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A new methodology for measuring harm in the dental office

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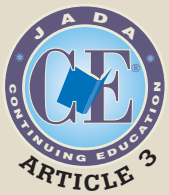
ABSTRACT



Background. There is a dearth of knowledge about the type and frequency of adverse events (AEs) in dentistry. Current approaches to obtaining information rely on reviews of randomly selected records, which may not be the most efficient or effective methodology.

Methods. Inspired by the Institute for Healthcare Improvement's (IHI) global and outpatient trigger tools, which identifies records with characteristics ("triggers") that are associated with AEs, the authors created the dental clinic trigger tool. The triggers included procedures for incision and drainage, failed implants and selected treatment patterns. The authors ran the trigger tool against six months of electronic health records data and compared its performance with that of a review of 50 randomly selected patient records.

Results. In total, 315 records were triggered, 158 (50 percent) of which were positive for one or more AEs; 17 (34 percent) of the 50 randomly selected records were positive for at least one AE. The authors assigned each AE an IHI severity ranking. Most AEs caused temporary harm, but nine were considered to have caused permanent harm according to a modified IHI severity ranking.

Conclusions. The study results demonstrate the promise of a directed records review approach, as the dental clinic trigger tool was more effective in identifying AEs than was a review of randomly selected records.

Practical Implications. All dental practices should proactively monitor the safety of the care they provide. Use of the trigger tool will help make this process more efficient and effective.

Key Words. Patient safety; trigger tool; adverse event; dentistry; electronic health record.

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Health care is a high-risk industry,[1] and monitoring the quality and safety of care provided in one's dental practice is central to providing high-quality dental care. Despite this, there have been no tools developed, to our knowledge, to assist dental care teams in efficiently and effectively conducting this fundamental task. Perhaps as a consequence, there is a dearth of information about the occurrence of adverse events (AEs) in the dental office. Significant AEs primarily are reported as case studies. These reports indicate the breadth of harm that can occur in the dental clinical setting, including deaths[2-5]; severe (life-threatening) events such as life-threatening airway obstruction[6,7]; severe (non–life-threatening) events, such as permanent nerve damage[8,9]; and less severe events, such as an allergy to nickel in an orthodontic patient[10] or extraction of the wrong tooth,[11] which are rectifiable. Thus, the existing literature supports the need for tools to help dental practices perform regular safety and quality assessments.

The Institute for Healthcare Improvement (IHI), Cambridge, Mass., developed trigger tools to address

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the fact that expensive and less effective methods (such as audits of patient records, voluntary reporting by providers and direct observations) had been used in medicine to identify AEs.[12-15] A trigger is an easily identifiable focused item in a patient record that can help lead to the identification of an AE. Triggers serve to alert reviewers who are looking for AEs in a sample of patients' records to focus further investigation on a subset of triggered records to determine whether an AE actually occurred.[16] For instance, administration of naloxone, a strong narcotic antagonist, often indicates overdosage, except in the case of drug abuse or a self-inflicted overdose.

The IHI initially developed global[16] and specialty-area[17] (for example, intensive care unit, mental health) tools for use in inpatient settings. Classen and colleagues[18] reported that the Global Trigger Tool[16] detected 10 times more AEs than did other approaches. In parallel, IHI developed an Outpatient Adverse Event Trigger Tool, with 11 triggers, which was tested at Kaiser Permanente and Baylor Health System in 2005 and 2006.[19]

Although useful in the medical outpatient setting, the Outpatient Adverse Event Trigger Tool would not be directly applicable to the dental clinical setting. For example, the trigger "abnormal laboratory value" is not broadly relevant in the dental care setting (Table 1[19]). Thus, we took our inspiration from the Outpatient Adverse Event Trigger tool to create a dental clinic trigger tool and to compare its performance with that of a review of randomly selected patient records.

