THE USE OF ORTHODONTIC PRACTICE MANAGEMENT SOFTWARE PROGRAMS IN EPIDEMIOLOGICAL RESEARCH

by

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Abstract

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Orthodontic practice management programs are becoming an essential component of the modern orthodontic practice. The purpose of this study was to examine selected demographic characteristics of patients treated in orthodontic practice. Five variables, gender, age when first seen, age at start of treatment, age at end of treatment and treatment duration were examined for orthodontic patients. This information was abstracted from the databases of thirteen practices using the practice management software program, Orthosoft™. Information on 25,364 patients was obtained. Of the 25,364 patients, 6,421 had data on all five variables. It was found that 21% of those treated were adults (nineteen years of age and over), slightly higher than what was reported in a 1999 practice survey. Interestingly, 29% of the patients examined were adult. Of those examined, 61% were females while 65% of those actually starting treatment were female. Among adults, the percentage of females was much higher at 78%. The average age that patients were first seen was 17.1 years. However the greatest percent of patients were twelve years of age. The

average age at the start of treatment was 16.7, while the greatest percent was twelve years of age. The average age at the end of treatment was 18.8 years old. However the greatest percent of patients completed treatment at fourteen years of age. The overall duration of orthodontic treatment was 25.2 months. When stratified by age, duration for children was slightly higher at 25.5 months compared to 24.1 months for adults. For the years 1992 through 1999, there was a trend for children to be first seen at a younger age and adults to be first seen at older ages.

DEDICATION

To my parents, thanks for encouraging me to aim high and to be the best that I can be.

To my brother, thanks for always providing me with a shoulder to cry on.

To my sister, thanks for being such a great sister and always being there when I need you.

To my grandmother, for leaving me with memories that I will cherish forever.

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INTRODUCTION

The Computer Technological Revolution

The world has been going through a technological revolution that is altering every facet of our lives. Information technology allows us to store, retrieve, analyze, and transmit enormous quantities of information quickly and accurately. These advances have had a significant impact in health care including dentistry and orthodontics. This capability has given us the potential to revolutionize not only patient care but research as well.

Informatics in Clinical Orthodontics

One aspect of computer technology that has had a major impact on almost all segments of our society is information systems. Medical informatics coined in 1974, is a relatively new knowledge domain of computer and information science. It encompasses technology, and communications in all fields of health and medicine, including research, education and practice. Only in the 1980's, has the term dental informatics begun to be recognized (Hou 1994). Not surprisingly, "informatics" has entered the modern orthodontic practice.

The 1999 Journal of Clinical Orthodontics practice survey results reported that 93.1% of orthodontists owned or leased an in-office computer (Gottlieb 1999). Practitioners are realizing the benefits of computerization. Specifically, computer

software systems for practice management are rapidly becoming an essential component of the modern orthodontic office. Today's orthodontists have become computer knowledgeable and many feel that having a computer based office management system is a necessity and not a luxury (Miller 1995).

Practice management software programs allow orthodontists to organize and analyze stored information. A computerized patient record system can serve as a form of direct data entry and collection as well as automatic data analysis for research purposes. When patient records are prepared in routine patient care the data is directly entered in a computer database and then the computer collects the data and the computer can be programmed to manage the data. The process of data entry is often the most non-productive and time-consuming step in epidemiological research. If one were to use existing practice management databases for research, this could facilitate research enormously. These software programs can eliminate many of the logistical problems of data collection because the data would already be entered in the computer during routine practice use. In other words, by the maintenance of electronic patient records, potentially useful epidemiological data would have already be collected and stored. If this data can be retrieved electronically, it could be then be analyzed for research purposes. The capability to store, collect and retrieve data greatly increases the usefulness of the information for research.

Implications of a Cooperative Effort by Private Practice

The key to identifying meaningful trends is well-structured quality data. In order to obtain sufficient quality data, a one-practice database may not be large enough.

However, data collected across many practices may be sufficient. Because computers have the ability to communicate with other computers, data can be shared.

There is much potential for progress in many types of orthodontic research if private practitioners would be willing to share data since there is a huge pool of data available in practice databases. There is no exact figure on the number of practicing orthodontists in the United States but the ADA reported 8,869 practicing orthodontists in 1995. In 1999, Gottlieb et al. mailed out a practice survey to 8,934 orthodontists whom they believed were all the practicing specialists in the United States. The 1999 Journal of Clinical Orthodontics practice survey reported the average number of case starts to be two hundred per year/orthodontist (Gottlieb et al. 1999). Multiplied by nine thousand orthodontists, there were 1.8 million patients who began orthodontic treatment that year. In addition, 93.1 % of orthodontists owned or leased an in-office computer. Roughly estimating that 60% of orthodontists used a practice management software program, multiplied by 1.8 million, there were more than one million patients entered into these computer databases. In other words, the sample size for research purposes would be potentially greater than one million. The implication of these enormous figures for research is profound.

Every private practice has the potential to produce a great amount of valuable data. It is virtually impossible to make the data useful without entering it into a computer. Because electronic patient record systems arrange data and assure a high quality of the data it allows for meaningful data analysis. Using the variety of data

analysis tools available with even the simplest of office computers, a practice can organize and summarize information to determine trends.

The present study abstracted information from practice management software program databases of private practices. These orthodontic practice management software programs aid orthodontists in running their offices. These programs cover everything from scheduling appointments, to printing out letters of referral, to treatment charting. Hence, the information that is entered into these software programs actually is a clinical database filled with a vast amount of potentially useful information. The purpose of the present study is to demonstrate how such orthodontic practice management software programs could be used to answer simple demographic and descriptive questions. Date information has been chosen to be examined because the nature of time is numerical, objective and straightforward. The present study is a descriptive study to investigate numerous aspects of the age and time period that is involved in orthodontic treatment.

LITERATURE REVIEW

Computer Patient Records

Although maintaining adequate patient records is tedious, it is also a practical, ethical and legal necessity in this day and age. (Preston 1992) The methods to "document" patient records developed during earlier and simpler times of healthcare can no longer continue in the same fashion as they have in the past. The obvious inadequacy of paper based patient records has become evident as computer based patient records have replaced them. The recording and retrieval of medical and dental information strains the abilities of the manual system (Barnett 1984). The requirements for patient records imposed by government agencies and insurance companies are becoming increasingly demanding. Moreover, in today's litigious atmosphere, practitioners feel it necessary to "document everything" which computers have made more convenient.

In the United Kingdom, electronic medical records have been admissible in medical litigation and criminal cases for some years (Purves 1996). The Civil Evidence Act requires that the computer system be created for the purpose for which it is being used and that there should be proper hardware and software maintenance. Moreover, electronic records should be contemporaneous, and a full audit trail of additions and deletions should be able to be tracked. There is now case law where

electronic medical records are used as evidence. Hence, in the U.K. it is legal to be paperless.

Manual Record Systems vs. Computer Record Systems

A manual record system has inherent deficiencies in providing rapid access to information. For example, patient records can be lost, misplaced or physically inaccessible. Also, records are often poorly organized or illegible. Redundant information (i.e., patient name) needs to be repeated on different sheets of paper in case a sheet may get lost from the chart. Furthermore, quality assurance and clinical studies require an aggregation of information from a great number of patient records and the arduous task of record collection and search must be done manually (Barnett 1984).

A computer-based system is not as restrained as a manual system. Computerized systems are capable of producing copies of the most up-to-date information at different locations simultaneously. Redundant data entry is avoided as a single entry is all that is needed for repetitive information to be automatically generated; i.e., patient name on every "page" of the chart. Computer based information systems require structured data organization, predefined vocabulary and predefined rules that are set by software designers and not the users (Barnett 1984).

The History of the Development of Practice Management Software

There has been tremendous activity within the computer industry to develop and refine products for dental office management. Computers arrived in the dental office as a natural extension of the database management programs developed for business.

The accounting procedures, as well as the organization of files, were very similar to those found in other industries. However, many business-related programs did not meet the specific needs of the dental or orthodontic office (Preston 1992).

Unfortunately, the development of office management programs was slow and difficult. Some of the companies that were major players failed in their early attempts, leaving users with incomplete and unsupported programs. However, as system developers learned more about the technology and practitioners' needs, the available hardware became more powerful and programs became quite sophisticated and effective (Preston 1992).

Practice Management Software Programs

Modern dental management systems must meet certain minimum requirements to be useful in today's dental practice. The ADA recently released Technical Report No. 1004 on practice management software. This report listed the basic and optional system features requested by practicing dentists. This report was prepared by volunteers of Accredited Standards Committee MD 156 Task Group on Dental Informatics. This group is dedicated to reporting the potential of practice management systems and developing guidelines for evaluation of administrative scheduling and clinical software systems. They classified dental practice software into two sections: Management systems which included financial, resource, and schedule management, and clinical systems which included the acquisition, storage, retrieval, presentation and communication of computerized patient information. In order to be considered a clinical software system, there must be basic features that

allow practitioners to effectively contact, plan treatment, and track patients. Charting software has allowed dentists a revolutionary opportunity. The ADA recognizes that, up to now, no standard has been set for a chart, in paper or electronic format. With no paper standard, the software standards remain controversial. The general consensus of this task force was that basic features should include variable patient retrieval (by name, I.D., and number, or parts thereof), medical health alerts, diagnostic records, treatment planning and tracking of procedures performed or pending, comprehensive display of treatment completed or planned and several other features.

Database Management Systems

In a "paperless" office, all relevant clinical and accounting information is entered into a computer-based data system and resides in permanent memory in a well-organized database. This means that the practitioner or researcher can summon relevant reports easily for any combination of data elements (Suddick 1995). The ease of accessibility of information from computerized record systems makes it possible to request any one of a set of predefined reports (Miller 1995). These practice management reports allow the researcher to analyze patient information using practice management software. Many computer based office practice systems also allow an ad-hoc report summarizing any part of the database (Barnett 1984).

Computers have the amazing capability to analyze enormous amounts of data. The problem that arises is extracting this information. The science of database management has progressed during the last twenty-five years. However,

standardizing database management continues to remain a challenge (Darling 1992).

Two strategies may be used to obtain non-routine, practice-specific reports. One is to use a professional computer programmer to write programs that will elicit custom reports. However, this method is costly and inefficient. Another approach is to use a data retrieval language or management system to express relatively complex retrieval and analysis requests (Darling 1992).

There are many different types of database management systems available. Flat file databases are the most limited and the least expensive. This technology dates back to the 1960's and was developed from the technology of eighty-column punch cards. Data is stored in long lists that can be sorted both physically and/or logically, and single records are easily located. The lack of sophistication lies in the systems inability to handle repetitive information. For example, finding a list of each patient and medications currently prescribed would be a very difficult task. Moreover, it does not allow the linkage of files based on common data elements. This application is crucial for a system to be useful for analysis of data for research purposes (Darling 1992).

The most common and a more complex type of database is the relational database, which was developed by combining set theory and the predicate calculus. Relational databases have the ability to link together separate files based on a common data element. A relational database allows the combination of two files by a common element; for example, a patient number and medications (Darling 1992).

There are two subsets of relational database called dBASE-style relational

databases and the Structured Query Language-Style relational databases (SQL). SQL provides better support for complex data structures and complex queries than dBASE For dBASE as the complexity of the question increases, it is much more difficult to extract data (Darling 1992).

Quality assurance

A major advantage of establishing a relational database through computerized patient records is that it provides an opportunity to collect data related to patient care. These data can be based on the practice of a single dentist, of a group practice or if properly aggregated, all dentists keeping similar data (Preston 1992)

Data can be acquired from a relational database quickly and easily, providing many benefits to the practice. The opportunity for an individual practice to create site-specific, *ad-hoc* data retrieval programs opens up immense opportunities for quality assurance. For example, in an article by Preston (1992), a dentist was asked "how long an average two surface amalgam alloy restoration would last?" With the use of dental practice database this would not be difficult to answer. This data could be compared to other practices and/or national average. Hence, these software programs can be tools for quality assurance.

Tools for Decision Making

Automated medical record systems and relational databases can also be useful for decision making by facilitating access to patient data, enhancing the possibilities of surveillance, and alerting practitioners to problems that could have otherwise been overlooked. Researchers such as Chowdbury et al. in Stockholm are developing an

integrated medical information system that combines a clinical database and a medical knowledge base (1990).

