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## Patient safety incidents in primary care dentistry in England and Wales: mixed methods study

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# 1 Patient safety incidents in primary care dentistry in England and Wales: mixed methods study

## 2 ABSTRACT

3 **Background:** In recent decades, there has been considerable international attention aimed at  
4 improving the safety of hospital care, and more recently this attention has broadened to  
5 include primary medical care. In contrast, the safety profile of primary care dentistry remains  
6 poorly characterized.

7 **Objectives:** We aimed to describe the types of primary care dental patient safety incidents  
8 reported within a national incident reporting database and understand their contributory  
9 factors and consequences.

10 **Methods:** We undertook a cross-sectional mixed-methods study, which involved analysis of a  
11 weighted randomized sample of the most severe incident reports from primary care dentistry  
12 submitted to England and Wales' National Reporting and Learning System. Drawing on a  
13 conceptual literature-derived model of patient safety threats that we previously developed,  
14 we developed coding frameworks to describe and conduct thematic analysis of free text  
15 incident reports and determine the relationship between incident types, contributory factors  
16 and outcomes.

17 **Results:** Out of 2,000 reports sampled, 1,456 were eligible for analysis. Sixty types of incidents  
18 were identified and organized across pre-operative (40.3%; n=587), intra-operative (56.1%;  
19 n=817) and post-operative (3.6%; n=52) stages. The main sources of unsafe care were *delays*  
20 *in treatment* (344/1,456; 23.6%), *procedural errors (excluding wrong-tooth extraction)*  
21 *(227/1,456; 15.6%), medication-related adverse incidents (161/1,456; 11.1%), equipment*  
22 *failure (90/1,456; 6.2%) and x-ray related errors (87/1,1456; 6.0%).* Of all incidents that  
23 resulted in a harmful outcome (n=77; 5.3%), over half were due to wrong tooth extractions  
24 (37/77; 48.1%) mainly resulting from distraction of the dentist. As a result of this type of  
25 incident, 34 of the 37 patients (91.9%) examined required further unnecessary procedures.

26 **Conclusions:** Flaws in administrative processes need improvement since they are the main  
27 cause for patients experiencing delays in receiving treatment. Checklists and standardization  
28 of clinical procedures have the potential to reduce procedural errors and avoid over-utilization  
29 of services. Wrong-tooth extractions should be addressed through focused research initiatives  
30 and encouraging policy development to mandate learning from serious dental errors like never  
31 events.

32

33 **Keywords:** Ambulatory dentistry, community dentistry, patient safety, patient safety  
34 incidents, primary dental care.

## 35 Introduction

36 Healthcare-associated harm is estimated to occur in between 3% and 16% of hospital admissions.<sup>1-3</sup> In  
37 primary care, between two and three patient safety incidents occur per every 100 encounters;<sup>4</sup> with  
38 approximately 4% of these primary care incidents resulting in severe harm.<sup>(4)</sup> Over the past 20 years,  
39 healthcare organizations, researchers and policymakers around the world have begun to pay increasing  
40 attention to patient safety. Accumulated evidence about the extent of harm and underlying causes has  
41 been translated into interventions designed to improve the safety of the healthcare system,<sup>5</sup> such as  
42 incident reporting systems.<sup>6,7</sup> The need to develop and introduce these systems was signalled within  
43 the reports *To Err is Human*<sup>8</sup> and *An Organisation with a Memory*.<sup>9</sup> Their fundamental role is “to  
44 enhance patient safety by learning from failures of the health care system”.<sup>10</sup> The analysis of the  
45 retrieved data from these systems provide valuable insights about the trends and patterns of patient  
46 safety hazards at an organizational level<sup>11</sup> and can allow the identification of priorities for  
47 intervention.<sup>12</sup> This information further bring opportunities to develop evidence-based models for safe  
48 practices and support for education and learning.<sup>11</sup> Compared with other data sources,<sup>13</sup> incident  
49 reporting systems can provide continuous, near real-time insights about diverse patient safety  
50 incidents, including near misses.

51 Patient safety in primary care is a field that remains largely unexplored.<sup>14,15</sup> In the United Kingdom (UK),  
52 initial mixed-methods studies analyzing general practice incident reports from the National Reporting  
53 and Learning System (NRLS) have shown their utility to categorize PSIs and identify patterns of  
54 contributory incidents and contributory factors.<sup>16-20</sup> However, patient safety research in dentistry is in  
55 its early development. A recent scoping review on PSIs and adverse events in dentistry shows that, over  
56 the past 20 years, this field has not employed standardized patient safety terminology and used varying  
57 study designs and methodologies to investigate unsafe care.<sup>21</sup> As a result, the current evidence cannot  
58 be generalised and provide reliable estimates of the frequency of incidents, their causes, or the  
59 outcomes of these errors. To standardize patient safety research in dentistry, recent studies have  
60 started to focus on the characterization of patient safety incidents,<sup>22</sup> including adverse events.<sup>23,24</sup> Only  
61 two studies have explored primary dental care data from national incident reporting systems,<sup>22,25</sup> from  
62 which one built an initial classification.<sup>(22)</sup> Although these classification systems provide a starting point,  
63 they should be further expanded/refined and include a clear distinction between incidents, their causes  
64 as well as the outcomes affecting the patient (adverse events) and healthcare system. Therefore, we  
65 aimed, firstly, to explore data from the NRLS to identify emerging themes and then develop categories  
66 and subcategories of incidents, their contributory factors, outcomes and degree of harm. Secondly, we  
67 aimed to describe incident patterns through identification of frequencies of the relationships between  
68 incidents and contributory factors. Thirdly, we aimed to describe the more frequent and harmful  
69 reported incidents.