METHODS

At the study site, patients can obtain dental care from predoctoral dental students and advanced graduate dental residents in the teaching practices (TPs) or from academic faculty members and hygienists in the faculty practice (FP), who provide care in a private group practice setting. Patients receive comprehensive care in general dentistry, periodontics, prosthodontics, implant dentistry, endodontics, orthodontics, oral surgery and dental hygiene. Only predoctoral dental students in years 3 and 4 of training treat patients in the TP. Dental students are overseen in the TP by full-time academic and adjunct (volunteer) faculty members. The FP is a completely separate practice in which 20 full-time faculty members provide care.

Electronic health record. In 2009, the TPs and FP implemented use of an electronic health record (EHR) (axiUm, Exan, Coquitlam, British Columbia, Canada). Before then, the practices documented patient care completely on paper, except for billing information and scheduling processes. Staff members transferred 24 months of billing data for active patients (those who had been seen within the last 24 months) into the EHR system; they did not transfer or scan any other data into the system. The EZCodes version 2012 dental diagnostic terminology[20] (president and fellows of Harvard College, Boston; Board of Regents of The University of Texas System, Houston; Academic Centre for Dentistry Amsterdam, Netherlands; and Regents of the University of California, San Francisco) is the diagnostic terminology in place at the study site.

Dental clinic trigger tool. The dental clinic trigger tool includes the following three triggers framed to gain insight into AEs that are related to underlying systemic issues: development of infections ("incision and drainage"), failure of complex procedures ("implant failure") and handoff ("multiple visits," defined in the next paragraph). We chose these three triggers because they related to triggers used by the IHI's Global Trigger Tool and could be queried in the EHR through the use of standardized Current Dental Terminology (CDT) codes.[21]

We defined the incision and drainage trigger as completion of the procedure described in CDT code D7510 (incision and drainage of abscess–intraoral soft tissue) or in D7520 (incision and drainage of abscess–extraoral soft tissue).[21] We defined the implant failure trigger as completion of the procedure described in CDT code D6100 (implant removal, by report) or in EZCodes 563101 or 977294 (failing implant or peri-implantitis). We defined the multiple-visits trigger as having fulfilled any of the following during the six-month review period: having had more than six completed visits; being seen by more than one general dentist or more than one prosthodontist or by a general dentist and a prosthodontist; being seen by a general dentist or prosthodontist and an endodontist; or having had three or more visits to an endodontist. Our rationale behind the design of the last trigger was that most treatment plans are completed within six months in the FP; being treated by more than one of the same type of provider (general dentist or prosthodontist for general dental care) might indicate that the patient was seeing another provider owing to an emergency; and

ABBREVIATION KEY. AE: Adverse event. **CDT:** Current Dental Terminology. **EHR:** Electronic health record. **FP:** Faculty practice. **ID:** Identification. **IHI:** Institute for Healthcare Improvement. **TP:** Teaching practice.

TABLE 1

Institute for Healthcare Improvement Outpatient Adverse Event Trigger Tool.*

TRIGGER NUMBER	DESCRIPTION
1	New diagnosis of cancer
2	Nursing home placement
3	Admission and discharge from the hospital
4	Two or more consultants in a year of review
5	Surgical procedure
6	Emergency department visit
7	More than five medications
8	Physician change
9	Complaint letter
10	More than three nursing calls in one week
11	Abnormal laboratory value

* Adapted with permission of the Institute for Healthcare Improvement from the Institute for Healthcare Improvement and Resar.[19]

TABLE 2

Institute for Healthcare Improvement classification of adverse event severity.*

CATEGORY	DESCRIPTION	EXAMPLE
E	Temporary harm to the patient and required intervention	Abscess after endodontic treatment requiring incision and drainage
F	Temporary harm to the patient and required initial or prolonged hospitalization	Space infection after third molar surgery with potential for sepsis and airway compromise
G	Permanent patient harm	Failed implant that was not replaced
H	Intervention required to sustain life	None identified
I	Patient's death	None identified

* Adapted with permission of the Institute for Healthcare Improvement from the Institute for Healthcare Improvement and Resar.[19]

multiple visits for general dental care that are followed by an endodontic visit may indicate pulpal exposure.