Implications of Clinical Databases

Automated patient record systems can serve as a database for the detection of new associations between diseases, tests and therapies. However, is it possible to draw conclusions from data that is collected not for research purposes, but for routine patient care? How does one analyze data that contains large numbers of variables, recorded by different providers on different occasions, and not recorded according to any structured protocol?

Computerized Patient Record Systems in Medicine

Medicine has realized the importance of informatics in research. Dental informatics should build on the lessons of more than twenty years of development from the medical field. Medical informatics has succeeded in developing many models and solutions that can be easily adaptable to dentistry. The dental record is essentially a specialized outpatient record. (Schleyer 1996)

The aggregation of clinical records should assist in providing large databases for epidemiological research. Computerized patient records, collected and stored in the course of routine practice, should be regarded as a resource for patient and practice management and for quality assurance, clinical research and surveillance. In medicine, it has become common to search hospital information systems for patient records for research purposes, especially medication records. The following are

studies of how clinical databases were used for research purposes in medicine.

Chowdbury et al. (1990) extracted information from a large primary health care computer database which served as the sole medical record at the Kronan Health Centre in Stockholm, Sweden. The system was based on a well-structured database with a predefined controlled vocabulary and effective search and query functions. In their study, they examined an association between hypertension and diabetes. Because they had access to this large primary care database they were able to select a study population of 6,660 patients who met all the specified criteria. Their methodology allowed them to acquire an enormous data set which would have taken much greater, effort, time and money if a computer database such as this one had not been used.

The authors asserted that the exploring of large primary health care databases will probably not provide the final proof of certain causal relationships. However, it might bring up a hypothesis worthy of further investigation. Furthermore, clinical databases are now key in building a knowledge base for decision-making support. For these support systems, the most important facts needed are prior probabilities (prevalence) for diseases, and sensitivity and specificity values describing the association between different types of clinical data. These parameters can be derived from the literature and from the estimates of medical experts, but generating them from a clinical database will likely produce a much more accurate result (Chowdbury et al. 1990).

Traditionally, the investigation of the incidence rate and prevalence of chronic

disease has been based on disease registers or health surveys. Such methods are costly and usually cover only a sample of the population. Hence, efforts to develop comprehensive surveillance systems have focused on disease of major public health significance because of impediments to data collection (Brameld et al.1999a).

An alternative approach is a reliance on administrative data already collected by the health system, made more interpretable for epidemiological surveillance purposes through the use of record linkage. Researchers such as Brameld have questioned whether the incidence rates and prevalence rates of administrative data are more, or less, accurate than those from disease registers or surveys.

A study by Brameld et al. (1999a) found that incidence and prevalence rates of end-stage renal failure, determined from the Western Australian Health Services Research Linked Database, were quite similar (within +/- 7%) to those based on the Australian and New Zealand Dialysis and Transplant Registry. The Western Australian Health Services Research Linked Database initially linked fifteen years of population based hospital morbidity data, mortality records (including individual patient records), mental health services data, cancer registrations and midwife notifications for 1980 to 1984. Its development began in 1995 and has been used in several studies since.

In another study, Brameld et al. (1999b) attempted to measure the incidence rate and prevalence and patterns of care of a chronic disease using linked hospital morbidity and mortality data from the Western Australian Health Services Research Linked Database. In the article, 1,046 patients were identified with the principal

diagnosis or procedure that met the criteria of end-stage renal failure during a nine-year span. Moreover, they found interesting trends on the incidence rate and prevalence of end-stage renal failure by sex and race. Patterns of care, indices of comorbidity and waiting time to transplantation were also calculated. From the database, many aspects of this disease could be explored. The authors contended that the linked data could provide a more accurate picture through objective selection criteria, the exclusion of preexisting prevalence cases from incidence figures, and the most complete coverage of all prevalent in-hospital cases.

A benefit of the use of computer database management systems is the ability to manage enormous amounts of data. Government agencies of the United Kingdom have recognized that computerized record systems in conjunction with private practice systems are a great resource of information on data collected since the 1980's.

The United Kingdom government, along with a commercial company Vamp Ltd., set up the UK General Practice Research Database (GPRD) in 1987. The United Kingdom is probably the country with the highest rate of computerization of family medicine, with greater than 90% computerized (Kidd 1995). Back in 1987, general practitioners were offered free computer equipment in return for entering clinical data in a standard manner into computer database and providing the anonymised data to Vamp. Photocopied hospital letters were also to be provided if requested. The objective was to develop an automated clinical research database containing longitudinal and ongoing information on four million patients,

representative of populations and of general practices in the UK. Moreover, the pharmaceutical industry could utilize this database in post-marketing surveillance studies. However, the database proved to be commercially unsuccessful and Vamp was taken over by Reuters in 1994 and then given to the UK Department of Health. It is presently managed by the Office for National Statistics (Walley and Mantgani 1997).

In 1997, general practitioners were receiving a small payment for supplying adequate and standard data. Despite modest compensation, participants believed that they were providing a valuable service to the National Health Service and some participants believed that their own work benefited from the high standard of record keeping required to participate (Walley and Mantgani 1997).

In July 1996, the GPRD had accumulated data of over twenty-five million patient years and covered a population of 3.5 million. It contained data since 1987 and, in 1994, covered 5.6% of the population of England and Wales. The population was representative of the UK population in age and sex. In April 1997, 480 practices were participating (Walley and Mantgani 1997).

The General Practice Research Database requires the input of demographic data on all patients including date of birth and date of registration with the practice. Additional information such as major illnesses, diagnoses, treatments and outcomes are also recorded (Walley and Mantgani 1997). Practices are required to meet minimum standards in order to participate. For example, 95% of prescribing and relevant patient-encounter events must be recorded. Internal data checks are routine

as practices are sent validation reports following each data collection. Checks include the weekly number of consultations and prescriptions, the completeness of data on indications for prescribing and the completeness of recording demographic data. Furthermore, there are specific audits of data supplied from individual practices. Only the data from practices that meet these strict standards are included in the GPRD. The data collected by general practitioners must be "up to standard", that is, satisfactory for research projects. There are many practices using the Vamp medical practice software that are not included on the database (Walley and Mantgani 1997).

There have been several studies that have evaluated the accuracy, quality and completeness of the GPRD. In 1991, a study by Jick et al. assessed the validity of information recorded on general practitioner based computerized databases. Specifically, they determined the extent of agreement between clinical information recorded on computers of selected general practitioners and similar information in manual records of letters from hospital consultants kept on file by the general practitioner. Records of 2,491 patients were examined for comparison of the computer-recorded diagnosis with the hospital consultant letter of clinical diagnosis. There was an 87% concordance between the consultant's letter of diagnosis and the diagnosis recorded in the computer. They concluded that the clinical information available on general practitioner computer records, whose data met the standard of quality was satisfactory to use for many clinical studies (Jick et al.1991).

In 1993 Nazareth et al. conducted another comparitive study of the computer system of general practitioners and written records. They were able to search through

eight thousand randomly selected patient records. They found that, of thirteen database practices, 75% of all consultations were recorded, 88% of diagnoses of schizophrenia had been recorded, and 95% of the prescriptions (Nazareth 1993). According to the authors, the recording of psychotic illness in the Vamp system was accurate and complete. Moreover, the prescribing of medication and consultations was even more thoroughly recorded than manually. They too believe that computer databases can serve as useful and important resource for research.

Another validation study was conducted in 1997, this time by the Office of National Statistics who compared the GPRD to the Morbidity Survey in General Practice in four specific areas, allergic rhinitis, chickenpox, asthma and diabetes. The Morbidity Survey was conducted in 1991 and collected information on morbidity in primary care. This survey had been the largest nationally recognized and most widely used source of epidemiological information on primary care. In this study, Hollowell et al. (1997) found that there was good agreement between the Morbidity Survey and the GPRD for acute conditions, allergic rhinitis, and chicken pox. However, chronic conditions diabetes and asthma, were 10-20% lower in the GPRD.

In 1999, Hansell et al. compared the use of the GPRD with the data obtained from the Fourth Morbidity Survey in General Practice (MSGP4) for respiratory epidemiology in 1999. They found that the GPRD had the potential to extend the analysis of data due to its larger size, longer time period covered and wide geographical representation and the ability to link prescription with diagnoses. The results of this study found similar epidemiological rates and that it was valid to use

the GPRD for research into respiratory disease. Healthcare planners and researchers need accurate data on the incidence and prevalence of common illnesses. The nature of the General Practice Research Database makes it a useful source of data for epidemiological study.

These studies of the General Practice Research Database have indicated that computer patient record systems and software of this kind can serve as a tool for deriving medical and dental information. It is indeed possible to draw conclusions from data that was not collected for the sole purpose of research. Although the database contained large numbers of variables, with data recorded by different providers on different occasions, the meticulously managed and high standard of quality data, in conjunction with the enormous data set, and completeness of the information provided a unique and reliable resource (Hansell et al. 1999). This database has served as a tool for a wide range of clinical studies that have been conducted more quickly and more economically because of it use. Moreover, the use of the GPRD for epidemiological analysis will undoubtedly increase as access to this data is easier now that CD-ROMs have become available

A similar computer and database system exists in Scotland. In a survey of general practices in early 1994, 845 practices (78%) were with operating the national software package called the General Practice Administration System for Scotland (GPASS), supplied by the Scottish Office Home and Health Department. The use of a standard software system for the storage of morbidity and repeat prescribing data on computer provides Scotland with the opportunity to amalgamate primary care data on

a national scale.

Since 1988, the GPASS data evaluation project has routinely extracted data on morbidity and repeat prescribing. This information has been amalgamated on a regional and national basis. In 1996, data from approximately 460 practices and 2.8 million patients had been compiled. A problem that became evident, however, was that practices varied widely in the extent of data entry. Moreover, a major limitation on the interpretation and use of the data collected was the absence of information on the completeness and accuracy of the computer database (Whitelaw et al. 1996).

Whitelaw et al. investigated the quality of data and specifically the data's accuracy and completeness held in computers by general practitioners. They compared data procured from the GPASS to data collected by scrutiny of paper records and patient questionnaires for each patient. In this study, the recording of morbidity over all conditions examined appeared to be only moderately complete (75%) but with a high level of accuracy (100%). According to Whitelaw et al., based on their study, the morbidity data derived from computerized medical records were as complete and accurate as the current standards available in Scotland, which are the morbidity statistics derived from hospital-based activities. Furthermore, they found that the recording of repeat prescription information on computer was both complete and accurate within the more highly computerized Scottish practices. The authors predicted that GPASS would soon become the only source of prescribing information in many practices and that it could form a basis for estimating the prevalence of major disorders and for assessing regional and national health care needs.

A study by Guess et al. (1983), using a computer database called the Saskatchewan Medical Records Linkage System, is another example of how quantitative epidemiological information about age and gender-specific risks can be ascertained using a population-based medical records linkage system. The investigators explored fatal upper gastrointestinal hemorrhage or perforation among users and non-users of non-steroidal anti-inflammatory drugs (NSAID) in 1983, using the Saskatchewan Medical Records Linkage System. Since 1975, this system has maintained a computer registry of all prescriptions and hospitalizations for approximately 995,000 members of the Saskatchewan Health Plan. Through the use of each patient's unique identification number, the prescription and hospitalization registries were linked on an individual patient basis to create a complete chronological record of every prescription and hospitalization. They found that the rate of fatal upper hemorrhage or perforation was higher for elderly female NSAID users than for male elderly users and hence, were able to identify epidemiological trends (Guess et al. 1987).

Computer databases are being used as tools in identifying trends by other industries as well. In a study by Meredith et al. (1998), the Physician Insurers Association of America Database (PIAA) was used as a surveillance tool for diabetes related malpractice claims in the United States. The PIAA is an association of insurance carriers that collectively insure 60% of the nations private practicing physicians and dentists and represents a nationally centralized database. The data is gathered and reported according to protocols developed by the PIAA. The authors

were able to gather descriptive data from twelve years of cumulative data contained in the Data Sharing Reports of the PIAA from 1985-1996. A total of 156,373 claims were filed, and out of these, 906 were diabetes related. The results of the study revealed demographic characteristics on the claims, (for example, a significant downward trend of diabetes claims from 1993-1996), of the insured (for example, the majority of the insured were men), of the claimants (for example most of the diabetes claims were filed by men). Meredith et al. (1998) asserted that, while the use of administrative databases for research into clinical practice or quality of care posed some restrictions, this did not preclude their utility. Although, medical malpractice data does not usually include patient profiles of those that do not sue, an analysis of this database of malpractice claims has produced useful empirical information. Meredith et al. concluded that the PIAA could be a useful resource to monitor trends in diabetes-related malpractice.