## 70 Methods

71 We conducted a two-stage cross-sectional, mixed-methods study of the NRLS with a selected  
72 sample of reports from primary dental care for analysis. We combined qualitative methods and  
73 iterative generation of data summaries using descriptive statistical and thematic analysis  
74 methods.<sup>26</sup>

75

## 76 Data source

77 The NRLS is a national reporting system created in 2003 for the NHS in England and Wales by the former  
78 National Patient Safety Agency (NPSA). It is one of the most comprehensive reporting systems in the  
79 world.<sup>27, 28</sup> It consists of a database of incident reports submitted by National Health Service (NHS)  
80 healthcare organizations, however, patients and other members of the public can also submit online  
81 reports directly to the NHS. The NHS definition for the reported patient safety incidents refers to “any  
82 injury or unexpected incident that could have or did lead to harm for one or more patients receiving  
83 NHS-funded healthcare.”<sup>29</sup> Although reporting was initially voluntary, it has since 2010 been mandatory  
84 to report any incidents that resulted in severe patient harm or death. The reports contain categorical  
85 data (e.g. age, incident location and severity of harm) and three unstructured free-text fields to  
86 encourage reporters to provide a narrative description of the event, perceived causes and potential  
87 preventive measures.<sup>26</sup> Incident reports describing severe harm and death outcome are reviewed by  
88 healthcare staff and safety experts responsible for the NRLS to identify opportunities for the continuous  
89 improvement of care.

## 90 Sample selection

91 The complete data set consisted of 42,729 reports over a period of 8 years (between April 2005  
92 and September 2013) from general practice in England and Wales. We applied the pre-coded  
93 NHS categories “Primary care setting” and “Dental surgery” to filter the dataset and obtain a  
94 sample of 11,836 records (see Figure 1). From these, we read the narrative descriptions and  
95 excluded the reports not related to dentistry. As a result, a revised sample of 4,247 reports  
96 was obtained. From this sample, all reports with a “moderate”, “severe” and “death”  
97 (combined total, n=257) outcome were included. From the remaining “no harm” and “low  
98 harm” reports (n=3990), a random sample of 1,743 reports, weighted by year and the severity  
99 of harm, was generated to prioritize more recent (2012-2013) and harmful reports. As a result,  
100 a total of 2,000 reports were included for coding. The detailed sampling strategy is shown in  
101 Appendix 1.

102

## 103 Methodology

104 An overview of the methodology is shown in Figure 1. For the first stage, we explored 300  
105 randomly-selected reports and deductively developed initial codes to structure the free-  
106 narrative descriptions of the reported incidents. This resulted in three coding frameworks to  
107 describe what happened, i.e. type of incident (Appendix 2), perceived reasons the incident  
108 occurred, i.e. contributory factors (Appendix 3) and incident outcomes (Appendix 4). These  
109 frameworks present a hierarchical arrangement of first- and second-level codes that were  
110 continuously refined throughout the study. The codes were constantly compared against  
111 categories from other patient safety classification systems. These included the World Health  
112 Organization’s (WHO) International Classification for Patient Safety,<sup>30</sup> the LINNEAUS Patient  
113 Safety Classification for Primary Care,<sup>31</sup> the Primary Care Patient Safety (PISA) Classification  
114 System<sup>18</sup> and the results obtained from our previous scoping review.<sup>21</sup> The reports were coded  
115 by the first author (EEC). Moreover, a second coder (AS) was trained and provided the same  
116 sample of 300 randomly-selected reports and discussed with the main author, the challenges  
117 and additional improvements to the coding frameworks. For the second stage, we applied the  
118 coding frameworks on our weighted randomized sample of 2,000 reports. Following the  
119 method described by Rees et al.,<sup>17</sup> we applied the nine rules of the Recursive Model of Incident

120 Analysis<sup>32</sup> to structure the coding process (see Appendix 5). Following this approach, we  
121 applied between one to four codes in chronological order to describe primary incidents,  
122 contributory incidents and contributory factors. The main incident was labelled as a 'primary  
123 incident', which was the closest incident to the outcome experienced by the patient. Then,  
124 'contributory incidents' were defined as those incidents preceding the primary incidents. Both  
125 primary incidents and contributory incidents were coded in accordance with the incident  
126 coding framework (see Appendix 2). A 'contributory factor' was defined as "*a circumstance,  
127 action or influence (such as poor rostering or task allocation) which is thought to have played a  
128 part in the origin or development of an incident, or to increase the risk of an incident*".<sup>33</sup>  
129 Contributory factors were coded in accordance with the contributory factors coding  
130 framework (see Appendix 3). Coding of the free-text narrative descriptions allowed the  
131 categorization of reports by incident type, potential contributory factors, outcome and severity  
132 of harm. This provided the basis for the subsequent data analysis. The severity of harm was  
133 assessed using the WHO's International Classification of Patient Safety definitions (see Table  
134 1).<sup>30</sup> To assess the inter-coder reliability, 20% of the reports (n=400) were double coded (EEC  
135 and AS). Then, raw agreement and Cohen's K statistics<sup>34</sup> were calculated for the primary  
136 incident. A kappa of >0.7 was sought between the two coders. Disagreements in coding were  
137 arbitrated by a third person.

