Virchows Arch (Pathol Anat) (1983) 401:345–354

Virchows Archiv A

A computerized data bank of surgical pathology and cytopathology diagnoses

Structure and purposes

Pietro Gallo and Virginia De Blasi

Department of Human Biopathology (Head Prof. E. Bonucci), Section of Morbid Anatomy, University of Rome, Italy

Summary. A computerized data bank was created to file the diagnoses from the Surgical Pathology and Cytopathology laboratories in a University Department of Pathology. The diagnoses are divided into separate diagnostic statements, coded according to SNOMed and stored on magnetic tapes. Coding procedures are made easier by the creation of a lexicon of diagnoses used. The use of additional keys, besides SNOMed codes, allows the retention of further information.

Several programs perform many data-retrieval operations both routinely and on request in order to meet different goals in the fields of quality control, diagnosis, education and research.

The system is characterized by low cost, flexibility and multi-purpose utilization.

Key words: Surgical pathology – Cytopathology – Electronic data processing – Education – Quality control

A department of Pathology continuously produces a lot of medical information. This is practically unemployable for research and teaching purposes unless a computerized data bank is set up. The computer, indeed, allows large sets of information to be properly stored and easily retrieved.

Moreover, the reports of a pathology department are specially fit for automatic data-processing. In fact, they are accurate enough to be considered reliable, and are also suitable to be divided into concise diagnostic statements, written with a rather strict and universally aknowledged vocabulary (Coles and Slavin 1979).

A formidable incentive to both the standardization of vocabulary and the feasibility of electronic data-processing in pathology was given by the creation of standardized nomenclatures like SNOP, first, and later SNOMed.

Offprint requests to: Prof. Pietro Gallo, I Istituto di Anatomia patologica, Policlinico Umberto I, Viale Regina Elena, 324, I-00161 Roma, Italy

The electronic data-processing in pathology, allowed and promoted by the above-mentioned conditions, has various aims. These lie in the fields of diagnosis (Codling et al. 1977), education in medicine (Gaynon and Wong 1972), training in pathology (Gallo et al. 1980), and research (Burkhardt and Kayser 1978). For scientific purposes, the data may be collected from several Institutes of pathology (Codling et al. 1977; Kayser et al. 1978; Loy and Gross 1978) to carry out research into geographic pathology (Jacob 1972) or epidemiology (Höpker 1972; Kayser and Schüler 1981), and to pool rare lesions (van der Esch 1972).

In the past, postmortem examinations were the main source of diagnostic information for institutes of pathology, and, as a result, the first data banks consisted of autopsy files (O'Connor and Smith 1973; Brust et al. 1974; Sutinen et al. 1974). Nowadays, surgical pathology and diagnostic cytology are playing an ever increasing role in providing diagnostic information, and their data demand computerization.

The Department of Human Biopathology, Section of Morbid Anatomy, of the University of Rome, Italy, has a nine years' experience in the field of electronic data processing of autopsy files (Gallo 1977). In 1980, a new data bank was created, which has been operating in order to store and retrieve reports from surgical pathology and diagnostic cytology laboratories. The purposes of this paper are to describe how this data bank was planned and works, and to discuss its aims and future development, in the light of the recent literature and our own experience.

Materials and methods

Computer facilities

The hardware of the system is based on the Univac 1100/82 Computer at the Inter-Faculty Computer Centre of the University of Rome. This Centre has many devices like visual display units, card readers and punchers, fast printers, magnetic tape and disk drives. Data are stored on magnetic tape (with a density of 1,600 Bpi). The software was written in FORTRAN V by one of the authors (P.G.), and comprises many programs and sub-routines.

Structure of the data bank

A preliminary and important decision one has to take when planning a data bank, is to settle the content of information to be stored. In diagnostic pathology one has to decide in advance whether to store only the final diagnosis, or the entire macro- and microscopic description of the specimen under examination. Another solution (Swettenham et al. 1982) is to keep two files distinct: the former for the entire description (to generate the final report) and the latter for the diagnostic codes (to perform data-retrieval operations). For our purposes, a detailed description seemed redundant, and it was decided to retain only the diagnosis, after subdividing it into separate and concise diagnostic statements.