Use of Orthodontic Practice Management Software Programs

There are many computer software programs that orthodontists can choose in order to manage their practices: Ims Technologies, Rx Video Communications Co., Mac Braces, New Horizons Software, Oasys, Ortho II, Orthocom, Orthosoft, Orthotrac/OPMS/Infocure, and Orthoware/Glentec

When an orthodontist utilizes one of these practice management software programs, information on each patient is entered into the database. This information usually includes basic demographic information about the patient. Such information includes, patient name, date of birth, gender, treatment dates and type of

malocclusion. From this information researchers can derive the age of patients when they first contacted an office, the age of the patients when first examined at an office, the age of the patient when they started treatment and the age of the patient when treatment was completed. Furthermore, the average length of orthodontic treatment and the percentage of males and females that seek treatment can be calculated.

The greatest barriers to the use of practice management software programs and computer patient records for research are the need for uniformity and standardization of recording methods, collecting data and making observations. Only then can the data be accurate enough for the goals of research. Standardization requires a consensus by practitioners to abide by certain protocols and rules. The problem is that private practitioners have very different philosophies, training and methodologies. Thus, if there are many practitioners involved there would be a non-homogeneous group of investigators. Differences in interpretation and investigator variation could make data worthless (Chilton and Varma1965).

Once the cooperation of busy practitioners on a large scale, perhaps nationally and even an international level is obtained, the most successful and rewarding results will be seen (Chilton and Varma 1965). The American health care community, and government agencies need to make a concerted and organized effort to grasp the limitless potentials for research developments that countries like the United Kingdom are realizing.

STATEMENT OF THE HYPOTHESIS

The aim of the present study is to abstract and analyze information contained in a common practice management program used by orthodontists (Orthosoft™ Inc. Plano, TX). Specifically, the patient identification number, date of birth, date first seen, date treatment started, date treatment ended and gender for orthodontic patients will be compiled to answer the following questions:

1. What is the average age that orthodontists first see, i.e., examine patients?
2. What is the average age that patients start treatment?
3. What is the average duration of treatment?
4. What is the percentage of adults and children undergoing orthodontic treatment?
5. What is the percentage of males and females undergoing orthodontic treatment?

MATERIALS AND METHODS

In order to aid in the abstraction of data from the clinical databases of private practitioners, Glenn Woods, the president of Orthosoft™ Inc, provided two software utilities that could be applied to the data files of either Orthosoft™ version 7.0 or 8.0. These software utilities abstracted targeted information from the databases of individual private practices to obtain the following variables: 1) patient identification number, 2) date of birth, 3) date first seen, 4) the date treatment started 5) the date treatment ended and 6) gender. The primary investigator traveled to the offices of Orthosoft™ in Plano, TX where the company had downloaded the data files of some of its patrons' practices. The data for thirteen practices were obtained.

Private practices were solicited for participation in this study using the following inclusion criteria: The office must have used the Orthosoft™ software program for a minimum of three years, and they must have used both the scheduling and treatment charting functions. The target number of patients was ten thousand, although half that number would have been acceptable as the minimum for successful testing of the utility.

All data was outputted into a Microsoft Excel® file, (Microsoft Inc., Seattle, WA). The procedure followed for data entry into the Orthosoft™ system at each office was fairly consistent. Each practice went through seven days of training by the

company's staff members in order to learn how to use the program. Orthosoft™ automatically generated a patient identification for each patient when creating a patient chart. The patient's gender and date of birth, was entered into the computer by office staff. The "first seen date" was recorded as the date that the patient first came into the office to be examined.

The "start date" was the date that the patient first entered into active treatment. The software program used a specific system in order to track active patients and the category of treatment that they fell under. "Stage 7 and 9" was arbitrarily designated by the Orthosoft™ and in agreement with the practitioner to mean that the patient actually started treatment, as opposed to being in an inactive stage, such as the consultation stage or a records stage. The software program tracked active treatment when the patient entered stage 7 or 9, or when the patient scheduled a procedure that was previously defined by the office as a start procedure. Treatment could have fallen under the category of comprehensive treatment, early treatment (Phase I treatment), a full fixed orthodontic appliance case (Phase II treatment), or even limited treatment (e.g., molar uprighting or crown lengthening). However, the majority of orthodontic cases fell under comprehensive orthodontic treatment. The utility did not distinguish between limited treatment, early/interceptive treatment or full comprehensive treatment.

The software program did not automatically record an "end of treatment date" as it did for the "first seen date" or "the start date". Instead the utility picked out the date that a specified procedure was completed. In this study, the specified procedure

was the check retainer appointment. This procedure was chosen because although there are different ways to deband a patient, all the doctors used check retainer appointments.

For the sake of expediency, the logistics of obtaining the databases of orthodontists around the United States were performed by the principal investigator who traveled to the headquarters of Orthosoft™ in Plano, TX. The identity of each patient was kept anonymous, as the patient identification number was the only identifier.

The output was carefully filtered and analyzed using Microsoft Excel®. The utility sometimes outputted data that was in error for example, missing start dates, nonsense data such as gender being "R", or negative duration times. All such data was thrown out. The data was parsed in order to meet basic accuracy standards. If certain criteria were not met, the entire patient's record was eliminated. The data could not have any missing birth dates, gender or first seen dates. In the case of inaccurate birth dates, gender or first seen dates the entire patient record was eliminated. Suspicious data such as an excessive number of identical start dates, start dates that were later than end dates, patients younger than two years old or older than seventy, treatment durations of less than two months, end dates with no start dates, or start dates with no end dates were purged.

For practices that re-entered all patients' records into the software database when Orthosoft™ was first installed in the office, no records were eliminated. However, for offices that did correct the first seen dates for patients seen prior to

installing the program, data anywhere from the first six months to two years were eliminated.

Statistical Design

All data was first outputted into a Microsoft Excel® spreadsheet. Descriptive statistics (i.e., means, medians, modes, standard deviations, and ranges) were calculated for each question. A t-test was used to compare the mean treatment time between children (under nineteen years of age) and adults (nineteen years of age and older), and males and females. The age nineteen was chosen to separate children from adults because this is the age when alveolar ridge growth is complete for most people. A p-value of 0.05 was used to assign statistical significance. A one-way analysis of variance (ANOVA) was used in order to compare different practices and the mean age that each practice first examined patients. An ANOVA was also utilized for mean start age of orthodontic treatment and mean treatment time for different practices. Patients were also segregated into start age groups, two through nine years, ten through twelve years, thirteen through eighteen years and adults. Mean duration of treatment was tested with a one-way analysis of variance. For the ANOVA, statistical significance was set at a p-value of < 0.05.

RESULTS

The utilities provided by Orthosoft™ Inc. were applied to the databases of thirteen practices using the software program. The practices were located in Colorado Springs, Co; Palm Harbor, FL; Wenatchee, WA; Fargo, ND; Dublin, GA; Lafayette, CA; and Millburn, NJ as well as six cities in Texas; Amarillo, Dallas, Humble, Corpus Cristi, and two practices from Plano. After parsing the data from the thirteen practices, the sample consisted of 25,364 patients. Of these 25,364 patients, 6,421 had complete records. A complete record consisted of a first seen date, a treatment start date, a treatment end date, a gender, and a patient identification number. Of the 25,364 patients, 18,943 patients had only patient identification number, gender and first seen date and, hence, were assumed to have not been treated. There was no further data to confirm or refute that these patients received treatment at another practice.

The mean age of the 25,364 patients when first seen was 17.1 years while the median and mode age when first seen was 13.3 and 12.0 respectively, significantly lower than the mean, suggesting that majority of patients were children. The mean age when first seen for the 18,943 patients who were not treated was 17.4 years while the median was 13.3 years old. The mode of nine years old suggested that the patients that entered an orthodontic practice at an early age were less likely to begin treatment than those screened at twelve years of age.

Of the patients that, in fact, started and completed treatment, the mean was higher than the mode or the median for age when first seen, age at start of treatment and age at end of treatment. This pattern suggested that the mean did not reflect the entire picture of the average age of the orthodontic patient as seen in histograms Figure 7, Figure 9, and Figure 10. Patient age ranged from two to seventy years old. (Refer to Table 1). For the average duration of treatment the mean was much closer to the median and the mode which suggested that there were less variation and extremes for duration of treatment. (Refer to Table 1)

TABLE 1.--Demographic Information for All Treated Patients (n=6,421) *

	Mean		Sd	Median	Mode	Minimum	Maximum
Initial Age (Years)	16.3	±	8.7	13.4	12.0	4.3	68.1
Start Age (Years)	16.7	±	8.6	13.6	12.0	4.8	68.1
End Age (Years)	18.8	±	8.6	15.7	14.0	5.3	69.0
Duration (Months)	25.2	±	11.9	24.0	21.0	2.0	71.7

*Each variable includes the mean with standard deviation, median, mode, minimum and maximum.

The stratification of the treated sample by age identified in 5,088 children and 1,333 adults. Table 2 shows the mean age when first seen, treatment start age and treatment duration of those 5,088 patients in our treated sample of children from two to eighteen years of age. As expected the mean, mode and median was much lower than for the overall treated patients. Table 2 shows the mean first seen age, start age and duration of those 1333 patients in our treated sample of adults from nineteen to seventy years of age. On average adults had slightly shorter treatment times, however, the mode duration for adults was significantly higher than the mode for

children. When a t-test was performed to compare the two groups, the difference was statistically significant with a p-value of <0.05. In contrast, the difference in the duration of treatment for males and females was not statistically significant.

Gender statistics

The percent of all females examined was 61%. However, the percentage of females actually undergoing orthodontic treatment was 65%. Thus, a higher percentage of women actually started orthodontic treatment. The percent of females among treated children was 62% versus 78% in adults. Hence, more females than males underwent orthodontic treatment and the differential was greater in adults than in children.

TABLE 2--Demographic Information for All Treated Children and Adults. *

	Children n=5088				Adults n=1333				
	Mean	Sd	Median	Mode	Mean	Sd	Median	Mode	
Initial Age (Years)	12.6 ±	2.6	12.6	12.0	30.7 ±	9.1	28.4	24.0	
Start Age (Years)	12.9 ±	2.4	12.9	12.0	30.8 ±	9.1	28.6	24.0	
Duration (Months)	25.5 ±	11.8	24.2	23.0	24.1 ±	12.4	23.2	30.0	

*Each variable includes the mean with standard deviation, median, and mode.

Frequencies

The distribution by age for the entire sample of 25,364 is shown in Figure 6. The highest percent of patients was first seen at age twelve and a slightly lower percent of patients were seen at eleven. Patients eight to fourteen years old comprised 46.8% of the entire sample.

In Figure 7, the distribution by age when first seen for the treated 6,421 patients

is shown. The highest percent of patients was first seen at age twelve. The peak was much more concentrated and spiked and less rounded than the "untreated" sample. A much smaller peak was seen at twenty-four years of age.

A histogram of the 18,943 patients that were not actively treated is shown in Figure 8. The highest percent of patients were first seen at a much younger age of nine than those that were treated. The percent of the start ages of the 6,421 treated patients is shown in Figure 9. Again, the highest number of patients started treatment at age twelve.

The distribution of the ages of the 6,421 treated patients at the time treatment ended is shown in Figure 10. The highest percent of patients completed treatment at age fourteen, two years older than when they started treatment. The distribution of patients by treatment duration for the 6,421 patients is shown in Figure 11. There were three peaks. The highest number of patients completed treatment in twenty-one months. The next highest peak was at thirty months and there was also a smaller third peak at eight months. The distribution of the treatment duration for the 5,088 treated children is shown in Figure 12. The highest number of patients completed treatment in twenty-three months and was the largest peak. There was a similar peak at thirty months.

