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Patient safety incidents reported by Finnish dentists; results from an internet-based survey

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Abstract

Background. Few data are available on dental patient safety (PS), as most PS studies have focused on other activities in health care. ***Objective.*** To detect types and causes of dental PS incidents (PSIs), including adverse events (AEs) and near misses (NMs), in Finnish dental care. ***Material and methods.*** Altogether 1041 privately or publicly employed dentists in southern Finland completed a structured questionnaire using an internet-based system (Webropol) in 2010. ***Results.*** Nearly one third of the dentists reported some PSI in the previous 12 months. Of the 872 reported events, 53% were classified as AEs, 45% as NMs and 2% remained unclassified. Nearly half of the PSIs had occurred during some form of dental treatment. One third of the AEs were related to dental equipment, devices and supplies. Most of the reported AEs resulted in little or no permanent harm to patients. However, 13% of AEs were considered as serious enough to potentially cause severe harm or did in fact cause permanent harm. ***Conclusions.*** Reported dental PSIs in Finland are in many respects similar to those reported in other countries. Compared to all annual dental visits in Finland, severe dental AEs seem to be relatively rare. Less severe AEs and NMs are not uncommon, especially in dental surgery, endodontic and restorative treatment. The results of this retrospective study, however, reveal more about incident types than their true prevalence and that further studies on dental PS are needed.

Key Words: *patient safety, dentistry, incident reporting, adverse event, near miss*

Introduction

Current dentistry is a complex activity and several factors make a dental operatory a potentially high-risk environment. Even though many patient safety (PS)-ensuring methods have been implemented in dental procedures, researchers have reported several hazards related to various dental treatments [1–10], dental equipment and devices [1], dental materials [11,12] and medications [13]. Furthermore, medical emergencies occur in dental care, although most of them are not life-threatening [14]. Dental instruments come into contact with patients' saliva and blood and inadequate infection control can spread diseases [15]. Still, systematic studies on PS in dentistry are few [1,2,6,15–17], possibly due to the general perception that dental adverse events (AEs) seldom lead to severe consequences in patients [1,15,16]. Nevertheless, the true incidence of many dental PS incidents (PSIs) remains unknown [3,5,6,11,16,17] and many of them seem to happen more often than is generally appreciated [5,6,9].

The modern way of focusing on learning from AEs and near misses (NMs) should be implemented in all healthcare [18]. The World Dental Federation (FDI) [19] and the Council of European Dentists (CED) [20] have addressed the need for increased PS awareness among dentists.

This work aims to map out the key PS issues confronting dentistry in Finland and especially to detect the types and causes of PSIs, including both AEs and NMs.

Material and methods

In 2010, 4021 dentists were working in Finland, 57% of whom worked mainly in the public sector and 43% as private practitioners [21]. Almost all (98%)

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licensed dentists in Finland were members of the Finnish Dental Association, most of whom worked in primary healthcare and only ~ 1% worked in hospitals [21]. In the summer of 2010, all dentists who were members of the Finnish Dental Association and worked in the area of three Regional State Administrative Agencies (RSAAs) in Finland (Southern, Southwestern and Western and Inland Finland) ($n = 1914$) received via e-mail a structured questionnaire in an internet-based system (Webropol).

Because so few studies have examined dental PS, we used multiple search terms to explore PubMed and Medline as well as several internet pages of Finnish and international healthcare organizations to obtain evidence before developing our questionnaire. The questionnaire asked dentists about the number and type of PSIs that occurred in their practice during the past 12 months. The questionnaire categorized PSIs into eight types as follows: incidents related to (1) diagnostics; (2) dental treatment; (3) dental equipment, devices and supplies; (4) infection control; (5) medication; (6) communication; (7) the physical environment; and (8) other incidents. The categories were modified from the Finnish anonymous reporting system HaiPro [22], used mainly in hospitals at that time. The Finnish definitions for AEs and NMs are based on an international PS taxonomy [23,24]. Some PSI types and sub-types were added to the questionnaire based on additional dental AE case reports or case series. We used Seiden and Barach's [6] definition of Wrong-Side/Wrong-Site, Wrong-Procedure and Wrong-Patient Adverse Events (WSPEs) as 'any procedure that was performed on the opposite side, incorrect site, or incorrect level of the body; was performed on the wrong patient; or was the wrong procedure' [6].