Another important choice is about the use of natural language versus that of code. The use of natural language is obviously more creative, but coding is extremely convenient for fast retrieval of data. In fact, a proper system of coding gains a significative advantage from obviating the use of synonyms, which are regrettably so widely used in medical language, and from connecting the various items hierarchically. The use of a standardized code, finally, makes it easier to perform an international comparison of data. In our opinion, all these

goals can be achieved by using the Systematized Nomenclature of Medicine (SNOMed), edited by the College of American Pathologists (1976).

Results

Operation of system

The system will be described listing the main computer programs, as recently done by other authors (Robboy et al. 1981; Swettenham et al. 1982). The flow-chart of the computer system is outlined in Fig. 1. Three different kinds of operations performed (i.e. the pathologist's activities, the clerical work and computer data processing, respectively) were separated graphically. The pathologist's functions were further subdivided into three fields: diagnosis, education and research.

Entry of data. The operation starts when the patient's demographic data are entered into the system. These data include the patient's full name, sex and year of birth, the date in which the specimen was received, the referring physician (otherwise the ward or the outside hospital), and the pathology accession number. This mark consists of a letter, a two-digital

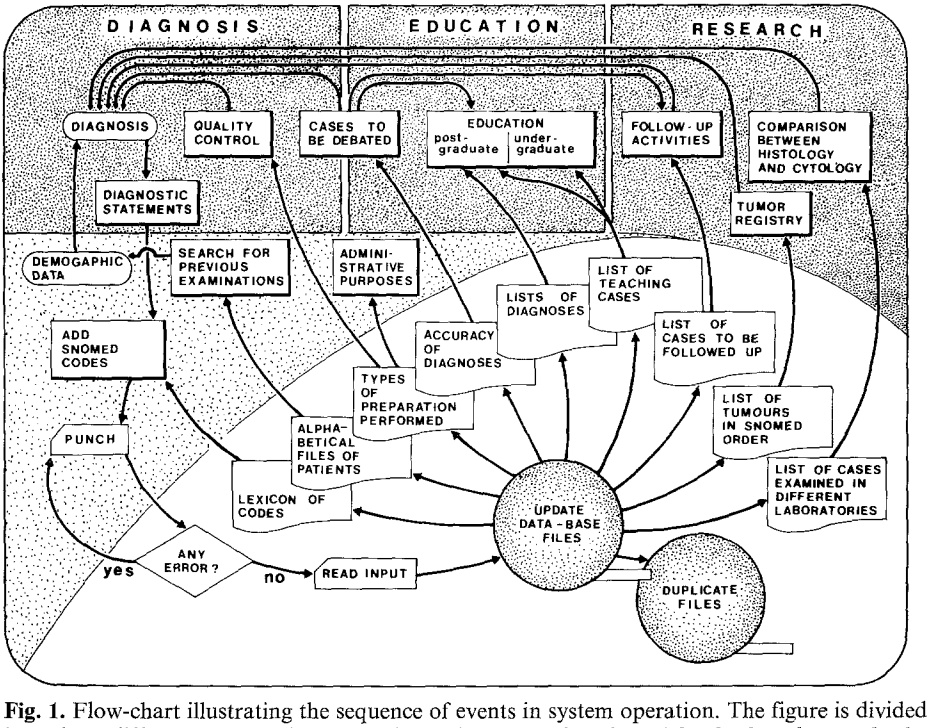

Fig. 1. Flow-chart illustrating the sequence of events in system operation. The figure is divided into three different areas, relevant to the pathologist's functions (*closely dotted ground*), the clerical work (*sparsely dotted ground*) and computer data processing (*clear ground*). The pathologist's activities are further subdivided into diagnosis, education and research

I ISTITUTO DI ANATOMIA ED ISTOLOGIA PATOLOGICA
UNIVERSITA' DI ROMA

01 Sigla: Roma1

ESAME ISTOLOGICO ☐
CITOLOGICO ☐

Cognome: Nome:
Sesso: Anno di nascita: 1
Data della richiesta:
Numero dell'esame:
Richiedente:
Numero dell'ultimo esame microscopico: O:
Materiale inviato:
Notizie cliniche:

Numero complessivo delle schede:

DIAGNOSI

Sc	Esame	E	Top.	Mor.	O	Mal.	Organo	L e s i o n e	Cm	A	F	D	I	C	S
02															
03															
04															
05															
06															
07															
08															
09															
10															
11															
Sc	Esame	E	Top.	Mor.	O	Mal.	Organo	L e s i o n e	Cm	A	F	D	I	C	S