The distribution of the treatment duration for adults from nineteen to seventy years of age is shown in Figure 13. Of the 1,333 patients, the highest percent of patients completed treatment in thirty months followed by twenty-two months. There was less of a distinction between the peaks in this data compared to that seen for

children.

The distribution of the treatment duration for children that started treatment at age nine and under is shown in Figure 14. Of the 582 patients, the greatest number of patients completed treatment in about seventeen months. There was less of a distinction of peaks in this data compared to older children.

The distribution of the treatment duration for children that started treatment at ten through twelve years of age is shown in Figure 15. Of the 2,052 patients, the highest percent of patients completed treatment in eighteen and twenty-four months. There was a smaller peak at thirty-two months.

The distribution of treatment duration for children who started treatment between ages thirteen through eighteen is shown in Figure 16. There were three peaks. Of the 2,432 patients, the highest number of patients completed treatment in twenty-two months. There was a smaller peak at thirty-one months and the smallest peak was at seven months.

Trends

In order to allow for better representation of all practices and to minimize over-representation of a few practices, each year had to contain data from at least one quarter of the total number of practices in the data set. Thus, at least some data from practices had to be a part of the year's data. This condition was met by the years for 1992–1999 and hence, eight years were examined to check for any trends.

Table 3 shows that the mean age when first seen for the entire sample of patients for the years 1992–1999 was relatively constant. However, the median and

mode decreased slightly. Figure 1 shows the downward trend for the mode and median of age when first seen.

TABLE 3.--First Seen Ages of All Patients Screened from 1992–1999 *

Years	Mean (Years)		Sd	Median (Years)	Mode (Years)	n=
1992	17.3	±	8.3	15.0	12	1550
1993	17.2	±	9.5	13.9	12	1824
1994	18.3	±	10.4	14.1	13	1942
1995	17.3	±	10.2	13.4	12	2793
1996	17.1	±	10.5	13.5	11	3960
1997	17.3	±	11.1	13.3	11	4247
1998	17.1	±	11.1	12.9	8	3937
1999	16.4	±	11.2	12.2	9	3979

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

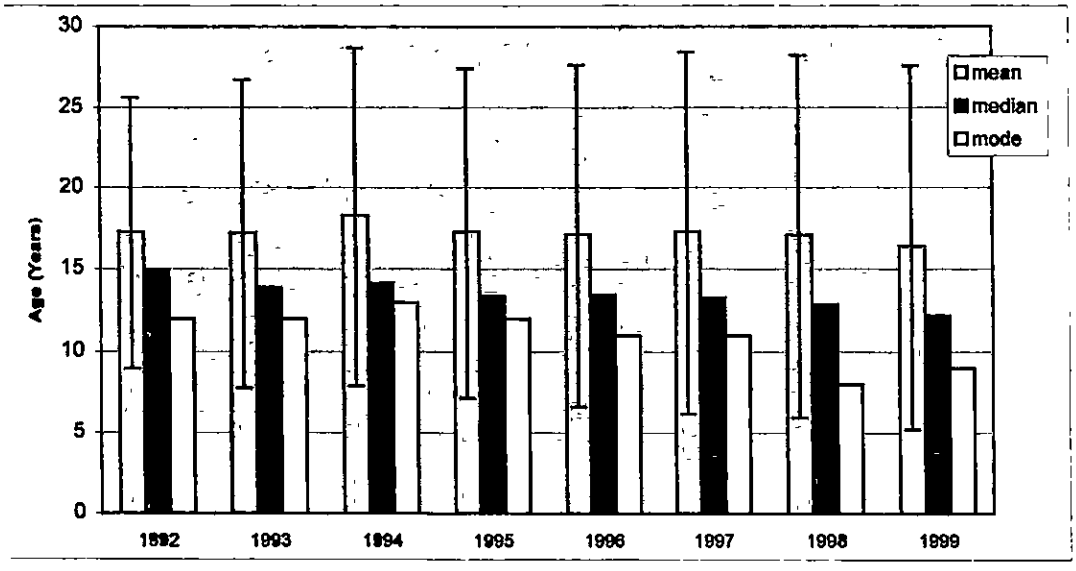


Figure 1. Bar chart showing the mean, median and mode first seen age of the entire sample of patients that were first examined within the years from 1992 to 1999. Notice the ages stayed relatively constant.

Table 4 shows the mean, median and mode of the age when first seen for all

children from age two to eighteen, first examined between 1992–1999. The mean age decreased gradually from 13 to 11.2 years of age. This trend was quite pronounced and was seen for the median and mode as well. Figure 2 illustrates these downward trends.

TABLE 4.--First Seen Ages of All Children Screened from 1992–1999 *

Years	Mean (Years)		Sd	Median (Years)	Mode (Years)	n=
1992	13.0	±	3.1	12.9	12	1101
1993	12.3	±	3.0	12.2	12	1289
1994	12.3	±	2.9	12.4	13	1306
1995	12.0	±	2.9	12.1	12	2022
1996	12.0	±	3.1	12.0	11	2930
1997	11.7	±	3.2	11.7	11	3136
1998	11.4	±	3.2	11.2	8	2905
1999	11.2	±	3.1	10.8	9	3062

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

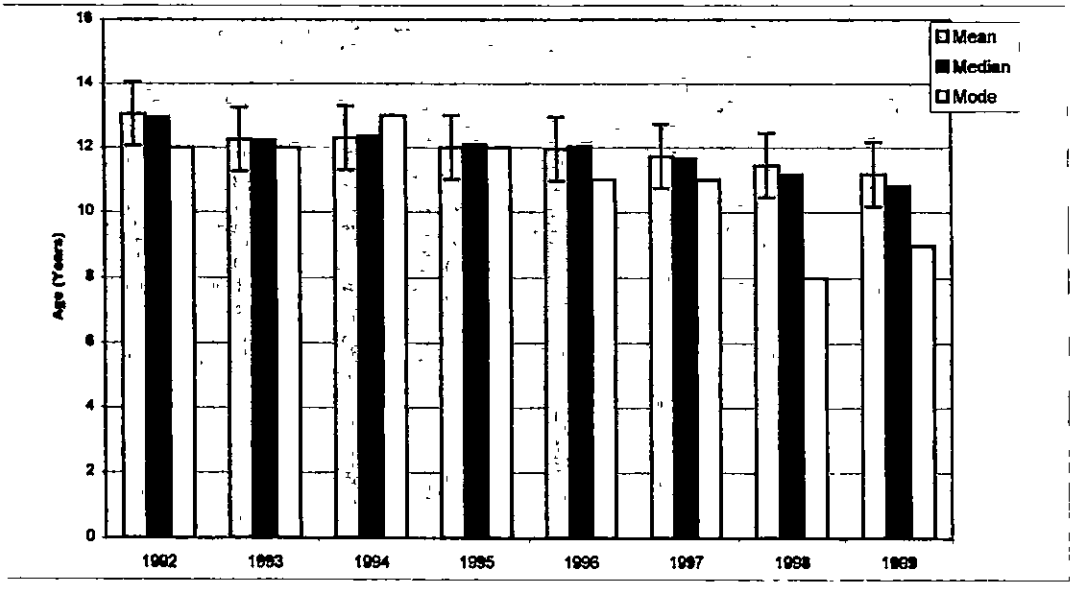


Figure 2. Bar chart showing the mean, median and mode first seen age of all the children from two to eighteen years of age that were first examined from 1992 to 1999.

In contrast with children and the overall sample, the mean age when first seen for adults increased from 27.7 to 33.9 years of age. Furthermore, the median and mode age for adults trended upward. (Refer to Figure 14).

TABLE 5.--First Seen Ages of All Adults Screened from 1992–1999 *

Years	Mean (Years)		Sd	Median (Years)	Mode (Years)	n=
1992	27.7	±	8.0	24.9	19	449
1993	29.2	±	9.0	26.6	20	535
1994	30.6	±	9.4	27.9	19	636
1995	31.1	±	9.3	29.0	20	771
1996	31.9	±	10.2	29.8	22	1030
1997	33.1	±	10.4	31.2	20	1111
1998	33.0	±	10.1	31.5	20	1032
1999	33.9	±	10.7	31.8	24	917

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

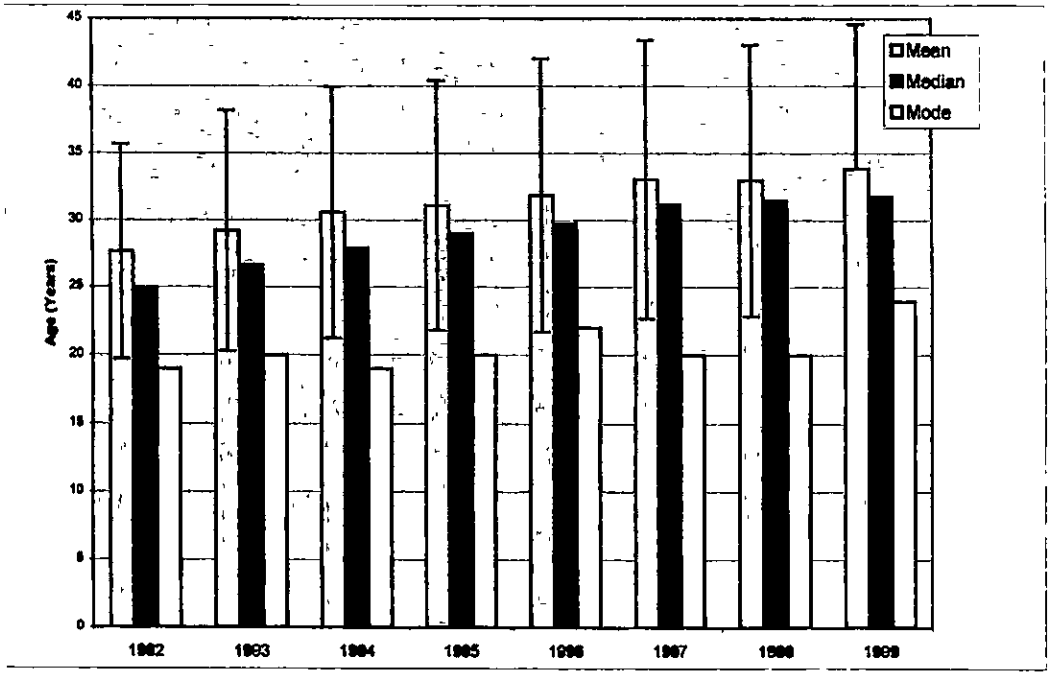


Figure 3. Bar chart showing the mean, median and mode first seen age of all the adults from 19 to 70 years of age that were first examined from 1992 to 1999.

The age subgroups at the start age are found in Table 6. Start ages were grouped into two through nine, ten through twelve, thirteen through eighteen and nineteen and over. The percent that each age group represented is shown as well. For the youngest age group, there was an increasing trend from 12.6 % to 30.8 % of the total sample for those patients starting treatment. This suggests a trend toward early treatment; starting treatment of patients before ten years of age. The percent that ten through twelve year olds represented remained relatively constant. For those thirteen through eighteen the percent dropped almost 40%. Surprisingly, adults, nineteen and over comprised a smaller percent over the years.