Respondents were asked to assess the outcome of each PSI by choosing from options NM (harm was avoided) or AE (some degree of harm). To collect specific information on each incident, dentists were asked to write a brief description of the PSI in free-text fields. The questionnaire also enquired about dentist characteristics. A pilot study was conducted to test the questionnaire on a small group of dentists ($n = 7$). We altered the questionnaire somewhat after reviewing the test-group feedback.

Ethical considerations

RSAAs in Finland are obliged to ensure that both public and private services in social care and healthcare comply with legislation and have the duty to monitor practitioners. This study was conducted in co-operation with the University of Helsinki and the RSAA for Southern Finland, so a research permit was unnecessary. Dentists responded voluntarily and their answers were handled anonymously. The data were not nor will be used for disciplinary purposes, the questionnaire solicited no identifying details of the patients.

Statistical analyses

The Webropol data were first anonymized by removing respondents' e-mail addresses and then exported to Excel. We used the SPSS Statistical package 15 for Windows (Chicago, IL) for statistical analyses. The Chi-square test (χ^2) served to test the significance of the differences between dentist groups. Alpha levels of less than 0.05 were considered statistically significant. We combined incident types with dentists' characteristics and used logistic regression analysis to examine connections with dependent and independent variables. We also applied both univariate and multivariate models and in the tables we present the odds ratios (OR) of all classified incidents with 95% confidence limits (CI).

Results

Participants

After we sent three reminders, a total of 1041 dentists (response rate 54%) responded to our questionnaire. Their characteristics appear in Table I.

Reported PSIs in dental care

Almost one third of the dentists ($n = 322$, 31%) reported one or more PSI in the previous 12 months. Nearly one fifth of all respondents ($n = 197$, 19%) had experienced AE/AEs. A total of 162 dentists (16% of respondents) reported NM/NMs. Altogether 872 incidents were reported, 53% of which were assessed as AEs, 45% as NMs and 2% remained unclassified; the unclassified ones were excluded from further analysis. The final study material consisted of 856 PSIs (Table II).

Most (61%) incidents included dentists' free-text descriptions, which enabled us to analyze the circumstances in which these incidents occurred. Some examples of the free-text answers:

- *Treatment-related NM, local anesthesia*: 'The dental nurse put a different anesthetic solution into the syringe than the dentist had ordered. The dentist noticed the error before administering it thanks to the differently colored texts in the ampoules'.
- *Treatment-related AE, local anesthesia*: 'After induction of local anesthesia, the patient experienced sensorial impairment lasting 6 months'.
- *Treatment-related NM, damage to the surrounding tissues*: 'While drilling into a tooth, the adjacent tooth was accidentally damaged. Because the adjacent tooth initially required restorative treatment, the error caused no real harm'.

Table I. Distribution (%) of dentists (participated in the study) (n = 1041) by gender and occupational characteristics.

Dentists' characteristics	*n*	%
Gender (n = 1005)		
Female	709	71
Male	296	29
Age (n = 1031)		
25–30 years	50	5
31–40	142	14
41–50	313	30
51–60	388	38
>60	138	13
Main working sector (n = 1010)		
Public	571	57
Private	439	43
Main working area (n = 1030)		
Southern Finland	560	54
Southwestern Finland	168	16
Western and inland Finland	302	30
Dental education[a] (n = 1028)		
Licentiate of dentistry, GDP	853	83
Dental specialist	148	14
PhD	47	5
Other studies	19	2
Clinical work mainly (n = 1020)		
With dental nurse	949	93
Without dental nurse	38	4
Not in clinical work	33	3
CPD days in 12 months (n = 1024)		
None	23	2
1–2	154	15
3–5	505	49
5–10	271	26
>10	78	8

[a]Several options were available to choose from.
GDP, General Dental Practitioner; CPD, Continuing Professional Development.