138

### 139 Data analysis

140 For the first stage, during the data coding, the reports were further thematically analyzed and  
141 re-read for familiarization. If needed, new codes were created to capture additional semantic  
142 (descriptive and in-depth) insights and latent (underlying or inferred) insights present in the  
143 narrative descriptions and the circumstances (context) in which the incidents occurred.<sup>35, 36</sup> All  
144 codes were grouped into themes and sub-themes to support our understanding of data and  
145 the underlying reasons for incidents that might not have been captured by the quantitative  
146 data.<sup>35, 36</sup> For the second stage, we undertook an exploratory, descriptive analysis<sup>37</sup> to generate  
147 descriptive summaries to identify priority areas based on: (i) the most frequent incidents; and  
148 (ii) the most harmful outcomes that resulted in moderate harm, severe harm or death.  
149 Following the method used by Rees et al.,<sup>17</sup> we employed pivot tables in Microsoft Excel<sup>38</sup> and  
150 cross-tabulated the most frequent incidents per clinical stage with available contributory  
151 incidents, contributory factor and their outcomes. We also cross-tabulated the degree of harm  
152 against the primary incident types to identify potential relationships in the data. Then, we  
153 identified additional patterns in the data by exploring all the frequencies of combinations of  
154 incidents and contributory factors (e.g. primary incident + secondary incident + contributory  
155 factor).

156

### 157 Ethics

158 Institutional Review Board approval was obtained from The University of Edinburgh's Centre  
159 for Population Health Sciences Research Ethics Committee.

### 160 Results

161 Of the 2,000 randomized reports, 1,456 were included in the quantitative analysis. Reports  
162 were excluded if they did not describe a patient safety incident (n=311), were not related to  
163 dentistry (n=125), concerned patient falls (n=31), contained insufficient details (n=23), dentist  
164 harmed rather than the patient (n=18), or were about general non-specific complaints (n=6).

165 Raw agreement (86.5%) and Cohen's kappa ( $\kappa$ ) statistic for inter-rater coding reliability for  
166 primary incidents was high ( $\kappa=0.860$ ;  $p<0.01$ ).

167

## 168 Incidents

169 Table 2 shows a description of the primary incidents we identified. These occurred in the pre-  
170 operative (40.3%;  $n=587$ ), intra-operative (56.1%;  $n=817$ ) and post-operative (3.6%;  $n=52$ )  
171 stages of dental care delivery. Main **pre-operative incidents** were delays in treatment (58.6%,  
172  $n=344$ ), inaccurate information on medical record (10.4%,  $n=61$ ) and breaches of  
173 confidentiality (4.8%,  $n=28$ ). In the **intra-operative stage**, these included procedural errors  
174 (27.8%,  $n=227$ ), medication-related adverse incidents (161/817; 19.7%) and equipment failure  
175 (11.0%,  $n=90$ ). The more frequent **post-operative incidents** were contraindicated medications  
176 prescribed/dispensed ( $n=15$ ; 28.8%) and errors in the process of delivering a medication ( $n=12$ ;  
177 23.1%). Regardless of the clinical stage, the main five incident types were *delays in treatment*  
178 (23.6%;  $n=344$ ), *procedural errors (excluding wrong-tooth extraction)* (15.6%;  $n=227$ ),  
179 *medication-related adverse incidents* (11.1%;  $n=161$ ), *equipment failure* (6.2%;  $n=90$ ) and *x-ray*  
180 *related errors* (6.0%;  $n=87$ ).

181

## 182 Contributory incidents and contributory factors

183 Of the 1,456 primary incidents, 34.8% ( $n=506$ ) contained data about *contributory incidents*.  
184 From these 506, main *contributory incidents* were the dentist's unavailability (20.2%),  
185 equipment failure (14.6%) and mismanagement of appointments (12.6%). Data about  
186 *contributory factors* were available in 42.8% ( $n=623$ ) of the reports. From these 623, main  
187 *contributory factors* included distraction (25.5%), insufficient staff members (25.5%) and  
188 inadequate skills or knowledge (11.2%). All the possible combinations of primary incidents with  
189 contributory incidents and contributory factors organized by clinical stage are available in  
190 Appendices 6-8.

191

192 In the pre-operative period, frequent *contributory incidents* for **delays in treatment or**  
193 **procedure ( $n=344$ )** were the dentist's unavailability (29.7%,  $n=102$ ), mismanaging of  
194 appointments (16.9%,  $n=58$ ), and ineffective transportation of patients (7.3%,  $n=25$ ) (Examples  
195 1 to 3 in Box 1). *Contributory factors* included insufficient staff members (32.3%,  $n=111$ )  
196 (Example 4 in Box 1) and lack of equipment maintenance (4.4%,  $n=15$ ). Secondly, for reports  
197 concerning **inaccurate information on records ( $n=61$ )**, main *contributory incidents* were  
198 Information Technology (IT)-related errors (23.0%,  $n=14$ ) (Example 5 in Box 1). Thirdly, for  
199 reports concerning **breaches of confidentiality ( $n=28$ )**, frequent *contributory incidents* were the  
200 inefficient transfer of information between healthcare settings and wrong medical records  
201 (7.1%;  $n=2$  each) (Example 6 in Box 1). Main *contributory factors* were failure to adhere to  
202 procedures or regulations (50.0%,  $n=14$ ) (Example 7 in Box 1) and distraction (14.3%,  $n=4$ ).