TABLE 6.--First Seen Age Groups and the Percent Comprised of the Total Sample Screened from 1992-1999

	First Seen Age Groups			
Years	2-9 year olds	10-12 year olds	13-18 year olds	>=19 years olds
1992	12.6%	23.5%	34.9%	29.0%
1993	17.9%	25.1%	27.7%	29.3%
1994	14.8%	24.4%	28.0%	32.7%
1995	19.0%	27.5%	25.9%	27.6%
1996	20.7%	25.3%	28.1%	26.0%
1997	24.7%	23.1%	26.1%	26.1%
1998	27.3%	23.6%	22.9%	26.2%
1999	30.8%	25.2%	20.9%	23.1%

Practices

For each practice, the mean first seen age varied significantly. Table 7 shows the mean, median and mode first seen ages for the thirteen practices. The range for the mean was from 15.0–20.7 years old. For the median the range was from 9.2 to 14.3 years old and the mode ranged from 7 years old to 14 years old. A one-way analysis

of variance was done and the p-value was significant at $p < 0.05$. (Refer to Table 7)

TABLE 7.-- First Seen Age by Different Practice *

Practices	Mean (Years)		Sd	Median(Years)	Mode(Years)	n=
Amarillo, TX	15.5	±	9.3	12.5	12	2665
Colorado Springs, CO	15.0	±	8.3	9.2	8	1444
Plano, TX '75	17.3	±	13.6	14.2	14	1723
Dallas, TX	19.5	±	12.1	14.3	11	1081
Plano, TX '94	17.9	±	10.7	12.5	8	1120
Humble, TX	17.5	±	13.1	13.4	13	928
Palm Harbor, FL	18.7	±	9.5	13.0	8	1664
Wenatchee, WA	16.5	±	9.9	13.9	12	836
Fargo, ND	15.8	±	10.5	12.4	12	3020
Dublin, GA	16.0	±	14.5	12.4	11	698
Lafayette, CA	20.7	±	9.1	13.6	7	882
Corpus Cristi, TX	18.5	±	10.5	15.3	13	5399
Milburn, NJ	16.0	±	9.5	12.0	9	3685

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

The start ages for each practice varied less than the first seen age. The mean, median and mode of the start age are shown for the thirteen practices in Table 8. The range for the mean was slightly smaller from 15.0 to 20.7 years than the first seen means. For the median the range was 2.4 years and the mode ranged from nine years old to fourteen years old. A one-way analysis of variance was done and the p-value was significant at $p < 0.05$. (Refer to Table 8).

TABLE 8.—Start Age by Different Practice *

Practices	Mean (Years)		Sd	Median (Years)	Mode (Years)	n=
Amarillo, TX	16.0	±	8.1	13.2	12	1252
Colorado Springs, CO	14.9	±	8.1	13.1	11	59
Plano, TX '75	18.2	±	9.3	14.2	14	414
Dallas, TX	15.7	±	9.5	12.2	11	109
Plano, TX '94	17.8	±	11.3	13.1	12	197
Humble, TX	17.4	±	9.7	14.0	12	72
Palm Harbor, FL	17.7	±	10.0	13.9	13	225
Wenatchee, WA	14.1	±	6.2	13.0	12	113
Fargo, ND	15.2	±	8.0	13.1	12	605
Dublin, GA	13.4	±	5.3	12.4	12	167
Lafayette, CA	18.3	±	12.7	13.0	9	314
Corpus Cristi, TX	17.4	±	7.5	14.6	13	2345
Milburn, NJ	15.4	±	10.1	11.8	11	538

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

Table 9 illustrates that mean, median and mode durations varied significantly from practice to practice. The mean duration of treatment ranged from 17.7 to 30.7 months. The mode varied from eleven to thirty months, a difference of nineteen months. Interestingly, the practice with the highest number of patients had the longest duration of treatment.

TABLE 9.--Treatment Duration by Different Practice*

Practices	Mean (Months)		Sd	Median(Months)	Mode(Months)	n=
Amarillo, TX	21.1	±	8.7	19.6	17	1252
Colorado Springs, CO	23.0	±	7.2	23.5	21	59
Plano, TX '75	20.6	±	12.1	19.1	16	414
Dallas, TX	23.8	±	8.3	25.1	29	109
Plano, TX '94	21.3	±	8.2	20.9	20	197
Humble, TX	17.4	±	7.3	14.0	12	72
Palm Harbor, FL	23.9	±	8.0	24.0	24	225
Wenatchee, WA	17.7	±	7.4	18.2	18	113
Fargo, ND	20.5	±	6.4	21.4	23	605
Dublin, GA	23.1	±	10.4	23.5	23	167
Lafayette, CA	19.1	±	11.7	17.0	11	314
Corpus Cristi, TX	30.7	±	12.2	31.7	30	2345
Milburn, NJ	28.4	±	15.5	25.5	19	538

*Mean with standard deviation (Sd), median, mode and the count (n) are shown.

Age Groups

Table 10 compares the percentage of each age group examined with those who went on to treatment by virtue of a start date. The percentage of patients nine and under examined was 15.3% but only 9.1% actually started treatment. The percent of ten through twelve year olds seen was 23.5% while a significantly higher percent actually started treatment. Thirteen through eighteen year olds comprised 32.5% of all those examined while 37.9 % were started treatment. The percentage of adults comprised 28.7% of the total number of patients examined and 21% of the total number of patients that started treatment. Figure 4 compares those examined with those starting treatment for patients grouped by age. Although patients 10–18 years of age constituted slightly more than half of those examined they constituted almost

70% of those who started treatment. In addition, one of four patients screened was an adult while one of five adults actually started treatment.

TABLE 10.--The Percent of Patients at First Examination and those Beginning Treatment

Age Groups	First Seen	Start
2-9 years	15.3%	9.1%
10-12 years	23.5%	32.0%
13-18 years	32.5%	37.9%
>19 years	28.7%	21.1%

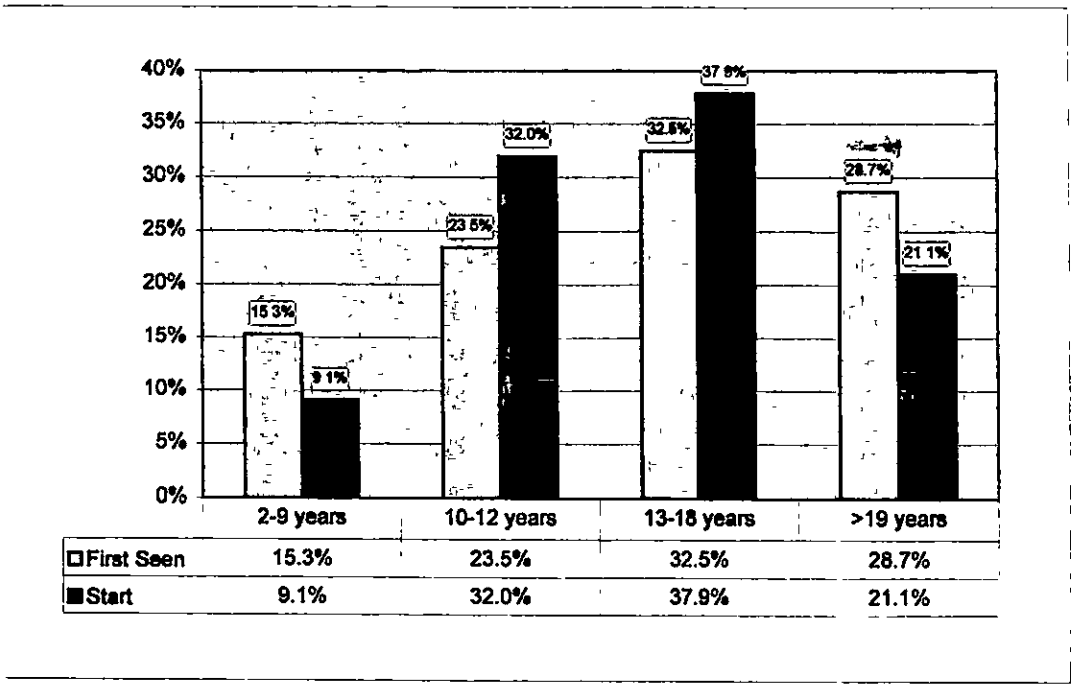


Figure 4. Bar chart showing age groups broken down into 2-9, 10-12, 13-18 and greater than and equal to 19 years old and the percent that each group comprised of those being first seen and those being started. Notice the significant difference between the first seen vs. the start percents of the 2-9 year olds and the greater than 19 year olds.

Table 11 summarizes the mean, median and mode of treatment duration for the sample population subdivided by age. The mean and median duration peaked in the ten through twelve-year-old group, but the mode was highest for adults. The mean and the median treatment duration was greatest for patients in the mixed dentition. An ANOVA was done and the p-value was significant at <0.05. (Refer to Figure 5)

TABLE 11.--Start Age Groups and their Treatment Durations*

Age Groups	Mean (Months)		SD	Median (Months)	Mode (Months)	n=
<2-9 years	23.1	±	16.1	18.8	16	582
10-12 years	27.3	±	11.3	26.0	23	2052
13-18	24.4	±	10.7	23.6	21	2432
>19 years	24.1	±	12.4	23.2	30	1355

*Mean with standard deviation (Sd), median, mode and count are shown

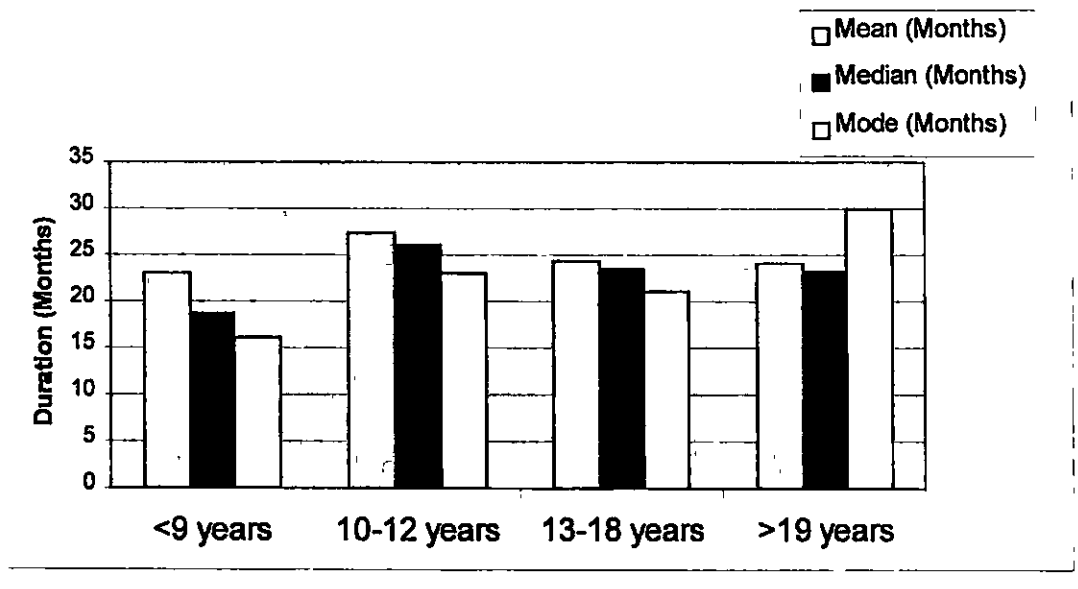


Figure 5. Duration by different start age group. Notice that the late mixed dentition of ten through twelve year olds had the longest duration for the mean and the median. The longest duration mode was for adults at thirty months.

DISCUSSION

The first question was, "What is the percentage of adults compared to children receiving orthodontic treatment?" Not surprisingly, the majority of patients were children. This concurs with most other studies that have reported about 20% of the orthodontic population were adult. The present study found that 21% of orthodontic patients were adults. Interestingly, there was a higher fraction of adults that were screened who did not start treatment as compared to younger age groups.

"What is the percentage of males compared to females undergoing treatment?" There could be many reasons that the overall percentage of females examined was greater than males, and why an even greater percentage of females actually proceeded with treatment. Perhaps, females are more esthetically driven and thus prioritize nice straight teeth more than males. Hence females, may be more determined to correct their malocclusion then males who are only somewhat inclined.

Interestingly, there was a difference in gender percentage for children and adults. Among adults, a much greater fraction, almost 4/5 were female. Basically, it would appear that the male adult patient is the least likely to actually start treatment.

A reasonable speculation is that for children, it is usually the parent's decision; with even more the mother's insistence to undergo treatment and, therefore, the importance of straight teeth for boys and girls is nearly equal. On the other hand,

for adults, it is the patient's choice. Adult women have traditionally been more esthetically oriented so it is not surprising that more adult females than males opt for orthodontic treatment.

When examining the age at which patients were first seen in orthodontic practices, it was found that the average was 17.1 years. When plotting a histogram, it was found that the greatest percent of patients was around twelve years of age. This suggests that, although there were many patients seeking orthodontic treatment at different ages, the majority of patients were adolescent. When looking at those patients who were assumed not to have been treated, the highest percentages were examined at around eight or nine years of age. Figure 8, (the histogram of patients that were examined but that did not start treatment), showed that children under twelve years of age and adults who get examined are less likely to start treatment than those patients around twelve years of age. Hence, patients are less likely to begin treatment at a very early age or at older ages. The reason may be due to the doctor's decision not to treat at an early age or that the parents or guardian may choose no treatment at this age.