- *Treatment-related AE, damage to the surrounding tissues*: 'During cavity preparation, the patient suddenly moved, and the drill damaged the surfaces of the adjacent tooth'.
- *Medication-related NM*: 'Several NM-situations (e.g. risk for hemorrhage, risk for missing the necessary prophylactic antibiotic) have resulted from the referring dentist's failure to check/ patient's failure to tell about his/her medical history'.
- *Medication-related AE*: 'A penicillin-allergic patient was prescribed phenoxymethylpenicillin. The patient was taken to hospital where he/she had to stay for several days'.

Diagnostics-related PSIs. These were most often related to x-rays (84%) and caused patients some harm, such as extra and unnecessary radiation exposure, delayed diagnosis, as well as incorrect or unnecessary treatment. Other diagnostic incidents were related to clinical evaluations of the oral cavity. In the NMs reported, the harm was most often avoided by chance or the cautious work of the dental team.

Treatment-related PSIs. These formed half of all reported AEs. According to the dentists' free-text descriptions, these were most often connected to tooth extractions, endodontic treatment, local anesthesia or restorative treatment. Incident descriptions seldom mentioned prosthetic, periodontal or orthodontic treatments. Almost one third (31%) of general dental practitioners (GDPs) reported some dental treatment PSI, compared to one fifth (20%) of dental specialists. Iatrogenic traumas to the lips, tongue and inside of the mouth were quite common and more than half were related to dental restorative treatment. Soft tissue ulcerations often resulted from sharp or rotating instruments or the sharp dental suction tip. In most iatrogenic ulcerations, symptomatic therapy was sufficient for soft tissue healing, which took days to a few months; some larger cuts required stitches. None of these caused permanent damage, however. Iatrogenic damage to adjacent tooth or other tooth damage occurred several times. Such incidents were typically related to tooth extractions. Some reports described ingestions of foreign dental objects during endodontic, restorative, orthodontic, surgical and prosthetic treatment. The ingested foreign bodies ranged from endodontic instruments, burs, crowns, a matrix band, an extracted tooth, impression material, dental fillings, implant components and a cotton roll. Once an MS patient had inhaled water during treatment and could not cough which caused a brief respiratory arrest. In such type of an incident, NMs were almost 3-times more prevalent than actual AEs. The dentists reported several AEs and NMs of WSPEs. Twice, the wrong patient received treatment. Wrong-side/wrong-site procedures included, for example, extractions or fillings of wrong teeth or anesthetizing the wrong side of the mouth. Wrong procedures included, for example, anesthetizing with the wrong anesthetic solution. Half of all local anesthesia-related AEs caused temporary nerve damage or sensory impairment lasting from a few weeks to more than 6 months. In addition, the dentists reported cases of hematoma, trismus or tissue emphysema. Eight patients had fainted in the dentist office; twice, fainting led to AE.

Equipment, devices and supplies-related PSIs. These comprised nearly a third of all reported AEs, most of which occurred during endodontic treatment. The breakage of an endodontic file into a root canal was

Table II. Dental patient safety incident (PSI) typology.

Type of PSI subtype		AEs		NMs	
		n	%	*n*	%
1. *Diagnostic PSI*		31	7	26	7
Clinical examination		4		16	
X-rays		26		9	
Laboratory tests		1		1	
2. *Dental treatment PSI*		232	49	170	41
WSPEs	Wrong patient	2		24	
	Wrong procedure	5		6	
	Wrong body part	21		14	
Ingesting or inhaling a foreign object		20		55	
Local anesthesia		42		12	
Iatrogenic damage to surrounding tissues	Tooth damage	49		10	
	Soft tissue damage	65		8	
Syncope		2		6	
Other		26		35	
3. *Dental equipment, devices and supplies PSI*		135	30	74	19
Dental chair and unit		13		24	
Fracture of endodontic file		102		6	
Other		20		44	
4. *Infection control PSI*		4	1	23	6
5. *Medication PSI*		26	6	37	9
Allergic reactions		15		12	
Drug interactions		4		10	
Wrong dose		3		5	
Other		4		10	
6. *Communication PSI*		29	6	61	15
7. *Physical environment-related PSIs* (falls, etc.)		3	1	4	3
8. *Other PSI*[a]		—	—	—	—
All reported AEs and NMs		461	100	395	100

