C O M P U T E R S I N D E N T I S T R Y

COMPUTERS IN DENTISTRY

A general review of computer applications in dentistry and a report on an experimental computer-based dental records system

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CONTENTS

SUMMARY

A system was developed to test the feasibility of using computer facilities for the storage and retrieval of dental treatment records. The general aim of the project was to reveal the nature of problems which might be encountered in the design and planning for future more comprehensive record systems.

Analysis of a conventional hospital system showed that twelve record events could be distinguished: registration; admission; assignment; history; examination; radiographic examination; laboratory examination; consultation; diagnosis and treatment plan; treatment; review; discharge. Individual records could be divided into episodes delineated by admission and discharge events. Records of eleven patients were analysed in the experiment and selected information was coded on punched cards for computer entry with a program which generated a magnetic tape master file storing the data in logical sequence. A second program written for punched card input and print output enabled simulation of on-line teletype keyboard and visual display unit communication with the computer. Responses to requests for five types of information could be elicited.

The experiment showed that computer storage of dental records and retrieval of information about the treatment management of individual patients was possible. However before a computer-based system could be specified and developed for implementation in a real situation there would be need for considerable further study of the usage of dental records and the computer methods which could be employed. Advice from systems analysts and computer experts would be essential.

SIGNED STATEMENT

This report contains no material which has been accepted for the award of any other degree or diploma in any University. To the best of my knowledge and belief, the report contains no material previously published or written by another person, except when due reference is made in the text of the report.

DIANE ROSEMARY HUNT

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CHAPTER 1

INTRODUCTION

Men have always sought ways to simplify the calculations which are part of daily life. The abacus was one device used for this purpose by ancient eastern civilizations, and indeed is still widely used in Asia. In 1641 Pascal developed a machine for adding and subtracting numbers which were represented by cogs on gear wheels. The idea of a machine that could be programmed to perform sequential calculations automatically is attributed to Charles Babbage (1792-1871), but the Analytical Engine which he designed was never built due to engineering difficulties. Major contributions were made by Boole in 1844, who devised a binary form of algebra, and by Hollerith in 1891, who first developed the punched card or paper tape as a means of storing and sorting data. The first automatic calculator was designed by Howard Aiken of Harvard University and built by International Business Machines Corporation in 1937. This was an automatic decimal machine using punched cards and paper tape and operating via gears and electromechanical relays.

The first electronic automatic calculator was developed in 1945 by John W. Mauchly and J. Presper Eckert. Storing of

numbers and computing was done by means of electronic circuits. Modern electronic computers now use transistors and micro-circuits and are capable of sophisticated data processing at fantastic speeds.

The past two decades have witnessed in the more affluent nations the introduction of automation into many fields of human activity. The basic need of the business and scientific worlds for faster, more efficient ways of handling larger quantities of information of diverse nature stimulated rapid and spectacular progress in computer technology, particularly as the potential for many specialized applications of computers became recognized. For example, many banks and businesses now use computers for handling accounts, mailing lists and inventories. International travel agencies arrange bookings via a centrally based computer. Government departments use computers to produce electoral rolls. Military applications range from control of guided missile systems to teaching by the simulation of battle situations.

Much of the recent increase in many areas of scientific knowledge, particularly in the physical sciences, would not have been possible without computers. Computer technology has provided scientific workers with a tool which performs calculations at tremendously high speeds, makes logical decisions on the results of intermediate calculations and so decides on subsequent

steps, and which has the capacity for permanent storage and rapid retrieval of immense quantities of data. The computer now handles much of the tedious, time-consuming data processing and statistical analysis in research - for example, in research relating to astronomy, engineering and the physical sciences. Thus, the scientist's time becomes more productive.

Unlike other branches of science, the potential for computers in medicine and dentistry was not appreciated until recent years when it was realized that many biomedical situations were amenable to computer assistance. Apart from the general uses of computers at the managerial level of hospital administration - consisting of handling accounts, inventories and payrolls - other specialized functions have been developed such as the maintenance of medical records. Computers have been widely used in medical research to store and analyse data - for example, in epidemiological investigations into the causes of cancer. The late entry of medicine and dentistry into computer technology was due primarily to a lack of suitably qualified workers. Major contributions have been made by those who have received cross-disciplinary training - for example, in the biomedical sciences, mathematics and statistics. Such a background enables researchers to logically analyse existing systems and to derive mathematical formulae which often form the basis of computer programs. Examples of specialized computer applications in medicine include

the monitoring of electrocardiogram equipment and general anaesthetic machines and also the calculation of the optimum radiation dosage distribution in radiotherapy. Computer-assisted medical diagnosis which offers a highly objective approach to the diagnostic process is another new and very promising development in computer technology. It is anticipated that as a result of wider medical applications of computers, in future more time will become available for doctors and paramedical staff to fulfil their primary function, that of caring for the patient.

The use of computers in dentistry is relatively new. LEDLEY (1954) was probably the first dentist to record the application of a computer for high speed processing of numerical data. Initially there were few investigations into computer applications in dentistry. This could be attributed to several factors. First, such investigations were limited to the larger dental institutions who could afford their own computer or to those dental schools with access to university-owned computers. The use of scientifically-orientated programming languages developed primarily for scientific research complicated the design of computer-assisted dental projects. Second, there was a lack of suitably qualified dentists who possessed an adequate knowledge of mathematics and computer technology.

Despite these problems, the use of computers has been reported in many aspects of dentistry: for example, computer assisted clinical management; craniofacial and general body growth analyses; student progress and teaching assessments; recording of dental examinations; treatment planning; and automated radiographic interpretation. It must be emphasized that most of these investigations are still at the research stage. Many research systems are functional, but the standard of operation has not yet proved adequate to justify their implementation into general use.

REPORT OBJECTIVES

The objectives of this report were to investigate the current status of computers in dentistry and to provide answers to the following questions: What is a computer? How have computers been used in dentistry? Which applications are most likely to benefit dentistry? What future developments may be expected?

In addition it was proposed to design and execute an experimental computer-based records system for dental patients to investigate the feasibility of future comprehensive communications systems for use in dental institutions.

CHAPTER 2

COMPUTER SYSTEMS

Any calculating machine whether operated by mechanical or electronic means is by definition a computer, however the term in its common usage refers to the electronic automatic calculating machine. The electronic computer is not only capable of performing complex arithmetic operations consisting of addition, subtraction, multiplication and division at speeds measured in millionths of a second but it can also be programmed to make powerful logical decisions during calculations which determine the subsequent course of calculations. In addition vast quantities of information can be permanently stored and rapidly retrieved upon demand. Despite its speed and versatility the computer is basically a highly sophisticated extension of the simple arithmetic calculator and is not capable of independent thought or action. Before it can perform the operations described the computer must be provided with a set of instructions or program which directs the computer step by step in the specific nature and sequence of tasks to be carried out. The term "computer software" refers to programs which are developed by highly trained computer programmers.

DIGITAL AND ANALOG COMPUTERS

There are two classes of electronic computers: digital computers operate on discrete numerical data whilst analog computers use data represented by continually varying magnitudes of physical quantities such as length, pH or voltage. The range of applications for the versatile electronic digital computer (EDC) is much wider than for analog computers which are usually "dedicated" or developed for specialized functions; for example, analog computers can be ideally applied to biological situations such as the monitoring of electrocardiogram machines where the input consists of varying potential differences.

BASIC COMPUTER COMPONENTS

A typical EDC is composed of peripheral processing units and a central processor which are collectively known as "computer hardware". Peripheral processing units consist of input and output devices; a compiler which translates programs into machine language; locations for the temporary storage of input data waiting to enter the central processor and output data waiting to be printed or displayed. The temporary storage locations are magnetic tapes or revolving magnetic drums or disks. The central processor is the actual computing and decision-making area of the computer since it contains the arithmetic unit and the central

memory unit where programs and data are stored during calculations (see Figure 1). The latest EDC is capable of central processing speeds of up to thirty million instructions per second and the current trend is towards the development of smaller and still faster computers.

COMMUNICATION

The components of electronic circuitry can exist in two possible physical states: for example, a switch can be open or closed; a transistor can be conducting or not conducting; a magnetic material can be magnetized or unmagnetized. Consequently the internal machine language used in electronic digital computers during computations is based upon a binary system for the representation of numeric and non-numeric data. The development of programming languages such as FORTRAN (FORmula TRANslation), ALGOL (ALGOrithmic Language), COBOL (COmmon Business Orientated Language) and compilers for the automatic translation of data to and from internal machine language have greatly simplified the problems of communication.

INPUT AND OUTPUT

Data may be input to a computer by means of punched cards, punched paper tape, documents with magnetic ink lettering, mark

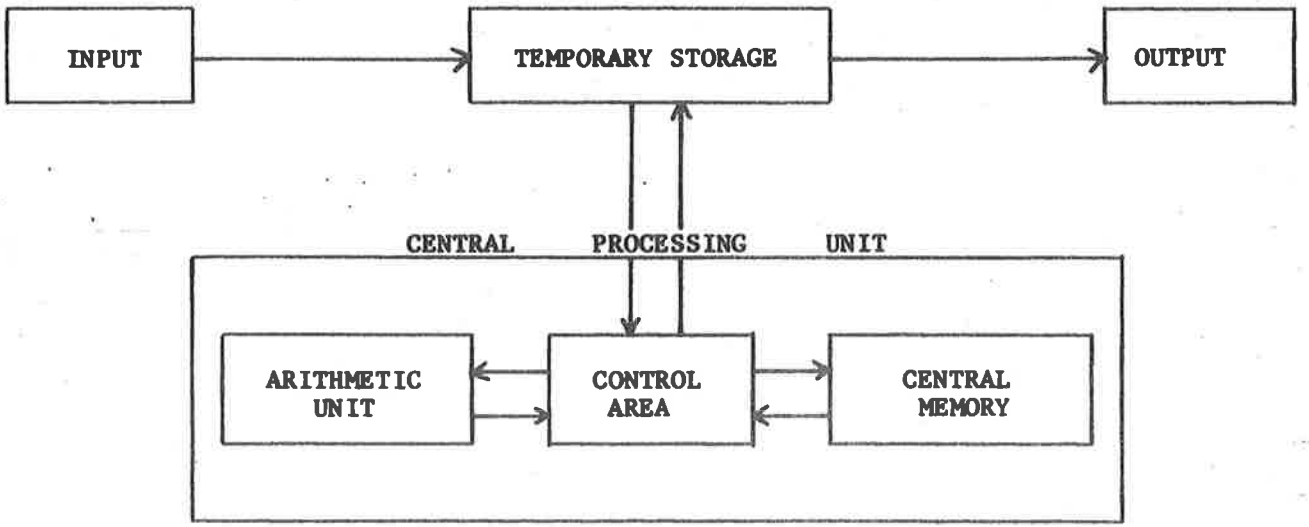
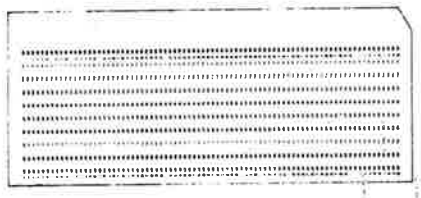


Figure 1. Basic components and data flow in a typical digital computer

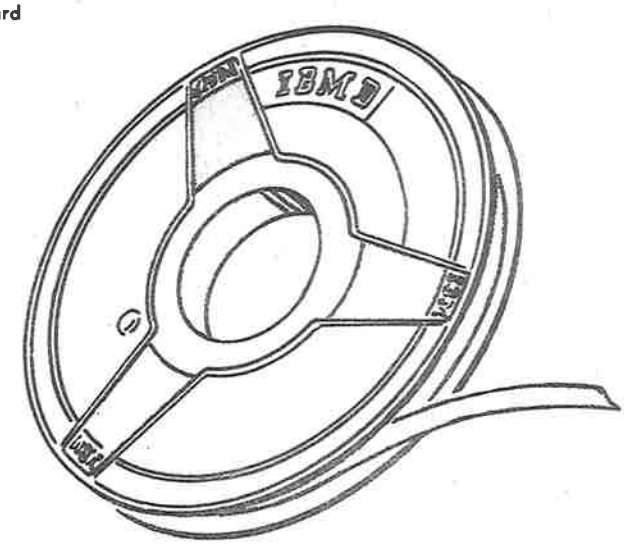
sense forms, magnetic tapes, teletype keyboard or "light pen" tracings on a cathode ray screen (see Figure 2). Punched cards and magnetic tapes are most commonly used indirect input devices. Data are recorded on punched cards using the Hollerith code which represents alphanumeric and other characters by specific combinations of holes punched in the 80 columns and 12 rows marked on standard computer cards. The input consists of a deck of cards which is read sequentially by the computer. Magnetic tapes are generated initially by computer and they provide a much cheaper means of storing data outside the computer than storage in the central memory which is very expensive and limited in capacity.

Computer output may be presented in several forms: for example, as a recording on magnetic tape, punched cards, printed output, plotted graphs or on a visual display unit (VDU). Printed output is produced by high-speed line printers capable of printing 500 lines or more per minute.

It is possible to communicate directly or indirectly with a computer. Direct "on-line" communication occurs via a remote terminal which permits "real-time" two-way interaction between user and computer (see Figure 3). The input device may be a teletype keyboard or a light pen which is traced over a cathode ray screen or VDU. Computer response is almost immediate and the output can be visually displayed on a screen or presented in any

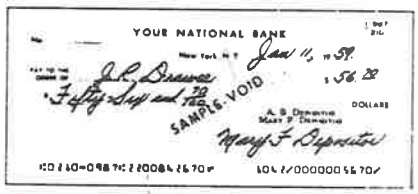


IBM Card



Magnetic Tape

Paper Tape



Magnetic Ink Characters

Figure 2. Input media
(from KRASNOFF, S.O., Computers in Medicine
Illinois, Charles C. Thomas Publisher, 1967)

Figure 3. Remote computer terminal showing teletype keyboard and VDU

of the forms previously described. This type of communication is most useful but very expensive since it occupies large portions of central memory space. Advances in computer technology are continually reducing costs and remote computer terminals will become more readily available in future.

Indirect "off-line" methods of communication are used more frequently at present due to lower costs. Prepared data such as punched cards are input to a computer which reads and then holds the data in temporary storage areas. A queue is formed of programs or "jobs" awaiting execution by computer and the time lapse before any job enters the central processor is influenced by the priority and the estimated processing time required. This delay between input and output makes indirect communication unsuitable for certain computer applications which require immediate contact with the computer.

TIME-SHARING

Time-sharing technics whereby a computer may process several programs simultaneously have been applied both to on-line and off-line situations. The central processor can handle data much faster than the input and output devices and time-sharing was developed to ensure that the central processor was used with maximum efficiency and not permitted to stand inactive.

SYSTEMS ANALYSIS

Systems analysis is an essential part of the preliminary investigations which precede the automation of any system. Computer programming technics require that a system by analysed into a logical sequence of specific events. The requirements for computer hardware, software and personnel are ascertained during the preliminary investigations: for example, the most suitable type of computer and input-output devices; the nature of programs needed to produce the desired results; the number of programmers, systems analysts, key-punch machine operators and the ancillary staff required for efficient operation of the system.

FACTS CONCERNING COMPUTER SYSTEMS

General conclusions which are based on experience in the planning and operation of computer-based systems are summarized as follows:

1. Computers will not resolve all problems and applications must be realistically developed for situations where systems analysis has shown that positive improvements will result.
2. Computers are not infallible and both accurate and inaccurate data will flow through the computer with equal ease ("garbage in - garbage out").

3. Computer-based systems are expensive to operate and should not be introduced until thorough investigation has established that sufficient benefits will be derived to justify the high cost.

4. Computer-based systems do not result in financial savings but can minimize future cost increases and provide intangible benefits such as improved efficiency and accuracy of reports.

REVIEW OF LITERATURE

The role of computers as a tool of modern scientific research, including dental research, is so well established now that reference to the use of computer facilities in research reports is frequently omitted. Consequently this review is not exhaustive but it does indicate the increasing research activity concerning dental applications of computers which may be grouped under the general headings of research, administration, dental records systems, dental education and clinical applications.

As far as can be ascertained the earliest application of computers in dentistry was by LEDLEY (1954). To assist his research on the functional force analysis of dental prostheses LEDLEY used a computer to prepare tables showing how the direction of masticatory forces varied with the slope of the occlusal plane of the mandibular denture and with the angle of upward swing of the mandible during chewing cycles. LEDLEY (1965) later suggested that the computer's ability to rapidly process data could be similarly applied in the analysis of functional forces associated with fixed and removable partial dentures, so leading to the selection of a design compatible with abutment support and the

mechanical strength of the design and materials used in its construction.

CARLOS (1964) reviewed the status of computers in dental research and education and drew attention to several possible reasons why only a limited number of dental schools were using computers. Amongst the reasons he suggested were inadequate guarantees that potential benefits would justify automation and the high cost, in terms of money and time, of electronic data processing compared with clerical and mechanical methods. He reported a survey conducted in Spring 1963 which showed that twenty-five out of fifty-seven dental schools in the United States were using computers to assist in dental research and education. Table 1 reproduces a summary of the survey. CARLOS concluded that the development of new and useful computer applications depended upon the "needs, imagination and ingenuity" of dental educators and researchers.

MOORE (1969) reported on the increasing use of computers in North American hospitals and dental schools. A majority of dental schools preferred to hire computer time since only the larger institutions could justify the installation of their own computer facilities. The most common application of computers was in the processing of research data. Other uses consisted of automated record systems; examination and allocation of patients;

Table 1. Reported use of computers in dental schools in the United States, Spring, 1963* (CARLOS, 1964)

	Number	Per Cent
Dental Schools Using Computers	25	59.5
	Number	Per cent of User Schools
Type of Use**		
Business administration	10	40.0
Clinical administration	5	20.0
Preclinical research	16	64.0
Clinical research	19	76.0
Evaluation of applicants	3	12.0
Evaluation of student achievement	10	40.0
Source of Computer Services**		
Own computer	3	12.0
University computer center	20	80.0
Purchase time on non-academic computer	8	32.0
Source of Programming Services**		
Professional programmers employed	10	40.0
Faculty members	10	40.0
Outside consultant programmers	15	60.0

* Based on responses from 42 of 57 (73.7 per cent) of schools questioned

** Several schools responded affirmatively to more than 1 item

assessing student progress; marking multiple choice examinations and the Medical Literature Analysis and Retrieval System (MEDLARS) which provided bibliographies on dental subjects upon request.

RESEARCH

The computer's capacity to store and retrieve data and rapidly perform complex calculations and logical operations has provided a powerful tool for use in dental research.

Computers have been used extensively in the research of general body growth and craniofacial growth and morphology (BJÖRK and SOLOW, 1962; GARN, 1962; TANNER and O'KEEFE, 1962; SAVARA, 1965; BJÖRK and SOLOW, 1966; SOLOW, 1966; GARN and HELMRICH, 1967; SAVARA and TRACY, 1967; SNEATH, 1967; WALKER, 1967a, 1967b; BARRETT and BROWN, 1968; McNULTY, BARRETT and BROWN, 1968; BROWN and BARRETT, 1969; SOLOW, 1969; WALKER, 1969; BROWN, BARRETT and CLARKE, 1970; SOLOW, 1970; BERKOWITZ, 1971; CLEALL and CHEBIB, 1971; HUDDART, CLARKE and THACKER, 1971; RIOLO, 1972). SAVARA (1972) and WALKER (1972) both reported the use of electronic data-processing techniques to develop complete three-dimensional mathematical models of the head, face and jaws, which were derived from specific recording points on antero-posterior and lateral cephalograms for individual patients. Printouts graphically illustrating predicted growth patterns and

showing the direction and magnitude of growth vectors for each anatomical landmark could be simulated by computer. SAVARA stated that stored discriminant data could be used to distinguish between normal and abnormal development patterns. It was proposed that this approach would provide orthodontists with a valuable diagnostic aid and guide for treatment planning.

BARRETT, BROWN and SIMMONS (1966) described numerous ways in which the computer could assist dental research as exemplified in a longitudinal growth study of Australian Aborigines. Records of literature references and research data could be categorized and stored. Whilst punched card sorters and tabulators performed similar functions, automatic data processing methods were much faster, more versatile and were capable of rapid, accurate statistical and numerical analysis of data. It was also suggested that research methodology would benefit from the exacting approach demanded by computer technics. The need for consultation with experts in data preparation and statistics was emphasized.

LU (1966) used a computer to predict the probable course of caries in individual teeth based on the Markov Analysis involving conditional probabilities. He pointed out the value of being able to estimate probable future dental needs for dental insurance companies and public health departments. Such information would

enable the dental practitioner to advise his patients objectively of susceptible tooth surfaces.

YALE (1968) discussed the application of computer programming principles to radiographic interpretation and he described a theoretical design model.

ANDO, NISHIOKA, OZAWA, YAMANO and SHINODA (1968) were amongst the first to develop a computerized system for the rudimentary analysis of radiographic images. Their aim was to standardize diagnostic criteria and so permit an objective approach to diagnosis of radiographs. The varying densities of an exposed bite-wing film were converted from analog to digital values and a visual image of the radiograph in spot characters representing certain density ranges was printed out by computer. This work was followed by a computer-based study of density changes in alveolar bone during healing (ANDO, NISHIOKA, SHINODA, YAMANO, and OZAWA, 1969).

THOMPSON and LEWIS (1969) considered how the scope of dental research has been expanded by the application of computer technology. However the salient point was made that for handling simple calculations the desk calculator remains indispensable.

DAVIDIAN (1971) reported the use of a computer model to study the force distribution on the root of a maxillary central incisor.

Any combination of forces and torques applied at varying locations on crown or root could be simulated. The root surface was serially divided into small segments and the resistance of each segment to applied torque was computed.

SOLOW (1971) described a system which had been used for the past six years at the Institute of Orthodontics in Copenhagen for the epidemiological registration and computerized tabulation of malocclusion prevalence. Composite types of malocclusion were defined in terms of their component individual traits by means of Boolean Algebra. Information concerning the prevalence of malocclusion was said to be useful for planning for and evaluating the effectiveness of existing dental services.

JACOBS, THOMPSON and BROWN (1971) used a computer to analyse thermal stress patterns in teeth. The predicted stress patterns were shown to correlate with crack patterns found experimentally in teeth subject to cycles of changing temperature extremes.

BIGGERSTAFF and WELLS (1972) reported a computerized analysis of the relationship of defined occlusal anatomical landmarks on the occlusal surfaces of maxillary and mandibular post-canine teeth. A two-dimensional mathematical model was derived from X and Y coordinate data from photographed dental casts and used to calculate the statistical range of variation for a particular

"type" of occlusion. A more complex three-dimensional model was a proposed future development.

DENTAL ADMINISTRATION

RUHLMAN and LOWE (1968) reported a computer-based system to reduce the amount of clerical work in dental clinics and to provide an accurate and efficient means of monitoring the progress of students and patients. In addition the system was designed to assign patients to students and retrieve patient case history data for research.