Da riempire solo nel caso che sia indicato il follow up:
Indirizzo del paziente:
Nome e indirizzo del medico curante:

Fig. 2. The Computer Report form. In the upper portion demographic data have to be typed. The lower part has to be filled up by the pathologist, who writes an abridged version of the diagnosis (up to ten different diagnostic statements) and enters some keys, and by the coding specialist. The demographic data are then punched on the identification card, the diagnostic statements on one or more diagnostic cards

number (equivalent to the last two digits of the current year), and a progressive number. The initial letter marks the laboratory (e.g. histopathology, cytopathology or electron microscopy) in which the specimen has to be processed. Should there be any previous examination, this is notified, too.

All these data are typed on the Report form (Fig. 2), which reaches the pathologist together with the slides. This form is made up of three sheets of paper: a Computer form and a double-copied Pathology form.

DI GIAMMARINO	GUERRINO	1911	B/80/	923
DI GIOVAMBATTIS	TA LUIGI	1923	B/80/	1673
DI GIULI	ROCCO	1894	B/80/	2185
DI GIULIO	GIOVANNI	1932	B/80/	1173
DI IORIO	LETIZIA	1925	S/80/	73
DI LELIO	IMMACOLATA	1935	C/80/	472
DI LORENZO	SALVATORE	1913	B/80/	1015
DI LORETO	ROMANO	1953	B/80/	1555
DI MALTA	FILOMENA	1903	B/80/	423
DI MARCO	IDA	1931	B/80/	1270

Fig. 3. Detail of the alphabetical list of all the cases examined. Surname, name, year of birth and pathology accession number are listed. The numbers refer to three different laboratories (B = histopathology, C = cytopathology, and S = resin embedded skeletal biopsies). Original surnames have been altered to preserve confidentiality

After rendering his final diagnosis and dictating it, the pathologist writes an abridged version of the diagnosis, in the form of one or more concise statements, on the computer sheet. Finally, he enters some additional codes (Fig. 2). One of these (E) identifies the types of specimen or preparation, that is paraffin section from surgery, endoscopy or needle biopsy, frozen section, or smear. Another code (Cp) indicates the initials of the pathologist who has signed the report. A single digital code (A) records the accuracy of the diagnosis (1 = certain, 2 = uncertain, 3 = consistent with..., 4 = unfeasible). Information about the use of special techniques are given by code S. The remaining codes are yes/no questions: whether a follow up is required (F), the slide has a definite didactic value (D), and it was photographed (I), or whether the surgical specimen was preserved (C).

Subsequently, the diagnosis is typed on the Pathology Report form: one copy is distributed to the patient's ward and the other is stored in the manual file, for legal purposes.

The Computer Report form, on the other hand, is completed by the coding specialist, who codifies the diagnostic statements according to SNOMed. The data are then punched on cards (Fig. 1).

Bi-monthly, the punched cards are checked for accuracy by the computer, by means of the FORTRAN program BIKONT, which verifies and validates the data. After the erratic cards have been replaced, valid data are transferred to magnetic tape files by the program BISCRI. The tapes are maintained in duplicate for security purposes (Fig. 1).

Printing out. The output from the computer is yielded both routinely, at bi-monthly intervals, and on request, to meet individual demands.

A list of all the diagnostic statements recorded, with their respective SNOMed codes, is brought up-to-date bimonthly by the program VOCBIO. Such a print-out is useful in that it supplies the coding specialist with a lexicon of codes which is written in Italian and restricted to the diagnoses actually made in our department.

The alphabetic list of all the cases examined is brought up-to-date routinely by the program AGENDA (Fig. 3). It provides useful information in searching for previous examinations performed, even in different laboratories and periods, on the same patient.