[a]Researchers categorized these 'other PSI' into groups 1–7 if possible; in 17 cases the type of incident could not be defined or were occupational incidents and were thus excluded.
AEs, Adverse Events; NMs, Near Misses.

the most common. The fractured file seldom caused immediate harm to the patient, but the healing of the root canal infection and the prognosis of the tooth were often questionable if the dentist was unable to remove it. In many cases, the patient had to be referred to a dental specialist for further treatment. Some incidents resulted from a malfunctioning dental chair and dental bur handpieces. In addition, some dentists reported soft tissue burns resulting from heated instruments used in endodontics, electrotome or overheated drill handpieces. Accidental lesions of chemical origin, such an etching liquid or bonding agent used for tooth fillings, also occurred. Sodium hypochloride, used in endodontic treatment, was involved in 13 incidents, nine of which occurred due to a fault in the flushing syringe tip connection: the tip had suddenly come loose and the liquid flowed all over the oral cavity or onto the patients' clothes, face or eyes.

Infection control-related PSIs. These included mainly NMs (85%), such as poorly decontaminated dental instruments. Most of these incidents were noticed beforehand, thus avoiding possible harm to the patient.

Medication-related PSIs. These included, for example, incorrect prescriptions for allergic patients or prescribing other contraindicated drugs. Cases of accidental overdose of a drug also occurred and more than half of them (60%) were NMs. An analysis of free-text answers revealed that antibiotics caused 37% of medication incidents. Other drugs involved in

Table III. Multivariate model[a] of the risk for patient safety incident (PSI) in relation to dentists'[b] characteristics.

		PSI		AE		NM	
Explanatory variable	*n*	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Gender							
Male	267	1		1		1	
Female	654	1.73 (1.22–2.44)	0.002	1.61 (1.09–2.37)	0.02	1.58 (1.03–2.41)	0.04
Age							
>50	469	1		1		1	
31–50	404	1.62 (1.20–2.19)	0.002	1.49 (1.07–2.08)	0.02	1.93 (1.33–2.79)	< 0.001
25–30	48	3.50 (1.89–6.47)	< 0.001	3.16 (1.69–5.93)	< 0.001	4.43 (2.31–8.49)	< 0.001
CPD days							
0–4	626	1		1		1	
5 or more	295	0.91 (0.66–1.25)	NS	0.87 (0.61–1.24)	NS	0.93 (0.63–1.38)	NS
Sector							
Public	495	1		1		1	
Private	426	0.90 (0.67–1.21)	NS	0.96 (0.69–1.33)	NS	0.87 (0.61–1.24)	NS
Degree of studies							
Specialist	121	1		1		1	
GDP	800	1.50 (0.92–2.43)	NS	1.91 (1.06–3.44)	0.03	1.49 (0.81–2.76)	NS

[a]Model includes dentist's gender, age, days spent on CPD in the previous 12 months, dental education and working sector.
[b]Those not in clinical work ($n = 33$) were excluded.
AE, Adverse Event; NM, Near Miss; CPD, Continuing Professional Development; GDP, General Dental Practitioner; NS, no statistically significant differences; OR (95% CI), odds ratio with 95% confidence interval.

medication incidents were local anesthetic agents (21%), anticoagulants (6%), analgesics (5%), benzodiazepines (5%) and some locally used drugs (3%). Other narrative texts related to medication incidents included no information on which drug was involved in the PSI.

Communication-related PSIs. These were connected to dentists' communication with their patients, to members of the dental team or to the availability of accurate information. The latter most often involved errors in patient records ($n = 69$). For instance, a referral would indicate the wrong tooth or medications were not checked before referring them. Some patients had forgotten or were unaware of the importance of telling all their medications to their dentist ($n = 16$). Some PSIs occurred due to deficiencies in the data systems used ($n = 14$).

Physical environment-related patient injuries (not related to treatment). These were rarely reported. Most such cases caused no bodily harm, but twice a patient had hit his head and once a patient had injured his leg from a fall in the dental office.