Furthermore, these data suggest that patients who enter the orthodontic practice at an early age, around eight or nine, are less likely to begin treatment than those that are screened at twelve years of age. There can be numerous reasons for this difference. Although patients might be first seen by an orthodontist before twelve years of age, perhaps the orthodontist opts to start treatment later because there are not enough permanent teeth, starting earlier is not more beneficial to the patient, the

patient is not emotionally mature, etc. One could also speculate that there is a window of opportunity around twelve years of age, when patients and parents are most likely to accept orthodontic treatment. Perhaps, after twelve years of age, upon entering into "teenagehood", when image is top priority and self-consciousness is often intense, patients start believing that they are "too old" for braces and that the outcome is not worth the trauma to their self image.

Contrary to popular belief, average treatment length in the current study was 25.2 months and not "two years" as is commonly thought. In the histogram of the duration for treated patients there were two, or arguably three peaks. One could argue that there was a smaller peak at around seven to nine months. Since the data did not abstract the type of treatment delivered, it is not know whether patients were in limited treatment, surgical treatment, two stage treatment, or were more complex non-surgical cases, etc. It could be speculated that the largest peak represented more complex cases, combined a two-phase treatment without a retention stage, were non-compliant, and/or appliance breakers. It could also be speculated that the smallest peak represented greater numbers of phase I treatments, early treatments, limited treatments, or comprehensive treatments with compromised treatment goals, and that the middle peak had many straightforward class I crowding cases.

Perhaps, these peaks had nothing to do with the nature of the treatment, but rather were more of a factor on the representation of each practice. Not all practices were equally represented. One or more practices could have contributed a significantly greater number of patients than the others and caused one of the peaks.

When considering adults only, duration of treatment did support the commonly held belief that average treatment time is two years. The t-test detected a statistical significance between duration times for adults compared to children, but not between males and females. Hence, on average, adults were treated faster than children. One could speculate the reason is that adults are more prone to comply, less likely to break appliances and have predictable growth patterns. In contrast, the duration mode was highest for adults according to Figure 16. Again, this could have been due to an over-representation of one or more practices.

Figure 16 also shows that the mean and median duration was greatest longest in the mixed dentition stage and shortest for the two through nine year old group. One could speculate for the two through nine-year-old group, treatments were short-term, mostly phase I; for example, expanders or functional appliances. On the other hand, treatment for patients in the mixed dentition stage lasted longer because the practitioners waited for deciduous teeth to exfoliate or permanent teeth to erupt. Or perhaps, there were more two-phase treatments where phase I blended into phase II, and there was no retention stage in between them. From a practice management standpoint, an orthodontist would find this information quite useful because he/she would charge accordingly – more for those in the mixed dentition stage and less for those two through nine year old.

Interestingly, the study results challenge the notion that adults comprise a much greater percentage of the total number of patients seeking orthodontic treatment than in the past. The percentage of adults examined actually decreased from 1992 to 1999.

Perhaps, the reason is that a large number of adults were treated previously as children and thus, adults comprise a smaller percentage of the total number of patients examined. In contrast, it was found that the under nine-year age group comprised a greater percentage of the total examined, up from 1992 to 1999. Hence, the recommendation of the American Association of Orthodontists that patients should be seen first around age seven seems to have had an effect on public awareness of the need for early examination.

From a practice management standpoint, there are many uses for studies like this one. For example, from Figure 15, it was found that those under nine years of age comprised double the percentage of patients examined compared with those actually started in treatment. There is definite difference in the age groups of those started in treatment and those examined. Furthermore, there was a greater likelihood that older children, that those ten through twelve years old, would go to start treatment following an examination. Considering this, an orthodontist may decide to forgo an examination fee for patients in this age group, since a fee could be incorporated with other fees later on during the course of treatment. In contrast, an orthodontist may want to charge an examination fee to those who are in a younger age group in order to receive compensation for their time.

This study was descriptive, designed to illustrate how the use of practice management programs in orthodontic private practice can be used for epidemiological research. However, as it was also a retrospective cross-sectional study, and there were inherent limitations in the study design. The thirteen practices were not a

random sample, but rather a convenience sample selected on the basis that the company Orthosoft™Inc. had already previously downloaded their data files. The company did this in order to aid those offices in their conversion of the earlier software version from 7.0 to 8.0. Furthermore, although the practices came from across the United States including Colorado, Florida, Washington, North Dakota, Georgia, California, New Jersey and Texas, many states were not represented. Therefore, the sample of patients was not randomly selected; it was a convenience sample.

The greatest barrier to the use of practice management software programs and computer patient records for research is the need for uniformity and a standardization of recording methods, collecting data and making observations. The largest drawback of the present study design was an inability to control the way information was entered into the computers at each private office. It had to be assumed that the procedure followed was fairly consistent between offices. This assumption was based on the knowledge that each practice went through seven days of training by staff members of Orthosoft™ who traveled to each office in order to instruct the doctor and staff on how to use the program. Thus, there was some uniformity in the training protocol. Another limitation was the inability to check or confirm that data were accurately entered.

On the other hand, a strength of the study design was the large sample size that minimized random errors. Unfortunately, there was no mechanism to evaluate treatment outcome. For example, there was no information to indicate if cases

completed after a longer treatment period produced better results than those treated over a shorter time.

In conclusion, the purpose of present study was to study the demographic characteristics of clinical orthodontic practice. Specifically, the goals of our research project was to determine the age at which patients are first getting examined, starting treatment, ending treatment, and the duration of treatment. Gender and age differences were also investigated. This study illustrated that orthodontic practice management programs used in the course of routine clinical practice can be useful in epidemiological research

CONCLUSIONS

The study utilized computer databases that contained large numbers of variables. Analyses of the data recorded by different providers on different occasions produced many interesting findings on the demographic characteristics of orthodontic patients.

1. The average age that patients are seeing and starting orthodontics was around sixteen to seventeen years of age although the highest percentage of patients was around twelve years old.

2. Twenty nine percent of patients being examined were adult while adults comprised 21% of those being treated.

3. Sixty five percent of all patients undergoing orthodontic treatment were female.

4. Seventy eight percent of adults undergoing treatment were female

5. The average duration of treatment was twenty-five months and children on average take slightly longer on average than adults.

6. There was a trend detected indicating that the first examination age of adult patients increased while that for children decreased.

APPENDIX 1. – Histograms

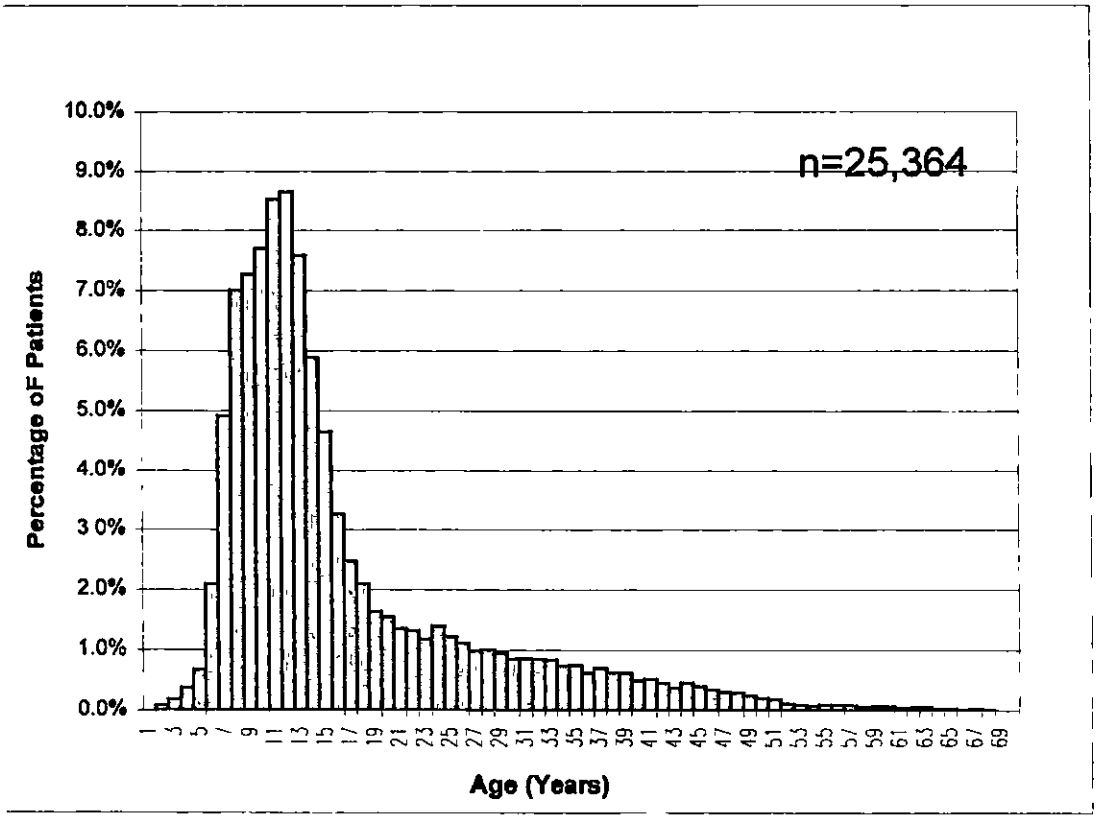


Figure 6. Histogram showing the percentage of all patients screened and their first seen ages.

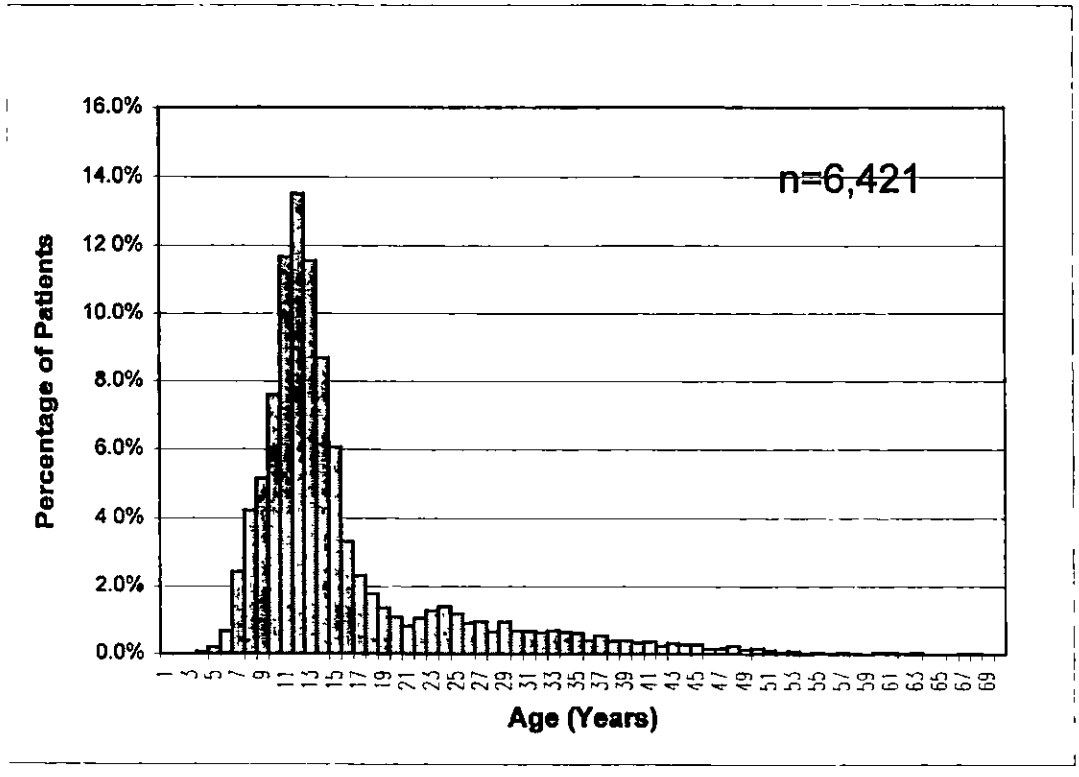


Figure 7. Histogram showing the percentage of treated patients and their first seen ages.

