

Use of an Electronic Patient Record System to Evaluate Restorative Treatment Following Root Canal Therapy

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Abstract: Electronic Patient Record (EPR) systems are rapidly gaining acceptance as an important tool for managing patient information. The purpose of this project was to evaluate the use of an EPR system for assessment of quality of care in an academic dental institution. The primary outcome of interest was the timeliness and completeness of restorative care following completion of nonsurgical root canal therapy. An initial query of the EPR database was performed using the following inclusion criteria: root canal treatment performed in the postgraduate endodontics clinic between September 2002 and June 2004, patient age ≥ 18 years old, and posterior tooth (premolars and molars). A total of 925 patients with 1,014 endodontically treated teeth met the inclusion criteria. A random sample of 30 percent of the treated teeth (302 teeth on 281 patients) was selected for detailed review. This sample of 302 teeth was then screened to determine if any restorative treatment had been performed between September 2002 and November 2005. Forty-eight percent ($n=146$) of the 302 teeth did not receive any form of permanent restoration over the time period studied. Twenty-five percent ($n=75$) of the teeth received a buildup only, and 27 percent ($n=82$) received the recommended treatment, a full occlusal coverage restoration. This study documents the use of an EPR system to objectively and efficiently assess one aspect of quality of care in a dental school environment.

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Effective use of information technology is becoming one of the standards for measuring excellence in dental education and clinical practice.^{1,2} One example of current information technology is the Electronic Patient Record (EPR). An EPR system has the potential to improve the quality of health care and control costs,^{3,4} although, to date, evidence of this is limited in medical practice⁵⁻⁷ and virtually nonexistent in dentistry. Resistance to use of EPR systems is based primarily on high initial cost and ongoing maintenance costs, lack of universal software standards, concerns about security of electronic records, time and effort involved in transferring existing paper records to an EPR, and reluctance of some health care providers to accept new technology.^{4,8} Potential advantages to use of an EPR system include ongoing quality assessment, accurate patient population dental and medical statistics, decision

support for clinical decision making and administrative purposes, and easy electronic transfer of patient information.⁹ In addition, the federally mandated National Health Information Infrastructure (NHII) will require that health care providers have the ability to electronically transfer patient health information by 2015. Dr. Joel Glover, chair of the American Dental Association (ADA) NHII Task Force, states that “ten years down the road, the most dramatic change in practice will be the use of electronic records and the computerization of the dental practice.”¹⁰ The ADA has taken the lead role in developing standards for the structure and content of EPRs (ANSI/ADA Specification No. 1000).¹¹ Clearly, dental schools have an obligation to prepare graduates for the significant changes in patient record-keeping systems that will become the expected standard of care in the very near future.

In 2003, an interdisciplinary expert panel report commissioned by the Institute of Medicine (*Health Professions Education: A Bridge to Quality*) proposed five core competencies for all health care professionals practicing in the twenty-first century, regardless of discipline.¹² The five competencies are delivery of patient-centered care, ability to work as part of an interdisciplinary team, practice of evidence-based health care, application of quality improvement, and utilization of informatics. While all of these competencies can be potentially connected to use of an EPR system, competency in quality improvement and utilization of informatics can be directly linked to use of an EPR system. We are unaware of any published studies related to the use of an EPR system to assess quality of care in a dental school environment. The purpose of this project was to evaluate the use of an EPR system for the assessment of quality of care in an academic dental institution.

Materials and Methods

One aspect of quality dental care—timeliness and completeness of restorative care following root canal treatment—was selected for evaluation in this study. For purposes of this study, timeliness was defined as the length of time elapsed between completion of root canal therapy and definitive restoration of the tooth. Restorative care was considered complete when the endodontically treated tooth received the recommended restoration. The quality of the coronal restoration is a significant predictor of success for endodontically treated teeth,^{13,14} and the preferred treatment for posterior teeth is full occlusal coverage restoration.¹⁵⁻¹⁷ However, the appropriate time frame for definitive coronal restoration (that is, maximum time elapsed between completion of root canal therapy and restoration) is somewhat controversial, and high-quality evidence to support a treatment recommendation is lacking. A recent study using an insurance database of 1.4 million endodontically treated teeth demonstrated 97 percent survival at eight years.¹⁸ Eighty-five percent of the teeth extracted did not have an adequate coronal restoration. Lazarski et al. found that non-restored endodontically treated teeth were four times more likely to be extracted compared to teeth that had been properly restored.¹⁹ *In vitro* leakage studies and limited clinical research suggest that endodontically treated teeth should be restored as soon as possible following completion of root canal therapy to decrease the potential for