Contributing factors

The dentists' free-text answers mentioned that aggressive patients ($n = 7$), small children ($n = 6$), elderly patients ($n = 13$) and some other patient groups (disabled or paralyzed patients, patients with MS or Parkinson's disease) were more likely to be involved in PSIs. A patient's sudden movement ($n = 29$) or the sudden detachment of equipment or part of a device ($n = 56$) during some procedure caused several PSIs. Hectic work conditions and distractions ($n = 25$) were often reported to provoke PSIs. Other, less frequently reported factors affecting dental PS were switching dentists, economizing in the dental practice (thereby impairing safety), unexpected complications, treating patients without protective equipment (rubberdam, lead apron for x-rays), poor visibility, fatigue, inadequately trained assisting staff or poor language skills (staff or patient).

Severity of PSIs

Most AEs caused only little or no permanent harm to a patient, but nearly 13% of all AEs caused the patient permanent harm or were considered serious enough to potentially cause severe harm ($n = 59$). AEs such as ingesting and inhaling of foreign bodies, WSPEs, events requiring further hospital treatment ($n = 6$), vasovagal collapse during treatment ($n = 1$), medication AEs where the wrong dose of a drug was administered ($n = 3$) or a drunk dentist at work ($n = 1$) were defined as potentially severe or permanent harm-causing events.

Reported incidents correlated to independent variables

The logistic regression models revealed no significant difference in the incident rate between public and private dental practice. Significantly more incidents occurred among younger dentists than seniors, GDPs than dental specialists and female dentists than male dentists. Table III shows the relationships between dentists' characteristics and reported incidents.

Discussion

The aim of this study was to discover the types and causes of PSIs in Finnish dentistry. This study showed that various PSIs can and do occur in dental practice. Dental PSIs most often relate to different treatment procedures, especially in dental surgery, endodontic and restorative treatment. In addition, several dental PSIs relate to the use of a medical device or communication breakdowns.

Most of the healthcare units reporting PSIs to HaiPro between 2007–2009 were secondary care units [25]. Because most Finnish dentists work in primary care [21], it seems plausible that dentists would make only a few HaiPro reports at that time. This prevents comparisons between HaiPro reports and our results.

Compared to all private and public dental visits in the three Finnish regions during the study period (4.9 million dental visits in 2010) [26], severe AEs seem to be relatively rare. Less severe events and NMs are surprising common, however. Yet even these non-permanent or mild harm-causing incidents can weaken patient confidence and co-operation in forthcoming visits [27]. All iatrogenic events are also stressful for the dental team. Future prevention should therefore focus on all kinds of dental PSIs.

This study has several limitations. The prevalence of incidents depended on each individual dentist's ability to recognize events as incidents. In particular, some dentists acknowledged the difficulty of retrospectively estimating accurately the number of incidents. Socially acceptable answering is always a challenge in survey studies, so under-reporting may have biased our results. Our study material provided no information on the legal, social and economic effects of dental PSIs which should be included in further discussions [2] and studies.

Dentists' characteristics

Our study population comprised about one fourth of all working dentists in Finland and represented well the structure of Finnish dentistry as a profession [21]. Female gender seems to associate with a significantly higher risk for PSIs. Whether this means that women dentists are at higher risk for PSIs in real life or simply reflects their higher awareness and activity in reporting requires further investigation. Young dentists reported significantly more incidents than did their senior colleagues. The reason for this remained unclear. Younger dentists may be more aware of treatment hazards and are, therefore, more likely to report them or are at higher risk for incidents due to their lack of experience. That women and young dentists report more actively than do other dentist groups, but experience fewer actual PSIs, agrees with the findings from Rissa et al. [28] that patients in Finland more often complain about male dentists, especially those aged 40–49. The fact that our dental specialists were at significantly lower risk for PSIs than were GDPs indicates that one PSI-preventive factor is training.