We implemented these triggers as a set of queries, which were run against EHR data from the study site's TPs and FP from July 1, 2011, through Dec. 31, 2011. One of us (E.K.) then reviewed the retrieved records to remove duplicates and records that had been identified falsely as being positive for one or more triggers. For comparison, we chose 50 records randomly from the complete set of patients seen by clinicians in the TPs and FP during the same six-month review period. Every month, we chose the first eight patients from a list of patients seen during that month, sorted according to patient identification (ID) number. The ID number had been assigned to the patient when he or she registered within the EHR at the study site. Because the study site's clinics transitioned to an EHR in 2009, both recent and long-standing patients had relatively new ID numbers. For the month of December, we added one additional FP patient and one additional TP patient to arrive at 50 unique records. We selected 50 records because this number afforded us sufficient statistical power to detect a difference of at least 10 percentage points by using the χ^2 test. Each record represented the complete EHR of a single patient.

As recommended by the IHI methodology,[16] two dentists (E.K., A.T.), who were experienced in reviewing patient records for the presence of AEs, independently reviewed each record. Also, in accordance with the IHI trigger tool specifications, we defined an AE as "harm caused by medical treatment, regardless [of] whether it is associated with error or considered preventable. … It is from the point of view of a patient that harm can sometimes be easily ascertained: 'If I were the patient, would I be happy if this happened to me?' "[19(p3)] The two dentists reviewed each record systematically by inspecting sections relating to the following:

- diagnoses indicating an AE (for example, "failed implant," "peri-implantitis");
- treatments or procedures in the EHR designated by CDT codes[21] that indicated a possible AE (that is, CDT D6100 [implant removal], CDT D7510 [incision and drainage of abscess]);
- narrative/progress notes indicating an AE.

If an AE was detected, each reviewer assigned a severity rating to the record; we used the same severity classification as that used in the IHI Outpatient Adverse Event Trigger Tool,[19] as shown in Table 2. The IHI severity index was adapted from the National Coordinating Council for Medication Error Reporting and Prevention Index for Categorizing Errors.[22] After reviewing the records independently, the two dentists compared their results and resolved any discrepancies.

Finally, we determined the positive predictive value (PPV), which is the proportion of triggered records that had one or more AEs associated with each trigger, as well as the performance

TABLE 3

Dental clinic trigger tool performance.

IDENTIFICATION MODE	AE* DETECTED	NO. OF RECORDS TRIGGERED	NO. OF RECORDS INDICATING AE	NO. OF AEs	POSITIVE PREDICTIVE VALUE (95% CI†)
Incision and Drainage Trigger (CDT‡ D7510, CDT D7520)	Inflammation/infection, iatrogenic injury	14	7	8	0.50 (0.27-0.73)
Implant Failure Trigger (CDT D6100, EZCode 563101§)	Implant failure, inflammation/infection	14	10	10	0.71 (0.53-0.89)
Multiple-Visits Trigger¶	Failed restoration, implant failure, temporomandibular joint complications, medical complication, poor healing, tooth fracture	287	140	183	0.49 (0.43-0.55)
All Triggers Combined	Inflammation/infection, iatrogenic injury, implant failure, failed restoration, temporomandibular joint complications, medical complication, poor healing, tooth fracture	315	157	201	0.50 (0.45-0.56)
Randomly Selected Patient Records	Iatrogenic injury, failed restoration, failed endodontic treatment, inflammation/infection	50	17	27	0.34 (0.22-0.48)

* AE: Adverse event.
† CI: Confidence interval.
‡ CDT: Current Dental Terminology. Source: American Dental Association.[21]
§ EZCode 563101 (president and fellows of Harvard College, Boston; Board of Regents of The University of Texas System, Houston; Academic Centre for Dentistry Amsterdam, Netherlands; and Regents of the University of California, San Francisco).
¶ Defined as having had more than six dental visits; being seen by more than one general dentist or by more than one prosthodontist, or by a general dentist and a prosthodontist; being seen by a general dentist or a prosthodontist and an endodontist; or having had three or more visits to an endodontist within the six-month period.

of the triggers as a whole. We also calculated the proportion of randomly selected records in which the reviewers identified an AE.