I ISTITUTO DI ANATOMIA PATOLOGICA
(DIRETTORE PROF. A. ASCENZI)

SERVIZIO DI ELABORAZIONE-DATI

OPERAZIONE DI DATA RETRIEVAL SUL MATERIALE BIOPTICO RELATIVA A PATOLOGIA CUTANEA

SESSO	ETA'	ORGANO	LESIONE	NUMERO DELL'ESAME	ACCURAT. DELLA DIAGNOSI	TIPO DI ESAME	PARTIC. VALORE DIDATT.
M	48	CUTE TEMPOR	BASALIOMA	B/80/ 21	1	B	0
F	70	CUTE COLLO	BASALIOMA ULCERATO	B/80/ 44	1	B	0
M	75	CUTEGUANCIA	SOSPETTO CARCINOMA MALPIGHIANO	B/80/ 36	2	B	0
M		CUTE GLUTEO	DERMATOFIBROMA	B/80/ 24	1	B	0
M	62	SOTTOCUTANEO	PROBABILE LIPOMA	B/80/ 96	2	B	0
F	40	CUTETRONC	SIRINGOMA	B/80/ 43	1	B	0
F	20	OSSO MASC	NECROSI	B/80/ 91	1	B	0
M	8	CUTE PIEDE	NEVO BLU	B/80/ 392	1	B	1
M		CUTE	ASSENZA LESIONI	B/80/ 513	1	B	0
F		CUTE	STRAVASI EMORRAGICI	B/80/ 514	1	B	0
M	70	SOTCUTLCERV	NEOPLASIA MALIGNA PROB EPITELIALE	B/80/ 51	2	B	0
F	27	CUTECOLLO	NEVO PAPILLOMATOSO	B/80/ 177	1	B	0
M		CUTE GAMBA	EMANGIOMA CAPILLARE	B/80/ 122	1	B	0
F	56	CUTE VISO	FLOGOSI GRANULOMATOSA	B/80/ 97	1	B	0
M		MANO	CISTI EPIDERMICA	B/80/ 172	1	B	0
F	29	CUTLATCERV	GRANULOMA NODUL ESENTE CARATSPEC	B/80/ 84	1	B	0
F	25	DORSO	LIPOMA	B/80/ 183	1	B	0
M		PAD AUR	BASALIOMA	B/80/ 182	1	B	0
M	21	CUTE	DERMATOFIBROMA	B/80/ 246	1	B	0
M	76	CUTE FRONTE	BASALIOMA	B/80/ 258	1	B	0
M		CUTE	ASSENZA LESIONI	B/80/ 691	1	B	0
M	70	CUTE	MELANOMA NON GRADAZ PER ARTEFATTI	B/80/ 648	1	V	0
F		COLLO	PSEUDOCISTI	B/80/ 591	2	B	0
F		CUTE	DERMATOFIBROMA	B/80/ 679	1	B	0
M		CUTE NASO	ELASTOSI SOLARE DEL DERMA	B/80/ 466	1	B	0
F	60	CUTE	BASALIOMA SUPERFICIALE	B/80/ 299	1	B	0
F	24	DORSO PIEDE	CISTI A PARETE FIBROSA	B/80/ 594	1	B	0
M		SOTTOC COSTA	CA INDIFFERENZIATO METASTATICO	B/80/ 945	2	B	0
F	50	CUTE	ESENTE LESIONI	B/80/ 322	1	B	0
F	52	PALPEBRA INF	BASALIOMA	B/80/ 304	1	B	0
F	58	ALA NASO	BASALIOMA CISTICO	B/80/ 612	1	B	0

Fig. 4. A print-out by the program RETBIO, listing all the diagnoses relevant to skin lesions

A report including the number of cases examined in a given period, tabulated by type of specimen and preparation is easily obtainable. It is used for administrative purposes and allows a quality control on the activities of each laboratory to be made.

One of the aims of recording the subjective exactness of all the pathological diagnoses, is to make it possible to retrieve the uncertain ones. This procedure allows the performance of periodical revisions of the slides or the preparation of departmental conferences on the discussion of the most intriguing cases.

For teaching purposes two programs are used: RETBIO and VETDID. The former is employed on request and the latter at bi-monthly intervals.The program RETBIO prints a list of diagnostic records (Fig. 4). Each record includes, besides the diagnosis, other data such as patient's age and sex, pathology accession number, diagnostic accuracy, kind of specimen or preparation, and existence of a particular teaching interest. RETBIO was planned to serve as a multipurpose searching program. In fact, it makes a data-retrieval operation on the basis of any single code or group of codes. A research making use of the Topographic code alone, for instance, gives rise to the list of all the diagnoses pertinent to a particular anatomic site, irrespective of the nature of the lesion. This kind of output from the computer is particularly fit for residents who want to study microscopic pathology systematically.

