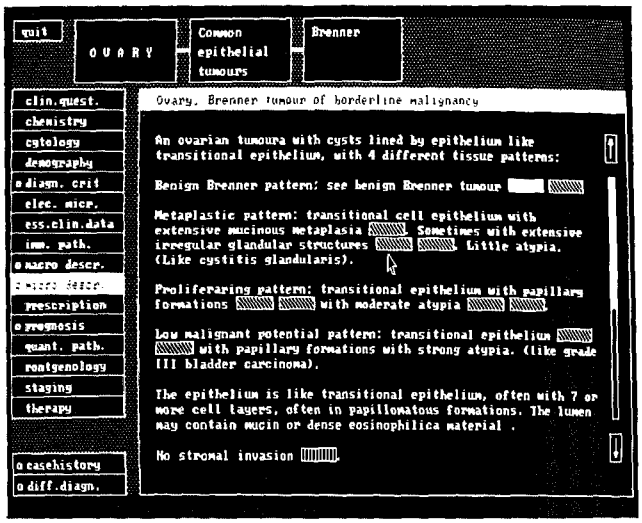

Fig. 4. A screen on common histology in DEW. The main text contains references to pictures which are shown after touching a sense field with the mouse. In a similar way literature references can be provided. In the margin is the list of categories of information which are immediately available.

In the margin of the text monitor are shown the other categories of information (see Table 1) that are also available for the diagnosis under discussion. By touching the appropriate sense fields with the mouse a screen with information is displayed on the text monitor. A similar list of options is presented on each of the screens.

To illustrate more fully the use of the system the diagnostic sequence of a hypothetical case will be presented.

A pathologist is confronted with a case for which he or she considers the diagnosis serous adenofibroma. In the menus "ovary", "serous tumours", and "adenofibroma"

are consecutively selected. As a result, the text on the histology of the serous adenofibroma is displayed, accompanied by the first illustration.

The text gives details concerning the structure of the tissue: the epithelium, consisting of cylindric or cuboid or flattened cells with rounded nuclei and eosinophilic cytoplasm and its relation to a thin apical mucinous layer and extensive masses of fibrous stroma. At the same time the picture monitor shows a colour picture at a low magnification. Reading through the text it is possible to select illustrations showing greater histological detail.

Other categories of information are readily available. Where necessary, macroscopical, immunopathological or even cytological information can be recalled.

The category "diagnostic criteria" gives a selection of the most important characteristics of serous adenofibromas.

The illustrated differential diagnoses display criteria for differentiation between a serous adenofibroma and other diagnostic possibilities. Should nuclear atypia suggest the possibility of a tumour with borderline characteristics it is just as easy to proceed with the working diagnosis "serous borderline tumour" instead of going back to "serous adenofibroma" and starting again. After touching the name of the alternative diagnosis with the mouse, the first text frame on borderline tumours (common histology, with illustrations) appears on the screen. From there similar pathways are followed but now in the diagnostic area of the serous borderline tumour.

Discussion

The Diagnostic Encyclopaedia Workstation (DEW) has a similar function as a series of manuals. It does, however, possess considerable advantages.

First it may contain much more textual information than a single book. This makes it possible to give more information on each diagnosis, including the results obtained by a variety of histopathological and cytological techniques and thereby cover more unusual conditions in the differential diagnosis. A considerable amount of this information remains unused but is immediately available if and when needed.

In the second place, DEW may contain many more illustrations than are found in books. This is a consequence of the low price of producing a video disc compared to the cost of printing colour pictures. It provides the possibility for extensive illustration of each diagnosis and its histological variations with representative case histories. Illustrations to other categories can also be included.

An important aspect considering the use of such systems in medicine is the quality of the pictures. In theory, as the storage on the laser disc is not entirely digital, noise and other aberrations may be introduced in the tv signal. The noise level, however, is specified not to introduce more aberrations than 1 intensity level out of 250. This noise level remains invisible to the human eye. The quality of the images in practice depends on the quality of the TV set and not on the disc used. We feel that for larger microscopic magnification even small sized monitors in the range of ECU 200.– to ECU 400.– may deliver image qualities superior to books, and are in any case sufficient for use in daily practice.

A third advantage of DEW is the prompt access to numerous varieties of information. A book, even with good cross referencing, implies an extensive search through pages of several chapters. In DEW by simply touching a sense field with the mouse the desired information is immediately displayed on the screen. In this way, when studying the histopathology of a tumour, it is possible to recall information on a considerable number of other diagnoses and categories of information, simply at the press of a button.

A fourth major improvement of DEW over books is the potential for updating the information both quickly and cheaply.

Finally, the possibilities of the system are not exhausted by the knowledge retrieval system described. Artificial intelligence can be added and may provide the pathologist with a diagnostic hypothesis. Such a system is already under construction in our laboratory. It is also possible to link the reasoning system to a computerized observation system[8] and in this way it is also possible to feed information from the observation system to the reasoning system. This same system may also be able to measure the tissues on the colour slides on the video disk and compare the results with those of the case under discussion.

The introduction of a system like DEW will be more effectively achieved once pathology laboratories accept the use of electronic archive systems as proposed by Pressman[9] or use electronic photography instruments as proposed by Preston[10]. Computer based archives will then not only include textual information but also the corresponding visual information. Systems like DEW could then provide the means for rapid and easy dissemination of medical knowledge.

It is concluded that the Diagnostic Encyclopaedia Workstation is a potentially important aid for the pathologist in daily diagnostic practice. Clinical trial of the present edition, covering a large spectrum of ovarian pathology, is nearing completion and further diagnostic techniques, using artificial intelligence, are under preparation.

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