RESULTS

A total of 8,931 patients were seen at the study site from July 1 through Dec. 31, 2011. The automated computer queries that were run against the EHR data initially identified 500 triggered records, some of which were duplicates because they were captured more than once by the queries. After removing duplicates and records that were incorrectly identified as being positive for the multiple-visits trigger, we had 315 unique and verified trigger-positive records. As mentioned earlier in the Methods section, we also reviewed 50 randomly selected records to compare the AEs identified with those in records retrieved by using the dental clinic trigger tool.

Tables 3[21] and 4 show the results of the records review. The two reviewers retrieved 14 records through the incision and drainage trigger, seven of which indicated one or more AEs, for a PPV of 50 percent. Among the AEs was infection, including abscess formation that required an incision and drainage procedure after endodontic, periodontic or surgical extraction treatment. Of the 14 records retrieved through the implant failure trigger, 10 indicated one or more AEs, for a PPV of 71 percent. These AEs included diagnoses of failed implants and peri-implantitis, requiring removal or replacement of the implant. Finally, we retrieved 287 records from the multiple-visits trigger; 140 of these indicated one or more AEs, for a PPV of 49 percent. These AEs were wide ranging, including decemented crowns, decemented temporary restorations, alveolar osteitis and a significant needle tract infection after a patient received a mandibular local anesthetic injection. Considered together, being positive for any of the three triggers was associated with a PPV of 50 percent. In comparison, the review of 50 randomly selected patient records revealed 27 AEs, for a PPV of 34 percent; this represents a statistically significant difference from the PPV of the trigger tool group (χ^2 test, $P = .03$). Table 3 shows these results.

Two of us (E.K., R.B.R.) organized the AEs into 10 categories, as shown in Table 4. The most common types of AEs identified according to both methods (that is, triggered selection and random selection) were failed permanent restorations within five years of placement, failed temporary restorations and inflammation/infection after dental treatment.

Regarding the severity of the AEs identi-

TABLE 4

Type and frequency of AEs* identified according to triggered and random reviews of patient records.

AE CATEGORY	EXAMPLE	TRIGGER OR RANDOM SELECTION	NUMBER (%) OF AEs (n = 228)
Failed Permanent Restoration Within Five Years of Placement	Fractured removable partial denture	Multiple visits, random	79 (34.6)
Failed Temporary Restoration	Lost temporary crown	Multiple visits, random	56 (24.6)
Inflammation/Infection After Dental Treatment	Needle-tract infection	Incision and drainage, failed implant, multiple visits, random	54 (23.7)
Iatrogenic Injury	Soft-tissue burn due to acid leak during acid etching	Incision and drainage, failed implant, multiple visits, random	14 (6.1)
Implant Failure	Fractured implant	Failed implant, multiple visits	8 (3.5)
Failed Endodontic Treatment	Failed endodontic treatment leading to tooth extraction	Multiple visits, random	6 (2.6)
Poor Healing	Dry socket	Incision and drainage, multiple visits	4 (1.7)
Temporomandibular Joint Complication After Dental Treatment	Trismus after endodontic treatment	Multiple visits	3 (1.3)
Tooth Fracture After Dental Treatment	Fracture of remaining tooth structure after endodontic treatment	Multiple visits	3 (1.3)
Medical Complication During Dental Treatment	Syncope	Multiple visits	1 (0.4)

* AE: Adverse event.

fied via the dental trigger tool, 191 were rated as "E," because the harm was temporary (for example, extreme pain or abscess formation) but required intervention (Table 2). However, we classified one AE as "F," which is temporary harm that required hospitalization (a space infection after third molar surgery with the potential for sepsis and airway compromise) and nine AEs as "G," which is permanent harm (for example, a failed implant that was not replaced). For the randomly selected patient records, we classified all 27 AEs as "E," because the harm was temporary but required intervention. None of these AEs required hospitalization or were permanent.