VETDID brings it up-to-date the list of all the slides, ordered by anatomical site, which were marked by the pathologist for their particular teaching value. They may concern some rare form of pathology or, in turn, be very demonstrative examples of an otherwise common disease.

CLASSIFICAZIONE DELLO SNOMED NEVI E MELANOMI			CODICI SNOMED COMPRESI TRA M-87200 E M-88000			
CODICE SNOMED	ORGANO	NEOPLASIA	ACC. DIAG	NUMERO DELL'ESAME		NUM. RIFER
M-87200	CONGIUNTIVA	NEVO SOTTOEPITELIALE	1	1	B/80/ 692	669
M-87203	MUCOSA NASAL	MELANOMA	1	1	B/80/ 1459	670
M-87203	CUTE	MELANOMA NON GRADAZ PER ARTEFATTI	1	1	B/80/ 648	671
M-87206	CUTE	MELANOMA METASTATICO	1	1	B/80/ 1755	672
M-87500	CUTE	NEVO INTRADERMICO	1	1	B/80/ 1854	673
M-87500	CUTE COLLO	NEVO INTRADERMICO	1	1	B/80/ 1548	674
M-87500	CUTE ORBITA	NEVO INTRADERMICO	1	1	B/80/ 922	675
M-87500	CUTE	NEVO INTRADERMICO	1	1	B/80/ 1295	676
M-87500	CUTE	NEVO INTRADERMICO	1	1	B/80/ 1992	677
M-87500	CUTE	NEVO INTRADERMICO PAPILLOMATOSO	1	1	B/80/ 1994	678
M-87500	CUTE MAMMELL	NEVO ESSENZIALM INTRADERMICO	1	1	B/80/ 1644	679
M-87500	CUTE TORACE	NEVO INTRADERMICO	1	1	B/80/ 1636	680
M-87500	CUTE	NEVO INTRADERMICO PAPILLOMATOSA	1	1	B/80/ 2298	681
M-87500	CUOIO CAPELL	NEVO INTRADERMICO	1	1	B/80/ 1795	682
M-87500	CUTE	NEVO NEVOC INTRADERMICO PAPILLARE	1	1	B/80/ 867	683
M-87500	CUTE	NEVO INTRADERMICO	1	1	B/80/ 550	684
M-87500	DORSO	NEVO INTRADERMICO	1	1	B/80/ 2024	685
M-87600	CUTEMAMM	NEVO COMPOSTO	1	1	B/80/ 430	686
M-87600	CUTE SPALLA	NEVO COMPOSTO	1	1	B/80/ 913	687
M-87600	CUTE	NEVO NEVOC COMPOSTO PAPILLARE	1	1	B/80/ 867	688
M-87600	CUTE DORSO	NEVO COMPOSTO	1	1	B/80/ 1887	689
M-87700	CUTE	NEVO DI SPITZ	1	1	B/80/ 475	690
M-87713	CORPO CILIAR	MELANOMA EPITELIOIDE	1	1	B/80/ 494	691
M-87713	IRIDE	MELANOMA EPITELIOIDE	1	1	B/80/ 494	692
M-87716	CRISTALLINO	INFILTRATO DA MEL EPITELIOIDE	1	1	B/80/ 494	693
M-87743	CONN EPISCL	MELANOMA FUSOCELLULARE B	1	1	B/80/ 494	694
M-87743	CONGIUNTIVA	MELANOMA FUSOCELLULARE B	1	1	B/80/ 494	695
M-87800	CUTEDORSOMAN	NEVO BLU	1	2	B/80/ 1219	696
M-87800	CUTE PIEDE	NEVO BLU	1	1	B/80/ 392	697
M-87800	CUTE GUANCIA	NEVO BLU	1	1	B/80/ 2272	698

Fig. 5. Detail of the print-out by the program TUMORS, listing the nevi and melanomas recorded. The diagnoses are ordered according to their SNOMed morphological codes

In the field of research a computerized data bank has multiple uses. Generally, definite requirements demand a suitable and specific software to be constructed. The flow-chart drawn in Fig. 1 shows, on the contrary, a few applications which are feasible simply on the basis of routine procedures.

By means of the computer, for instance, the cases which demand a follow-up can be retrieved periodically. This procedure has proven to be important in diagnosis sometimes, but it also has an established value in research.