OLDE and LUEBKE (1968) discussed the application of computer technics in a dental clinic teaching program for reviewing student clinical activities, patient treatment progress and generating accounts. It was pointed out that as the emphasis in teaching clinics changed from quota fulfilment by students to total patient care, the need would arise for rapid, more efficient means of processing information.

SMITH (1969) described a computer-based method for assigning patients to students in a dental clinic. A system for quantitatively evaluating any particular assignment was developed and a computer was used to select the optimum assignment of patients to students which satisfied the needs of student and patient, the student-patient compatibility and the patient priority.

MECKLENBURG (1970) reported a computer-assisted dental administration system used by the Indian Health Service since 1965 to help overcome the inefficiency and errors of the previous record system. Regular incoming reports maintained up-to-date files on all patients and dentists. The system provided varying types of group information which guided the administration in making the most practical use of resources and could be used to justify additional resources.

BARRETT (1970) reported in outline a computer-based system developed for use in the Dental Department of the Royal Adelaide Hospital for the management of patients assigned for treatment in university clinics. Students received suitable patients from a waiting list of all patients which specified their basic treatment requirements. Card files of patients for whom each student was responsible were periodically submitted to a computer. A complete list of patients was printed out and reviewed for current responsibility for each patient and their treatment progress.

MAYER (1971) described the use of an off-line computerized billing service and management analysis in a private dental office. Information concerning treatment and accounts was entered on "standard control slips" and sent to a computer centre which provided itemized day-sheets and practice analysis reports and which mailed monthly accounts to patients. Savings in time and improved management control were benefits claimed.

SOKOLOW and RUHLMAN (1971) discussed factors involved in the implementation of a dental clinic computer system based on three years' experience with the computer-based dental records system of the University of California, Los Angeles, which was first reported by RUHLMAN and LOWE (1968). Attention was drawn to the misconception that computerized systems require less personnel when in fact the reverse is true. In addition it was recommended that the number and complexity of data collection forms be minimized and that data processing be limited to information which would yield immediate positive benefits.

DENTAL RECORDS SYSTEMS

FISCHMAN, NEIDERS and GREENE (1965) recognized the expediency of preparing for automation of oral pathology records. Accordingly they suggested an improved system for indexing the results of pathological examinations. Oral diseases were classified into groups and subgroups and each was assigned a numerical code suitable for input and storage within a computer. In conclusion these workers stressed the need for standardization of nomenclature and classification of oral diseases.

MACGREGOR and HALABISKY (1967) were amongst the first to report the use of a computer for storage and retrieval of dental patient file information. A numeric code suitable for input to

a computer was devised for each item of patient information consisting of history, diagnosis, treatment required and received. The coded summary was punched on computer cards and input to a computer. The master file containing data on all patients was stored on magnetic tape and was regularly updated by merging with a new file of current records. Ready access to individual patient records or cross-referenced information for research purposes was possible by specifying the desired code combinations.

JAMES, GOOSE and MOORE (1968) attributed the limited use of computers in dentistry to problems of cost and access to computer facilities. Automatic processing of student achievement records and of research data were cited as practical applications being developed. A study was described, being undertaken at the Liverpool Dental Hospital, to determine the feasibility of maintaining a computer-based dental records system. Attention was drawn to the value of such a system in improving communication within the dental profession and in amassing data for statistical research into disease.

BOGNORE, MAYHEW and HOERMAN (1971) described a prototype model for an automated dental health screening program. A patient was seated at a teletype keyboard where he responded to questions shown on a computer display unit. Succeeding questions were determined by the response to previous questions. The

system was well received by dentists and patients and provided concise comprehensive summaries of patients' personal information and history.

DENTAL EDUCATION

GLASS, ALMAN and FLEISCH (1965) reported a computer-based method for recording and grading students' clinical achievements. A number of operative procedures in conservative and prosthetic dentistry, pedodontics and periodontics were numerically coded and printed on standard punch cards. Student, patient and tutor names and identification numbers together with the dental operation performed and grading received were recorded on these cards. This information was punched on cards and machine-tabulated to produce summaries of student clinical performance. Only the average gradings for students were generated by computer.

EHRLICH, JONES and BRITTON (1969) reported a similar computerized student evaluation system which maintained accurate current information on clinical work done by students. A general increase in the efficiency of handling records was observed. Rapid feed-back of grades kept students informed of their own progress and permitted the ready identification of students who were experiencing academic difficulties in time for special assistance to be given.

KILLIP (1968) suggested that conventional methods of teaching dental students be augmented with computer-assisted instruction. The latter would permit high speed interaction between student and subject matter with provision for adaptation to the different learning rates between students.

GASTON (1971) described the use of on-line computer assisted instruction (CAI) in the diagnosis of oral cancer at the State College of Dentistry, The Ohio State University. A simulation sequence for six typical patients was established to permit student interaction with the computer program to develop a freely structured case history, physical examination and laboratory data. On-line communication occurred via teletype keyboard, cathode ray screen and a 35 mm projector. Students found CAI a valuable adjunct to general course work. However GASTON drew attention to the high costs of developing programmed courses.

SOKOLOW and SOLBERG (1971) described a pilot study for computer-assisted instruction in the diagnosis of temporomandibular joint disorders. Computer-student interaction occurred via a display screen upon which appeared simulated case histories, requests for diagnosis and corrective instruction. The student typed his response on a keyboard, thus setting up an information feed-back to the computer.

DILSWORTH and PELTON (1972) reported a computer simulation study of a dental practice. Models were developed to describe relationships between various procedures occurring in the practice in terms which could be analysed by a computer. The computer produced statistics for assessing the performance of each dental team working under pre-determined conditions. Simulation proved to be a valuable tool for analysing the efficiency and economic implications of various dental care delivery systems with respect to personnel and scheduling methods employed.

KOEHLER (1972) discussed modern methods available for literature search and information retrieval which enable the dental clinican or researcher to stay abreast of current developments. For example, the MEDLARS computer system and other computer-generated systems for selective dissemination of information (SDI) to clinicians have been introduced in some North American States. Basically SDI is accomplished by submitting a list of key terms describing the user's interest which is then compared with computer files containing title or key-word-in-context descriptions of current articles. A printout of bibliographic citations of articles that match the user's interest is sent out.

CLINICAL APPLICATIONS

GLASS, ALMAN, FLEISCH, KAPUR and EPSTEIN (1969) described one of the first automated dental records systems in which a computer participated in planning dental treatment for patients based upon the oral examination. It was found that certain examination findings correlated with recognized preventive and periodontal treatments - for example, routine prophylaxis and topical fluoride application for patients under sixteen years. The priority treatment status of carious teeth was automatically computed and listed from numerical values allocated by the examiner for different stages of caries.

RICKETTS (1969) discussed the potential of the computer as an aid to orthodontic diagnosis - for example, in the analysis of lateral head radiographs - by providing the clinician with computer-generated tables showing normal ranges for various dento-facial measurements. A computer-based information bank was suggested with clinicians contributing their own clinical knowledge and experience and conversely having access to that of others.

KRAMER (1969) and KRAMER, LUCAS, EL-LABBAN and LISTER (1970a and 1970b) used computers in their efforts to develop more accurate means of differentiating between various white lesions of oral mucosa. In particular the research was directed towards

easier identification of those lesions which were likely to undergo malignant change.

CLARKE (1971) and KRAMER (1971) discussed the use of computers in understanding the diagnostic process. CLARKE stated that computers can be applied "to test theories of how people learn to perform complex intellectual tasks by formulating these theories as computer programmes and comparing the results with those achieved by people". KRAMER described a study involving the diagnosis of two very similar lesions; lichen planus and leukoplakia. A computer was given detailed information concerning both lesions and programmed to perform discriminant analysis of input data. Clinical diagnoses were checked against the computer's quantitative diagnostic assessments. In this manner it was suggested that computers can indicate human errors or even new disease entities or diagnostic categories at present unknown.

BIGGERSTAFF (1970) presented a research report relating to the development of a computer system to assist in the analysis and planning of corrective orthodontic treatment. Two-dimensional outlines of the occlusal surfaces of the upper and lower dentition were superimposed and displayed on an oscilloscope screen. Communication with the computer via a light pen or a teletype

keyboard resulted in visual simulated realignment of individual malposed teeth to more esthetic positions.

HAYWARD (1971) discussed the impact of the new science of cybernetics upon the future of dentistry. He cited examples of cybernated dental procedures developed by the United States Army, including diagnostic analysis of radiographs, computer-directed construction of inlays, orthodontic appliances and denture prostheses.

CHAPTER 4

AN EXPERIMENTAL DENTAL RECORDS SYSTEM *

CONVENTIONAL RECORDS SYSTEMS

Conventional dental records are handwritten documents providing a complete record in one file for each patient. Patients' record files are stored in a records library in numerical or alphabetical sequence on shelves or in filing cabinets. Retrieval of information and the addition of new information about a patient require a search for the file which is sent to a clinic or office where the file is read and a new entry is made. The file is then returned to the records library. Institutions dealing with many patients are faced each day with a large number of transactions and file movements of this nature. For example, the Dental Department of the Royal Adelaide Hospital which is not a large institution currently maintains record files for 85,000 patients and the number increases by about 8,000 each year. On average about 200 record files are used each day.

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Conventional records systems have several disadvantages. Considerable space is required - for example, the approximate floor area occupied by the dental records library and activities associated with the records department at the Royal Adelaide Hospital is 1,850 square feet. Occasional loss or misplacement of records are problems inherent to the manual filing system. Information stored in record files is often illegible, disordered and lacking in logical structure. Information retrieval which involves scanning through dental records may be a prolonged and arduous task, particularly when the records are bulky as in the case of patients who have extensive dental histories. Similarly, retrieval of statistics in planning improved patient management or for research studies is often difficult.

STUDY OBJECTIVES

An experimental computer-based system was developed as a first step in testing the feasibility of storing dental records for a number of patients on computer files with provision for updating the files and searching them for retrieval of information. The author was involved in the specification of program requirements but the actual programs were written with considerable assistance from an experienced programmer.

The general aim of the project was to reveal the nature of problems which might be encountered in the design and planning for future more comprehensive records systems.

METHODS AND RESULTS

ANALYSIS OF A CONVENTIONAL DENTAL RECORDS SYSTEM

The first stage in the experiment involved a critical analysis of a conventional dental records system into a logical sequence of events and episodes.

Events

A study of the records system currently used in the Dental Department of the Royal Adelaide Hospital showed that at least twelve events were distinguishable during patient management. These were: registration; admission; assignment; history; examination; radiographic examination; laboratory examination; consultation; diagnosis and treatment plan; treatment; review; discharge.

Registration: an office recording of personal information about a prospective patient - consisting of name, address, date of birth and title. A unique registration or hospital number was allocated to identify the patient's records.

Admission: an office recording of a patient's admission for treatment. Admission usually depended on the nature of treatment sought or required and on the assessment of the prospective patient's eligibility to receive treatment.

Assignment: a recording of the placement of a patient's name on a list which was either the list of the dentist who assumed responsibility for the patient or a waiting list for subsequent transfer to a dentist's list.

History: a recording of chief complaint, history of complaint, dental and medical history.

Examination: a recording of the general, oral and dental examinations.

Radiographic examination: a recording of the type of examination and the report on the examination.

Laboratory examination: a recording of the type of examination - pathology or culture, for example - and the report of the examination.

Consultation: a recording of the outcome of a consultation with another department or dentist who may be asked to treat the patient.

Diagnosis and treatment plan: a recording of diagnosis, treatment plan and prognosis.

Treatment: a recording of treatments carried out during each visit.

Review: a recording of periodic review of a patient's treatment progress and current treatment status.

Discharge: a recording of a patient's discharge stating the reason for discharge, a summary of treatment received and the status of the patient on discharge.

Episodes

A study of the dental histories for several patients showed that the continuing dental care of a patient invariably consisted of episodes of active treatment delineated by admission and discharge events. The episodes were separated by periods during which no treatment was required or sought by the patient. When an episode was incomplete by the time of graduation of a dental student treating a patient, the patient was reassigned to a waiting list or to a new student or graduate dentist. In the experiment it was considered useful to demarcate the transfer of a patient to another dentist's care by taking the date of transfer to indicate the beginning of a new episode.

DESIGN OF AN EXPERIMENTAL COMPUTER-BASED RECORDS SYSTEM

Experimental design will be discussed under two main headings: first, storage of patient information on a computer file; second, retrieval of specified information from the file.

Storage

The input for electronic data processing consists of coded data and a program instructing the computer how to operate on the data to obtain the desired result.

In the experiment the dental records of eleven patients were analysed and selected information was recorded on data sheets and transcribed on to punched cards. The card deck was then submitted to a computer together with PROGRAM CN1 also coded on punched cards (see Appendix B). This program effected transfer of the data to a magnetic tape thus creating a master file storing the data within the computer.

The methods and criteria for recording examinations, diagnosis, treatment plan, prognosis and the type of statistics required by the various specialist departments were expected to differ. Consequently the records for three hypothetical orthodontic patients were included in the experiment to determine the efficacy of computer storage and retrieval of this specialized type of dental record.

Information

Information collected from the casenotes consisted of two types: patient and dentist data; and event data.

Patient and dentist data

Identification of the patient required a record of hospital registration number, surname, initials, title, birth date and address. Identification of the dentist in charge of the patient's treatment management required a record of surname, initials, title and hospital status.

Event data

The date and relevant details relating to any of the twelve previously described events were recorded for each patient.

Records

The transfer of information to punched cards was simplified by the minimal use of coding.

Communication

Two types of input card were used: type one, a name card for recording the name and other information about the patient or dentist; type 2, a text card for recording additional data or descriptive information about the various events (see Figure 4).

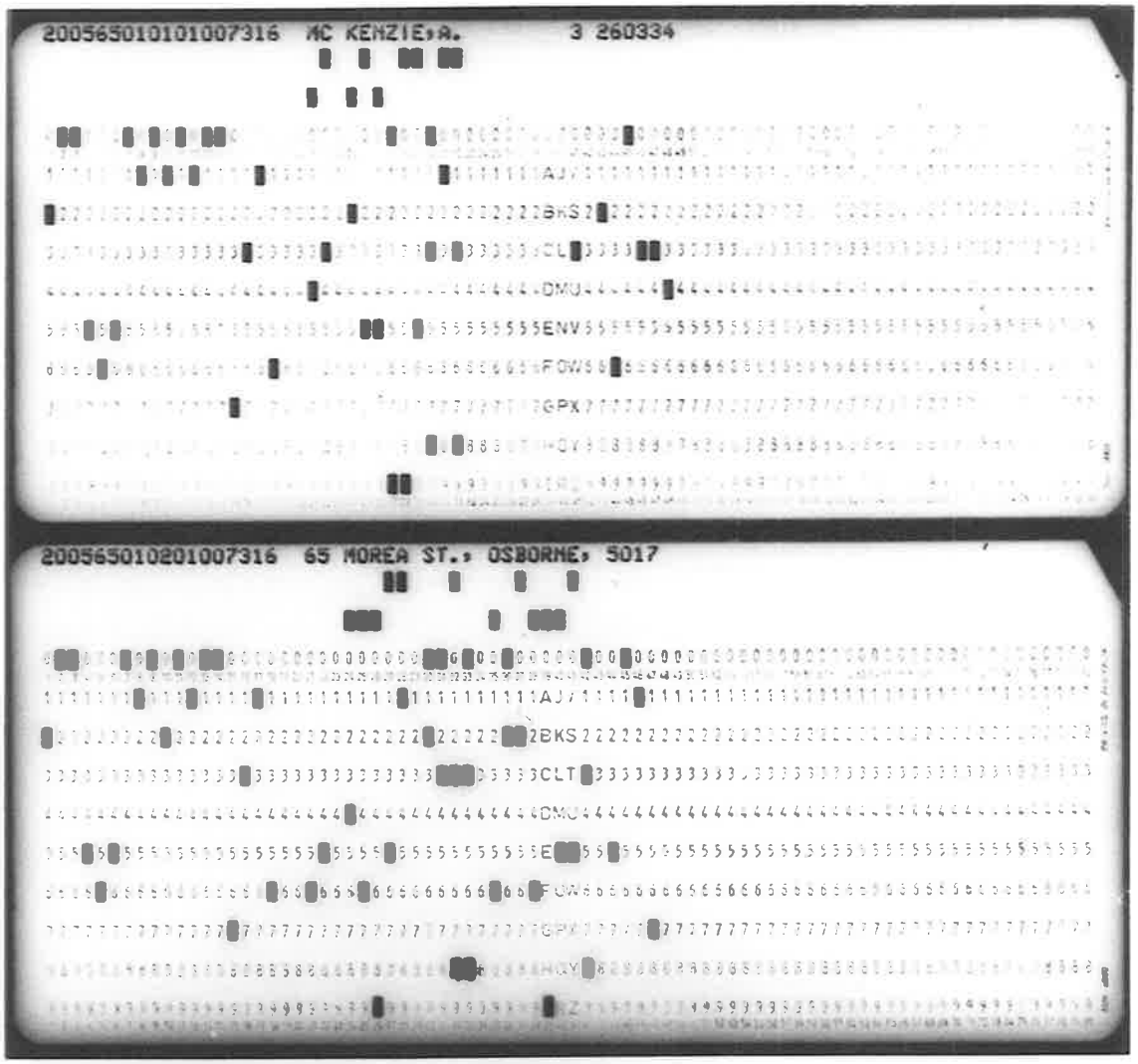

Figure 4. Examples of a name card (upper) and a text card (lower) punched for input

Both card types had the same format so far as PROGRAM CN1 which generated the record library file was concerned.

Input card format

The 80 columns on punched cards were divided into fields which contained specific defined variables.

Record day, month and year of an event were recorded in columns 1 to 6 which contained fields 1, 2 and 3, each consisting of two characters.

A two digit code specified events in field 4, columns 7 and 8.

01	registration
02	admission
03	assignment
04	history
05	examination
06	radiographic examination
07	laboratory examination
08	consultation
09	diagnosis and treatment plan
10	treatment
11	review
12	discharge

Cards type one and two were designated respectively by 01 or 02 entered in field 5, columns 9, 10.

In the case of card type two when more than one card was needed, the sequence was indicated by a number punched in field 6, columns 11, 12.

The cards forming a set for one event for one patient were linked by the patient's hospital registration number punched in field 7, columns 13 through 18.

Four variables each defined by a unique range of numerical values could be specified in field 8, columns 19, 20. Numbers between 11 and 85 punched in this field designated specific teeth by means of the two-digit tooth code recommended by the International Dental Federation (F.D.I.) (see Table 2). Information of special note was indicated by punching 99 in columns 19, 20. One of five possible orthodontic treatment stages was recorded by punching the appropriate number from 90 to 94. Finally, 01 to 09 punched in field 8 indicated the group number for the malocclusion classification system which was used in the records of the three orthodontic patients in the experiment (see page 63).

Fields 9 to 14, columns 21 to 80 contained alphanumeric data for purposes differing according to card type (see page 44).

Input card entries

One name card and one or more text cards were required to record information about an event. Each card in a set of cards relating to one event included the day, month and year of the event, the patient's hospital registration number, the event code,

Table 2. The F.D.I. two-digit tooth code for permanent and primary teeth*

Permanent Tooth	Quadrant			
	Upper Right	Upper Left	Lower Left	Lower Right
Third molar	18	28	38	48
Second molar	17	27	37	47
First molar	16	26	36	46
Second premolar	15	25	35	45
First premolar	14	24	34	44
Canine	13	23	33	43
Lateral incisor	12	22	32	42
Central incisor	11	21	31	41

Primary Tooth	Quadrant			
	Upper Right	Upper Left	Lower Left	Lower Right
Second molar	55	65	75	85
First molar	54	64	74	84
Canine	53	63	73	83
Lateral incisor	52	62	72	82
Central incisor	51	61	71	81

* Field 8 entries - see text

the card type and the card sequence when more than one card of type two was used.

Values coded in the first seven fields uniquely described each record card. Entries in the other fields varied between name cards and event cards and between events.

Field 8 was not used in name cards and fields 9 to 14 were re-defined.

A patient's surname and initials were recorded in field 9, columns 21 to 40 for the registration event only. For all other events field 9 contained the surname and initials of the dentist in charge. The appropriate title was specified in field 10, column 41 by a single digit code:

1	Mr
2	Miss
3	Mrs
4	Dr
5	Professor

The status of the dentist was coded and punched in field 11, column 42:

1	3rd year student
2	4th year student
3	5th year student
4	postgraduate student
5	hospital honorary
6	hospital staff

The patient's birth day, month and year were recorded on the name card in fields 12, 13, 14 in columns 43 to 48 only for the registration event.

In the text cards the tooth designation was entered in field 8, columns 19, 20 to enable retrieval of records for any event relating to specific teeth. Use of the code 99 in the same field marked the entry as a "note well" record - a history of rheumatic fever or drug idiosyncrasy, for example - which was brought to attention on all printed outputs from the file for a particular patient. Entries preceded by the malocclusion classification code 01 to 09 in field 8 were retrieved by computer and included in printouts in response to enquiries concerning orthodontic treatment progress.

Fields 9 to 14 of text cards were used to enter alphanumeric data representing all relevant information relating to any of the twelve events previously described. Sixty characters were available on each card and up to nine cards could be used to record each event.

Casenotes library magnetic tape file

PROGRAM CN1 was used to start the system. Input consisted of a card file of dental records prepared as previously described. The cards were arranged in ascending order of record day, record

month, record year, event, card type and card sequence for each patient. In addition the card files for individual patients were placed in strict ascending numerical order of hospital registration numbers.

The program generated three index numbers for each record:

(1) the sequence number of the record in the card file;

(2) a number compounded of hospital number, record year, record month and record day;

and (3) a number compounded from event, card type and card sequence.

The first index number located each record on the magnetic tape file and the second and third index numbers in combination uniquely designated each record irrespective of its place on the file. It was anticipated that the future use of a sort and merge routine would enable arrangement of the record card images in ascending order of the latter two index numbers thereby eliminating the need for arranging card files in strict numerical sequence.

The program prepared an index of the card images in three arrays (see Table 3). Corresponding elements of the arrays recorded the patient's hospital number (Array 1), the sequence number of the first record (Array 2) and the number of records on file for the patient (Array 3). For example for the patient with

Table 3. Index of card images in three arrays

	Hospital Number	Sequence Number	Number of Records
	Array 1	Array 2	Array 3
Values in array elements	1325	1	11
	1620	12	16
	7316	28	372
	10203	400	114
	11535	514	19
	12345	533	160
	13212	693	16
	20304	709	104
	22473	813	27
	23325	840	30
	25399	870	30

hospital number 7316, the sequence number of the first record is 28 and the total number of records on file is 372. The three index arrays were written on the casenotes magnetic tape file as one logical record. This record was followed by one logical record for each card image and its three index numbers.

Appendix C shows a printout of a section of the magnetic tape file representing the data written for one patient. Each line of the printout consists of the three index numbers and the card image constituting one logical record.