203

204 In the intra-operative period, *contributory incidents* for **procedural errors ( $n=227$ )** included  
205 equipment failure (9.3%,  $n=21$ ) (Example 8 in Box 1) and insufficient clinical examination (2.2%,  
206  $n=5$ ). Main *contributory factors* were distraction (31.3%,  $n=71$ ) (Example 9 in Box 1),  
207 unexpected movement from the patient (10.1%,  $n=23$ ) (Example 10 in Box 1) and inadequate  
208 skills or knowledge (8.8%,  $n=20$ ). Then, for **medication-related adverse incidents ( $n=161$ )**,  
209 *contributory factors* included the patient's previous health-related conditions (13.7%,  $n=22$ )  
210 (Example 11 in Box 1) and non-compliance from the patient (5.6%,  $n=9$ ) (Example 12 in Box 1).  
211 Lastly, for incidents concerning **equipment failure ( $n=90$ )**, main *contributory factors* were lack

212 of equipment maintenance (44.4%, n=40) and poor equipment design (6.7%, n=6) (Example 13  
213 in Box 1). In the post-operative period, *contributory incidents* for **contraindicated medications**  
214 **prescribed/dispensed (n=15)** were insufficient clinical examination (20.0%, n=3) (Example 14 in  
215 Box 1). *Contributory factors* included the patient's previous history on allergies (46.7%, n=7)  
216 (Example 15 in Box 1) and staff distraction (20.0%, n=3) (Example 16 in Box 1). **Errors in the**  
217 **process of delivering a medications (n=10)** (Example 17 in Box 1) did not include *contributory*  
218 *incidents or factors*.  
219

## 220 Outcomes

221 Table 3 shows the characterization of incident outcomes. Of the 1,456 incidents, 40.0%  
222 (n=583) did not describe an outcome. The more frequent outcomes were *increased*  
223 *documentation/follow-up* (12.4%; n=181), *vasovagal response* (8.2%; n=119),  
224 *laceration/bleeding* (6.9%; n=100), *delays in using the dental clinic* (5.8%; n=84), *unnecessary*  
225 *x-ray exposure* (5.1%; n=74) and *repeated procedures/additional treatment* (4.9%; n=72).  
226 Cross-tabulations of outcomes (n=1,456) with the degree of harm showed that 97.7% resulted  
227 in either no harm or low harm (n=1,379), and only 5.3% were harmful (n= 77). The main  
228 harmful outcomes were unnecessary procedures (44.2%; n=34), anaphylaxis (9.1%; n=7) and  
229 vasovagal responses (7.8%; n=6). Cross-tabulations of these harmful outcomes with the  
230 primary incidents showed that all harmful reports that resulted in unnecessary procedures  
231 (n=34) were due to *wrong-tooth extractions*. Then, harmful reports involving anaphylaxis  
232 (n=7) were mainly due to medication-related adverse incidents (42.9%; n=3) and  
233 contraindicated medications prescribed/dispensed (28.6%; n=2). Finally, harmful vasovagal  
234 responses (n=6) were mostly due to medication-related adverse incidents (83.3%; n=5).  
235

236 For the main pre-operative incidents, frequent outcomes for **delays in treatment** (n=344)  
237 included increased documentation/follow-up (23.3%, n=80) and repeated procedures or  
238 additional treatment (5.8%, n=20) (Examples 18 and 19 in Box 1). **Incorrect or unavailable**  
239 **documentation** (n=61) mostly led to increased documentation/follow-up (14.8%, n=9) and  
240 delays in using the dental clinic (8.2%, n=5) (Examples 20 and 21 in Box 1). One **breach of**  
241 **confidentiality** resulted in legal implications (3.6%, 1/28;). Secondly, for the main intra-  
242 operative incidents, **procedural errors** (n=227) included laceration/bleeding (41.9%, n=95),  
243 chemical injuries (9.3%, n=21), repeated procedures/additional treatment (7.5%, n=17) and  
244 thermal injuries (6.2%, n=14) (Examples 23 to 26 in Box 1). **Medication-related adverse**  
245 **incidents** (n=161) mostly led to a vasovagal responses (64.0%, n=103) (Examples 27 and 28 in  
246 Box 1). **Equipment failure** (n=90) mostly led to delays in using the dental clinic (34.4%, n=31)  
247 (Example 29 in Box 1). Finally, for main post-operative incidents, **contraindicated medications**  
248 **prescribed/dispensed** (n=15) led to increased documentation/follow-up and anaphylaxis  
249 (20.0%, n=3 each) (Example 30 in Box 1). The majority of the reports concerning errors in the  
250 process of delivering a medication did not describe harmful outcomes (75.0%, 9/12).  
251

## 252 Discussion

253 To our knowledge, this is the first mixed-methods study of incident reports from primary care  
254 dentistry, identifying the main incident types, their contributory factors and outcomes (clinical  
255 and non-clinical). At a conceptual level, our methodological approach aligns with the Swiss  
256 Cheese Model of System Accidents proposed by Reason.<sup>39</sup> Moreover, this mixed-methods  
257 approach seeks to identify the chronological sequence of events leading up to error by drawing



258 upon the Recursive Model for Incident Analysis. This approach has been used in general  
259 practice<sup>16-18, 40, 41</sup> and has received positive reviews.<sup>42</sup> We drew on a large national database of  
260 incidents and achieved very good agreement between two independent coders. Our coding  
261 frameworks enabled us to understand the relationships between incident types and  
262 contributory factors which highlight opportunities to improve patient safety.