As a basis for the tumour registry, a list of all the neoplasms observed in the various laboratories is generated and bi-monthly brought up-to-date by the program TUMORS. The neoplasias are ordered according to their SNOMed Morphological codes and grouped into categories (Fig. 5). Apart from code, the diagnosis expressed in natural language, the accuracy of diagnosis, and the pathology accession number are printed for each tumour.

A definite scientific importance, finally, may be attached to the comparison between the results of various means and methods of diagnosis, such as cytology, histology and electron microscopy. In our system, the diagnoses from the different laboratories, though kept distinct, merge into a single data bank. Such a file structure offers an easy method of retrieving the cases examined in several laboratories, and allows the diagnoses from different sources to be compared.

Future development

The present system will be developed in two prospects: an improvement of the computer facilities, and a nation-wide linkage with other data banks.

As regards to the input of data, batch processing still meets our Department's demands. But as far as the output is concerned, the off-line printing, which is satisfactory enough for teaching and research purposes, does not fulfil all the diagnostic requirements. For instance, for comparing a new case with a previous paradigmatic diagnosis it is often useful to have direct access to the computer files. Therefore an on-line connection with the computer centre has been devised and many programs will be accordingly revised to construct an interactive software.

Another important aim to be attained enabling the exploitation of the potentialities of pathology data banks is the construction of a nation-wide data-base. The significance of pooling data from large networks has been repeatedly emphasized in literature (Jacob 1972; van der Esch 1972; Codling et al. 1977; Loy and Gross 1978) and derives from the necessity of collecting information from all the sources available in a certain area in order to use biopsy data for descriptive epidemiology (Macartney et al. 1980; Kayser and Schüler 1981). We are planning to construct a wide data-base in cooperation with the Italian Division of the International Academy of Pathology (Arrigoni et al. 1982).

Discussion

The present paper follows that by Brust, Doerr, Höpker and Kayser (1974) in Virchows Archiv's aim of describing information systems for pathologists. Several computer assisted information systems for histopathology and cytopathology have been reported in other journals and some of them, at present, are available on sale. Nevertheless, the purposes and the activities of different departments of Pathology often are so distinguished that many systems could hardly be suited to departments different from those they were created for. The aims for which this system was planned are relevant and proportionate to the activities of a medium-sized University Department of Pathology. It is not surprising, therefore, that such a system is different from others which were designed for private laboratories (Ashworth et al. 1979) or for large-sized Institutions (Pratt and Pacak 1969; Wong and Gaynon 1971; Hercz et al. 1975; Okubo et al. 1975). Many peculiar features of this system, indeed, arrive at a compromise between retaining the maximum of information and meeting the exigencies of low cost and easy utilization. For our goals, for instance, to keep the entire description of the specimen in the computer files is redundant whereas, on the other hand, to store the codes alone (Swettenham et al. 1982) risks a real loss of information. As a compromise, we devised to store the codes together with a concise diagnostic statement: the codes are used for retrieval purposes and the natural language statements offer additional data (like the stage of a tumour, the number of metastatic lymph nodes, and so on). However, the use of such a comprehensive nomenclature as SNOMed actually reduces the need for natural language to a minimum. The risk that the comprehensive structure of SNOMed might turn to a drawback, by making its consultation time consuming, was avoided by the creation of our own lexicon. This lexicon is

an alphabetically ordered list of all the diagnoses actually performed in our department, with their respective SNOMed codes. It is automatically generated and brought up-to-date by the computer itself, and reduces the need for searching new codes considerably.

The question whether it is better to use large computers or small dedicated ones is difficult to solve in that either possibility has pros and cons. Nevertheless, a large computer proves more suitable to meet our demands, which provide for a use of the data bank in epidemiological research. In fact, large computers allow the storage of unlimited amounts of data and make it easy to process them by means of any kind of statistics.

Finally, we found it very useful to use some keys for the storage of additional information, like the kind of preparation, the initials of the pathologist, the degree of accuracy of the diagnosis, the didactic value of a specimen, the existence of photographic documentation, the need for follow-up, the use of special stains or methods. All these keys, indeed, allow to prepare many kinds of prints which are very helpful in fields like quality control, diagnosis, education and research.

In conclusion, a computerized data bank of histopathological and cytopathological diagnoses proves very useful in helping pathologists in their manifold activities, improving their professional skill, saving precious time, contributing to their continuous education, offering them the instruments to be effective teachers, and opening new frontiers in many fields of research.