Retrieval

For retrieval of information specific enquiries were coded on punched cards and submitted to the computer together with the master file and PROGRAM CN2 (see Appendix B). This second program searched the master file and presented answers as printed output.

In the experiment information retrieval was limited to five typical enquiries.

Records on file: are the records for a particular patient on file?

Event information: what information is available on any combination of the twelve events previously described since a specified date?

Number of visits: how many visits has the patient made since a specified data?

Tooth information: what information is available for a particular tooth?

Orthodontic treatment progress: what is the current orthodontic treatment status of the patient?

It was realized of course that a more comprehensive system would have to accommodate requests for many other types of information.

Enquiry card format

The response to each request was evoked by a single punched card (see Figure 5). The 80 columns were divided into 18 fields containing specifically defined variables.

Hospital number was punched in field 1, columns 1 to 6.

The type of information sought was specified by a response code punched in field 2, columns 7, 8.

Response Code	Enquiry
01	Records on file
02	Event information
03	Number of visits
04	Tooth information
05	Orthodontic treatment progress

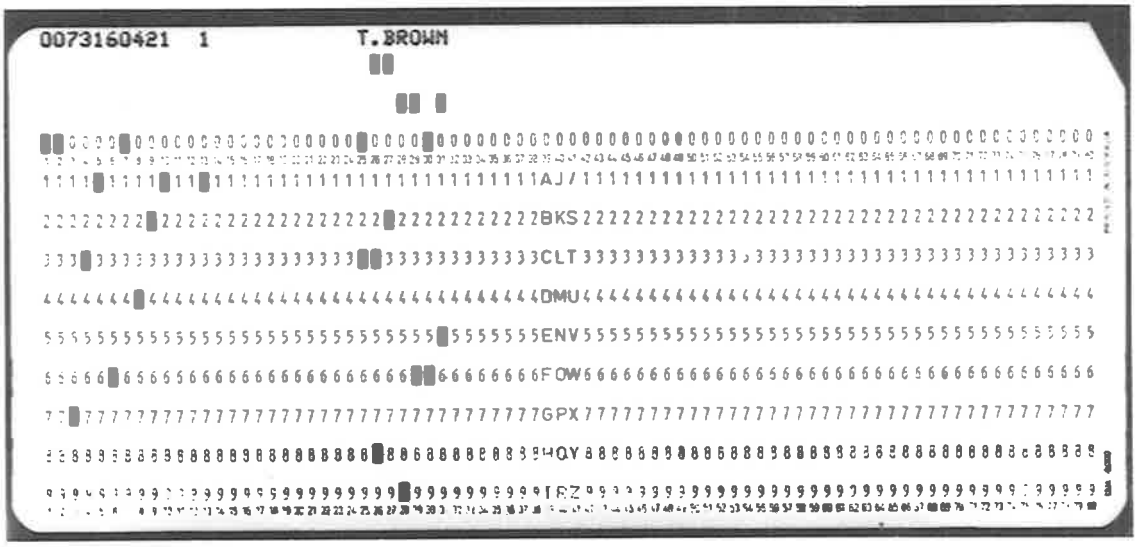

Figure 5. A punched request card for input

Field 3, columns 9, 10 contained either of two variables which were determined by the preceding response code. Information recorded since a particular date was retrievable by specifying the month and year. When preceded by response codes 02 or 03 in field 2, numbers between 1 and 12 punched in columns 9, 10 specified the "from month" value of the date. Field 4, columns 11, 12 specified the last two digits of the year of that date - that is, the "from year" value.

Response code 04 in field 2 and the F.D.I. two-digit code 11 to 85 punched in field 3 identified a particular tooth.

Twelve single-column fields, columns 13 to 24, were available for indicating the event or combination of events of interest. Events on which information was sought were specified by punching 1 in the appropriate columns. A blank or 0 punched in any of these columns indicated unrequired events.

Field	Column	Event
5	13	registration
6	14	admission
7	15	assignment
8	16	history
9	17	examination
10	18	radiographic examination
11	19	laboratory examination
12	20	consultation
13	21	diagnosis and treatment plan
14	22	treatment
15	23	review
16	24	discharge

Finally, the initials and surname of the person making the enquiry were punched in field 17, columns 25 to 80.

Enquiry card entries and print output

Although batch processing with punched card input and print output was used in the experiment, PROGRAM CN2 simulated on-line interaction between user and the computer via teletype keyboard and visual display unit. The format of the output was planned to simulate a display on a cathode ray screen.

Records on file

The input card contained hospital number and response code (01) only.

The answer was either yes or no. If yes, the printout gave the patient's hospital number, name and initials, title, birth date, date of registration, address and other information recorded at the time of registration and age at the date of registration. If the answer was no, the printout stated that the records were not on file (see Figure 6).

Event information

Hospital number, response code (02), "from month", "from year" and specified events were entered on the input card.

```
17/11/72 INQUIRY   1 BY A.MATHEW

INPUT DATA    7316 1 0 0000000000000A.MATHEW

INQUIRY - ARE RECORDS ON FILE
```

```
RESPONSE TO
17/11/72 INQUIRY   1 BY A.MATHEW

SEE BELOW OR FOLLOWING FRAME
```

```
RECORDS ARE ON FILE FOR PATIENT NO.   7316

7316  MRS MC KENZIE,A.        B/D 26/ 3/34 REGISTERED 20/ 5/65   AGE 31
```

Figure 6a. Affirmative response to an inquiry - "Are patient's records on file?"

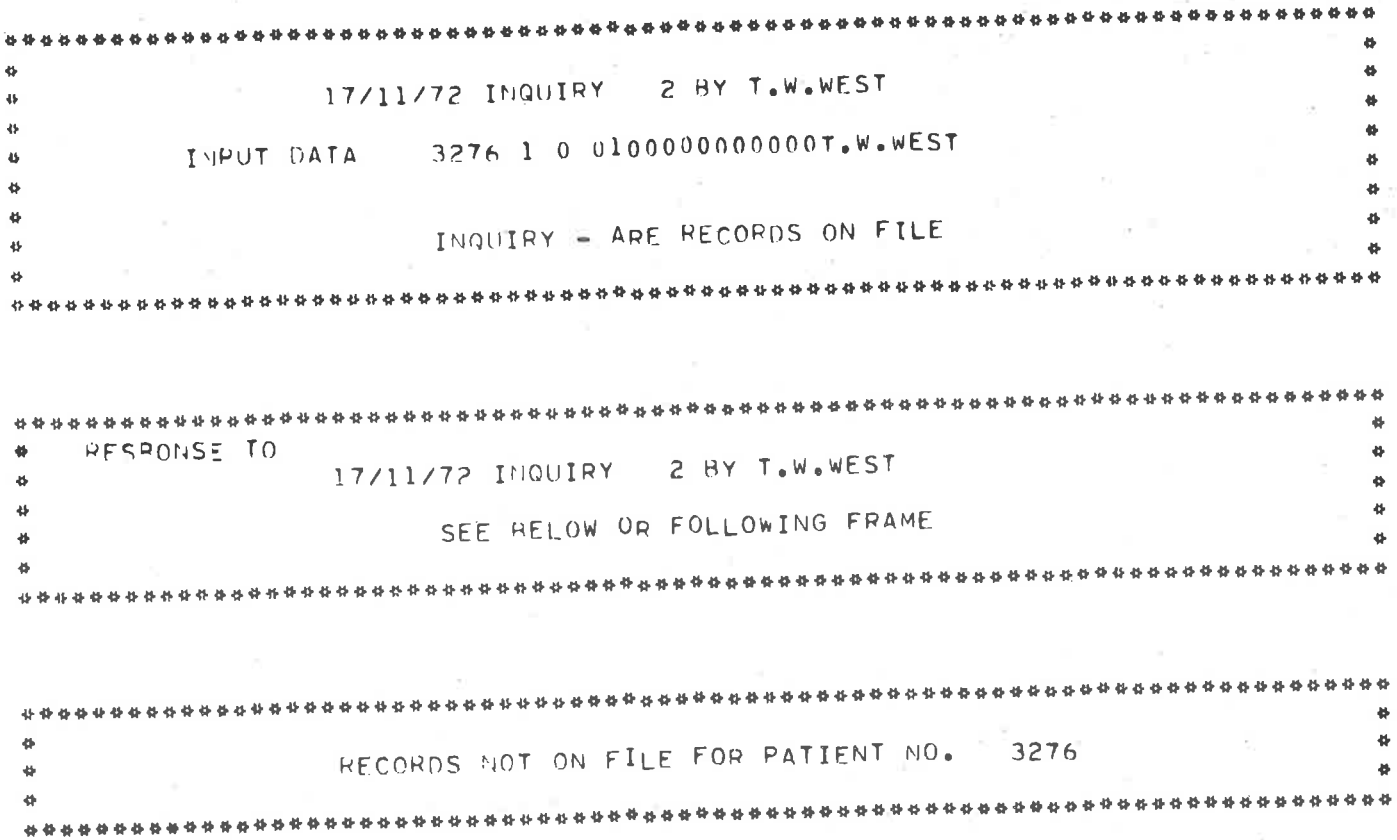

Figure 6b. Negative response to an inquiry - "Are patient's records on file?"

Failure to specify the month and year resulted in a printout of required events from the date of registration. As mentioned previously, any combination of the twelve events could be retrieved. The program first determined whether the patient's records were on file and if they were not, a message was printed out to that effect. If the records were on file the program listed the information requested, preceded by the registration and "note well" information (see Figure 7).

Number of visits

Hospital number, response code (03), "from month" and "from year" were entered on the input card.

Providing the records were on file the printout gave the information sought (see Figure 8).

Tooth information

Hospital number, response code (04) and F.D.I. tooth code were punched on the input card.

If the records were on file the computer searched the entire file for the patient and the printout listed all the entries having the specified tooth coded in field 8 of the original input data cards (see Figure 9).

```
17/11/72 INQUIRY   3 BY M.J. BARRETT

INPUT DATA    7316 2 0 0110000000001M.J. BARRETT

INQUIRY - SPECIFIED EVENTS

                    REGISTERED
                    ADMITTED
                    DISCHARGED
```

```
RESPONSE TO
17/11/72 INQUIRY   3 BY M.J. BARRETT

SEE BELOW OR FOLLOWING FRAME
```

Figure 7. Response to a request for specified "event information"

```
                        RESPONSE 17/11/72 FRAME  1

 7316  MRS MC KENZIE,A.          B/D 26/ 3/34 REGISTERED 20/ 5/65   AGE 31
          65 MOREA ST., OSBORNE, 5017
 ***************************************************************************
          RAH APPROVES NO CHARGE FOR FURTHER TREATMENTS WHICH INVOLVE
          RE-DOING EXISTING RESTORATIONS AND BRIDGE.
 ***************************************************************************

 EPISODE  1                                                          AGE 31
   20/ 5/65 ADMITTED    MRS MINKIEWICZ,I.A.       ST
   27/ 5/65 DISCHARGED  DR MACKENZIE,I.A.         ST
            ROUTINE CHECK, 22 ROP, SPECIAL W/L FILLINGS

 EPISODE  2                                                          AGE 31
   15/10/65 ADMITTED    DR SCOLLIN,J.             ST
   15/10/65 DISCHARGED  DR SMITH,J.D.             ST
            36 ROP

 EPISODE  3                                                          AGE 31
   22/11/65 ADMITTED    DR CHEETHAM,J.D.          ST
    7/ 1/66 DISCHARGED  DR CHEETHAM,J.D.          ST
            FROM W/L. INLAY AND SIMPLE AMALGAMS COMPLETED

 EPISODE  4                                                          AGE 32
   29/ 9/66 ADMITTED    DR SCOLLIN,J.             ST
   29/ 9/66 DISCHARGED  DR SCOLLIN,J.             ST
            NO TREATMENT PRESCRIBED

 EPISODE  5                                                          AGE 33
    9/ 1/67 ADMITTED    DR KUUSK,S.               ST
   16/ 1/67 DISCHARGED  DR KUUSK,S.               ST
            PRESENTED 22 WITH MILD PAIN. RADIOGRAPH NAD. QUERY PAIN

                                                 CONTINUED ON FRAME  2
```

Figure 7. (continued)

```
                        RESPONSE 17/11/72 FRAME  2
7316  MRS MC KENZIE,A.

            ASSOCIATED WITH PINNED INLAY. QUERY DEGENERATING PULP.
            FAILED TO RETURN AFTER 1/52 FOR CHECK.

                                                                    AGE 33
EPISODE  6
  30/ 3/67 ADMITTED     DR SCOLLIN,J.           ST
  30/ 3/67 DISCHARGED   DR OTHER,A.N.           ST
            12 FRACTURED. ROP.

                                                                    AGE 33
EPISODE  7
  26/ 4/67 ADMITTED     MRS HEW                 ST

                                                                    AGE 35
EPISODE  8
  10/ 2/69 ADMITTED     DR MAKINSON,O.F.        HON

                                                                    AGE 37
EPISODE  9
   9/ 3/71 ADMITTED     DR KIRKWOOD,J.          HON
```

Figure 7. (continued)

```
17/11/72 INQUIRY   4 BY P.PASTEL

INPUT DATA    7316 3 171000000000000P.PASTEL

INQUIRY - HOW MANY VISITS
```

```
RESPONSE TO
17/11/72 INQUIRY   4 BY P.PASTEL

SEE BELOW OR FOLLOWING FRAME
```

```
7316  MRS MC KENZIE,A.        B/D 26/ 3/34 REGISTERED 20/ 5/65   AGE 31
      65 MOREA ST., OSBORNE, 5017

24 TREATMENT VISITS FROM  1/71
```

Figure 8. Response to a request concerning "number of visits" since a specified date

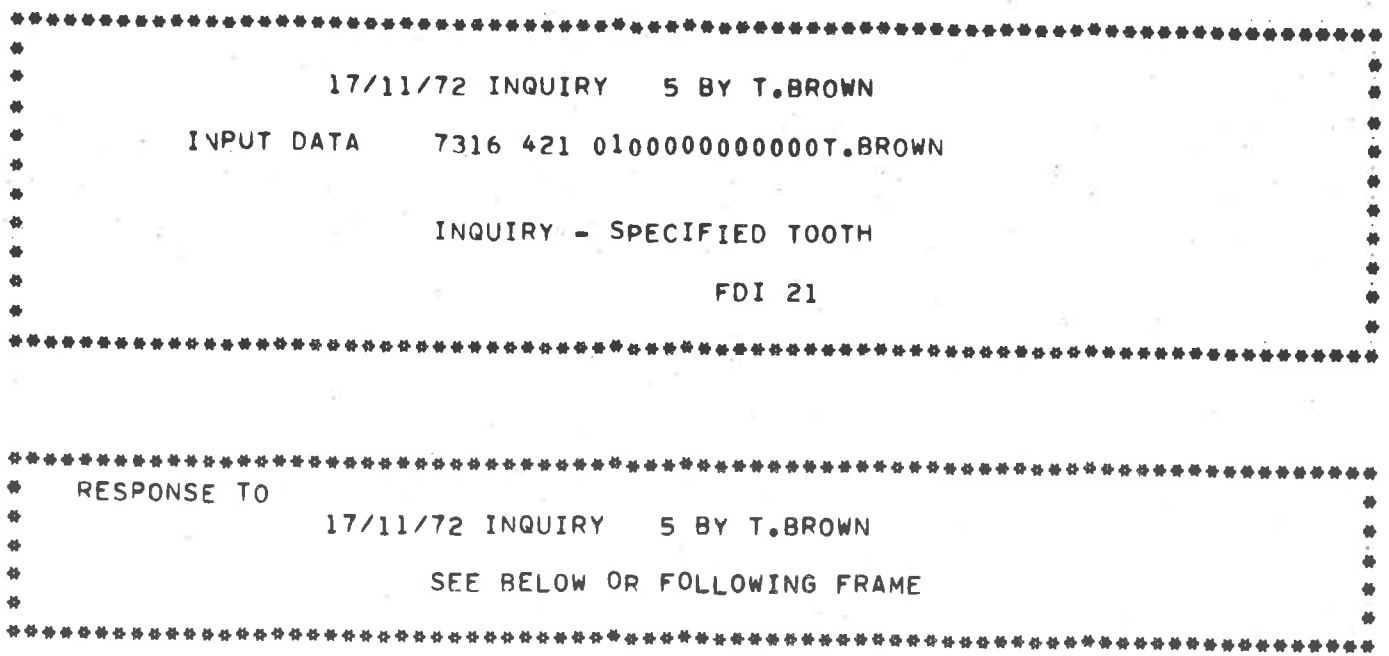

Figure 9. Response to a request for information about a "specified tooth"

```
                    RESPONSE 17/11/72 FRAME  1

 7316  MRS MC KENZIE,A.          B/D 26/ 3/34 REGISTERED 20/ 5/65   AGE 31
            65 MOREA ST., OSBORNE, 5017
            RAH APPROVES NO CHARGE FOR FURTHER TREATMENTS WHICH INVOLVE
            RE-DOING EXISTING RESTORATIONS AND BRIDGE.
  3/ 6/68 21 PERIAPICAL VIEW    - REPORT - NAD
  5/ 6/68 21 RE-CEMENT DISTAL INLAY.
  2/10/68 21 DISTAL DRESSING
          21 PREPARED FOR CLASS IV LINGUAL VENEER
  9/10/68 21 RUBBER IMPRESSION TAKEN
  2/ 7/69 21 CLASS IV INLAY CEMENTED
  9/ 7/69 21 OPENED
          21 PULPECTOMY, CULTURE TAKEN, REAMING AND FILING. CORRECT
          21 LENGTH 21MM BY RADIOGRAPH. SEALED WITH PNB AND CAVIT
          21 PERIAPICAL VIEW
 16/ 7/69 21 ENDO CULTURE REPORT.  NEGATIVE
  2/ 9/69 21 ROOT FILLED WITH GP AND AH26
  9/ 3/71 21 PREPARATION AND INSERTION OF GOLD FOIL
          21 PERIAPICAL VIEW - REPORT
 27/ 4/71 21 ROOT-FILLING 4MM SHORT OF APEX. P-A RADIOLUCENCY 1X2MM
  4/ 5/71 21 REDO ENDO. OLD GP FILLING REMOVED. SEALED WITH CAVIT
          21 ENDO. CANAL PREPARED WITH NO 6 FILE TO TRUE LENGTH 20MM BY
          21 RADIOGRAPH. ROOT FILLED WITH AH26 AND GP WITH LATERAL
          21 CONDENSATION. SEALED WITH CAVIT
          21 PERIAPICAL VIEWS - REPORT

                                          CONTINUED ON FRAME  2
```

Figure 9. (continued)

```
**********************************************************************
*                                                                    *
*                        RESPONSE 17/11/72 FRAME  2                  *
*   7316  MRS MC KENZIE,A.                                           *
*                                                                    *
*   14/ 9/71 21 SATISFACTORY ROOT-FILLING                            *
*   28/ 9/71 21 PJC PREP                                             *
*            21 PJC CEMENTED WITH ZNPHOS                             *
*                                                                    *
**********************************************************************
```

Figure 9. (continued)

Orthodontic treatment progress

Only hospital number and response code were required on the input card.

A new computer-orientated scheme for classifying malocclusion was proposed by ACKERMAN and PROFFIT (1969). By this system the orthodontist simultaneously classifies and diagnoses malocclusions into nine groups based on the prevalence of problems associated with each of five diagnostic subgroups: tooth and arch alignment; profile / esthetics; the Angle classification of malocclusion; bite depth; and lateral arch relationship between posterior teeth. A high group number indicates a less favourable prognosis due to increased complexity of the contributing etiological factors and the treatment required to correct the malocclusion. The relative contribution of problems from the individual subgroups to the total malocclusion is assessed by the orthodontist who subjectively assigns a score to each subgroup. The total score out of a maximum of 45 indicates the severity of the malocclusion.

This classification system was used in the experiment and the various categories as described above formed part of a special printout format in response to enquiries concerning orthodontic treatment progress. If the records were on file the printout listed the registration and "note well" information followed by the name of the orthodontist who determined the treatment plan,

the group classification and details of the diagnosis and treatment plan provided the group classification number was entered on the original input records. This was followed by a tabulation of the treatment progress which gave the month and year when each stage of treatment was begun, whether the stage had been completed, the number of visits in each stage and the duration in months. Finally cumulative totals of visits and months duration since active treatment was begun were listed (Figure 10).

Error messages

Specification of the response code precisely defined the legal range of values which could be entered in the fields containing "from month", tooth code and specified event information. Illegal field entries or failure to specify hospital number or response code resulted in the printout of error messages which listed and totalled all errors made on the input enquiry card.

Incorrect enquiries were not answered (see Figure 11).