fracture and/or microbial contamination of the root canal space and periradicular tissues.²⁰⁻²³ In a retrospective cohort study of endodontically treated teeth that were not restored with a full occlusal coverage restoration, survival at one, two, and five years was 96 percent, 88 percent, and 36 percent, respectively.²⁴ For purposes of quality assessment in this study we considered restoration within ninety days of completion of root canal therapy to be ideal and restoration within eighteen months to be the outer limit of our acceptable range. We feel that these are reasonable quality control parameters, based on our clinical experience and our interpretation of the best available evidence, although we acknowledge that evidence to support these guidelines is limited.

An EPR system (axiUm™) has been in use at the University of Illinois at Chicago College of Dentistry since September 2002. Many standard reports can be easily generated by axiUm users; however, out of the ordinary reports such as those needed to match certain patient demographic and treatment variables require special programming of the system. With the assistance of our axiUm IT expert, an initial query of the EPR database was performed using the following inclusion criteria: root canal treatment performed in the postgraduate endodontics clinic between September 2002 and June 2004, patient age ≥ 18 years old, and posterior tooth (premolars and molars). A total of 925 patients with 1,014 endodontically treated teeth met the inclusion criteria. A random sample of 30 percent of the treated teeth (302 teeth on 281 patients) was selected for detailed review. This sample of 302 teeth was then screened using the following parameters for the time period from September 2002 to November 2005 (minimum seventeen months after completion of root canal therapy): no treatment; core buildup; prefabricated or cast post; crown (any type); inlay or onlay; simple or multi-surface direct restoration; retreatment root canal; surgical root canal; and extraction. Treatment codes and dates of treatment were identified. Patients were also stratified into two groups based on length of their relationship with the College of Dentistry. “New patients” were those admitted to the College of Dentistry clinics within the three-month period prior to initiation of root canal treatment. “Established patients” were defined as patients of record in the College of Dentistry for at least three months before root canal therapy and were therefore likely to have an assigned student and comprehensive treatment plan. Payment category was also recorded: self-pay, public aid, other. Each patient record was manually

reviewed, and the findings were compared to the EPR-generated report. The manual review involved verification of patient inclusion criteria, exclusion of patients referred from dentists outside of the College of Dentistry and patients with pre-existing full occlusal coverage restorations (when one of these patient records was encountered, it was excluded, and the next patient record on the random list was selected), and date and type of restorative treatment performed. Patient payment category and length of relationship with the College of Dentistry were not verified by manual review. The manual review, although very tedious and time-consuming, is considered the gold standard for comparison purposes in this study. The

research protocol was approved by the University of Illinois at Chicago Institutional Review Board prior to initiating the study.

Results

Forty-eight percent (n=146) of the 302 teeth did not receive any form of permanent restoration over the time period studied. Twenty-five percent (n=74) of the teeth received a buildup only, and 27 percent (n=82) received the recommended treatment, a full occlusal coverage restoration (Figure 1). The mean time between completion of root canal therapy