263  
264 However, we also acknowledge that the reports analyzed likely constitute the tip of the  
265 iceberg<sup>43</sup> as these only included events that were actually reported. Although the NRLS has  
266 collected over 15 million reports since 2003, less than 1% of these reports originate from  
267 primary care.<sup>44</sup> Whilst NHS healthcare professionals might be aware of the NRLS, their fear of  
268 punishment from reporting incidents, the time required to report, and the lack of belief that  
269 reporting will lead to change are all recognized barriers to reporting.<sup>44</sup> Also, our ability to  
270 extract detailed information surrounding context (e.g. demographics and disciplines involved)  
271 was limited as the reports were largely unstructured. Renton and Sabbah (2016) also reported  
272 this data quality issue.<sup>25</sup> In addition, the free narrative descriptions were often shorthanded  
273 and contained abbreviations or other jargon to describe clinical procedures. To bring sense to  
274 the data and avoid the risk of confirmation bias,<sup>45</sup> we assigned codes which represented what  
275 was explicitly described in the reports; inferences were avoided, in particular when no explicit  
276 description was available. Therefore, following the rules from the Recursive Model of Incident  
277 Analysis, we coded “primary incidents” as those closest to the outcome. Then, if available, we  
278 coded “contributory incidents” as those incidents that preceded the primary incident. We  
279 believe this work provides a starting point to systematically characterize future incident reports  
280 from primary care dentistry (Appendices 2 to 4).<sup>22, 23, 25, 46-50</sup>

281

## 282 Incidents

283 In our study, *delays in treatment* were the main pre-operative incidents and remained as the  
284 most frequent among all incident types. Although these incidents were not harmful in our  
285 study, their presence reveal flaws in the provision of efficient dental care. Nevertheless, delays  
286 in treatment can still contribute to diagnostic delays, which can result in the unnecessary  
287 clinical deterioration or complication of the patient’s condition or disease.<sup>51</sup> Therefore, we  
288 recommend improving administrative processes by understanding the demand for dental care  
289 services in the range of care contexts used for delivery. Guidance for the provision of safe,  
290 reliable and effective care is available from the Institute for Healthcare Improvement (IHI),<sup>52</sup>  
291 including a dentistry-focused IHI Open School course in partnership with the Dental Quality  
292 Alliance, established by the American Dental Association.<sup>53</sup>

293

294 Our findings also revealed that *procedural errors* were the main intra-operative incidents and  
295 the second most frequent among all incident types. Their frequency could be reduced by  
296 determining warranted and unwarranted variations in clinical practice. This might be achieved  
297 by reviewing compliance with evidence-based or best practice guidelines. However, an  
298 emerging threat to patient safety is the increasing complexity of clinical cases and multi-  
299 morbidities as the population gets older by living longer.<sup>54</sup> Therefore, as discussed by Hollnagel  
300 et al.,<sup>55</sup> clinicians should also have flexibility to adapt their procedures in accordance with the  
301 specific needs of the patient being treated. *Equipment failure* was the third most common  
302 intra-operative incident and the fourth most frequent among all incident types. This type of  
303 incident has been described previously by Perea-Perez et al.,<sup>47</sup> Hiivala et al.<sup>48, 50</sup> and an issue  
304 identified from the Food and Drug Administration (FDA) and the Manufacturer and User Facility

305 Device Experience (MAUDE) database.<sup>56</sup> Based on our findings, we believe equipment-failure  
306 incidents can be reduced by having all staff members familiarized with the maintenance  
307 processes and assign responsibility to team members to carry out this task on a periodical basis.  
308 In identifying patterns of incidents, we also identified *equipment failure* as a “contributory  
309 incident” for other “primary incidents” such as *procedural errors* and *errors in obtaining or*  
310 *processing x-rays*. This highlights the interaction of healthcare professionals with sophisticated  
311 tools and technologies could increase risk to patient safety,<sup>54</sup> and manufacturers should  
312 support practitioners and staff to safely use their equipment.

313  
314 In our study, *wrong-tooth extractions* were the main source of harmful incidents. Although not  
315 frequent (2.7%), these have been studied previously<sup>22, 25</sup> and they meet the criteria of ‘never  
316 events’ due to their severity and degree of preventability.<sup>25, 57</sup> Prevention of these and other  
317 incidents can be achieved through the use available procedural checklists<sup>58-61</sup> to reduce  
318 reliance on memory and thus, limiting the impact of distraction or inattention in the  
319 occurrence of incidents.<sup>62</sup> A recent systematic review on patient safety interventions in  
320 dentistry revealed that surgical safety checklists, which covers tooth extractions,  
321 demonstrated efficacy to reduce or minimize AEs.<sup>63</sup> We also identified other less frequent  
322 intra-operative incidents, which have been also reported in the literature. These include the  
323 *inhalation and ingestion of foreign objects*, reported through the review of relatively small  
324 samples of adverse event case reports,<sup>49</sup> malpractice cases,<sup>47</sup> and dental patient records.<sup>64</sup>  
325 Although not frequent, inhalation of foreign objects alone has recently been proposed as a  
326 “never event” through international consensus.<sup>65</sup>