DISCUSSION

The present study achieved its objectives: to design an experimental computer-based records system; to write programs to effect desired results; and to execute the programs with test data.

```
**********************************************************************
*                                                                    *
*                17/11/72 INQUIRY   6 BY E.T. CETERA                 *
*                                                                    *
*        INPUT DATA    7316 5 0 0000000000000E.T. CETERA             *
*                                                                    *
*                                                                    *
*                      INQUIRY - ORTHO PROGRESS                      *
*                                                                    *
**********************************************************************


**********************************************************************
*   RESPONSE TO                                                      *
*                17/11/72 INQUIRY   6 BY E.T. CETERA                 *
*                                                                    *
*                     SEE BELOW OR FOLLOWING FRAME                   *
*                                                                    *
**********************************************************************


**********************************************************************
*                                                                    *
*          THERE ARE NO RECORDS OF ORTHODONTIC TREATMENT ON FILE      *
*                                                                    *
**********************************************************************
```

Figure 10a. Negative response to an inquiry for "orthodontic treatment progress"

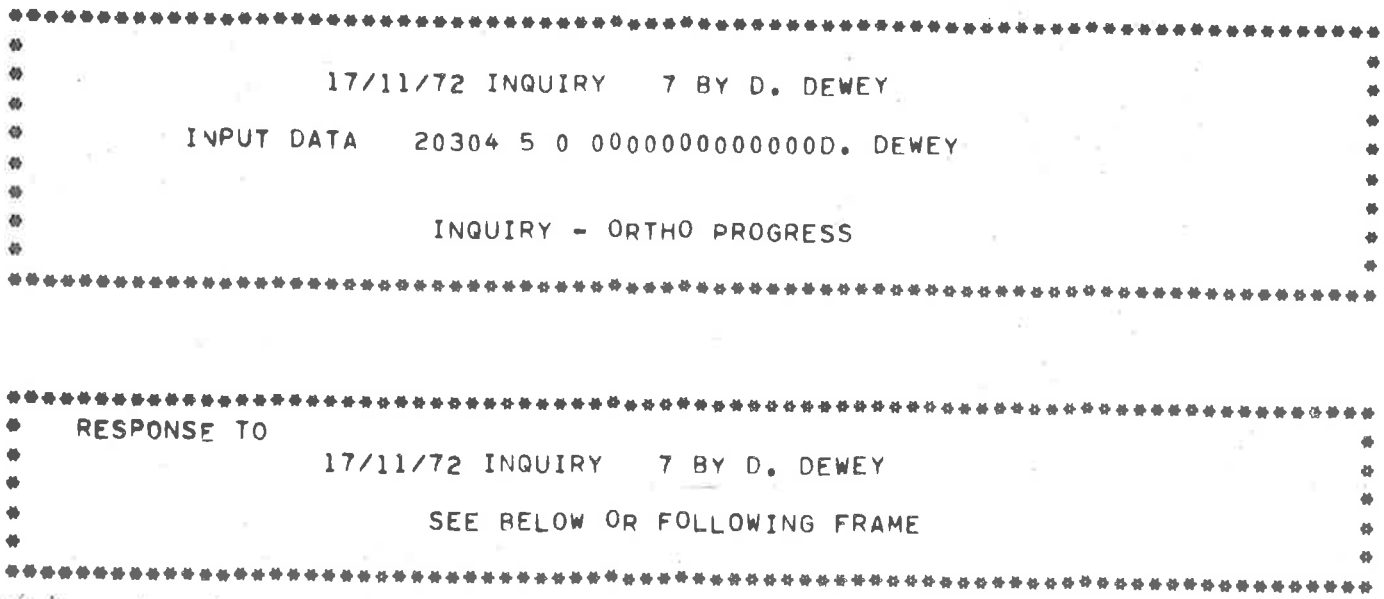

Figure 10b. Affirmative response to an inquiry for "orthodontic treatment progress"

RESPONSE 17/11/72 FRAME 1

20304 MAST BARRETT,MICHAEL B/D 3/ 8/55 REGISTERED 11/ 4/69 AGE 14
20 PARK TCE, GILBERTON, 5081
MOTHER - MARY BARRETT (SAME ADDRESS)
LATE NOON APPOINTMENTS ONLY PLEASE

LATE NOON APPOINTMENTS ONLY PLEASE

25/ 4/69 TREAT/PLAN DR JAMES,P.R. P/G

7 DIAGNOSIS AND CLASSIFICATION - GROUP 7 SCORE 16/45
7 ALIGNMENT - MILD CROWDING BOTH ARCHES SCORE 2/10
7 PROFILE/ESTHETICS - CONVEX SCORE 3/05
7 CLASS - II SKELETAL-DENTAL SCORE 7/10
7 BITE DEPTH - ANT DEEP ,DENTAL SCORE 4/10
7 T/PLAN
7 1. EXT 14-24-34-44
7 2. STRAIGHT PULL H.G.
7 3. LEVEL, ALIGN, PREP MOD. ANCHORAGE
7 4. HI-PULL H.G. WITH CL II
7 5. DETAIL - QUERY POSITIONER

	STAGE BEGAN	STAGE ENDED	WITHIN-STAGE VISITS	WITHIN-STAGE MONTHS	CUMULATIVE VISITS	CUMULATIVE MONTHS
PRE-TREAT	APR 69	YES	9	2	0	0
STAGE 1	JUN 69	YES	11	6	11	6
STAGE 2	JAN 70	YES	5	5	16	11
STAGE 3	JUN 70	YES	8	6	24	17
STAGE 4	JAN 71	YES	10	24	34	41
POST-TREAT	JAN 73	YES	1	0	0	0

PATIENT DISCHARGED - JAN 73

Figure 10b. (continued)

```
**********************************************************************
*                                                                    *
*              17/11/72 INQUIRY   8 BY I.M.A. NUTT                   *
*                                                                    *
*       INPUT DATA    1325 022701230000000451.M.A. NUTT              *
*                                                                    *
*            YOU SHOULD SPECIFY THE RESPONSE YOU REQUIRE             *
*            YOU HAVE SPECIFIED MONTH 22                             *
*            YOUR SPECIFICATION  2 IS ILLEGAL                        *
*            YOUR SPECIFICATION  3 IS ILLEGAL                        *
*            YOUR SPECIFICATION  4 IS ILLEGAL                        *
*            YOUR SPECIFICATION  5 IS ILLEGAL                        *
*            THERE ARE AT LEAST  6 ERRORS IN YOUR DEMAND - TRY AGAIN *
*                                                                    *
**********************************************************************


**********************************************************************
*  RESPONSE TO                                                       *
*              17/11/72 INQUIRY   8 BY I.M.A. NUTT                   *
*                                                                    *
*                        INQUIRY NOT ANSWERED                        *
*                                                                    *
**********************************************************************
```

Figure 11. Error messages

```
17/11/72 INQUIRY   9 BY A. TWIT

INPUT DATA       0 4 8 0000000000000A. TWIT

    YOU SHOULD SPECIFY THE HOSPITAL NO. OF YOUR PATIENT
    YOUR TOOTH CODE SPECIFICATION IS ILLEGAL
    THERE ARE AT LEAST  2 ERRORS IN YOUR DEMAND - TRY AGAIN

            INQUIRY - SPECIFIED TOOTH

                          FDI  8
```

```
RESPONSE TO
            17/11/72 INQUIRY   9 BY A. TWIT

                    INQUIRY NOT ANSWERED
```

Figure 11. (continued)

The system performed satisfactorily under a variety of test conditions. In mind at all stages of the experiment was the need to reveal problems which would have to be faced in planning a more comprehensive record system such as the one described on pages 76 to 87.

Computer-based systems are expensive and time-consuming to design and operate. Distinct advantages for a proposed system over a conventional system must therefore be shown in order to justify the high costs of computer equipment, developing computer programs and systems maintenance. Existing manual systems should be analysed to assess their value in terms of efficiency in time and personnel and their contribution to the care of patients. It is possible that thorough systems analysis may lead to improvements in existing systems without introducing computer techniques.

The experiment showed that before a computer-based records system could be specified and developed for implementation in a real situation, considerable further study was needed in three areas which are discussed below under the headings: information; suitable computer systems; other considerations.

INFORMATION

Obvious stages in the development of any computer-based system are to define the objectives and then consider the various

ways in which the objectives can be achieved. The scope of a records system should be clearly defined at the outset so as to provide positive objectives and to avoid accumulating unnecessary information.

A comprehensive records system would have to process a much greater volume of information than was used in the experiment. The development of a working system would require the collaboration of dentists, professional systems analysts and computer experts. The professional and lay usage of dental records would have to be examined more closely and taken into account. Further investigation is needed to define the special requirements of the different dental departments with respect to recording methods and retrieval of statistics most useful for patient management within the different departments. In the experiment, malocclusions were qualitatively and quantitatively described using a new computer-orientated orthodontic classification system which facilitated retrieval of useful statistics on the treatment progress of orthodontic patients. Research into the other specialized dental departments to identify similar systems for classifying patients into logical groups would be essential before computer techniques could be applied effectively.

Recording systems employed must be simple from the point of view of users who would be mainly lay personnel with little

knowledge of computer techniques. Consequently the recording system used in the experiment provided for text entries free of format restrictions and minimal use of coding. In this manner the dentist retained his right of freedom of expression since no demands were made to regulate the length or content of casenotes entries.

The results of the experiment emphasized the need for both programs and input data to be free of errors otherwise the output was inaccurate and therefore useless. Certain discrepancies in the data were detectable by special subprograms incorporated within the main programs but it was virtually impossible to eliminate human errors from the system which relied on manual methods for recording and transcribing information. On this point it is interesting to note the experience of the Institute of Medical and Veterinary Science in Adelaide. A considerable number of data entry errors may occur, notwithstanding the provision of sight verification - that is, the screen display of the data to be entered for confirmation by the operator before the data are sent to the computer.

SUITABLE COMPUTER METHODS

It was shown that batch-processing of punched cards did not provide adequately fast interchange with the computer and would therefore be unacceptable for an extensive records system.

Direct data entry and information retrieval via widely distributed on-line remote computer terminals with teletype keyboards and visual display units would be an essential feature of any future system. It is not unreasonable to suggest that dentists themselves could be trained to operate computer terminals and to enter information directly into the computer on teletype keyboards which are very similar to ordinary typewriter keyboards. This procedure would reduce the time and number of errors associated with the transcription of data from recording sheets to a computer by a special terminal operator. However, experience with the development of computer systems for use in United States hospitals has shown that it is very difficult to convince doctors that they should use the teletype keyboards themselves. A possible explanation is the widespread practice in that country of assigning the task of medical recording to clerks.

Capital and running costs of a comprehensive computer-based system would be dependent on the costs of central processor and peripheral devices including remote terminals and storage facilities. Preliminary systems analyses would be needed to reveal the hardware and software requirements of individual dental institutions. As previously mentioned the Dental Department of the Royal Adelaide Hospital maintains records for 85,000 patients and this number increases by about 8,000 each year. The records could be grouped into an active file and an

archives file (see page 75). On the assumption that an average of 50 logical records each consisting of an average of 40 characters are stored for each patient, the number of characters involved in an active file of about 5,000 patients would be approximately 10 million. Storage requirements would vary with the storage medium - for example, 10 million characters would occupy approximately one magnetic tape, 2,400 feet in length. However storage of the remaining 80,000 dental records on an archive file involving some 160 million characters would present a much greater problem. A cheaper storage medium - for example microfilm - might offer an economically convenient solution.

There would be many advantages in having a dedicated computer; that is, a computer limited in use to the records system with specific capabilities to perform the required tasks. For an outlay of about $50,000 it would be possible to purchase a computer suitable for the Royal Adelaide Hospital Dental Department. However, further expenditure from acquiring the necessary programs, training staff and from running costs would finally determine the economic feasibility of such a system. Owning a computer as opposed to buying computer time and sharing a central computer with other users would probably reduce running costs. Another advantage would be easier control of access by unauthorized persons to confidential information in the computer files.

OTHER CONSIDERATIONS

Medico-legal requirements

Members of the medical and dental professions are at present required by law to acknowledge their responsibility - usually by their personal signature - for entries in case-notes. With the advent of computer-based records systems, alternative means will need to be devised for identifying dentists responsible for entries which are at the same time accepted in law and suitable for input to a computer. Microfilm copies of records which bear some mark of verification by a dentist might be legally acceptable. Two other methods have been suggested. First, identification badges could be slotted into a computer terminal, read by the computer and checked against a listing of persons with authorized access to the computer. Second, the computer may be used to verify signatures input to the computer by means of inscribing on a cathode ray screen with a "light pen".

Filing systems

A future computer-based system would probably require two files: an active file and an archival file. Only the records of patients who had recently received treatment would be included on the active file. After a specified time lapse during which no further entries were made on a particular patient's file, these

records would be transferred to an archival file and stored for an indefinite period. Should the patient return for treatment at a later date his record file would be transferred from the archives back to the active file.

A comprehensive computer-based records system would be obviously highly dependent on the continued operation of the computer and intact computer files. Standard computer procedures in file manipulations provide protection in the event of accidental erasure of the master file. Each day before any new transactions are made, the master file from the previous day is duplicated and held in reserve. The master file is then updated as a result of the day's transactions which are recorded separately and also held in reserve. Should the day file be accidentally erased, a new day file can be readily constructed from the duplicate master file from the previous day and the record of the day's transactions.

A HYPOTHETICAL COMMUNICATIONS SYSTEM

Any future system must be an economically feasible proposition with the following objectives: first, the provision of improved service to patients; and second, more efficient utilization of the hospital's resources in terms of personnel and facilities. These objectives would be accomplished by an improved system of communication capable of rapidly delivering accurate information upon demand to locations throughout the hospital.

This section describes the basic operation of a system which might be designed for use in a dental hospital. On-line communication would be an essential feature of such a scheme as previously mentioned. Remote computer terminals linked to a centrally located dedicated computer would be widely distributed in all hospital departments (see Table 4). The system in operation is illustrated below by an account of the sequence of events following the arrival of a new patient at the dental hospital (see Figure 12). The present tense will be used to simplify the description.

REGISTRATION

The new patient first reports to the Registration Office where a clerk types in the registration data including name and address on the teletype keyboard of a remote terminal. The data are input to the computer which searches through an alphabetical file of the names of previously registered patients. If the patient has been registered before, a message is displayed on the cathode ray screen (VDU) in the Registration Office. However, if the search is unsuccessful the computer assigns to the patient the next unused record number on the numerical master file. The new patient is then referred by the clerk to the Admissions Clinic where details of registration have already been printed out on a continuous hard-copy day sheet at the remote terminal located there.

Table 4. Distribution of remote computer terminals

Department	Comments
Registration Office	
Admission Clinic	One terminal is available for each Admission Officer
Radiology	
Oral Surgery	
Relief of Pain Clinic	These two clinics deal with patients' immediate treatment needs
Denture Clinic	
Instrument Supply	
Technical Services Laboratory	
Conservative Dentistry	Remote terminals are located at the Reception Area and every treatment cubicle
Prosthetic Dentistry	
Periodontology	
Pedodontic	
Orthodontic	

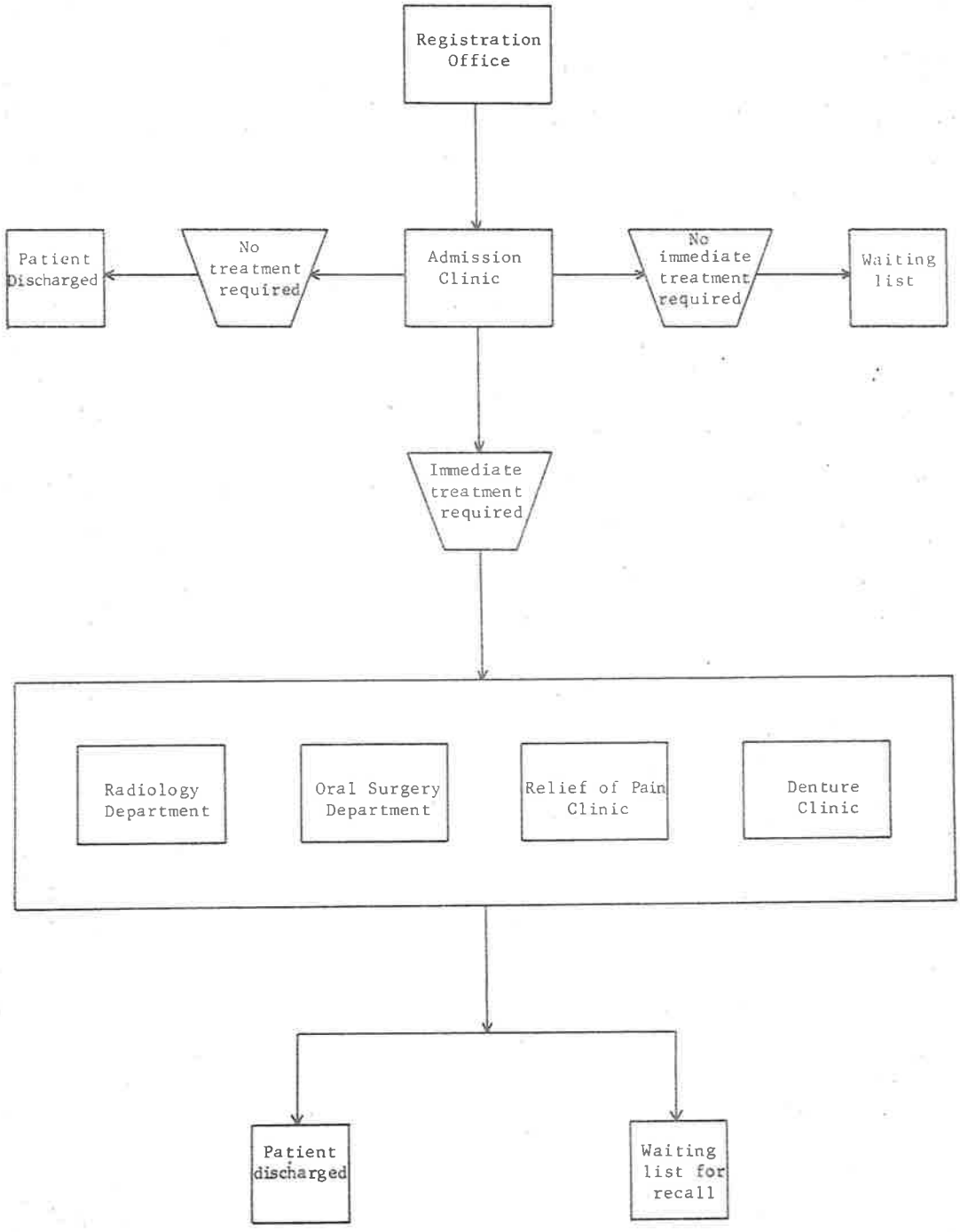

Figure 12. Flow chart depicting routes for immediate referral of patient from the Admission Clinic

ADMISSION AND ASSIGNMENT

The Admission Clinic is concerned with immediate management of the patient. The admission officer checks the registration data. Details of the chief complaint, relevant medical or dental history and a screening oral examination are entered on the teletype keyboard by the dentist himself or by an assistant. The examining dentist then makes a decision on how the patient's immediate problems should be handled and assigns the patient to the appropriate departments. Instructions or treatment recommendations are also entered at the terminal. Before data are sent to the computer they are displayed on the VDU for sight verification by the Admissions Officer.

If no treatment is indicated the patient is discharged and the name may be placed on a computer waiting-list for future recall.

If treatment is needed but is not urgent, the patient's name is placed on a waiting-list for treatment by the appropriate department.

EMERGENCY TREATMENT

If emergency treatment is required, the Admission Officer refers the patient to the necessary departments: Radiology; Oral Surgery; Relief of Pain Clinic for caries control procedures;

or the Denture Clinic for adjustment or repair of dental prostheses. Registration data, requests for treatment and subsequent routing of the patient are printed out on the continuous day file at the terminal of each department to which the patient is referred. For example, on referral to Radiology a print-out consisting of registration data, radiographic examination requested and subsequent disposal of the patient is added to the day file for this department. Radiographs taken are identified by attaching a slip of paper printed out at the terminal and bearing registration data for the patient. The patient may be referred back to the Admission Clinic for diagnosis or to any of the other three departments where treatment requests are fulfilled. Details of treatment received are input on a teletype, checked on the VDU and sent to the computer.

When the immediate treatment needs of the patient have been satisfied, the patient may be discharged or placed on a computer waiting-list for recall or for further treatment. Each phase in this episode and in subsequent episodes in the dental history of the new patient is input to the computer which assembles all relevant information from each department to form a composite file for the patient. This file constitutes a small section of the master file.

SUBSEQUENT TREATMENT

The computer maintains separate waiting-lists for urgent and routine treatment in each clinical department as well as lists of patients assigned to dental operators. Every dentist is responsible for regularly checking his patient register and appointment schedule which is accomplished by entering the appropriate request code on the teletype keyboard and observing displays on the VDU screen. When a new patient is needed, the dentist informs the computer and any special treatment requirements are specified. The computer selects a suitable patient from a waiting-list and displays the patient's registration data and a summary of treatment required on the VDU screen for acceptance or rejection by the dentist. Should the dentist wish to learn more about the new patient he may key in a request for specified information from existing case-records which will appear on the VDU screen or alternatively, be presented as a hard-copy print output from the terminal. Appointment schedules for each operator are organized by the computer which reserves the next available appointment for the patient selected. At another terminal the computer prints the name, address and appointment details on a special form ready for mailing to the new patient.

At some future date the new patient previously considered is recalled for treatment - for example, in a conservative dental

clinic - and notification of an appointment time is sent to the patient (see Figure 13). At the same time dental instruments which will be needed at the first appointment are selected by the computer from a list and an order is recorded on the Instrument Supply Department's files.

On the first day (see Figure 14) the patient arrives and the clinic receptionist checks the patient's name against the clinic's day file which is a printout listing all patients appointed for that day. The Instrument Supply Department has provided the previously ordered instruments which are included on the department's current computer printout listing the daily instrument requirements of each hospital clinic. The new patient enters one of the treatment cubicles, each equipped with its own remote terminal. On the VDU screen the dentist checks registration data and aspects of previous dental history if desired - for example, details of the preceding admission and a summary of the patient's status at discharge when placed on the waiting-list. Details of medical or dental history and the results of an examination are entered on the teletype by the dentist or an assistant and displayed on the VDU screen for verification by the dentist before sending the data to the computer. Requests for radiological examinations, special laboratory tests or consultation with a specialist are input to the computer as previously described. The dentist types in his diagnosis and treatment plan

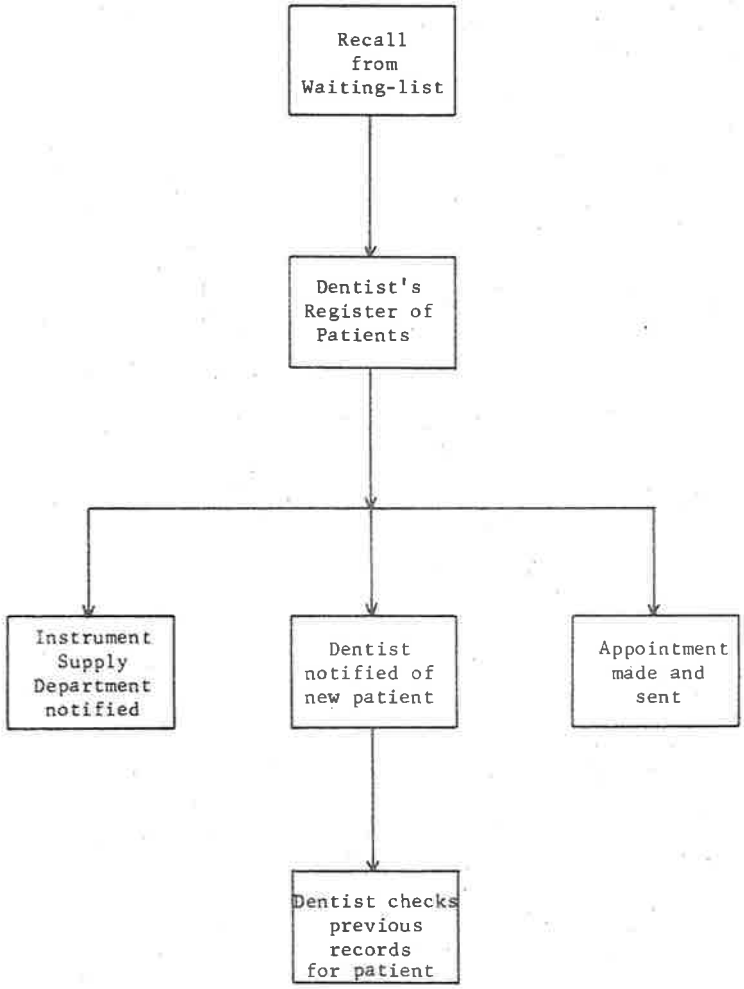

Figure 13. Flow chart depicting immediate events following the patient's recall from a waiting-list