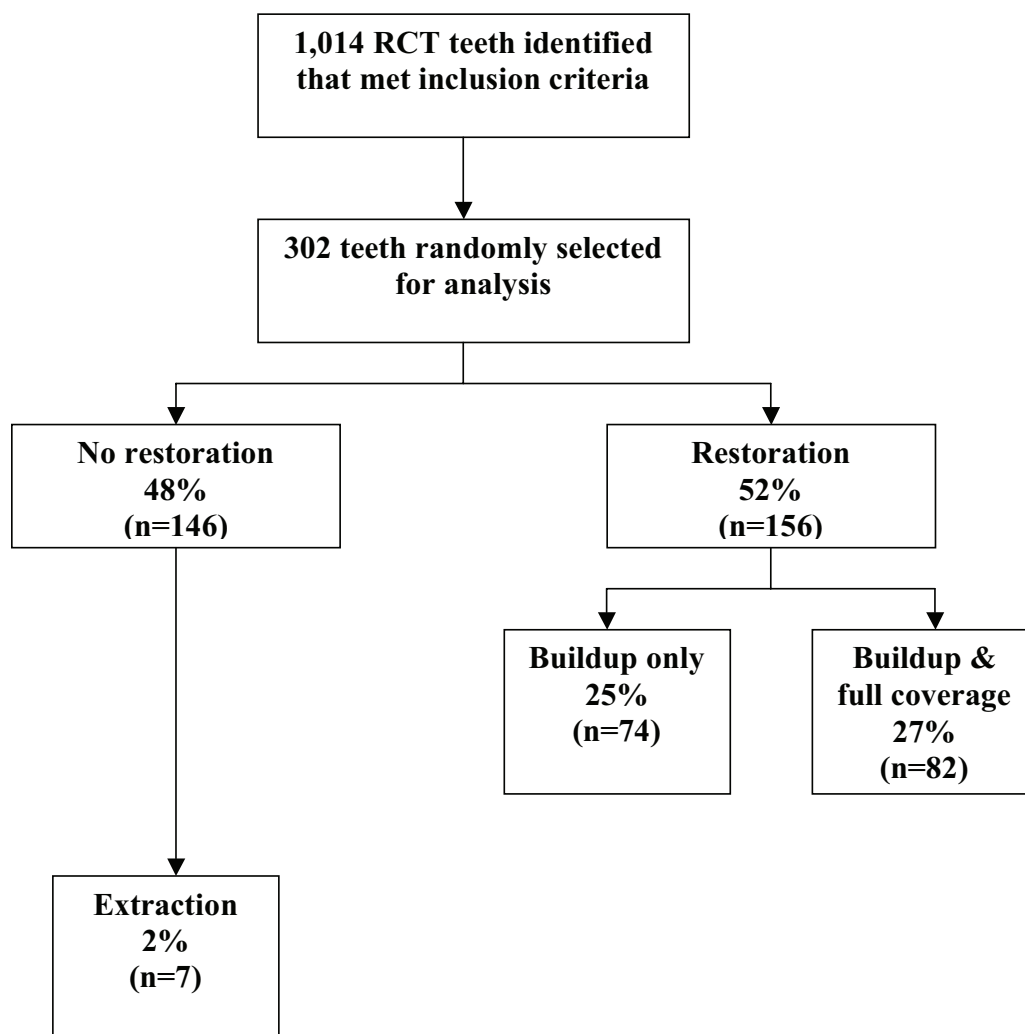


Figure 1. Flow chart displaying restorative treatment following completion of nonsurgical root canal therapy in the postgraduate endodontics clinic

and placement of a buildup restoration was 146 days (range 0 to 1115 days) and placement of full occlusal coverage restoration was 318 days (range 28 to 1034 days). Twenty-eight percent of patients received a buildup within ninety days, and only 3 percent received a full occlusal coverage restoration within this time frame. Seven teeth were extracted, all in the non-restored group.

When patients were grouped according to payment category, 71 percent were classified as self-pay, 19 percent were covered by public aid, and 10 percent were classified as "other." The "other" payment category was predominantly comprised of patients referred from our Special Patient Care Clinic and whose treatment was subsidized by external funding. There were no significant differences in type of treatment among groups based on payment category.

New patients represented 30 percent (n=92) of the sample. Sixty-five percent (n=60) of the teeth in this group did not receive a permanent restoration, 17 percent (n=16) received a buildup only, and 17 percent (n=16) received a full occlusal coverage restoration. Established patients represented 70 percent (n=210) of the sample. Forty-one percent (n=86) of teeth in this group did not receive a permanent restoration, 28 percent (n=58) received a buildup only, and 31 percent (n=66) received a full occlusal coverage restoration (Figure 2).