327  
328 Perea-Perez et al.<sup>47</sup> and Hiivala et al.<sup>48, 50</sup> also previously reported similar post-operative  
329 incidents. However, incidents related to prescription of medications, or their dispensing,  
330 remain largely unreported.<sup>21</sup> Therefore, the evidence base about medication errors in dentistry  
331 needs further investigation. Medication errors involving antibiotics for example contribute to  
332 antimicrobial resistance worldwide<sup>66</sup> and antimicrobial resistance is an emerging threat to  
333 patient safety in the next 30 years.<sup>54</sup> Recently, the World Health Organization (WHO) launched  
334 the third Global Patient Safety Challenge to minimize medication related error<sup>67</sup> and dentistry  
335 should consider its contribution to this global agenda.

336

### 337 [Contributory incidents and contributory factors](#)

338 The majority of medical errors are due to faulty systems and processes.<sup>8</sup> Reason’s Swiss cheese  
339 model of system accidents<sup>39</sup> shows that human errors are often a consequence of latent  
340 organizational flaws, such as administrative or management issues. Our findings corroborate  
341 this and revealed issues of accessibility to services and mismanagement of appointments,  
342 insufficient staff members and lack of equipment maintenance. These issues were mainly  
343 related, as a contributory incident or a contributory factor, to patients experiencing delays in  
344 receiving treatment, which was the main incident reported to the NRLS. Although these  
345 incidents did not lead to harmful outcomes, they reveal the underutilization of primary dental  
346 care services. Underutilization of care is a prevalent issue in both high- and low-income  
347 economies.<sup>68</sup> Factors contributing to this issue broadly include: a) inaccessible healthcare  
348 services to the patient, b) the unavailability of effective services, for instance the result of a  
349 lack of resources, c) the clinician’s failure to provide effective care, and d) the patients’  
350 (inadequate) compliance and adherence to effective healthcare interventions.<sup>68</sup> As the  
351 organizational structure of dental care is likely to differ between countries and clinical settings,

352 we believe quality improvement strategies should be developed and implemented locally.  
353 *Distraction and unexpected movement from the patient* were the most frequent “contributory  
354 factors” for procedural incidents and wrong-tooth extractions. This highlights any unexpected  
355 distraction can create conditions for unsafe care. Other reported contributory factors in the  
356 literature for wrong-extractions include: i) inadequate checks, ii) incorrect radiographs, and iii)  
357 wrong diagnoses have also been reported as causes for wrong-tooth extraction.<sup>25</sup>  
358

## 359 Outcomes

360 Vasovagal responses and lacerations/bleeding were the most commonly described adverse  
361 outcomes. However, the majority of outcomes resulted in either no harm or low harm (94.7%;  
362 n=1,379) which frequently resulted in increased documentation/follow-up, delays in using the  
363 dental clinic, unnecessary x-ray exposure and repeated procedures/additional treatment. The  
364 identification of these outcomes showed the presence of flaws in the provision of efficient and  
365 effective primary dental care, which in addition to patient safety highlight two further  
366 compromised aims of quality improvement, as proposed by the former IOM.<sup>51</sup> Moreover, the  
367 over-utilization of healthcare services can: a) contribute to future unnecessary harm; b) result  
368 in additional financial demands for the patient; and c) cause waste of resources within the  
369 healthcare system.<sup>69</sup>  
370

371 Our findings have helped to identify priority issues for improvement and are a starting point  
372 for setting patient safety research priorities in dentistry.<sup>70</sup> Patient safety in dentistry is still an  
373 emerging discipline which needs to be further developed in parallel with the quality of care.  
374 Health services researchers designing patient-safety-oriented interventions<sup>51</sup> should consider  
375 the more frequent and most harmful incidents reported in this study. Policy makers could take  
376 note of these emerging priorities and allocate resources accordingly. We believe this approach  
377 will contribute to reduce unintended harm and support appropriate utilization of primary  
378 dental care services. Our proposed priority issues can be pursued within research strategies  
379 that embrace robust primary research designs and methods with agreed working definitions.<sup>30</sup>  
380 Examples of these research designs include mixed methods studies of a mix of complimentary  
381 secondary data (e.g. medical records, malpractice cases). In doing so, priority areas and  
382 knowledge gaps should be corroborated in local contexts,<sup>71</sup> as well as furthering advances  
383 already made for data collection methods and taxonomies for patient safety in dentistry.<sup>72</sup>  
384 Natural Language Processing (NLP) could support the pace of progress and in terms of  
385 analysing large volumes of data about unsafe dentistry offers a set of informatics tools capable  
386 of transforming text into a structured format that can be used for research.<sup>73</sup> For example,  
387 data extraction systems based on NLP have been developed in the medical domain.<sup>74</sup> However,  
388 this innovation has yet to be explored in dentistry. Incident reporting systems, such as the NRLS  
389 in England and Wales, have generated many lessons to improve patient safety. The Council of  
390 European Dentists’ has already recommended the development of reporting systems in  
391 dentistry,<sup>75</sup> and these should now be either developed exclusively for the profession or  
392 integrated into existing reporting systems, such as the NRLS, now the Patient Safety  
393 Information Management System led by NHS Improvement. Also, any further dentistry-  
394 focused initiative needs to be supported by clear regulations and policies that allow private  
395 and healthcare-funded dental practices to report incidents, preferably to a single system.  
396 Where multiple regulators have complimentary functions in countries, clear processes about  
397 incident reporting are needed for the dental profession to follow.<sup>76</sup>  
398