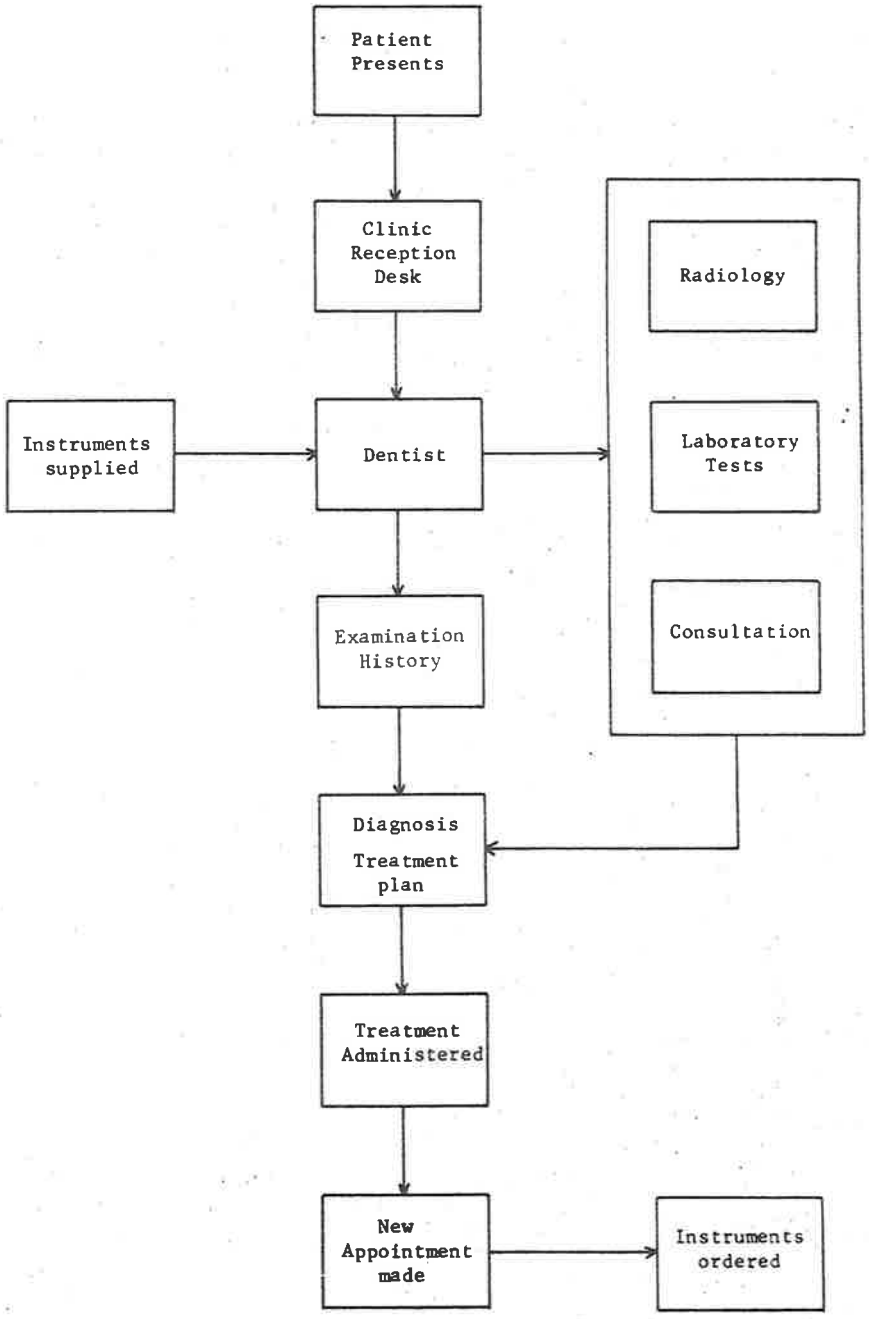

Figure 14. Flow chart depicting events which occur during the first appointment

which is itemized in order to provide the computer with a check-list for indicating treatment progress when requested by the operator on subsequent occasions. Details of treatment administered are also entered and checked at the terminal. At conclusion of the appointment, the next available appointment is indicated by the computer on the VDU screen for acceptance or rejection by the dentist. The confirmed time of the next appointment, the treatment to be carried out and instruments required are input to the computer and entered on a master appointment record. A statement of the next appointment time is printed by the computer on a slip of paper which serves as the patient's own record of the appointment.

At the next and subsequent appointments a display of details of treatment received during the last visit together with the treatment planned for the current visit may be ascertained by entering the suitable request codes on the teletype. In addition any specified information in the patient's dental record may be retrieved - including, for example, displays of the original treatment plan or outstanding items on the treatment plan. When the services of the Technical Laboratory are required, the dentist needs to know when the work will be completed so that the patient can be re-appointed. Accordingly the dentist inputs a standard code for the type of work required together with an appropriate request code. The computer checks the work load and schedules

for each laboratory technician and assigns the particular job to an available technician. The time for completion of the job is calculated by the computer which displays the estimated date of completion on the dentist's VDU. The dentist then requests that the next appointment after the date of completion be reserved for the patient and an appointment slip is printed out as before. On the day of the subsequent appointment, the patient's name and work requested are included on the continuous printout at the Technical Services Laboratory. This list indicates all jobs which must be completed on this day as well as the clinics where they are required. Laboratory technicians, like dentists, are responsible for regularly checking their own work lists which include requested completion dates. For various reasons a technician may get behind his work schedule. Consequently each day the computer checks all the work files and schedules and locates any jobs which are calculated to exceed previously estimated completion times. The dentist concerned is notified and requested to change the appointment time.

CHAPTER 5

GENERAL DISCUSSION AND CONCLUSIONS

The literature review has revealed the diversity of computer applications in dentistry; those in operation and those currently being investigated. These applications may be grouped under the following headings: research; administration; dental records systems; dental education; clinical applications. Most of the computer uses discussed in the literature are still considered research topics and have not yet been developed to the stage where replacement of existing systems is feasible. Notable exceptions are the research applications.

RESEARCH

The computer's capacity to store and retrieve data and to rapidly perform complex calculations and logical operations has proved a powerful tool for use in dental research. The computer can process research data and perform statistical analyses with greater speed and accuracy than the research worker with only a desk calculator at his disposal. The researcher and his staff are thereby relieved of tedious and time-consuming tasks. This situation is well exemplified in growth studies where the immense

volume of calculations would not be feasible relying on desk calculators alone. Application of computer technics has expanded the scope of dental research and has liberated human effort for more profitable research activities.

ADMINISTRATION

The task of administering dental institutions becomes more complex as the number of patients, staff and students increases. Greater demands are placed upon clinical, clerical and teaching departments. Already some of the larger dental institutions in the United Kingdom, Canada and the United States have reached a stage where manual systems can no longer cope effectively and so computer systems are being introduced. The application of computer technics to dental administration benefits from the experience obtained during the development of computer systems for medical hospitals which encountered similar problems in coping with the work load much earlier. In addition, computer systems intended for use in general business are available for the automation of clerical procedures such as accounting and making inventories. Several dental centres are developing computer-based systems which maintain waiting-lists of patients together with their treatment requirements and priority. Allocation of suitable patients to students, compatible with the students' capabilities and requirements is facilitated. Comprehensive reports of patient

treatment progress and student responsibility for patients can be readily obtained. Thus the application of computer technics in future will result in increased efficiency and control in the administration of dental clinics.

DENTAL RECORDS SYSTEMS

The maintenance of accurate and up-to-date case records becomes more difficult as the number of patients treated within a dental institution increases. The computer has a vast capacity for storage and almost immediate retrieval of information and is capable of maintaining highly sophisticated filing systems. Application of computer technics opens the possibility for the development of automated dental records systems such as described in Chapter 4 in which a master file consisting of all data normally recorded within casenotes may be stored on magnetic tapes or disks. Recorded in this manner, patient information may be readily updated and rapidly retrieved on demand. In addition the computer may perform statistical analyses on the total patient data and determine correlations and trends within groups which may influence future administrative decisions and make data available for research.

Computer processing technics, as applied to dental records systems, require the standardization of all terms used to describe

input data: for example, information recorded during oral examinations must be as objective as possible and to minimize subjective observations, precise definitions of dental and oral conditions are required. However, the controversy amongst members of the dental profession arising from the recommendation of a universal system for tooth identification suitable for computer input by the International Dental Federation (DRUM, 1970) indicates the problems which can arise when attempts are made to standardize dental terminology.

The literature review indicates wide interest in the automation of dental records systems which is an extremely useful computer application with great potential in dentistry. However, further development is impeded by the slowness of present data processing methods. Most dental institutions must rely on indirect or "off-line" access to computing facilities which means high expenditure of human time in coding and punching data cards. As computer technology advances and computer equipment becomes less expensive, direct or "on-line" communication via remote terminals - located in dental clinics for example - will become more readily available. Data may then be directly input to the computer through a teletype keyboard and the output displayed on a visual display unit thereby eliminating the task of data preparation and minimizing human transcription errors.

DENTAL EDUCATION

Modern computer technology has recently been applied in the development of more efficient means of monitoring the effectiveness of training programs for dental students. The use of computers to assist in the assessment of student achievement by analysing data generated by a grading system for clinical performance has made possible the rapid relay of information about student progress back to the teaching departments. Since direct "on-line" access to a computer is not essential, student monitoring systems are feasible for most dental schools and greater use of such systems can be expected in future.

Computer teaching methods are being developed which represents a new approach to student instruction in the diagnosis of oral disease. Interaction occurs directly between student and computer; for example, computer output is shown on a visual display unit before the student who types back his response on a teletype. Preparation of suitable teaching programs is time consuming and requires extensive collaboration between dental specialist and programmer. The use of specialized computer-assisted teaching methods is at present limited to dental schools with "on-line" computer facilities but the potential exists for improving student instruction in clinical diagnosis by the use of simulation techniques.

CLINICAL APPLICATIONS

The clinical practice of dentistry is concerned with the following procedures: examination; diagnosis; prognosis; treatment planning; and treatment administration. Some of these - certain preventive treatments for example - are currently performed by auxiliary dental staff, but the dentist retains total responsibility for patient care. The application of computers in clinical dentistry does not aim to displace the dentist from his professional role but rather to reinforce his ability to treat patients by improving the quality and quantity of information available to him.

Computer systems are being developed to assist in the diagnosis of intra-oral and lateral head radiographs - leading, it is hoped, to a more objective approach to radiographic interpretation. Analysis of consecutive lateral head radiographs by computer could provide the orthodontist with useful information relating to growth trends in individual patients.

Investigations into the feasibility of using computers to assist in dental diagnosis and treatment-planning have so far failed to establish simple correlations between sets of dental observations and the treatment prescribed. Dental diagnostic procedures are frequently subjective and are often based upon clinical experience whilst computer programming technics require

analysis of the diagnostic process into logical consecutive steps. In addition, differing diagnostic criteria between members of the dental profession present problems which must be overcome before computer-assisted dental diagnosis becomes feasible.

FUTURE USES ARISING FROM CURRENT RESEARCH

Identification of victims of air disasters must often rely upon attempts to match dental characteristics of victims with dental records when these are available. The procedure involves detailed and lengthy examination of the existing dentition and opinions between forensic specialists frequently differ (GUSTAFSON, 1966).

Currently being investigated is the feasibility of using computers to identify dental arch shape, given the coordinates of at least three distant points on the occlusal surface of each arch. A computer has been used to calculate the specific spacial relationship between the occlusal landmarks which appears to be as unique to the individual as his fingerprint pattern. The application of this technique to forensic odontology could provide a more objective means of identifying victims, even when teeth other than those bearing the reference points have been lost.

Computers are programmed to control certain industrial tasks - repetitive machining processes for example - which are

performed with greater accuracy and speed than by manual means of control. Similarly computer technics may eventually be applied in dentistry for the construction of precision custom-made dental appliances such as inlays, orthodontic bands and archwires, and denture prostheses. Preliminary investigations have already established the feasibility of this computer application.

CONCLUSIONS

1. There are many ways in which computers and electronic data processing methods are being used in dentistry at the present time.

2. Applications in research are more advanced than in the administrative, communications, educational and clinical fields.

3. Further investigations of computer applications in dentistry are required. Pilot studies should be undertaken to evaluate the practicability of various methods.

4. Computer studies require the collaboration of dentists, professional systems analysts and computer experts.

5. The development and implementation of computer methods in dentistry is limited firstly by insufficient research in computer applications due to the lack of dentists suitably trained in computer technology and the high costs of electronic data

processing; and secondly by the resistance of the dental profession to change.

APPENDIX A

GLOSSARY OF COMPUTER TERMS

Algol

ALGOrithmic Language, an arithmetic data-processing language used to express problem-solving formulas for machine solution.

Analog computer*

A computer dealing with physical quantities (such as electrical voltages) which are continuously variable.

Cobol

COmmon Business Orientated Language. This is a common procedural language designed for commercial data processing.

Dedicated*

A computer system which is entirely concerned with a single application.

Digital computer*

A computer dealing with digital quantities which can be varied only in discrete steps.

Fortran

FORmula TRANslator. A programming system including a language and a processor (compiler) which allows programs to be written in a mathematical-type language.

Hardware*

Electronic circuitry, mechanical devices, etc. Contrasts with software.

Light pen*

A device which when pointed at a cathode-ray tube can sense whether the spot pointed at is illuminated or not. Used as an input/output device with a VDU.

Off-line*

A situation in which a device produces information in machine readable form (such as punched paper tape) for subsequent processing by a computer.

On-line*

Acting under direct computer control, for example a visual display unit connected to the computer.

Peripheral*

A hardware item which can be connected to the computer.

Real-time*

The actual elapsed time of the real-life procedure; for example, a real-time simulation is one which takes the same amount of time as the process simulated. Simulations can therefore also be faster than real-time or slower than real-time. This meaning has been extended to include responding in time to affect the real-life situation; for example, patient-monitoring.

Software

The internal programs or routines professionally prepared to simplify programming operations. These routines permit the programmer to use his own language (English) or mathematics (Algebra) in communicating with the computer.

Teletype*

Trade-name of a device resembling a typewriter with which a paper tape reader and punch can be combined and which is capable of serving as a computer terminal.

Terminal*

A device for providing input-output facilities to and from a computer, often at some distance and probably not including any computational facilities of its own. Examples are teletypes and visual display units.

Time-sharing

Time-sharing is a computing technique in which numerous terminal devices can utilize a central computer concurrently for input, processing and output functions.

Visual display unit (VDU)

A terminal whose output device is a cathode-ray tube on which text and possibly diagrams can be displayed. The input device may be a complete typewriter-like keyboard, a more limited keyboard or a light pen.