Manual review of the EPR determined that 48 percent of the teeth in our sample received no

restoration over the course of this study, as reported above. The electronic database query review showed that 61 percent of the teeth had not been restored. Length of time to placement of restoration, patient payment category, and patient status were not reviewed manually.

Discussion

In a 2003 survey of information technology use in U.S. dental schools, approximately 90 percent of the schools reported using some form of practice management software in student clinics for tasks such as appointments, billing, charting and treatment planning, or grading.²⁵ At the time of this survey, six U.S. dental schools reported using axiUm in their student clinics, making it the fourth most commonly used clinical practice management and patient management software program. AxiUm is currently in use at twenty-seven dental schools in North America and Europe.²⁶ Use of an EPR system in clinical education seems particularly appropriate and can be viewed as a natural extension of the current trend to greater use of information technology throughout the curriculum.²⁷

One measure of quality in clinical dentistry is the timeliness (e.g., patient's length of time to receive follow-up treatment) and completeness of restorative care following root canal therapy. Although, as previ-

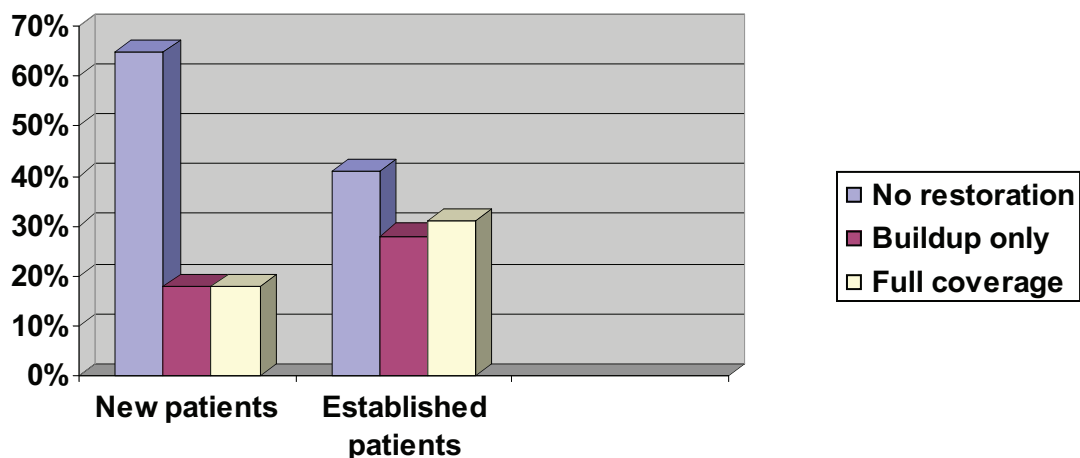


Figure 2. Restorative treatment following completion of nonsurgical root canal therapy by patient status (new or established)

ously noted, our timeliness standard for restorative treatment is subject to debate, this was the standard we established for this study based on our interpretation of the best available evidence. Although we were disappointed to find that our standard was not being met, our results are not surprising when compared to the findings from a large retrospective study of insured dental patients. In a cohort of 34,525 endodontically treated teeth followed for a minimum of two years after completion of nonsurgical root canal therapy, Lazarski et al. found that only 57 percent received the recommended full occlusal coverage restoration and 29 percent received no permanent restoration.¹⁹

Since we viewed our findings as an opportunity to improve quality of care in the dental school, several corrective actions have been taken. During and prior to this study, the process for tracking patients referred from the predoctoral clinics to postgraduate endodontics and then back to the predoctoral clinics after completion of root canal therapy was not clearly defined. After completion of treatment in the postgraduate endodontics clinic, patients were advised to contact their student dentist to arrange for restoration of the endodontically treated tooth as soon as possible. However, many patients failed to contact their students to schedule the restorative appointment in a timely manner, and there were additional problems with continuity of care when a referring student dentist graduated prior to completion of post-endodontic restorative treatment. Postgraduate endodontic residents are now paired with specific predoctoral group practice clinics for teaching and endodontic referral purposes and therefore develop a relationship with their group of referring predoctoral students and faculty. The endodontic residents now email (using axiUm) the referring predoctoral student and supervising faculty when root canal treatment is complete and the patient is ready for definitive restoration. The axiUm email function is readily accessible to residents, students, and faculty whenever the axiUm program is open and running. An additional benefit is the real-time availability of information in the EPR. Access to patient information is restricted to those with a legitimate need to know. Students can view EPR information only for patients who have been assigned to them by supervising faculty. Endodontic residents are encouraged to communicate with referring students in a manner that more closely approximates a private practice setting. Supervising faculty in the predoctoral clinics have agreed to make restoration of endodontically treated