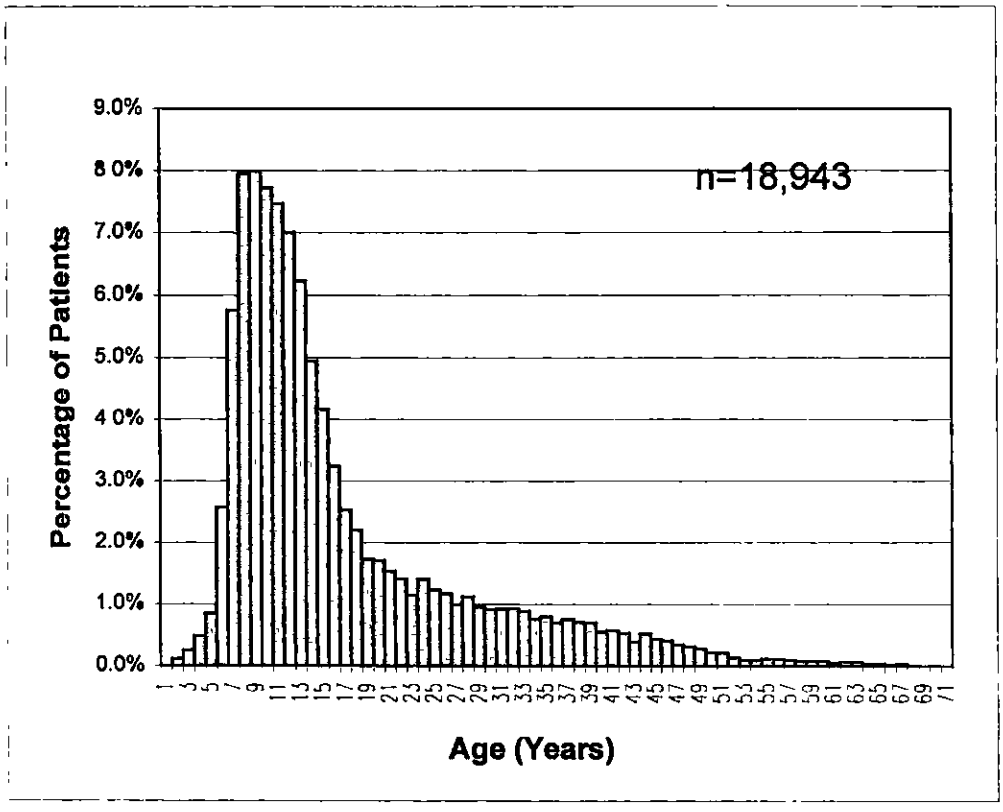


Figure 8. Histogram showing the percentage of "untreated" patients and their first seen ages.

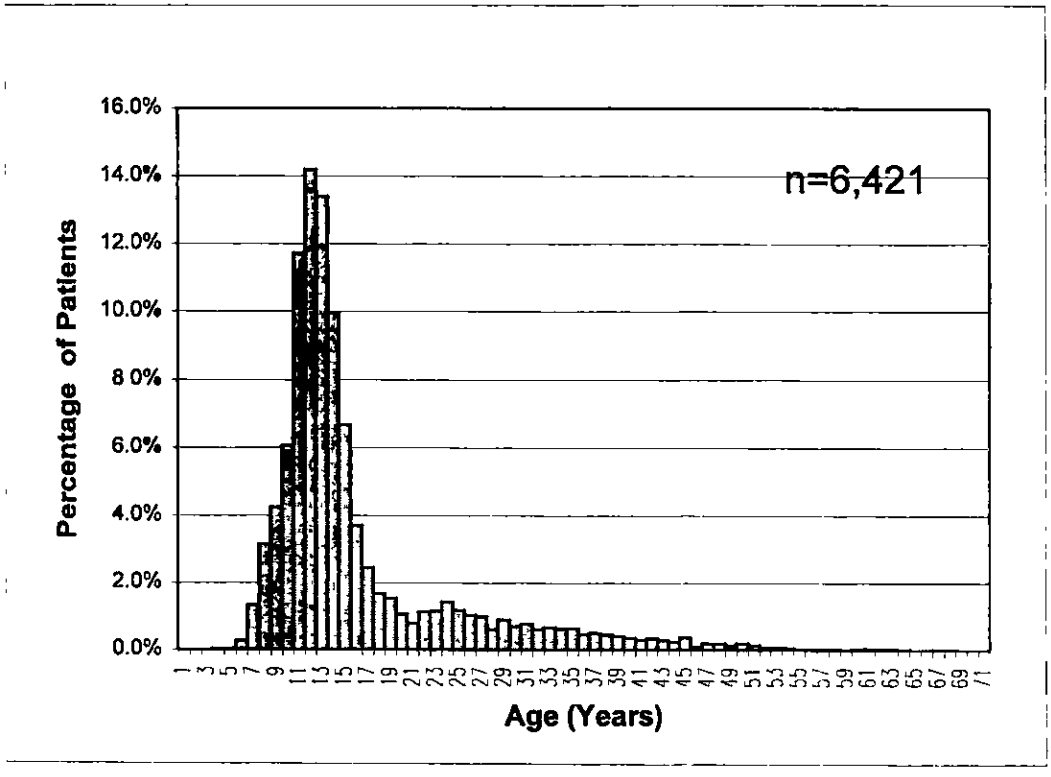


Figure 9. Histogram showing the percentage of treated patients and their start ages.

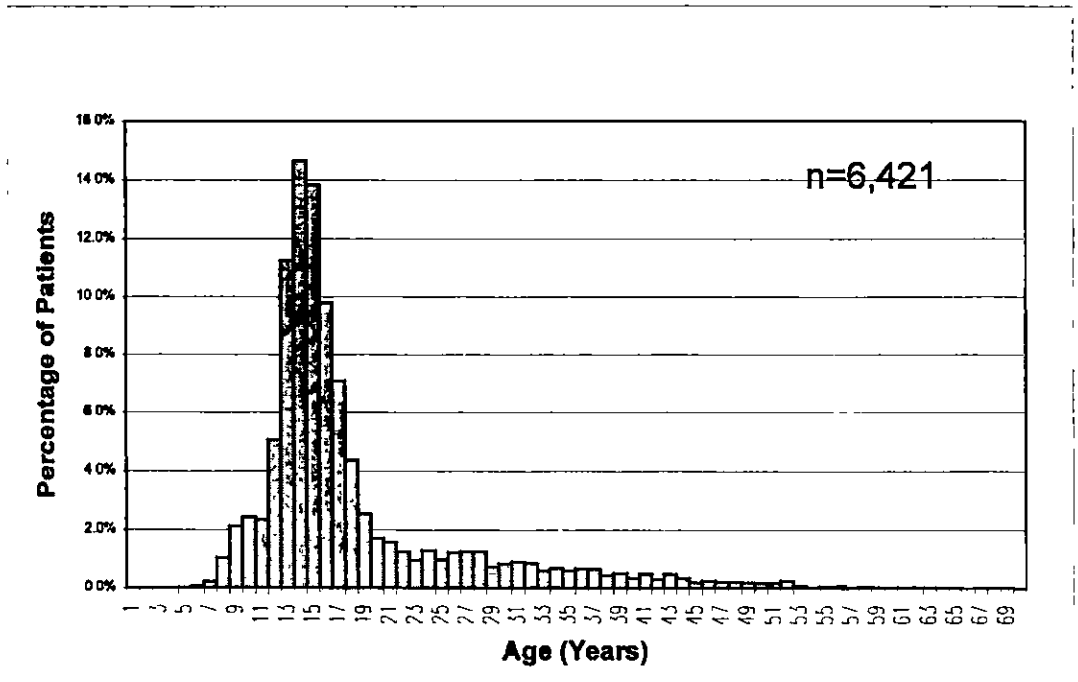


Figure 10. Histogram showing the percentage of treated patients and their end ages.

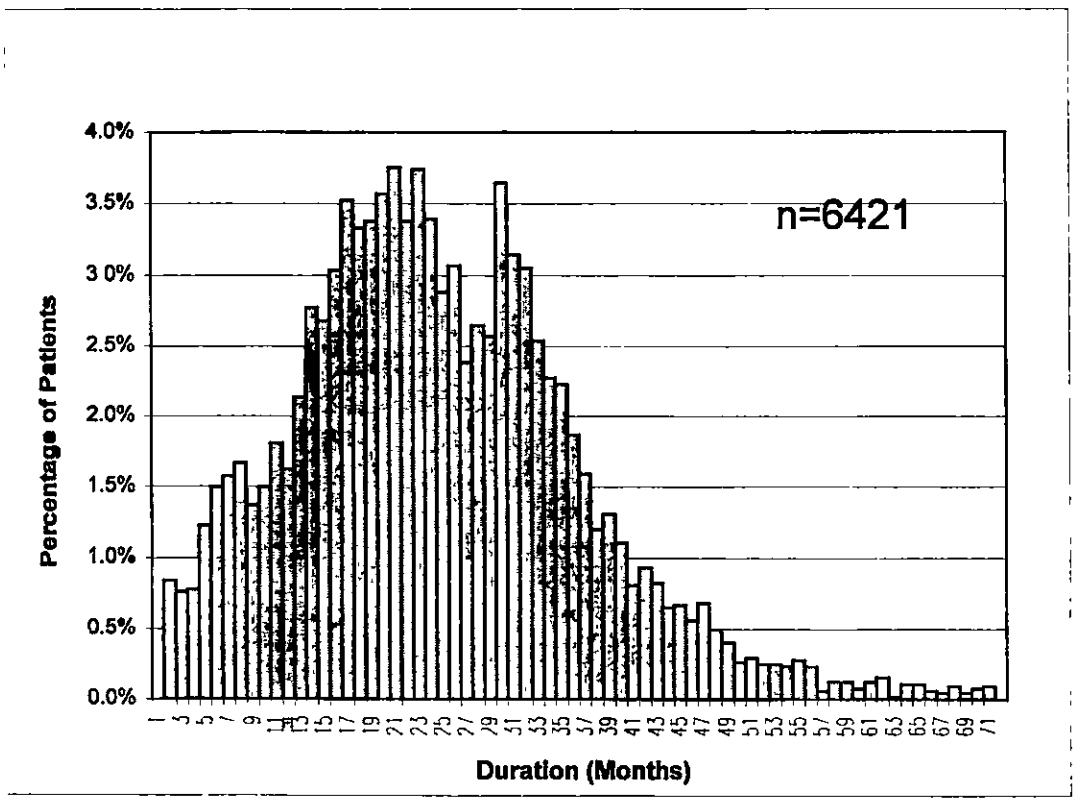


Figure 11. Histogram showing the percentage of treated patients and their treatment durations

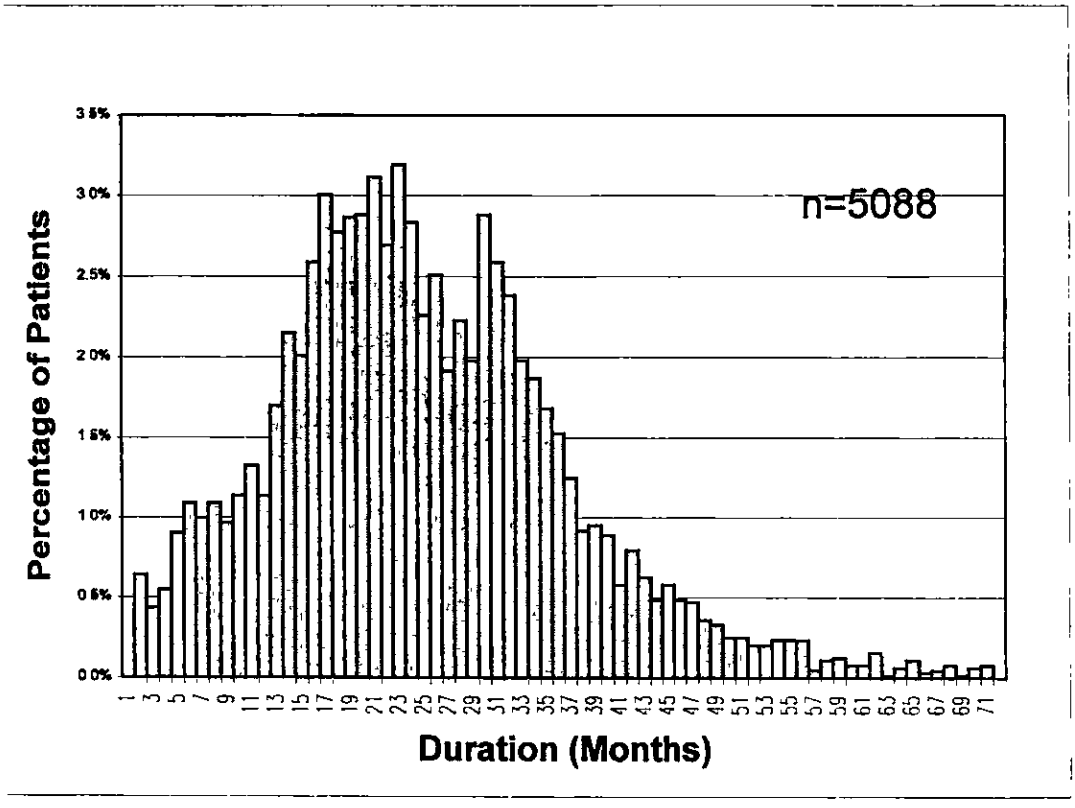


Figure 12. Histogram showing the percentage of children and their treatment durations