* Definitions given by OCKENDEN (1970) "Focus on medical computer development" pages 114 to 117.

```
      PROGRAM CN1(INPUT,OUTPUT,TAPE1=INPUT,TAPE2,TAPE3)
*   THIS PROGRAM STARTS THE DENTAL CASENOTES SYSTEM.   INPUT IS A CARD *
* FILE OF DENTAL RECORDS PREPARED AS FOLLOWS.                          *
*              VARIABLE                    NO     NAME    COLS   FORMAT *
*         RECORD DAY                       (1)     RD      1,2     I2   *
*         RECORD MONTH                     (2)     RM      3,4     I2   *
*         RECORD YEAR                      (3)     RY      5,6     I2   *
*         EVENT: CODE                      (4)     EV      7,8     I2   *
*           01 REGISTRATION                                             *
*           02 ADMISSION                                                *
*           03 ASSIGNMENT                                               *
*           04 HISTORY                                                  *
*           05 ORAL EXAM                                                *
*           06 RADIOG EXAM                                              *
*           07 LAB EXAM                                                 *
*           08 CONSULTATION                                             *
*           09 TREAT/PLAN                                               *
*           10 TREATMENT                                                *
*           11 REVIEW                                                   *
*           12 DISCHARGE                                                *
*         CARD TYPE: CODE                  (5)     CT      9,10    I2   *
*           01 NAME CARD                                                *
*           02 TEXT CARD                                                *
*         CARD SEQUENCE                    (6)     CS     11,12    I2   *
*         HOSPITAL NO.                     (7)     NO     13-18    I6   *
*         TOOTH DESIGNATION (FDI CODE)     (8)      T     19,20    I2   *
*         ALPHANUMERIC DATA          (9)-(14)    BCD     21-80   6A10  *
*   THREE INDEX NUMBERS ARE GENERATED FOR EACH RECORD: N1- THE SEQUENCE*
* NUMBER OF THE RECORD IN THE CARD FILE; N2- A NUMBER COMPOUNDED OF    *
* HOSPITAL NUMBER, RECORD YEAR, RECORD MONTH, RECORD DAY; N3- A NUMBER *
* COMPOUNDED FROM EVENT, CARD TYPE, CARD SEQUENCE.  THE CARD IMAGES    *
* PRECEDED BY THEIR INDEX NUMBERS ARE WRITTEN ON TAPE 2.               *
*   AN INDEX TO THE TAPE 2 FILE IS PREPARED AS ONE LOGICAL RECORD      *
* WRITTEN ON TAPE 3: IP- PATIENTS HOSPITAL NUMBERS; IQ- FIRST RECORD   *
* SEQUENCE NUMBERS; IR- NUMBERS OF RECORDS.  THE INDEX LOGICAL RECORD  *
* IS FOLLOWED BY RECORDS WRITTEN ON TAPE 3 FROM TAPE 2.                *
```

```
      DIMENSION M(14),IP(100),IQ(100),IR(100)

* GET DATE, INITIALIZE
      CALL KDATE(KK)$ DECODE(6,1,KK)KY,KM,KD$ PRINT2,KD,KM,KY
    1 FORMAT(3I2)
    2 FORMAT(1H1// 20X*TAPE 2 AS AT*,I3,2(*/*,I2)/)
      REWIND 2$ REWIND 3$ N1=0$ DO102I=1,100
  102 IP(I)=IQ(I)=IR(I)=0

* READ CARDS, GENERATE INDEX NUMBERS, WRITE ON TAPE2, LIST
    3 READ4,M$ IF(EOF,1)7,5
    4 FORMAT(6I2,I6,I2,6A10)
    5 N1=N1+1$ N2=M(7)*10**6+M(3)*10**4+M(2)*10**2+M(1)
       N3=M(4)*10**4+M(5)*10**2+M(6)
      WRITE(2)N1,N2,N3,M$ PRINT6,N1,N2,N3,M$ GOTO3
    6 FORMAT(10XI3,I13,I7,6I3,I7,I3,X6A10)
    7 ENDFILE 2$ REWIND 2 $            NO=NR=IN=0

* PREPARE INDEX OF PATIENTS WITH RECORDS AND WRITE ON TAPE3, LIST
    8 READ(2)N1,N2,N3,M$ IF(EOF,2)14,9
    9 IF(NO.EQ.0)13,10
   10 IF(NO.EQ.M(7))11,12
   11 NR=NR+1$ GOTO8
   12 IP(IN)=NO$ IR(IN)=NR
   13 NO=M(7)$ NR=1$ IN=IN+1$ IQ(IN)=N1$ GOTO8
   14 IP(IN)=NO$ IR(IN)=NR$WRITE(3)IP,IQ,IR$PRINT15,IP,IQ,IR$ REWIND 2
   15 FORMAT(10X20I6)

* COPY TAPE 2 TO TAPE 3 AND ENDFILE
   20 READ(2) N1,N2,N3,M$ IF(EOF,2)22,21
   21 WRITE(3)N1,N2,N3,M$ GOTO20
   22 ENDFILE 3$ REWIND 3
      STOP$ END
```

```
      PROGRAM CN2(INPUT,OUTPUT,TAPE1=INPUT,TAPE2,TAPE3,TAPE4)
*   THIS PROGRAM SIMULATES ON-LINE INTERACTION BETWEEN DENTIST AND      *
* COMPUTER VIA TYPEWRITER KEYBOARD AND VISUAL DISPLAY UNIT.  WITH THIS *
* EXPERIMENTAL PROGRAM THE DENTIST COMMUNICATES VIA PUNCHED CARDS AND  *
* THE COMPUTER VIA PRINTOUTS.                                          *
*   CARD INPUT FORMAT IS AS FOLLOWS:                                   *
*                  VARIABLE                NAME   COLS   FORMAT       *
*             (1) HOSPITAL NO.              NN     1-6     I6         *
*             (2) RESPONSE CODE             RC     7,8     I2         *
*                       01 = ARE PATIENTS RECORDS ON FILE QUERY        *
*                       02 = LIST SPECIFIED EVENTS                     *
*                       03 = HOW MANY TREATMENT VISITS                 *
*                       04 = REFERENCES TO SPECIFIED TOOTH             *
*                            (FDI CODE IN COLS 9,10)                   *
*                       05 = ORTHO PROGRESS REPORT                     *
*             (3) FROM MONTH                FM     9,10    I2         *
*             (4) FROM YEAR                 FY     11,12   I2         *
*       (5)-(16) SPECIFIED EVENTS           SP     13-24  12I1        *
*                       0 = NO; 1 = YES IN COLUMNS AS BELOW:           *
*   13 REGISTRATION       17 ORAL EXAM            21 TREAT/PLAN        *
*   14 ADMISSION          18 RADIOG EXAM          22 TREATMENT         *
*   15 ASSIGNMENT         19 LAB EXAM             23 REVIEW            *
*   16 HISTORY            20 CONSULTATION         24 DISCHARGE         *
*      (17),(18) INQUIRER                 NM     25-44  2A10          *
*   INDICES OF ARRAYS ARE AS FOLLOWS:                                  *
*      L(1) RECORD NO.     M(3) RECORD YEAR     M(7) HOSPITAL NO.      *
*   L(2),(3) INDEX NOS.    M(4) EVENT           M(8) TOOTH             *
*      M(1) RECORD DAY     M(5) CARD TYPE        BCD TEXT DATA         *
*      M(2) RECORD MONTH   M(6) CARD SEQUENCE                          *
*   TAPES ARE USED IN THE PROGRAM AS FOLLOWS:                          *
*             TAPE1 = SPECIFICATION CARDS                              *
*             TAPE2 = SAVE TAPE HOLDING RECORDS FILE (TAPE K639)       *
*             TAPE3 = RECORDS FOR ONE PATIENT                          *
*             TAPE4 = NOTE WELL RECORDS TO BE PRINTED                  *
```

```
      DIMENSION L(3),M(8),IS(12),IP(100),IQ(100),IR(100),OD(100),NOV(7),
     XOBS(7),IT(6,7),LEG(6),NM(2),IM(8),IB(6),IH(12)
      INTEGER RC,FY,FM,SP(12),ROF,BCD(6),R1(5),R2(5),OS(100),DM,DY,TF,RM
     X,RY
      DATA (R1(I),I=1,5)/10HARE RECORD,10HSPECIFIED ,10HHOW MANY V,
     X10HSPECIFIED ,10HORTHO PROG/
      DATA (R2(I),I=1,5)/10HS ON FILE ,10HEVENTS    ,10HISITS     ,
     X10HTOOTH     ,10HRESS      /
      DATA (LEG(I),I=1,6)/10HPRE-TREAT ,10HSTAGE 1   ,10HSTAGE 2   ,
     X10HSTAGE 3   ,10HSTAGE 4   ,10HPOST-TREAT/
      DATA (IH(I),I=1,12)/
     X10HREGISTERED,10HADMITTED  ,10HASSIGNED  ,10HHISTORY   ,
     X10HORAL EXAM ,10HRADIOG XAM,10HLAB EXAM  ,10HCONSULT   ,
     X10HTREAT/PLAN,10HTREATED   ,10HREVIEWED  ,10HDISCHARGED/

* GET DATE, INITIALIZE
      CALL KDATE(KK)$ DECODE(6,1,KK)KY,KM,KD$ REWIND3$ REWIND4$ NI=0
    1 FORMAT(3I2)
    2 REWIND 2$ NB=0

* READ SPECIFICATION CARD
    3 NI=NI+1$ READ4,NN,RC,FM,FY,SP,NM$ IF(EOF,1)500,5
    4 FORMAT(I6,3I2,12I1,2A10)
    5 IF(NN.LT.1)NN=0$ IF(RC.LT.1)RC=0$ IF(FM.LT.1)FM=0$ IF(FY.LT.1)FY=0
      DO1005I=1,12$ IF(SP(I).LT.1)SP(I)=0
 1005 CONTINUE$ PRINT2005$ PRINT3005$ PRINT4005
 2005 FORMAT(1H1/////)
 3005 FORMAT(20X78(1H*))
 4005 FORMAT(20X1H*,76X1H*)
      PRINT5005,KD,KM,KY,NI,NM$PRINT4005
 5005 FORMAT(20X1H*,17XI2,2(*/*,I2),* INQUIRY*,I4,* BY*,X2A10,15X1H*)
      PRINT6,NN,RC,FM,FY,SP,NM$ PRINT4005
      CALL CHECK(NN,RC,FM,FY,SP,KY,IE)$ PRINT4005
    6 FORMAT(20X1H*,9X*INPUT DATA  *,I6,3I2,12I1,2A10,11X1H*)
      IF(RC.GE.1.AND.RC.LE.5)1006,3006
 1006 PRINT2006,R1(RC),R2(RC)$ PRINT4005$ IF(RC.NE.2)GOTO8005
```

```
2006 FORMAT(20X1H*,23X*INQUIRY -*,X2A10,23X1H*)
     DO7005I=1,12$ IF(SP(I).EQ.1)PRINT6005,IH(I)
6005 FORMAT(20X1H*,39XA10,27X1H*)
7005 CONTINUE$ PRINT4005
8005 IF(RC.NE.4)GOTO3006$ PRINT9005,FM$ PRINT4005
9005 FORMAT(20X1H*,39X*FDI*,I3,31X1H*)
3006 PRINT3005$ PRINT4006$ PRINT3005$ PRINT4005$ PRINT5006
4006 FORMAT(X//)
5006 FORMAT(1H+19X1H*,3X  *RESPONSE TO *)
     PRINT5005,KD,KM,KY,NI,NM$ PRINT4005$ IF(IE.GT.0)6006,8006
6006 PRINT7006$ PRINT4005$ PRINT3005$ GOTO3
7006 FORMAT(20X1H*,28X*INQUIRY NOT ANSWERED*,28X1H*)
8006 PRINT9006$ PRINT4005$ PRINT3005
9006 FORMAT(20X1H*,23X*SEE BELOW OR FOLLOWING FRAME*,25X1H*)

* QUERY RECORDS ON FILE
     ROF=NQ=NR=0$ READ(2)IP,IQ,IR$ DO7I=1,100
     IF(NN.GT.0.AND.NN.EQ.IP(I))8,7
   7 CONTINUE$ GOTO10
   8 ROF=1$ NQ=IQ(I)$ NR=IR(I)
     NTR=0$ DO9I=1,100
   9 NTR=NTR+IR(I)

* BRANCH ACCORDING TO RESPONSE CODE
  10 REWIND 2$ GOTO(11,21,51,61,81)RC

* RESPONSE 01 - ARE PATIENTS RECORDS ON FILE
  11 PRINT4006$ PRINT3005$ PRINT4005$ IF(ROF.EQ.1)GOTO13
     PRINT12,NN$ GOTO17
  12 FORMAT(20X1H*,
    X       17X*RECORDS NOT ON FILE FOR PATIENT NO.*,I7,17X1H*)
  13 PRINT14,NN$ PRINT4005$ N=0$ REWIND 2
  14 FORMAT(20X1H*,17X*RECORDS ARE ON FILE FOR PATIENT NO.*,I7,17X1H*)
  15 N=N+1$ READ(2)$ IF(N.EQ.NQ)16,15
  16 READ(2)L,M,BCD$ CALL PRINT(KD,KM,KY,M,BCD,RC)
  17 PRINT4005$ PRINT3005$ GOTO2
```

```
* RESPONSE 02 - IF RECORDS ON FILE EXCLUDE EVENTS NOT SPECIFIED
   21 IF(ROF.EQ.1)GOTO22$ PRINT12,NN$ GOTO2
   22 IN=0$ DO23I=1,12$ IF(SP(I).EQ.0)GOTO23$ IN=IN+1$ IS(IN)=I
   23 CONTINUE

* SHIFT PATIENTS RECORDS TO TAPE 3 AND NOTE WELL RECORDS TO TAPE 4
      CALL SHIFT(NQ,NR,L,M,BCD,NB)

* LIST RECORDS OF SPECIFIED EVENTS
   41 READ(3)L,M,BCD$ IF(EOF,3)50,42
   42 IF(M(4).EQ.1)43,44
   43 CALL PRINT(KD,KM,KY,M,BCD,RC)$ RM=M(2)$ RY=M(3)$ GOTO41
   44 IF(NB.EQ.0)GOTO47$ PRINT45
   45 FORMAT(20X1H*,2X73(1H*),X1H*)
      DO46I=1,NB$ READ(4)IM,IB$ CALL PRINT(KD,KM,KY,IM,IB,RC)
   46 CONTINUE$ PRINT45$ NB=0
   47 DO49I=2,IN$ IF(IS(I).EQ.M(4))48,49
   48 MM=(12*M(3)+M(2))-(12*FY+FM)$ IF(MM.LT.0)GOTO49
      CALL PRINT(KD,KM,KY,M,BCD,RC)
   49 CONTINUE$ GOTO41
   50 PRINT4005$ PRINT3005$ GOTO2

* RESPONSE 03 - HOW MANY TREATMENT VISITS
   51 IF(ROF.EQ.1)GOTO52$ PRINT12,NN$ GOTO2
   52 CALL SHIFT(NQ,NR,L,M,BCD,NB)$  NTV=0
   53 READ(3)L,M,BCD$ IF(EOF,3)58,54
   54 IF(M(4).EQ.1)55,56
   55 IF(M(5).EQ.1)155,255
  155 PRINT4006$ PRINT3005
  255 CALL PRINT(KD,KM,KY,M,BCD,RC)$ RM=M(2)$ RY=M(3)$ GOTO53
   56 IF(M(4).EQ.10.AND.M(5).EQ.1)57,53
   57 MM=(12*M(3)+M(2))-(12*FY+FM)$ IF(MM.LT.0)GOTO53$ NTV=NTV+1$GOTO 53
   58 IF(FM.EQ.0)FM=1$ IF(FY.EQ.0)FY=RY$ IF(FY.EQ.0)FM=RM
      PRINT4005$ PRINT4005$ PRINT59,NTV,FM,FY$ PRINT4005$PRINT3005$GOTO2
   59 FORMAT(20X1H*,I17,* TREATMENT VISITS FROM*,I3,*/*,I2,31X1H*)
```

```
* RESPONSE 04 - REFERENCES TO SPECIFIED TOOTH
   61 IF(ROF.EQ.1)GOTO62$ PRINT12,NN$ GOTO2
   62 CALL SHIFT(NQ,NR,L,M,BCD,NB)
   63 READ(3)L,M,BCD$ IF(EOF,3)2,64
   64 IF(M(4).EQ.1)65,66
   65 CALL PRINT(KD,KM,KY,M,BCD,RC)$ GOTO63
   66 IF(NB.EQ.0)GOTO68$ PRINT45
      DO67I=1,NB$ READ(4)IM,IB$ CALL PRINT(KD,KM,KY,IM,IB,RC)
   67 CONTINUE$ PRINT45$ NB=0$ GOTO63
   68 REWIND 3$ TF=0$ PD=0.
   69 READ(3)L,M,BCD$ IF(EOF,3)73,70
   70 IF(FM.EQ.M(8))71,69
   71 D=M(3)+M(2)/12.+M(1)/365.$ IF(D.EQ.PD)172,171
  171 PRINT72,M(1),M(2),M(3)
   72 FORMAT(1H+,19X1H*,I5,2(*/*,I2))
  172 CALL PRINT(KD,KM,KY,M,BCD,RC)$ PD=D$ TF=TF+1$ GOTO69
   73 IF(TF.EQ.0)74,50
   74 PRINT4005$ PRINT4005$ PRINT75,FM$ PRINT4005$ PRINT3005$ GOTO2
   75 FORMAT(20X1H*,13X*THERE ARE NO RECORDS OF TOOTH*,I3,* ON FILE*,13X
     X1H*)

* RESPONSE 05 - ORTHO TREATMENT PROGRESS
   81 IF(ROF.EQ.1)GOTO82$ PRINT 4006$ PRINT3005$ PRINT4005
      PRINT12,NN$ PRINT4005$ PRINT3005$ GOTO2
   82 CALL SHIFT(NQ,NR,L,M,BCD,NB)
      IN=0$ DO83I=1,100$ OS(I)=0$ OD=0.0
   83 CONTINUE$ ODD=0.
   84 READ(3)L,M,BCD$ IF(EOF,3)87,85
   85 IF(M(8).GE.90.AND.M(8).LE.95)86,84
   86 IN=IN+1$ OS(IN)=M(8)-90$ OD(IN)=M(3)+M(2)/12.+M(1)/365.
      IF(M(4).EQ.12.AND.M(8).EQ.95)ODD=M(3)+M(2)/12.+M(1)/365.$ GOTO84
   87 IF(IN.EQ.0)88,30
   88 PRINT4006$ PRINT3005$ PRINT4005$ PPINT89
   89 FORMAT(20X1H*,
     X       11X*THERE ARE NO RECORDS OF ORTHODONTIC TREATMENT ON FILE*,
     X12X1H*)
```

```
      PRINT4005$ PRINT3005$ GOTO2

*  LIST PATIENT, ORTHODONTIST, TREATMENT GROUP DATA
   30 REWIND 3
   31 READ(3)L,M,BCD$ IF(EOF,3)91,32
   32 IF(M(4).EQ.1)33,34
   33 CALL PRINT(KD,KM,KY,M,BCD,RC)$ GOTO31
   34 IF(NB.EQ.0)GOTO36$ PRINT45
      DO35I=1,NB$ READ(4)M,BCD$ CALL PRINT(KD,KM,KY,M,BCD,RC)
   35 CONTINUE$ PRINT45$ NB=0$ GOTO31
   36 IF(M(4).EQ.9)37,31
   37 IF(M(8).EQ.90)33,38
   38 IF(M(8).GE.1.AND.M(8).LE.9)33,31

*  SCREEN ORTHO TREATMENT RECORDS
   91 DO92I=1,7$ NOV(I)=0$ DBS(I)=0.
   92 CONTINUE$ DO95I=1,IN$ J=OS(I)+1$ DO93K=1,6$ IF(J.EQ.K)GOTO94
   93 CONTINUE
   94              IF(NOV(K).EQ.0)DBS(K)=OD(I)$ NOV(K)=NOV(K)+1
   95 CONTINUE$ DBS(7)=ODD$ IF(ODD.GT.0)NOV(6)=NOV(6)-1
      DO99I=1,6$ J=I+1$ K=I-1
      IT(I,1)=IT(I,3)=3H    $ IT(I,2)=IT(I,4)=IT(I,5)=IT(I,6)=IT(I,7)=0
      CALL DCB(DBS(I),IT(I,1),IT(I,2))$ IT(I,4)=NOV(I)
      IF(DBS(J).GT.0.)96,97
   96 IT(I,3)=3HYES
      IF(DBS(I).EQ.0)DBS(I)=DBS(K)
                     IT(I,5)=IFIX((DBS(J)-DBS(I))*12.)
   97 IF(I.GE.2.AND.I.LE.5)98,99
   98 IT(I,6)=IT(K,6)+IT(I,4)$ IT(I,7)=IT(K,7)+IT(I,5)
   99 CONTINUE$ J=0$DO100I=1,6$ IF(IT(I,4).GT.0)J=J+1
  100 CONTINUE

*  OUTPUT ORTHO PROGRESS REPORT
      PRINT4005$ PRINT4005$ PRINT101$ PRINT4005$ DO102I=1,J
  101 FORMAT(20X1H*,24X
     X*STAGE*,7X*WITHIN-STAGE*,5X*CUMULATIVE*,13X1H*/20X1H*,
     X20X*BEGAN   ENDED  VISITS  MONTHS  VISITS  MONTHS*,11X1H*)
```

```
102 PRINT103,LEG(I),(IT(I,J),J=1,7)$ PRINT4005$ IF(ODD.EQ.0.)104,107
103 FORMAT(20X1H*,9XA10,XA3,I3,3XA3,I7,3I8,13X1H*)
104 PRINT105$ PRINT4005$ PRINT3005$ GOTO2
105 FORMAT(20X1H*,9X*PATIENT NOT YET DISCHARGED*,41X1H*)
107 DM=3H    $ DY=0$ CALL DCB(ODD,DM,DY)$ PRINT 108,DM,DY
    PRINT4005$ PRINT3005$ GOTO2
108 FORMAT(20X1H*,9X*PATIENT DISCHARGED - *,A3,I3,40X1H*)
500 STOP 500$ END
```

```
      SUBROUTINE CHECK(NN,RC,FM,FY,SP,KY,IE)
      INTEGER RC,FM,FY,SP(12),TC
*     THIS ROUTINE CHECKS FOR ERRORS IN RESPONSE SPECIFICATION CARD.     *
      IE=0$ IF(NN.EQ.0)1,3
    1 PRINT2$ IE=IE+1
    2 FORMAT(20X1H*,13X
     X          *YOU SHOULD SPECIFY THE HOSPITAL NO. OF YOUR PATIENT*,
     X12X1H*)
    3 IF(RC.EQ.0)4,6
    4 PRINT 5$ IE=IE+1
    5 FORMAT(20X1H*,13X
     X          *YOU SHOULD SPECIFY THE RESPONSE YOU REQUIRE*,20X1H*)
    6 IF(RC.EQ.1)GOTO22$ IF(RC.EQ.4)GOTO19$ IF(RC.GT.5)7,9
    7 PRINT8,RC$ IE=IE+1
    8 FORMAT(20X1H*,13X
     X*RESPONSE*,I3,* IS NOT IN THE PROGRAM YET*,26X1H*)
    9 IF(FM.GT.12)10,12
   10 PRINT11,FM$ IE=IE+1
   11 FORMAT(20X1H*,13X
     X          *YOU HAVE SPECIFIED MONTH*,I3,36X1H*)
   12 IF(FY.GT.KY)13,15
   13 PRINT14,FY
   14 FORMAT(20X1H*,13X
     X          *YOU HAVE SPECIFIED YEAR*,I3,* - CHECK THIS*,24X1H*)
   15 IF(SP(1).EQ.0)SP(1)=1$ DO18I=1,12$ IF(SP(I).GT.1)16,18
   16 PRINT17,SP(I)$ IE=IE+1
   17 FORMAT(20X1H*,13X
     X          *YOUR SPECIFICATION*,I3,* IS ILLEGAL*,31X1H*)
   18 CONTINUE$ GOTO22
   19 TC=0$ IF(FM.LT.11.OR.FM.GT.85)TC=TC+1
      IF(FM.GT.18.AND.FM.LT.21)TC=TC+1$ IF(FM.GT.28.AND.FM.LT.31)TC=TC+1
      IF(FM.GT.38.AND.FM.LT.41)TC=TC+1$ IF(FM.GT.48.AND.FM.LT.51)TC=TC+1
      IF(FM.GT.55.AND.FM.LT.61)TC=TC+1$ IF(FM.GT.65.AND.FM.LT.71)TC=TC+1
      IF(FM.GT.75.AND.FM.LT.81)TC=TC+1$ IE=IE+TC$ IF(TC.GT.0)20,22
```

```
20 PRINT 21
21 FORMAT(20X1H*,13X
  X          *YOUR TOOTH CODE SPECIFICATION IS ILLEGAL*,23X1H*)
22 IF(IE.EQ.0)GOTO25$ IF(IE.EQ.1)PRINT23$    IF(IE.GT.1)PRINT24,IE
23 FORMAT(20X1H*,13X
  X           *THERE IS AT LEAST 1 ERROR IN YOUR DEMAND - TRY AGAIN*,
  X11X1H*)
24 FORMAT(20X1H*,13X
  X           *THERE ARE AT LEAST*,I3,* ERRORS IN YOUR DEMAND - TRY A
  XGAIN*,8X1H*)
25 RETURN$ END
```

```
      SUBROUTINE PRINT(KD,KM,KY,M,BCD,IR)

*****************************************************************************
*                                                                           *
*   THIS ROUTINE ACCEPTS CODED CASENOTES RECORDS AND PRINTS THEM IN         *
* DECODED FORM.                                                             *
*                                                                           *
*****************************************************************************

      DIMENSION TI(6),ST(6),IH(12),BCD(6),NM(2),PN(2),M(8)
      INTEGER PAGE,PN,YB
      INTEGER TI,ST,RD,RM,RY,EV,CT,CS,T,BCD,TIT,S,BD,BM,BY,AGE,PT,DT
      DATA (TI(I),I=1,6)/4H  MR,4HMISS,4H MRS,4H  DR,4HPROF,4HMAST/
      DATA (ST(I),I=1,6)/3H3RD,3H4TH,3H5TH,3HP/G,3HHON,3HST /
      DATA (IH(I),I=1,12)/
     X10HREGISTERED,10HADMITTED  ,10HASSIGNED  ,10HHISTORY   ,
     X10HORAL EXAM ,10HRADIOG XAM,10HLAB EXAM  ,10HCONSULT   ,
     X10HTREAT/PLAN,10HTREATED   ,10HREVIEWED  ,10HDISCHARGED/
    1 FORMAT(20X78(1H*))
    2 FORMAT(20X1H*,76X1H*)
    3 FORMAT(1H1/////)
    4 FORMAT(20X1H*,53X*CONTINUED ON FRAME*,I3,2X1H*)
      RD=M(1)$ RM=M(2)$ RY=M(3)$ EV=M(4)
      CT=M(5)$ CS=M(6)$ NO=M(7)$ T=M(8)
      GOTO(11,51)CT
* CARD TYPE 1 FOUND
   11 DECODE(28,12,BCD)NM,TIT,S,BD,BM,BY
   12 FORMAT(2A10,2I1,3I2)
      IF(EV.EQ.1)GOTO13$ IF(EV.EQ.2)GOTO21$ GOTO31

* REGISTRATION RECORD
   13 IF(IR.EQ.1.OR.IR.EQ.3)GOTO15$ PRINT3$ PRINT1$ PRINT2
      NEP=0$ PAGE=1$ PRINT14,KD,KM,KY,PAGE$ NL=6
   14 FORMAT(20X1H*,25X*RESPONSE*,I3,2(*/*,I2),* FRAME*,I3,25X1H*)
   15 AGE=RY-BY$ IF(AGE.LE.0)AGE=100+AGE$ PN(1)=NM(1)$  PN(2)=NM(2)
      PT=TI(TIT)$ IF(AGE.LE.14.AND.TIT.EQ.1)PT=TI(6) $ YB=BY$ PRINT2
```

```
      PRINT16,NO,PT,NM,BD,BM,BY,IH(1),RD,RM,RY,AGE$ NL=NL+1$ GOTO60
   16 FORMAT(20X1H*,I7, XA4,X2A10,*B/D*,I3,2(*/*,I2),XA10,I3,2(*/*,I2),*
     X    AGE*,I3,2X1H*)
   17 FORMAT(20X1H*,I7 ,XA4,X2A10,43X1H*)

*  ADMISSION RECORD
   21 IF(NL.GE.30)22,23
   22 PAGE=PAGE+1$PRINT2$PRINT4,PAGE$PRINT2$PRINT1$PRINT3$PRINT1$PRINT2
      PRINT14,KD,KM,KY,PAGE$ PRINT17,NO,PT,PN$ NL=6
   23 AGE=RY-YB$ IF(AGE.LE.0)AGE=100+AGE
      DT=TI(TIT)$ IS=ST(S)
      NEP=NEP+1$ PRINT2$ PRINT24,NEP,AGE$ NL=NL+1
   24 FORMAT(20X1H*,3X*EPISODE*,I3,55X*AGE*,I3,2X1H*)
      PRINT25,RD,RM,RY,IH(EV),DT,NM,IS$ NL=NL+1$ GOTO60
   25 FORMAT(20X1H*,I7,2(*/*,I2),XA10,XA4,X2A10,XA3,22X1H*)

*  OTHER RECORDS
   31 IF(NL.GE.30)32,33
   32 PAGE=PAGE+1$PRINT2$PRINT4,PAGE$PRINT2$PRINT1$PRINT3$PRINT1$PRINT2
      PRINT14,KD,KM,KY,PAGE$ PRINT17,NO,PT,PN$ PRINT2$ NL=6
   33 DT=TI(TIT)$ IS=ST(S)
      PRINT25,RD,RM,RY,IH(EV),DT,NM,IS$ NL=NL+1$ GOTO60

*  CARD TYPE 2 FOUND
   51 IF(NL.GE.30)52,53
   52 PAGE=PAGE+1$PRINT2$PRINT4,PAGE$PRINT2$PRINT1$PRINT3$PRINT1$PRINT2
      PRINT14,KD,KM,KY,PAGE$ PRINT17,NO,PT,PN$ PRINT2$ NL=6
   53 IF(T.EQ.0.OR.T.EQ.99)GOTO56
      PRINT54,T,BCD$ NL=NL+1$ GOTO60
   54 FORMAT(20X1H*,12XI2,X6A10,X1H*)
   56 PRINT57,BCD$ NL=NL+1$ GOTO60
   57 FORMAT(20X1H*,15X6A10,X1H*)

*  END PROCESSING
   60 RETURN$ END
```

```
      SUBROUTINE SHIFT(NQ,NR,L,M,BCD,NB)

*****************************************************************************
*                                                                           *
*   THIS ROUTINE SHIFTS PATIENTS RECORDS FROM TAPE 2 TO TAPE 3.  NQ IS      *
* BEGINNING INDEX NUMBER AND NR IS NUMBER OF RECORDS TO BE COPIED.          *
* THESE ARE COMPUTED IN FIRST SEARCH OF TAPE 2 IN MAIN PROGRAM - QUERY      *
* RECORDS ON FILE.  IN ADDITION THE NOTE WELL RECORDS ARE SHIFTED TO        *
* TAPE 4 FOR LISTING AFTER REGISTRATION RECORDS.                            *
*                                                                           *
*****************************************************************************

      DIMENSION L(3),M(8)
      INTEGER BCD(6)
      REWIND 3$ REWIND 4$ N=NB=0
    1 N=N+1$ READ(2)$ IF(N.EQ.NQ)2,1
    2 N=0
    3 N=N+1$ READ(2)L,M,BCD$ WRITE(3)L,M,BCD$ IF(M(8).EQ.99)4,5
    4 NB=NB+1$ WRITE(4)M,BCD
    5 IF(N.EQ.NR)6,3
    6 ENDFILE 3$ REWIND 3 $ ENDFILE 4$ REWIND 4
      RETURN$ END
```

```
      SUBROUTINE DCB(DY,IM,IY)
      DIMENSION M(12)
*****************************************************************************
*                                                                           *
*   THIS ROUTINE DECODES DECIMAL YEAR TO INTEGER MONTH IN ALPHA             *
* CHARACTERS AND INTEGER YEAR.                                              *
*                                                                           *
*****************************************************************************

      DATA (M(I),I=1,12)/3HJAN,3HFEB,3HMAR,3HAPR,3HMAY,3HJUN,3HJUL,3HAUG
     X,3HSEP,3HOCT,3HNOV,3HDEC/
      IF(DY.EQ.0.0)GOTO1
      IY=INT(DY)$ J=IFIX((DY-IY)*12.)$ IM=M(J)
    1 RETURN$ END
```