teeth a higher priority, at least through the buildup stage. In the past, comprehensive treatment plans were often developed that placed endodontic care in the very early stages of the overall process of patient care but deferred restoration of these teeth until multiple other treatment needs had been met.

Another finding in our study was that new patients were even less likely to have restorative treatment in a timely fashion when compared to established patients (65 percent vs. 48 percent non-restored, respectively). This is not surprising considering the amount of time it typically takes to progress through comprehensive treatment planning in a dental school, but we have made efforts to expedite scheduling of these patients for limited post-endodontic restorative care. If it seems likely that the tooth will not be restored in a timely fashion, the endodontic residents typically place a more durable interim restoration (e.g., glass ionomer) instead of the usual temporary restorative material. In fact, a good argument can be made for placement of the permanent buildup restoration immediately after completion of root canal therapy (i.e., at the same appointment), although this is not currently a common practice at our institution. We have also abandoned our paper (postcard) recall system and started using the automated recall exam feature in axiUm to help improve patient follow-up evaluation and treatment.

Our study demonstrates that use of an EPR system creates an opportunity to efficiently monitor quality of care in a dental school environment. Once initial parameters are set, it is relatively easy to generate a report. However, as shown by the discrepancy between manual and computerized review of the number of non-restored teeth (48 percent vs. 61 percent, respectively), information retrieved is only as good as the quality of information entered into the system. This finding is consistent with several recent studies of EPRs to evaluate quality of medical care and adherence to accepted treatment guidelines.⁵⁻⁷ In our study, the computerized review of the EPR overestimated the number of non-restored teeth and made our somewhat disappointing findings look even worse. However, it should be noted that this study was implemented during the initial introduction of the EPR system in the dental clinics and, consequently, entry errors were not uncommon. For example, placement of a restoration could be confirmed by manual review of the EPR but would not show up on the computerized search if the procedure was entered as a treatment note instead of using the proper treatment code. This problem has been largely corrected

through greater attention to detail by clinical faculty, students, and staff and by regular auditing by College of Dentistry clinic administration. Nevertheless, our study highlights the learning curve and one of the potential problems associated with the introduction of any new and innovative technology.

Another less obvious limitation to use of an EPR is that only procedures and items found in the relational database can be searched. For example, we were not able to identify in our computerized query of the EPR which endodontically treated teeth had pre-existing crowns (and therefore would not necessarily need new crowns). This limitation would underestimate the number of properly restored teeth and is only correctable if the database is structured in such a way as to allow for matching of existing adequate restorations with current treatment codes. We were only able to exclude patients with pre-existing full occlusal coverage restorations by manual review of the EPR record. This potential information gap highlights the importance of faculty and administrator involvement during the EPR planning stages to help determine what information is important from a clinic operations and academic management standpoint. Finally, there are legitimate reasons beyond the clinician's control to explain why a tooth may not be restored in a timely fashion (e.g., patient finances, guarded prognosis, concurrent periodontal or orthodontic therapy, health or family issues, etc.).

Conclusions

We feel that use of an EPR system has great potential for ongoing quality assessment and improvement. This is particularly important in a teaching environment since continuity of care is often a concern. Even though this study only considered one small facet of quality control in clinical dentistry, the concepts may be applied to a wide range of clinical quality questions. In addition, since we hope dental students will carry many of the positive habits acquired during training into private practice, familiarity with an EPR and its use for quality control could ultimately lead to improved patient treatment outcomes in clinical practice.

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