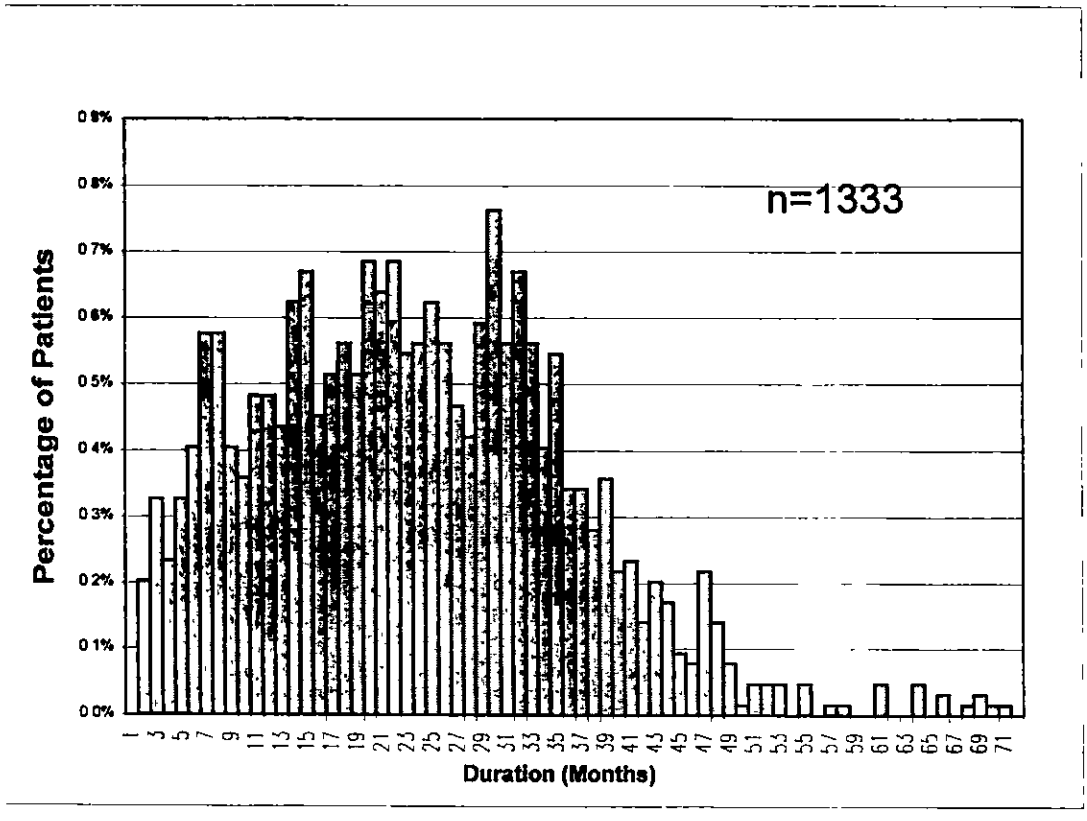


Figure 13. Histogram showing the percentage of adult patients and their treatment duration

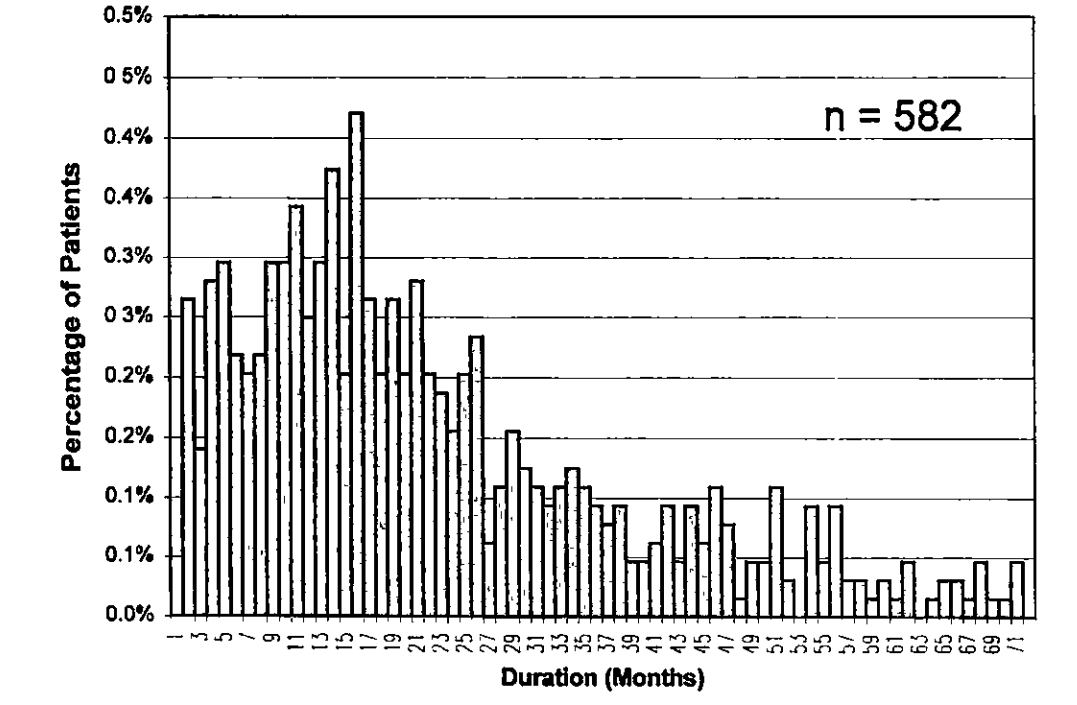


Figure 14. Histogram showing the percentage of patients under 9 and their treatment durations

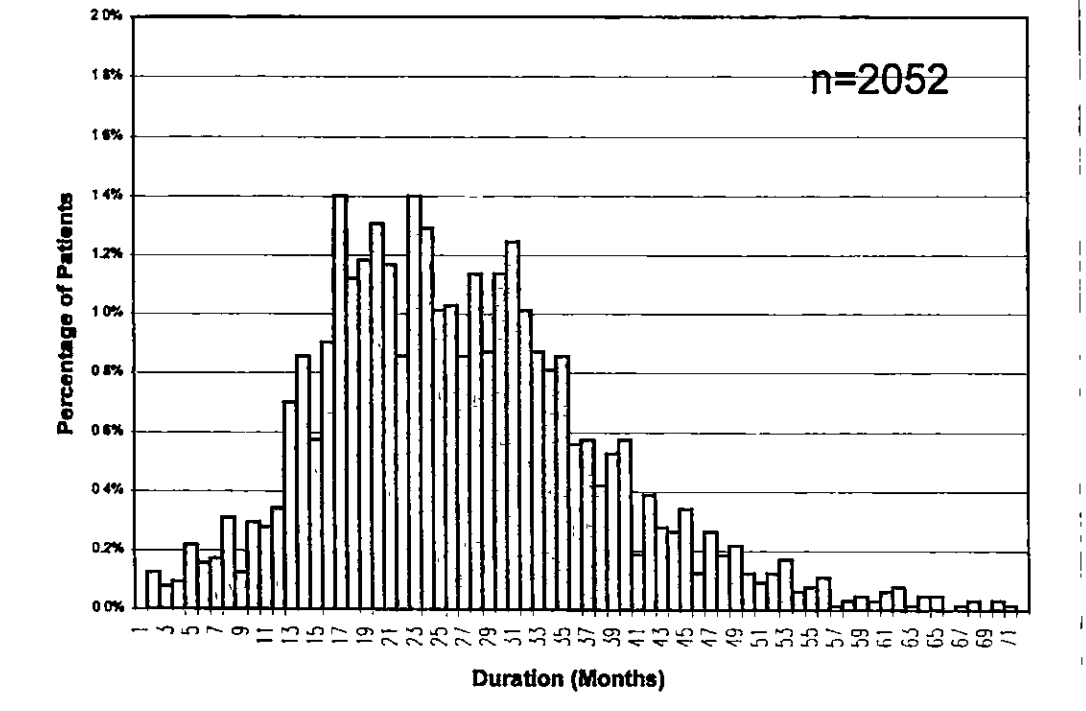


Figure 15. Histogram showing the percentage of patients from 10-12 years of age and their treatment durations

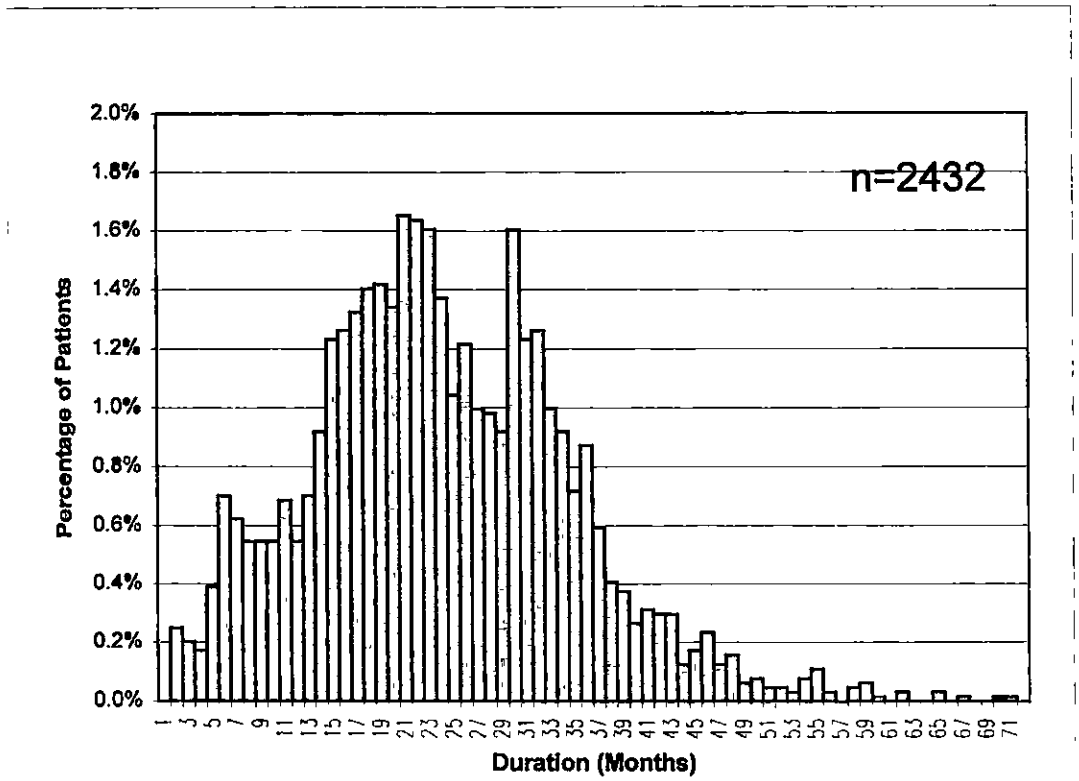


Figure 16. Histogram showing the percentage of patients 13-18 years of age and their treatment durations

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