A DENTAL FILE PRINTOUT

28	7316650520	10101	20	5	65	1	1	1	7316	-0	MC KENZIE,A.	3 260334
29	7316650520	10201	20	5	65	1	2	1	7316	-0	65 MOREA ST., OSBORNE, 5017	
30	7316650520	20101	20	5	65	2	1	1	7316	-0	MINKIEWICZ,I.A.	36
31	7316650520	40101	20	5	65	4	1	1	7316	-0	MINKIEWICZ,I.A.	36
32	7316650520	40201	20	5	65	4	2	1	7316	-0	ATTENDED FOR ROUTINE CHECK	
33	7316650520	50101	20	5	65	5	1	1	7316	-0	MINKIEWICZ,I.A.	36
34	7316650520	50201	20	5	65	5	2	1	7316	22	CARIOUS	
35	7316650520	50202	20	5	65	5	2	2	7316	47	CARIOUS	
36	7316650520	90101	20	5	65	9	1	1	7316	-0	MINKIEWICZ,I.A.	36
37	7316650520	90201	20	5	65	9	2	1	7316	-0	APPOINT ROP. SPECIAL W/L FILLINGS	
38	7316650520	50201	20	5	65	5	2	1	7316	-0	EXAM. SPECIAL W/L FILLINGS. APPOINT ROP.	
39	7316650527	100101	27	5	65	10	1	1	7316	-0	MACKENZIE,I.A.	46
40	7316650527	100201	27	5	65	10	2	1	7316	22	CARIES REMOVED. KALZINOL DRESSING.	
41	7316650527	120101	27	5	65	12	1	1	7316	-0	MACKENZIE,I.A.	46
42	7316650527	120201	27	5	65	12	2	1	7316	-0	ROUTINE CHECK, 22 ROP, SPECIAL W/L FILLINGS	
43	7316651015	20101	15	10	65	2	1	1	7316	-0	SCOLLIN,J.	46
44	7316651015	40101	15	10	65	4	1	1	7316	-0	SCOLLIN,J.	46
45	7316651015	40201	15	10	65	4	2	1	7316	-0	COMPLAINED OF TOOTHACHE ON BITING	
46	7316651015	50101	15	10	65	5	1	1	7316	-0	SCOLLIN,J.	46
47	7316651015	50201	15	10	65	5	2	1	7316	36	CAUSING PAIN	
48	7316651015	100101	15	10	65	10	1	1	7316	-0	SMITH,J.D.	46
49	7316651015	100201	15	10	65	10	2	1	7316	36	KALZINOL DRESSING.	
50	7316651015	120101	15	10	65	12	1	1	7316	-0	SMITH,J.D.	46
51	7316651015	120201	15	10	65	12	2	1	7316	-0	36 ROP	
52	7316651122	20101	22	11	65	2	1	1	7316	-0	CHEETHAM,J.D.	46
53	7316651122	30101	22	11	65	3	1	1	7316	-0	CHEETHAM,J.D.	46
54	7316651122	100101	22	11	65	10	1	1	7316	-0	CHEETHAM,J.D.	46
55	7316651122	100201	22	11	65	10	2	1	7316	36	AMALGAM. KALZINOL BASE. LA.	
56	7316651129	100101	29	11	65	10	1	1	7316	-0	CHEETHAM,J.D.	46
57	7316651129	100201	29	11	65	10	2	1	7316	47	AMALGAM. KALZINOL BASE.	
58	7316651216	100101	16	12	65	10	1	1	7316	-0	CHEETHAM,J.D.	46
59	7316651216	100201	16	12	65	10	2	1	7316	22	PREPARED FOR 3/4 CROWN VENEER. 2 PINS.	
60	7316651222	100101	22	12	65	10	1	1	7316	-0	CHEETHAM,J.D.	46
61	7316651222	100201	22	12	65	10	2	1	7316	22	CROWN INSERTED.	
62	7316660107	100101	7	1	66	10	1	1	7316	-0	CHEETHAM,J.D.	46
63	7316660107	100201	7	1	66	10	2	1	7316	-0	POLISH. TREATMENT COMPLETED.	
64	7316660107	120101	7	1	66	12	1	1	7316	-0	CHEETHAM,J.D.	46
65	7316660107	120201	7	1	66	12	2	1	7316	-0	FROM W/L. INLAY AND SIMPLE AMALGAMS COMPLETED	
66	7316660929	20101	29	9	66	2	1	1	7316	-0	SCOLLIN,J.	46
67	7316660929	40101	29	9	66	4	1	1	7316	-0	SCOLLIN,J.	46
68	7316660929	40201	29	9	66	4	2	1	7316	-0	ATTENDED FOR ROUTINE CHECK	
69	7316660929	50101	29	9	66	5	1	1	7316	-0	SCOLLIN,J.	46
70	7316660929	50201	29	9	66	5	2	1	7316	36	CARIOUS	
71	7316660929	120101	29	9	66	12	1	1	7316	-0	SCOLLIN,J.	46

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 72  7316660929 120201 29  9 66 12  2  1   7316 -0 NO TREATMENT PRESCRIBED
 73  7316670109  20101  9  1 67  2  1  1   7316 -0 KUUSK,S.                46
 74  7316670109  40101  9  1 67  4  1  1   7316 -0 KUUSK,S.                46
 75  7316670109  40201  9  1 67  4  2  1   7316 -0 COMPLAINED OF PAIN ON EATING IN REGION OF 21,22
 76  7316670109  50101  9  1 67  5  1  1   7316 -0 KUUSK,S.                46
 77  7316670109  50201  9  1 67  5  2  1   7316 22 SLIGHTLY SENSITIVE TO PERCUSSION
 78  7316670109  60101  9  1 67  6  1  1   7316 -0 KUUSK,S.                46
 79  7316670109  60201  9  1 67  6  2  1   7316 21 PERIAPICAL VIEW    - REPORT - NAD
 80  7316670109  60202  9  1 67  6  2  2   7316 22 PERIAPICAL VIEW    - REPORT - NAD
 81  7316670109  90101  9  1 67  9  1  1   7316 -0 KUUSK,S.                46
 82  7316670109  90201  9  1 67  9  2  1   7316 -0 DIAGNOSIS - 22 PULP PROBABLY DYING. TCA 1/52 FOR NEW RADIOG
 83  7316670109  90202  9  1 67  9  2  2   7316 -0 AND PULP TEST.
 84  7316670116 120101 16  1 67 12  1  1   7316 -0 KUUSK,S.                46
 85  7316670116 120201 16  1 67 12  2  1   7316 -0 PRESENTED 22 WITH MILD PAIN. RADIOGRAPH NAD. QUERY PAIN
 86  7316670116 120202 16  1 67 12  2  2   7316 -0 ASSOCIATED WITH PINNED INLAY. QUERY DEGENERATING PULP.
 87  7316670116 120203 16  1 67 12  2  3   7316 -0 FAILED TO RETURN AFTER 1/52 FOR CHECK.
 88  7316670330  20101 30  3 67  2  1  1   7316 -0 SCOLLIN,J.             46
 89  7316670330 100101 30  3 67 10  1  1   7316 -0 OTHER,A.N.              46
 90  7316670330 100201 30  3 67 10  2  1   7316 12 ROP. KALZINOL DRESSING.
 91  7316670330 120101 30  3 67 12  1  1   7316 -0 OTHER,A.N.              46
 92  7316670330 120201 30  3 67 12  2  1   7316 -0 12 FRACTURED. ROP.
 93  7316670426  20101 26  4 67  2  1  1   7316 -0 HEW                    36
 94  7316680426  40101 26  4 68  4  1  1   7316 -0 HEW                    36
 95  7316680426  40201 26  4 68  4  2  1   7316 -0 PATIENT REQUESTS INLAY FOR 12
 96  7316680426 110101 26  4 68 11  1  1   7316 -0 JOYCE,W.E.              45
 97  7316680603  30101  3  6 68  3  1  1   7316 -0 CASTLE,D.T.            13
 98  7316680603  40101  3  6 68  4  1  1   7316 -0 CASTLE,D.              13
 99  7316680603  40201  3  6 68  4  2  1   7316 -0 CHIEF COMPLAINT - INLAY FALLEN OUT, NO TOOTHACHE
100  7316680603  40202  3  6 68  4  2  2   7316 -0 DENTAL HISTORY - PATIENT HAS ATTENDED RAH DENT DEPT FOR ROP,
101  7316680603  40203  3  6 68  4  2  3   7316 -0 ROUTINE CHECKS AND FILLINGS OVER SEVERAL YEARS. ACCEPTED FOR
102  7316680603  40204  3  6 68  4  2  4   7316 -0 5TH YR COMPLEX CONS AND ASSIGNED TO MR CASTLE.
103  7316680603  40205  3  6 68  4  2  5   7316 -0 MEDICAL HISTORY - POLIO WHEN CHILD - UNEVENTFUL RECOVERY.
104  7316680603  40206  3  6 68  4  2  6   7316 -0 PATIENT SAYS SHE IS OVERWEIGHT AND EXPERIENCES MILD
105  7316680603  40207  3  6 68  4  2  7   7316 -0 DIZZINESS. QUERY HYPERTENSION. NOT CURRENTLY UNDER MEDICAL
106  7316680603  40208  3  6 68  4  2  8   7316 -0 SUPERVISION OR TAKING DRUGS. HAS HAD 8 CHILDREN.
107  7316680603  50101  3  6 68  5  1  1   7316 -0 CASTLE,D.              13
108  7316680603  50201  3  6 68  5  2  1   7316 -0 SOFT TISSUES NAD. ANGLE CLASS II MALOCCLUSION
109  7316680603  50202  3  6 68  5  2  2   7316 -0 TEETH MISSING - 18,28,17,38,44,48
110  7316680603  50203  3  6 68  5  2  3   7316 13 MESIAL CARIES
111  7316680603  50204  3  6 68  5  2  4   7316 12 MESIAL CARIES
112  7316680603  50205  3  6 68  5  2  5   7316 22 LINGUAL CARIES AND TENDER TO PERCUSSION
113  7316680603  50206  3  6 68  5  2  6   7316 26 DISTAL,LINGUAL CARIES
114  7316680603  50207  3  6 68  5  2  7   7316 27 DISTAL CARIES
115  7316680603  50208  3  6 68  5  2  8   7316 37 DISTAL CARIES
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116	7316680603	50209	3	6	68	5	2	9	7316	35	DISTAL CARIES
117	7316680603	50210	3	6	68	5	2	10	7316	34	DISTAL CARIES
118	7316680603	50211	3	6	68	5	2	11	7316	-0	MANY RESTORATIONS UNSATISFACTORY. IN GENERAL MARGINS ARE
119	7316680603	50212	3	6	68	5	2	12	7316	-0	UNSOUND AND DISCOLOURED BUT NOT DUE TO RECURRENT CARIES.
120	7316680603	90101	3	6	68	9	1	1	7316	-0	CASTLE,D.T. 13
121	7316680603	90201	3	6	68	9	2	1	7316	-0	AMALGAMS - 35MOD, 34DO, 36MOD PINNED, 37MOD PINNED, 45DO,
122	7316680603	90202	3	6	68	9	2	2	7316	-0	46DO,BU, 24DO, 25MOD, 27MOD,LI, 13D-LI, 16MOD PINNED, 22LI
123	7316680603	90203	3	6	68	9	2	3	7316	-0	GOLD - 14BU INLAY, 21D INLAY, 46,47 FULL CROWN, 36 FULL
124	7316680603	90204	3	6	68	9	2	4	7316	-0	CROWN, 12 3/4 VENEER, BRIDGE ABUTMENTS - 14 3/4 VENEER,
125	7316680603	90205	3	6	68	9	2	5	7316	-0	16 FULL CROWN, 11 D-LI 1/2 VENEER
126	7316680603	90206	3	6	68	9	2	6	7316	-0	PULPECTOMY 22.
127	7316680603	100101	3	6	68	10	1	1	7316	-0	CASTLE,D. 13
128	7316680603	100201	3	6	68	10	2	1	7316	-0	PROPHY. EXAM. RADIOGRAPHS.
129	7316680603	100202	3	6	68	10	2	2	7316	21	RE-CEMENT DISTAL INLAY.
130	7316680603	60101	3	6	68	6	1	1	7316	-0	CASTLE,D. 13
131	7316680603	60201	3	6	68	6	2	1	7316	-0	R AND L BITEWINGS - REPORT
132	7316680603	60202	3	6	68	6	2	2	7316	16	DISTAL CARIES
133	7316680603	60203	3	6	68	6	2	3	7316	37	DISTAL CARIES
134	7316680603	60204	3	6	68	6	2	4	7316	35	DISTAL CARIES
135	7316680605	100101	5	6	68	10	1	1	7316	-0	CASTLE,D. 13
136	7316680605	100201	5	6	68	10	2	1	7316	-0	TREATMENT PLAN. RADIOGRAPHS.
137	7316680605	100202	5	6	68	10	2	2	7316	35	DISTAL DRESSING.
138	7316680605	100203	5	6	68	10	2	3	7316	12	MESIAL DRESSING.
139	7316680605	100204	5	6	68	10	2	4	7316	21	DISTAL DRESSING
140	7316680605	60101	5	6	68	6	1	1	7316	-0	CASTLE,D. 13
141	7316680605	60201	5	6	68	6	2	1	7316	-0	FULL MOUTH SURVEY - REPORT
142	7316680605	60202	5	6	68	6	2	2	7316	22	PERIAPICAL PATHOLOGY
143	7316680612	100101	12	6	68	10	1	1	7316	-0	CASTLE,D. 13
144	7316680612	100201	12	6	68	10	2	1	7316	36	MOD PINNED AMALGAM. KALZINOL BASE.
145	7316680612	100202	12	6	68	10	2	2	7316	35	MOD AMALGAM. DYCAL AND COPALITE.
146	7316680612	100203	12	6	68	10	2	3	7316	34	DO AMALGAM. KALZINOL BASE.
147	7316680612	100204	12	6	68	10	2	4	7316	37	MOD PREPARED. CARIES FREE.
148	7316680617	100101	17	6	68	10	1	1	7316	-0	CASTLE,D. 13
149	7316680617	100201	17	6	68	10	2	1	7316	22	PULPECTOMY. CANAL REAMED TO NO. 3 REAMER. LENGTH
150	7316680617	100202	17	6	68	10	2	2	7316	22	DETERMINED AT 20.5 MM BY RADIOG. CULTURE TAKEN.
151	7316680617	100203	17	6	68	10	2	3	7316	22	SAVLON DRESSING. CANAL SEALED WITH CAVIT.
152	7316680617	60101	17	6	68	6	1	1	7316	-0	CASTLE,D. 13
153	7316680617	60201	17	6	68	6	2	1	7316	22	PERIAPICAL VIEWS FOR ENDO
154	7316680617	70101	17	6	68	7	1	1	7316	-0	CASTLE,D. 13
155	7316680617	70201	17	6	68	7	2	1	7316	22	ENDO CULTURE REPORT. NEGATIVE
156	7316680619	100101	19	6	68	10	1	1	7316	-0	CASTLE,D. 13
157	7316680619	100201	19	6	68	10	2	1	7316	22	PULPECTOMY. CANAL FILLED WITH AH26 AND GP POINTS.
158	7316680619	100202	19	6	68	10	2	2	7316	22	SEALED WITH ZNP04 CEMENT.
159	7316680626	100101	26	6	68	10	1	1	7316	-0	CASTLE,D. 13