Acknowledgements. The skilled assistance of Dr. M. Sergi and Mr. L. Virgilii is gratefully acknowledged. The paper is dedicated to Mrs. E. Gilardi, who lives in our memory.

References

Arrigoni A, Barbolini G, Gallo P, Mambelli V, Massarelli G (1982) Archiviazione automatica dei dati in Anatomia patologica. III int Congr SAPOI

Ashworth CT, McConnell TH, Nielsen C, Ashworth RD, Sanford J (1979) A computerized word-processing and data system for histology in a private medical laboratory. Am J Clin Pathol 71:257–262

Brust A, Doerr W, Höpker WW, Kayser K (1974) A Standardized Autopsy-Protocol. Problems and Solutions. Virchows Arch [Pathol Anat] 364:1–14

Burkhardt H-U, Kayser K (1978) Einsatzbereiche eines Kleincomputers am Pathologischen Institut der Universität Heidelberg. Verh Dtsch Ges Pathol 62:464

Codling BW, Alexander MK, Parker RGF, Curran RC (1977) The Birmingham Histopathology Data Pool: a co-operative project among 10 laboratories. J Clin Pathol 30:1110–1118

Coles EC, Slavin G (1979) Experience of automatic coding of histopathology diagnoses. Medinfo 79:789–796

College of American Pathologists (1976) Systematized nomenclature of medicine. I ed, Skokie, Illinois

Gallo P (1977) Computerizzazione dei referti anatomo-patologici. Considerazioni generali e descrizione di un metodo. Arch "De Vecchi" 62:69–91

Gallo P, De Blasi V, Sergi M (1980) Computer assisted training in pathology using a data bank of SNOMed-coded diagnoses. XIII Int Congr Int Acad Pathol 172

Gaynon P, Wong RL (1972) A retrieval system for a library of pathology reports, slides and Kodachromes. Methods Inf Med 11:152–162

Hercz L, Laszlo CA, Reesal MR (1975) A computerized information system for pathology. Methods Inf Med 14:181–188

Höpker WW (1972) Statistische Grundregeln in der epidemiologischen Pathologie. Beitr Pathol 145:401–410
Jacob W (1972) Documentation methods and retrieval purposes in a Pathological Institute. Pathol Eur 7:187–192
Kayser K, Schüler G (1981) The uses of data obtained in institutes of pathology for epidemiologic research. IV Annu WAMI Meeting 318–322
Kayser K, Burkhardt H-U, Jacob W (1978) The regional registry of gastro-intestinal cancer North Baden (2.2 million inhabitants). Virchows Arch [Pathol Anat] 380:155–162
Loy V, Gross U (1978) Datenverarbeitung in der Pathologie. Verh Dtsch Ges Pathol 62:403
Macartney JC, Rollason TP, Codling BW (1980) Use of a histopathology data pool for epidemiological analysis. J Clin Pathol 33:351–355
O'Connor ML, Smith JC (1973) A computer-assisted information system for anatomic pathology. Am J Clin Pathol 59:357–364
Okubo RS, Russel WS, Dimsdale B, Lamson BG (1975) Natural language storage and retrieval of medical diagnostic information. Experience at the UCLA Hospital and Clinics over a 10-year period. Comput Progr Biomed 75:105–130
Pratt AW, Pacak M (1969) Identification and transformation of terminal morphemes in medical English. Methods Inf Med 8:84–90
Robboy SJ, Altshuler BS, Chen HY (1981) Retrieval in a Computer-assisted Pathology Encoding and Reporting System (CAPER). Am J Clin Pathol 75:654–661
Sutinen S, Koskinen P, Vastmäki R (1974) A method for automatic storage and retrieval of alphabetic autopsy diagnoses coded by computer. Lab Invest 30:762–766
Swettenham KV, Nickols C, Berry CL (1982) Computer programs in histopathology record keeping. J Clin Pathol 35:40–44
van der Esch EP (1972) Coding and storage of pathological diagnoses in an automated archive with a countrywide network. Pathol Eur 7:181–185
Wong RL, Gaynon P (1971) An automated parsing routine for diagnostic statements of surgical pathology reports. Methods Inf Med 10:168–175

Accepted June 20, 1983