399 **Conclusions**

400 Our study represents an important step forward into the characterization patient safety  
401 incidents and their contributory factors in primary care dentistry. Initiatives to improve quality,  
402 including patient safety, in dentistry should focus on improving the main sources of unsafe care  
403 identified in this work. However, our findings also reveal that over-utilization of dental care  
404 services is an issue that can be easily overlooked by researchers, policy makers and members  
405 of the dental profession. As more patient safety focused evidence continues to emerge, this  
406 needs to be integrated into evidence-based guidelines and compliance with these guidelines  
407 needs to be encouraged through fostering a patient safety culture. Patient safety is an  
408 emerging field in dentistry that offers a wide spectrum of opportunities for both research and  
409 improvement.

410

## 411 References

- 412 1. Jha AK, Prasopa-Plaizier N, Larizgoitia I, et al. Patient safety research: an overview of the  
413 global evidence. *Qual Saf Health Care*. 2010;19(1):42-7.
- 414 2. World Health Organization. IBEAS: a pioneer study on patient safety in Latin America.  
415 Towards safer hospital care. Geneva, Switzerland: World Health Organization; 2011.
- 416 3. de Vries EN, Ramrattan MA, Smorenburg SM, et al. The incidence and nature of in-  
417 hospital adverse events: a systematic review. *Qual Saf Health Care*. 2008;17(3):216-23.
- 418 4. Panesar SS, Carson-Stevens A, Cresswell KM, et al. How safe is primary care? A  
419 systematic review. *BMJ Qual Saf*. 2015;bmjqs-2015-004178.
- 420 5. Wilson T, Sheikh A. Enhancing public safety in primary care. *BMJ*. 2002;324(7337):584-7.
- 421 6. Doupi P. National reporting systems for patient safety incidents: A review of the  
422 situation in Europe. 2009.
- 423 7. Department of Health. Building a Safer NHS for Patients: Implementing an Organisation  
424 with a Memory. Department of Health (UK) London; 2001.
- 425 8. Kohn LT, Corrigan JM, Donaldson MS. To Err Is Human: Building a Safer Health System:  
426 National Academies Press; 2000.
- 427 9. Department of Health. An Organisation with a Memory: Report of an Expert Group on  
428 Learning from Adverse Events in the NHS Chaired by the Chief Medical Officer: The  
429 Stationery Office London; 2000.
- 430 10. World Health Organization. WHO Draft Guidelines for Adverse Event Reporting and  
431 Learning Systems. From Information to action. 2005.
- 432 11. Rooksby J, Gerry RM, Smith AF. Incident reporting schemes and the need for a good  
433 story. *Int J Med Inform*. 2007;76 Suppl 1:S205-11.
- 434 12. Brown C, Hofer T, Johal A, et al. An epistemology of patient safety research: a framework  
435 for study design and interpretation. Part 3. End points and measurement. *Qual Saf*  
436 *Health Care*. 2008;17(3):170-7.
- 437 13. Hogan H, Olsen S, Scobie S, et al. What can we learn about patient safety from  
438 information sources within an acute hospital: a step on the ladder of integrated risk  
439 management? *Qual Saf Health Care*. 2008;17(3):209-15.
- 440 14. Sheikh A, Panesar SS, Larizgoitia I, et al. Safer primary care for all: a global imperative.  
441 *Lancet Glob Health*. 2013;1(4):E182-E3.
- 442 15. Sheikh A, BatesMD DW. Iatrogenic harm in primary care. *Harvard Health Policy Review*.  
443 2014;4(1):4-8.
- 444 16. Cooper A, Edwards A, Williams H, et al. Sources of unsafe primary care for older adults: a  
445 mixed-methods analysis of patient safety incident reports. *Age Ageing*. 2017;46(5):833-  
446 9.
- 447 17. Rees P, Edwards A, Powell C, et al. Patient Safety Incidents Involving Sick Children in  
448 Primary Care in England and Wales: A Mixed Methods Analysis. *PLoS Med*.  
449 2017;14(1):e1002217.
- 450 18. Carson-Stevens A, Hibbert P, Williams H, et al. Characterising the nature of primary care  
451 patient safety incident reports in the England and Wales National Reporting and  
452 Learning System: a mixed-methods agenda-setting study for general practice. *Health*  
453 *Services and Delivery Research*. 2016;4(27):1-76.
- 454 19. Williams H, Edwards A, Hibbert P, et al. Harms from discharge to primary care: mixed  
455 methods analysis of incident reports. *Br J Gen Pract*. 2015;65(641):e829-37.
- 456 20. Rees P, Edwards A, Panesar S, et al. Safety incidents in the primary care office setting.  
457 *Pediatrics*. 2015;135(6):1027-35.
- 458 21. Ensaldo-Carrasco E, Suarez-Ortegon MF, Carson-Stevens A, et al. Patient Safety Incidents  
459 and Adverse Events in Ambulatory Dental Care: A Systematic Scoping Review. *J Patient*  
460 *Saf*. 2016;Publish Ahead of Print.
- 461