DISCUSSION

In our study population, more than one-third of the randomly selected patients had experienced an AE. Several of the AEs identified via the trigger tool necessitated hospitalization or resulted in permanent harm. This baseline is a clear call to action: as a practice and as a profession, we must strive to do better by the patients who entrust us with their health and safety. The dental profession can and should learn from its mistakes, celebrate its successes and share best practices, as outlined in a recent editorial by Ramoni and colleagues.[23] The dental school settings in which we conducted this research are governed by the Commission on Dental Accreditation, which states that "the dental school must conduct a formal system of continuous quality improvement for the patient care program that demonstrates evidence of" the following: "standards of care that are patient-centered, focused on comprehensive care"; an "ongoing review of a representative sample of patients and patient records"; "mechanisms to determine the cause(s) of treatment deficiencies"; and patient review policies.[24]

Indeed, all dental care teams should initiate regular assessments of AEs that occur within their practices, including conducting records reviews. Patient safety activities must occur in conjunction with other essential functions of a busy dental practice, so it is our goal to create tools that make these monitoring activities as efficient and effective as possible. The IHI's trigger tools[25] pointed the way to a promising approach to accomplish just that.

Inspired by the IHI tools, we created the dental clinic trigger tool, a trigger-based approach to AE monitoring in dental practices. Our trigger tool corresponds with the following IHI triggers:

- The multiple-visits trigger was based on the IHI physician change trigger (number 8).[19]
- The implant failure trigger was based on the IHI surgical procedure trigger (number 5).[19]

■ The incision and drainage trigger was based on the IHI emergency department visit trigger (number 6).[19]

Our study results show that the trigger tool approach is capable of identifying AEs more efficiently: 50 percent of records that were positive for any of the three dental triggers contained an AE, whereas 34 percent of randomly selected patient records indicated an AE. Our results indicate that use of triggers also may enable clinicians to identify more severe AEs, though given the relatively low rate of more severe AEs, a significantly larger sample size would be required to generalize the results of our study.

Although we developed the three triggers as an electronic script and ran it in the context of an EHR, they can be implemented readily in a paper environment. The IHI described extensively how to implement a records review in a paper environment.[19] In brief, a member of the dental team quickly reviews the records of recently seen patients for the presence of a trigger; the records that are positive for a trigger then are subjected to a more in-depth review by at least two people to determine whether an AE actually has occurred.

In the context of the trigger tool, an AE involves harm to the patient, regardless of whether the AE is associated with error.[19] As defined by the IHI, harm is "unintended physical injury resulting from or contributed to by medical care that requires additional monitoring, treatment or hospitalization, or that results in death."[19] Many errors do not lead to patient harm, and harm may not be associated with a specific error.[26] Focusing on errors shifts the discussion toward individual blame, whereas concentrating on events experienced by patients helps to keep the focus on systemic improvement to reduce patients' suffering.

Our work on the dental clinic trigger tool reminds us that improving quality and safety is a journey rather than a destination to be reached in one fell swoop. This first step was limited to two practice settings: the study site's TPs and FP, which cover the full gamut of training levels (predoctoral students to specialist faculty members) and specialties. The implant failure trigger, for instance, may be less predictive of AEs in clinics in which practitioners do not place implants, and the performance of the dental clinic trigger tool in its entirety may vary according to site.

It is likely that expanding the dental clinic trigger tool to include additional triggers (such as letters of complaint) will make it more effective and robust to differences across sites. As the trigger tool evolves, so will the range of AEs detected. As our colleagues at the IHI stated, "The triggers listed in the outpatient trigger tool have been tested but certainly are not the only possible triggers; they represent a good starting point."[19] In the near future, we plan to significantly expand our research in this area: our deliverables will include the creation of an iteratively tested and improved patient safety toolkit for broad use in clinical practice to identify AEs, the estimation of sensitivity and the development of a classification system to catalog AEs consistently.

CONCLUSION

AEs in the dental practice vary from temporary to resulting in permanent harm and can be detected through targeted records reviews. The use of triggers, or clues, to identify AEs from records reviews is a promising method for measuring the overall level of harm to patients from care. Such review of patient records may help dentists understand underlying systemic issues (such as the need for additional training) and becomes an important component of ongoing quality improvement efforts. ■

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The authors invite readers to commit to proactively monitoring quality by testing in their own dental practices the dental clinic trigger tool, which can be obtained through the corresponding author; by sharing their experiences with the authors; and by suggesting additional triggers.

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