Patient factors

This study showed that patient behavior during dental treatment is difficult to predict. Children and uncooperative patients in particular can suddenly move [2], resulting in iatrogenic traumatic gingival lesions or lesions of the lips or tongue, regardless of the skill of the dentist. Such iatrogenic traumas can therefore be difficult to prevent, especially in the absence of adequate soft tissue protection for retracting the lips, tongue and cheek away from the bur working area.

Out-reported PSIs compared to earlier evidence

Our study corroborates that of Seiden and Barach [6] and Perea-Pérez et al. [15] in that dental errors sometimes stem from human error, such as communication breakdowns, but are often of system origin [15], as in technical failures or lack of safety systems.

The PSI types in this study resemble those in studies of dental PSIs reported to the NRLS in the UK [1] and of mistakes, negligence and legal offences (MNLOs) in pediatric dentistry in Israel [2]. In all of these studies PSIs were categorized somewhat differently, which makes detailed comparisons difficult. In Israel and in Finland, the more frequently reported incidents correlated with temporary body damage or mild harm to a patient; more severe cases were less frequent. In both studies the more severe cases were WSPEs, swallowing an instrument or receiving an incorrect drug dose. Studies show that foreign body ingestion is far more common than foreign body inhalation [7,8,10], which our findings also support. The use of bur and extractions caused many injuries to oral soft tissues in both our study and in the UK [1].

Even medical emergencies, ranging from vasovagal syncope, hypertensive crisis, seizure, hypoglycemia, asthma, acute coronary syndrome, allergic reactions and cardiac arrest to airway obstruction can occur in dentistry [1,14]. We uncovered several reports of syncope and allergic reactions that occurred here in Finland.

Statistics from the Finnish Patient Insurance Centre (FPIC) indicate that the most prevalent of officially reported dental AEs relate to endodontics, prosthetics and oral surgical procedures [29]. Analysis of dental patient claims to the State Provincial Office in Southern Finland between 1998–2004 reveal that the four main clinical procedures causing complaints were restorative treatment, prosthetics, endodontics and dental surgery [28]. Our research supports the fact that endodontic [28,29], surgical treatments [28,29] and dental restorative treatment [28] clearly represent dental PS risk areas in Finland. Interestingly, however, our dentists reported few prosthetic treatment incidents.

Fracturing endodontic file was our most prevalent single-incident sub-type. Nearly half of all endodontic treatment accidents are reimbursed; and, together, these reimbursement costs represent a significant portion of dental compensation paid by the FPIC [29]. Technical complications, including the fracture of endodontic instruments, are among the main causes of dental litigation in endodontics internationally [30,31].

A few of our reported PSIs were related to infection control. The low frequency of reported infection control PSIs does not necessarily indicate the actual occurrence of such incidents, but may nevertheless stem from dentists' lack of awareness of all the steps involved in the equipment hygiene process, which is often the responsibility of dental auxiliaries.

The number of incidents related to dental devices, equipment and supplies was several times higher than in dentists' mandatory reports to Finnish health officials [32]. Evidence suggests that dental staff are inactive in their reporting of PSIs [1,9,16] and adverse reactions due to dental materials [11]. Even some adverse drug reactions may remain unreported [13]. Explanations include lack of consensus among dentists as to what incidents should be reported [11,13,16], lack of feedback given to reporters [16], unclear benefits of reporting [16] or lack of user-friendly reporting systems designed especially for dentistry [1,16].

Conclusions

Even anonymous and non-punitive reports, such as those in this study, prove useful only in detecting types and causes of dental PSIs rather than in revealing their true prevalence. Finnish health officials may receive substantially under-reported figures for dental PSIs.

The need for greater awareness of potential dental treatment hazards among dentists in Finland is clear and PS issues should be more actively implemented in dental education and especially in undergraduate education. In particular, precautions for preventing WSPEs and ingesting or inhaling foreign objects need enhancement. The accuracy of dental records also needs improvement. To improve PS, all dentists must be prepared not only for possibly severe acute situations, but also for multiple minor harm-causing PSIs.

Further studies on aspects of dental PS are necessary to target error-preventing methods specifically in dentistry. Multiple sources, such as medical claims, patient enquiries and safety-culture assessments combined will reveal the framework of dental PS.

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