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160  7316680626 100201 26  6 68 10  2  1   7316 -0 PATIENT CANCELLED
161  7316680703 100101  3  7 68 10  1  1   7316 -0 CASTLE,D.              13
162  7316680703 100201  3  7 68 10  2  1   7316 37 MOD AMALGAM - 2 DISTAL PINS CEMENTED. COMPLETED.
163  7316680710 100101 10  7 68 10  1  1   7316 -0 CASTLE,D.              13
164  7316680710 100201 10  7 68 10  2  1   7316 46 DOB AMALGAM - D-B PINHOLE STRUCK PULP. PULPDENT AND
165  7316680710 100202 10  7 68 10  2  2   7316 46 CAVIT PLACED. TO BE OBSERVED.
166  7316680710 100203 10  7 68 10  2  3   7316 45 DO AMALGAM - KALZINOL AND COPALITE. COMPLETED.
167  7316680710 100204 10  7 68 10  2  4   7316 34 DO AMALGAM POLISHED
168  7316680710 100205 10  7 68 10  2  5   7316 35 MOD AMALGAM POLISHED
169  7316680710 100206 10  7 68 10  2  6   7316 36 MOD AMALGAM POLISHED
170  7316680710 100207 10  7 68 10  2  7   7316 37 MOD AMALGAM POLISHED
171  7316680717 100101 17  7 68 10  1  1   7316 -0 CASTLE,D.              13
172  7316680717 100201 17  7 68 10  2  1   7316 46 DOB AMALGAM - DYCAL AND COPALITE, PACKED. COMPLETE.
173  7316680724 100101 24  7 68 10  1  1   7316 -0 CASTLE,D.              13
174  7316680724 100201 24  7 68 10  2  1   7316 16 MOD PINNED AMALGAM - DYCAL - INSERTED.
175  7316680724 100202 24  7 68 10  2  2   7316 13 D AMALGAM INSERTED WITH DYCAL LINING
176  7316680731 100101 31  7 68 10  1  1   7316 -0 CASTLE,D.              13
177  7316680731 100201 31  7 68 10  2  1   7316 27 MOD AMALGAM INSERTED WITH DYCAL LINING
178  7316680731 100202 31  7 68 10  2  2   7316 27 LI AMALGAM INSERTED WITH DYCAL LINING
179  7316680731 100203 31  7 68 10  2  3   7316 24 DO CAVITY PREP. ZNO-EUG DRESSING
180  7316680828 100101 28  8 68 10  1  1   7316 -0 CASTLE,D.              13
181  7316680828 100201 28  8 68 10  2  1   7316 24 DO AMALGAM INSERTED
182  7316680828 100202 28  8 68 10  2  2   7316 14 B CLASS V INLAY CAVITY PREPARED AND WAX PATTERN
183  7316680902 100101  2  9 68 10  1  1   7316 -0 CASTLE,D.              13
184  7316680902 100201  2  9 68 10  2  1   7316 -0 U AND L ALGINATE IMPRESSIONS
185  7316680902 100202  2  9 68 10  2  2   7316 14 B CLASS V GOLD INLAY INSERTED
186  7316680902 100203  2  9 68 10  2  3   7316 14 INLAY IS DEFICIENT AT MES GING ANGLE. FULL CROWN TO BE
187  7316680902 100204  2  9 68 10  2  4   7316 14 PREPARED.
188  7316680902 100205  2  9 68 10  2  5   7316 25 MOD CAVITY PREPARED. AMALGAM INSERTED - DYCAL AND COPALITE.
189  7316680911 100101 11  9 68 10  1  1   7316 -0 CASTLE,D.              13
190  7316680911 100201 11  9 68 10  2  1   7316 14 PREPARED FOR 3/4 CROWN
191  7316680911 100202 11  9 68 10  2  2   7316 16 PREPARED FOR FULL CROWN
192  7316680911 100203 11  9 68 10  2  3   7316 -0 RUBBER IMPRESSION TAKEN. SEVRETON TEMPORARY CROWNS
193  7316680918 100101 18  9 68 10  1  1   7316 -0 CASTLE,D.              13
194  7316680918 100201 18  9 68 10  2  1   7316 11 PREPARED FOR D-LI 1/2 VENEER CROWN
195  7316680918 100202 18  9 68 10  2  2   7316 12 PREPARED FOR 3/4 CROWN
196  7316680918 100203 18  9 68 10  2  3   7316 -0 THIOKOL IMPRESSION REJECTED
197  7316681002 100101  2 10 68 10  1  1   7316 -0 CASTLE,D.              13
198  7316681002 100201  2 10 68 10  2  1   7316 21 PREPARED FOR CLASS IV LINGUAL VENEER
199  7316681002 100202  2 10 68 10  2  2   7316 21 RUBBER IMPRESSION TAKEN
200  7316681009 100101  9 10 68 10  1  1   7316 -0 CASTLE,D.              13
201  7316681009 100201  9 10 68 10  2  1   7316 16 BRIDGE RETAINER CEMENTED..
202  7316681009 100202  9 10 68 10  2  2   7316 14 BRIDGE RETAINER CEMENTED
203  7316681009 100203  9 10 68 10  2  3   7316 15 REPLACED BY PONTIC OF FIXED BRIDGE FROM 16 TO 14
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204   7316681009 100204   9 10 68 10   2  4   7316 21 CLASS IV INLAY CEMENTED
205   7316681015 100101  15 10 68 10   1  1   7316 -0 CASTLE,D.            13
206   7316681015 100201  15 10 68 10   2  1   7316 11 INLAY PREPARATION MODIFIED
207   7316681015 100202  15 10 68 10   2  2   7316 12 INLAY PREPARATION MODIFIED
208   7316681015 100203  15 10 68 10   2  3   7316 -0 RUBBER IMPRESSIONS TAKEN
209   7316681021 100101  21 10 68 10   1  1   7316 -0 CASTLE,D.            13
210   7316681021 100201  21 10 68 10   2  1   7316 11 INLAY CEMENTED, TO BE REDONE
211   7316681021 100202  21 10 68 10   2  2   7316 12 INLAY CEMENTED, TO BE REDONE
212   7316681021 100203  21 10 68 10   2  3   7316 -0 ALL AMALGAMS POLISHED
213   7316690210  20101  10  2 69  2   1  1   7316 -0 MAKINSON,O.F.        45
214   7316690210 110101  10  2 69 11   1  1   7316 -0 MAKINSON.O.F.        45
215   7316690210 110201  10  2 69 11   2  1   7316 -0 ACCEPTED FOR 5TH YEAR COMPLEX CONS. RECEIVED EXTENSIVE
216   7316690210 110202  10  2 69 11   2  2   7316 -0 TREATMENT WITH AMALGAM, CAST GOLD, ROOT FILLINGS AND BRIDGE
217   7316690210 110203  10  2 69 11   2  3   7316 -0 WORK. TREATMENT INCOMPLETE. TRANSFER TO ANOTHER STUDENT.
218   7316690210 110204  10  2 69 11   2  4   7316 -0 22 ENDO TO BE CHECKED BY RADIOGRAPH. CHECK VITALITY OF 37,
219   7316690210 110205  10  2 69 11   2  5   7316 -0 46,47. REFER FOR BITEWINGS. CHECK TREATMENT PLAN
220   7316690210  30101  10  2 69  3   1  1   7316 -0 VAN DER LINDEN,F.    13
221   7316690611  40101  11  6 69  4   1  1   7316 -0 VAN DER LINDEN,F.    13
222   7316690611  40201  11  6 69  4   2  1   7316 -0 COMPLAINED OF SENSITIVITY OF 16
223   7316690611  50101  11  6 69  5   1  1   7316 -0 VAN DER LINDEN,F.    13
224   7316690611  50201  11  6 69  5   2  1   7316 16 DENTINE EXPOSED BUCCO-GINGIVALLY
225   7316690611 100101  11  6 69 10   1  1   7316 -0 VAN DER LINDEN,F.    13
226   7316690611 100201  11  6 69 10   2  1   7316 -0 EXAMINATION. REFERRED FOR RADIOGRAPHS
227   7316690611  60101  11  6 69  6   1  1   7316 -0 VAN DER LINDEN,F.    13
228   7316690611  60201  11  6 69  6   2  1   7316 -0 R AND L BITEWINGS
229   7316690611  60202  11  6 69  6   2  2   7316 22 PERIAPICAL VIEW
230   7316690618  90101  18  6 69  9   1  1   7316 -0 VAN DER LINDEN,F.    13
231   7316690618  90201  18  6 69  9   2  1   7316 -0 DIAGNOSIS - 21,22 HAVE PERIAPICAL LESIONS, 16 SENSITIVE,
232   7316690618  90202  18  6 69  9   2  2   7316 -0 EXPOSED ROOT, 16 LI CARIES
233   7316690618  90203  18  6 69  9   2  3   7316 -0 TREAT/PLAN - 12,22 ROOT CANAL THERAPY, FOLLOWED BY LINGUAL
234   7316690618  90204  18  6 69  9   2  4   7316 -0 GOLD FOIL TO REPAIR DEFECT IN EXISTING GOLD VENEER CROWNS,
235   7316690618  90205  18  6 69  9   2  5   7316 -0 16 LI AMALG, RE-MAKE BRIDGE 16-14.
236   7316690618 100101  18  6 69 10   1  1   7316 -0 VAN DER LINDEN,F.    13
237   7316690618 100201  18  6 69 10   2  1   7316 22 OPENED, REAMED,FILED
238   7316690618  60101  18  6 69  6   1  1   7316 -0 VAN DER LINDEN,F.    13
239   7316690618  60201  18  6 69  6   2  1   7316 -0 PERIAPICAL VIEWS OF 16,15,14,24,25,26
240   7316690625 100101  25  6 69 10   1  1   7316 -0 VAN DER LINDEN,F.    13
241   7316690625 100201  25  6 69 10   2  1   7316 22 ALL OLD GP ROOT-FILLING REMOVED. TOOTH LENGTH 20MM BY
242   7316690625 100202  25  6 69 10   2  2   7316 22 RADIOGRAPH. CULTURE TAKEN
243   7316690625  70101  25  6 69  7   1  1   7316 -0 VAN DER LINDEN,F.    13
244   7316690625  70201  25  6 69  7   2  1   7316 22 ENDO CULTURE REPORT.  NEGATIVE
245   7316690702 100101   2  7 69 10   1  1   7316 -0 VAN DER LINDEN,F.    13
246   7316690702 100201   2  7 69 10   2  1   7316 22 ROOT FILLED WITH GP
247   7316690702 100202   2  7 69 10   2  2   7316 21 OPENED
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248  7316690709 100101  9  7 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
249  7316690709 100201  9  7 69 10  2  1   7316 21 PULPECTOMY. CULTURE TAKEN. REAMING AND FILING. CORRECT
250  7316690709 100202  9  7 69 10  2  2   7316 21 LENGTH 21MM BY RADIOGRAPH. SEALED WITH PNB AND CAVIT
251  7316690709 100203  9  7 69 10  2  3   7316 22 RADIOGRAPH SHOWS SATISFACTORY ROOT-FILLING
252  7316690709  60101  9  7 69  6  1  1   7316 -0 VAN DER LINDEN,F.    13
253  7316690709  60201  9  7 69  6  2  1   7316 21 PERIAPICAL VIEW
254  7316690709  60202  9  7 69  6  2  2   7316 22 PERIAPICAL VIEW
255  7316690709  70101  9  7 69  7  1  1   7316 -0 VAN DER LINDEN,F.    13
256  7316690709  70201  9  7 69  7  2  1   7316 21 ENDO CULTURE REPORT.  NEGATIVE
257  7316690716 100101 16  7 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
258  7316690716 100201 16  7 69 10  2  1   7316 21 ROOT FILLED WITH GP AND AH26
259  7316690902 100101  2  9 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
260  7316690902 100201  2  9 69 10  2  1   7316 21 PREPARATION AND INSERTION OF GOLD FOIL
261  7316690902 100202  2  9 69 10  2  2   7316 22 PREPARATION AND INSERTION OF GOLD FOIL
262  7316690917 100101 17  9 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
263  7316690917 100201 17  9 69 10  2  1   7316 -0 PATIENT CANCELLED. UNABLE TO ATTEND FOR SIX WEEKS
264  7316691015 100101 15 10 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
265  7316691015 100201 15 10 69 10  2  1   7316 26 LI CLASS V AMALGAM, CAVITY, DYCAL, INSERTION
266  7316691022 100101 22 10 69 10  1  1   7316 -0 VAN DER LINDEN,F.    13
267  7316691022 100201 22 10 69 10  2  1   7316 26 AMALGAM POLISHED. TREATMENT INCOMPLETE
268  7316691022 110101 22 10 69 11  1  1   7316 -0 MAKINSON,O.F.        45
269  7316691022 110201 22 10 69 11  2  1   7316 -0 ROOT FILLINGS, AMALGAM AND FOIL RESTORATIONS. 3-UNIT BRIDGE
270  7316691022 110202 22 10 69 11  2  2   7316 -0 TO BE RE-MADE. TRANSFER TO ANOTHER STUDENT.
271  7316710216 100101 16  2 71 10  1  1   7316 -0 LAM,K.P.              44
272  7316710216 100201 16  2 71 10  2  1   7316 -0 PATIENT FAILED APPOINTMENT
273  7316710309  20101  9  3 71  2  1  1   7316 -0 KIRKWOOD,J.          45
274  7316710309  40101  9  3 71  4  1  1   7316 -0 KIRKWOOD,J.          45
275  7316710309  40201  9  3 71  4  2  1   7316 -0 PATIENT FAILED APPOINTMENT AND WAS DISCHARGED ON 16/2/71 DUE
276  7316710309  40202  9  3 71  4  2  2   7316 -0 TO A MISUNDERSTANDING. PATIENT LATER REINSTATED AND ASSIGNED
277  7316710309  40203  9  3 71  4  2  3   7316 -0 TO MRS HUNT.
278  7316710309 110101  9  3 71 11  1  1   7316 -0 KIRKWOOD,J.          45
279  7316710309  60101  9  3 71  6  1  1   7316 -0 HUNT,D.R.            44
280  7316710309  60201  9  3 71  6  2  1   7316 -0 R AND L BITEWINGS - REPORT
281  7316710309  60202  9  3 71  6  2  2   7316 16 DISTAL ROOT PERFORATED BY PIN - NO PATHOLOGY
282  7316710309  60203  9  3 71  6  2  3   7316 21 PERIAPICAL VIEW - REPORT
283  7316710309  60204  9  3 71  6  2  4   7316 21 ROOT-FILLING 4MM SHORT OF APEX. P-A RADIOLUCENCY 1X2MM
284  7316710309  60205  9  3 71  6  2  5   7316 -0 FULL MOUTH SURVEY - REPORT
285  7316710309  60206  9  3 71  6  2  6   7316 -0 AMALGAM OVERHANGS 37,36,35,34,47. 1 TO 2MM GENERAL LOSS OF
286  7316710309  60207  9  3 71  6  2  7   7316 -0 CRESTAL BONE
287  7316710330  30101 30  3 71  3  1  1   7316 -0 HUNT,D.R.            44
288  7316710330 100101 30  3 71 10  1  1   7316 -0 HUNT,D.R.            44
289  7316710330 100201 30  3 71 10  2  1   7316 -0 EXAMINATION, SCALING WITH CAVITRON, PROPHYLAXIS, U AND L
290  7316710330 100202 30  3 71 10  2  2   7316 -0 IMPRESSIONS FOR STUDY MODELS
291  7316710406 100101  6  4 71 10  1  1   7316 -0 HUNT,D.R.            44
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292  7316710406 100201  6  4 71 10  2  1   7316 -0 PERIODONTAL POCKETS CHARTED. EXAM CHECKED
293  7316710413 100101 13  4 71 10  1  1   7316 -0 HUNT,D.R.          44
294  7316710413 100201 13  4 71 10  2  1   7316 -0 PATIENT CANCELLED
295  7316710420  40101 20  4 71  4  1  1   7316 -0 HUNT,D.R.          44
296  7316710420  40201 20  4 71  4  2  1   7316 -0 HEALTH GOOD - NO CHANGE
297  7316710420  50101 20  4 71  5  1  1   7316 -0 HUNT,D.R.          44
298  7316710420  50201 20  4 71  5  2  1   7316 -0 SOFT TISSUE NAD. PERIODONTAL - GINGIVAE NORMAL HEALTHY
299  7316710420  50202 20  4 71  5  2  2   7316 -0 ANTERIORLY, SOME SUPRA-GI CALCULUS ON LINGUAL LOWER ANTS.
300  7316710420  50203 20  4 71  5  2  3   7316 -0 CHRONIC GINGIVITIS AND APPROX 1MM GI RECESSION ON BUCCAL OF
301  7316710420  50204 20  4 71  5  2  4   7316 -0 UPPER POST TEETH.
302  7316710420  50205 20  4 71  5  2  5   7316 -0 OCCLUSION - PREMATURE CONTACTS WITH FORWARD AND LATERAL
303  7316710420  50206 20  4 71  5  2  6   7316 -0 SLIDE TO LEFT BETWEEN 24 AND 43.
304  7316710420  90101 20  4 71  9  1  1   7316 -0 HUNT,D.R.          44
305  7316710420  90201 20  4 71  9  2  1   7316 -0 DIAGNOSIS - MUCH OF THE EXTENSIVE DENTAL TREATMENT RECEIVED
306  7316710420  90202 20  4 71  9  2  2   7316 -0 OVER THE YEARS IS UNSATISFACTORY AND REPLACEMENT WITH CAST
307  7316710420  90203 20  4 71  9  2  3   7316 -0 GOLD RESTORATIONS AND PORCELAIN CROWNS IS INDICATED.
308  7316710420  90204 20  4 71  9  2  4   7316 -0 OCCLUSAL RECONSTRUCTION IS NECESSARY TO CORRECT PRESENT
309  7316710420  90205 20  4 71  9  2  5   7316 -0 OCCLUSAL INBALENCE.A CHRONIC PERIODONTAL CONDITION WITH
310  7316710420  90206 20  4 71  9  2  6   7316 -0 MODERATE POCKETING AND GINGIVAL RECESSION EXISTS IN POST .
311  7316710420  90207 20  4 71  9  2  7   7316 -0 ARCH REGIONS
312  7316710420  90208 20  4 71  9  2  8   7316 -0 TREAT/PLAN - INITIAL PHASE. SCALING, PROPHYLAXIS, APPLY
313  7316710420  90209 20  4 71  9  2  9   7316 -0 TOPICAL FLUORIDE, ORAL HYGIENE INSTRUCTION. REFILL ROOT OF
314  7316710420  90210 20  4 71  9  2 10   7316 -0 21. OCCLUSAL ADJUSTMENTS.
315  7316710420  90211 20  4 71  9  2 11   7316 -0 ESTABLISH ANT GUIDANCE PATH - 13 PINNED 3/4 VENEER,
316  7316710420  90212 20  4 71  9  2 12   7316 -0 23 PINNED MESIAL 1/2 VENEER, 12,11,21,22 JACKET CROWNS.
317  7316710420  90213 20  4 71  9  2 13   7316 -0 QUADRANT RESTORATION - 46 MOD INLAY, 47 FULL CROWN, 45 DO
318  7316710420  90214 20  4 71  9  2 14   7316 -0 INLAY AND MESIAL GOLD FOIL, 28 BUC AMALG, 26,25 MOD INLAY,
319  7316710420  90215 20  4 71  9  2 15   7316 -0 24 DO INLAY, 37,36,35 MOD INLAY, 34 DO INLAY.
320  7316710420  90216 20  4 71  9  2 16   7316 -0 REMAKE BRIDGE - 16,14 RETAINERS PORC-METAL CROWNS, 15 VMK
321  7316710420  90217 20  4 71  9  2 17   7316 -0 PONTIC.
322  7316710420 100101 20  4 71 10  1  1   7316 -0 HUNT,D.R.          44
323  7316710420 100201 20  4 71 10  2  1   7316 -0 U AND L PERMELASTIC IMPRESSIONS. FACEBOW AND JAW RELATION
324  7316710420 100202 20  4 71 10  2  2   7316 -0 RECORDS FOR OCCLUSAL ANALYSIS
325  7316710427 100101 27  4 71 10  1  1   7316 -0 HUNT,D.R.          44
326  7316710427 100201 27  4 71 10  2  1   7316 11 NEAR EXPOSURE ON LINGUAL. CAPPED WITH DYCAL AND IRM
327  7316710427 100202 27  4 71 10  2  2   7316 21 REDO ENDO. OLD GP FILLING REMOVED. SEALED WITH CAVIT
328  7316710427  60101 27  4 71  6  1  1   7316 -0 HUNT,D.R.          44
329  7316710427  60201 27  4 71  6  2  1   7316 11 PERIAPICAL VIEW - REPORT NAD
330  7316710504  40101  4  5 71  4  1  1   7316 -0 HUNT,D.R.          44
331  7316710504  40201  4  5 71  4  2  1   7316 99 RAH APPROVES NO CHARGE FOR FURTHER TREATMENTS WHICH INVOLVE
332  7316710504  40201  4  5 71  4  2  1   7316 99 RE-DOING EXISTING RESTORATIONS AND BRIDGE.
333  7316710504 100101  4  5 71 10  1  1   7316 -0 HUNT,D.R.          44
334  7316710504 100201  4  5 71 10  2  1   7316 21 ENDO. CANAL PREPARED WITH NO 6 FILE TO TRUE LENGTH 20MM BY
335  7316710504 100202  4  5 71 10  2  2   7316 21 RADIOGRAPH. ROOT FILLED WITH AH26 AND GP WITH LATERAL
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336  7316710504 100203  4  5 71 10  2  3   7316 21 CONDENSATION. SEALED WITH CAVIT
337  7316710504  60101  4  5 71  6  1  1   7316 -0 HUNT,D.R.            44
338  7316710504  60201  4  5 71  6  2  1   7316 21 PERIAPICAL VIEWS - REPORT
339  7316710504  60202  4  5 71  6  2  2   7316 21 SATISFACTORY ROOT-FILLING
340  7316710511 100101 11  5 71 10  1  1   7316 -0 HUNT,D.R.            44
341  7316710511 100201 11  5 71 10  2  1   7316 -0 OCCLUSAL ADJUSTMENT. INTERFERRING CONTACTS BETWEEN CR AND CO
342  7316710511 100202 11  5 71 10  2  2   7316 -0 GROUND.  JAW SEPARATION AT CO NEEDS FURTHER REDUCTION
343  7316710608 100101  8  6 71 10  1  1   7316 -0 HUNT,D.R.            44
344  7316710608 100201  8  6 71 10  2  1   7316 -0 FURTHER OCCLUSAL ADJUSTMENT
345  7316710608 100202  8  6 71 10  2  2   7316 13 PINLEDGE PREPARATION. INCOMPLETE. SEVRITON TEMPORARY
346  7316710615 100101 15  6 71 10  1  1   7316 -0 HUNT,D.R.            44
347  7316710615 100201 15  6 71 10  2  1   7316 23 1/2 VENEER PREP INCOMPLETE. COPALITE AND SEVRITON TEMPORARY
348  7316710622 100101 22  6 71 10  1  1   7316 -0 HUNT,D.R.            44
349  7316710622 100201 22  6 71 10  2  1   7316 13 PREP COMPLETE. PERMELASTIC IMPRESSION. COPALITE, SEVRITON
350  7316710622 100202 22  6 71 10  2  2   7316 13 TEMPORARY
351  7316710622 100203 22  6 71 10  2  3   7316 23 PREP COMPLETE. GINGIVAL PINHOLE FRACTURED DURING IMPRESSION
352  7316710622 100204 22  6 71 10  2  4   7316 23 TAKING. SEVRITON TEMPORARY
353  7316710629 100101 29  6 71 10  1  1   7316 -0 HUNT,D.R.            44
354  7316710629 100201 29  6 71 10  2  1   7316 23 PREP MODIFIED
355  7316710629 100202 29  6 71 10  2  2   7316 23 PERMELASTIC IMPRESSION. JAW RELATIONS AND FACEBOW RECORD
356  7316710720 100101 20  7 71 10  1  1   7316 -0 HUNT,D.R.            44
357  7316710720 100201 20  7 71 10  2  1   7316 13 INLAY UNSATISFACTORY
358  7316710720 100202 20  7 71 10  2  2   7316 23 INLAY UNSATISFACTORY
359  7316710720 100203 20  7 71 10  2  3   7316 -0 NEW IMPRESSIONS AND TEMPORARIES MADE.
360  7316710727 100101 27  7 71 10  1  1   7316 -0 HUNT,D.R.            44
361  7316710727 100201 27  7 71 10  2  1   7316 13 INLAY CEMENTED
362  7316710727 100202 27  7 71 10  2  2   7316 23 INLAY CEMENTED
363  7316710727 100203 27  7 71 10  2  3   7316 11 POST-HOLE PREPARED FOR POST-CROWN. PERMELASTIC IMPRESSION.
364  7316710727 100204 27  7 71 10  2  4   7316 11 SCUTAN TEMPORARY
365  7316710810 100101 10  8 71 10  1  1   7316 -0 HUNT,D.R.            44
366  7316710810 100201 10  8 71 10  2  1   7316 11 POST-CORE CEMENTED. PJC PREP, SCUTAN TEMPORARY
367  7316710831 100101 31  8 71 10  1  1   7316 -0 HUNT,D.R.            44
368  7316710831 100201 31  8 71 10  2  1   7316 -0 PATIENT FAILED APPOINTMENT
369  7316710914 100101 14  9 71 10  1  1   7316 -0 HUNT,D.R.            44
370  7316710914 100201 14  9 71 10  2  1   7316 21 PJC PREP
371  7316710914 100202 14  9 71 10  2  2   7316 11 PJC PREP
372  7316710914 100203 14  9 71 10  2  3   7316 -0 PERMELASTIC IMPRESSIONS - SENT TO ADELAIDE LABS. SCUTAN
373  7316710914 100204 14  9 71 10  2  4   7316 -0 TEMPORARIES
374  7316710921 100101 21  9 71 10  1  1   7316 -0 HUNT,D.R.            44
375  7316710921 100201 21  9 71 10  2  1   7316 47 FULL CROWN PREP. SCUTAN TEMPORARY
376  7316710921 100202 21  9 71 10  2  2   7316 46 MOD-BU PREP FOR AMALGAM CORE. SCUTAN TEMPORARY
377  7316710928 100101 28  9 71 10  1  1   7316 -0 HUNT,D.R.            44
378  7316710928 100201 28  9 71 10  2  1   7316 11 PJC CEMENTED WITH ZNPHOS
379  7316710928 100202 28  9 71 10  2  2   7316 21 PJC CEMENTED WITH ZNPHOS
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380  7316711005 100101  5 10 71 10  1  1   7316 -0 HUNT,D.R.              44
381  7316711005 100201  5 10 71 10  2  1   7316 46 MOD AMALGAM CORE FOR CROWN
382  7316711005 100202  5 10 71 10  2  2   7316 45 DO INLAY PREP, SCUTAN TEMP
383  7316711012 100101 12 10 71 10  1  1   7316 -0 HUNT,D.R.              44
384  7316711012 100201 12 10 71 10  2  1   7316 46 CROWN PREP
385  7316711012 100202 12 10 71 10  2  2   7316 -0 PERMELASTIC IMPRESSIONS MADE OF 47,46,45. SCUTAN TEMPS
386  7316711021 100101 21 10 71 10  1  1   7316 -0 HUNT,D.R.              44
387  7316711021 100201 21 10 71 10  2  1   7316 -0 PROPHYLAXIS, SCALING. NEW TEMPS MADE FOR 45,46
388  7316711025 100101 25 10 71 10  1  1   7316 -0 HUNT,D.R.              44
389  7316711025 100201 25 10 71 10  2  1   7316 47 CROWN CEMENTED
390  7316711025 100202 25 10 71 10  2  2   7316 46 CROWN CEMENTED
391  7316711025 100203 25 10 71 10  2  3   7316 45 DO-LI INLAY CEMENTED
392  7316711026 100101 26 10 71 10  1  1   7316 -0 HUNT,D.R.              44
393  7316711026 100201 26 10 71 10  2  1   7316 -0 OCCLUSION OF 45,46,47 CAST RESTORATIONS CORRECTED FOR
394  7316711026 100202 26 10 71 10  2  2   7316 -0 HIGH SPOTS
395  7316711026 110101 26 10 71 11  1  1   7316 -0 HUNT,D.R.              44
396  7316711026 110201 26 10 71 11  2  1   7316 -0 MANY RESTORATIONS REQUIRED RE-DOING. OCCLUSION RECONSTRUCT
397  7316711026 110202 26 10 71 11  2  2   7316 -0 REQUIRED WITH NEW CROWNS, INLAYS, BRIDGE. MODERATE PERIO
398  7316711026 110203 26 10 71 11  2  3   7316 -0 CONDITION. QUERY NEED FOR GINGIVAL SURGERY. TREATMENT
399  7316711026 110204 26 10 71 11  2  4   7316 -0 INCOMPLETE - CONTINUE IN 1972.
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