- 462 22. Thusu S, Panesar S, Bedi R. Patient safety in dentistry - state of play as revealed by a  
463 national database of errors. *Br Dent J.* 2012;213(3):E3.
- 464 23. Maramaldi P, Walji MF, White J, et al. How dental team members describe adverse  
465 events. *J Am Dent Assoc.* 2016;147(10):803-11.
- 466 24. Kalenderian E, Obadan-Udoh E, Maramaldi P, et al. Classifying Adverse Events in the  
467 Dental Office. *J Patient Saf.* 2017.
- 468 25. Renton T, Sabbah W. Review of never and serious events related to dentistry 2005-2014.  
469 *Br Dent J.* 2016;221(2):71-9.
- 470 26. Carson-Stevens A, Hibbert P, Avery A, et al. A cross-sectional mixed methods study  
471 protocol to generate learning from patient safety incidents reported from general  
472 practice. *BMJ Open.* 2015;5(12):e009079.
- 473 27. Lamont T, Scarpello J. National Patient Safety Agency: combining stories with statistics  
474 to minimise harm. *BMJ.* 2009;339:b4489.
- 475 28. National Patient Safety Agency. National Reporting and Learning Service 2003 [Available  
476 from: <http://www.nrls.npsa.nhs.uk>].
- 477 29. National Patient Safety Agency. What is a Patient Safety Incident? National Health  
478 Service; 2011 [Available from: [http://www.npsa.nhs.uk/nrls/reporting/what-is-a-](http://www.npsa.nhs.uk/nrls/reporting/what-is-a-patient-safety-incident/)  
479 [patient-safety-incident/](http://www.npsa.nhs.uk/nrls/reporting/what-is-a-patient-safety-incident/)].
- 480 30. World Alliance For Patient Safety Drafting Group, Sherman H, Castro G, et al. Towards an  
481 International Classification for Patient Safety: the conceptual framework. *Int J Qual*  
482 *Health Care.* 2009;21(1):2-8.
- 483 31. Klemp K, Dovey S, Valderas JM, et al. Developing a patient safety incident classification  
484 system for primary care. A literature review and Delphi-survey by the LINNEAUS  
485 collaboration on patient safety in primary care. *Eur J Gen Pract.* 2015;21 Suppl(sup1):35-  
486 8.
- 487 32. Hibbert P, Runciman W, Deakin A. A recursive model of incident analysis. Australian  
488 Patient Safety Foundation. 2007.
- 489 33. World Alliance For Patient Safety Drafting Group. The Conceptual Framework for the  
490 International Classification for Patient Safety. World Health Organization; 2009.
- 491 34. McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med (Zagreb).*  
492 2012;22(3):276-82.
- 493 35. Denzin NK, Lincoln YS. *The Sage Handbook of Qualitative Research*: Sage; 2011.
- 494 36. Creswell JW, Clark VLP. *Designing and Conducting Mixed Methods Research*: SAGE  
495 Publications; 2010.
- 496 37. Tukey JW. *Exploratory data analysis*. Addison-Wesley Series in Behavioral Science:  
497 Quantitative Methods, Reading, Mass: Addison-Wesley, 1977. 1977.
- 498 38. Excel Redmond, WA: Microsoft Corporations; 2011.
- 499 39. Reason J. Human error : models and management. 2000;320(March):4-6.
- 500 40. Rees P, Carson-Stevens A, Williams H, et al. Quality improvement informed by a  
501 reporting and learning system. *Archives of disease in childhood.* 2014;99(7):702-3.
- 502 41. Rees P, Edwards A, Powell C, et al. Pediatric immunization-related safety incidents in  
503 primary care: A mixed methods analysis of a national database. *Vaccine.*  
504 2015;33(32):3873-80.
- 505 42. Schiff GD. Sick Children Crying for Help: Fostering Adverse Event Reports. *PLoS Med.*  
506 2017;14(1):e1002216.
- 507 43. Boxwala AA, Dierks M, Keenan M, et al. Organization and representation of patient  
508 safety data: current status and issues around generalizability and scalability. *J Am Med*  
509 *Inform Assoc.* 2004;11(6):468-78.
- 510 44. Mayer E FK, Callahan R, Darzi A. National Reporting and Learning System Research and  
511 Development. England: NHIT Imperial Patient Safety Translational Research Centre;  
512 2016.

- 513 45. Johnson CW. Reasons for the Failure of Incident Reporting in the Healthcare and Rail  
514 Industries. In: Redmill F, Anderson T, editors. Components of System Safety: Proceedings  
515 of the Tenth Safety-critical Systems Symposium, Southampton, UK 2002. London:  
516 Springer London; 2002. p. 31-57.
- 517 46. Perea-Perez B, Santiago-Saez A, Labajo-Gonzalez ME, et al. Professional liability in oral  
518 surgery: legal and medical study of 63 court sentences. *Med Oral Patol Oral Cir Bucal*.  
519 2011;16(4):e526-31.
- 520 47. Perea-Perez B, Labajo-Gonzalez E, Santiago-Saez A, Albarran-Juan E, Villa-Vigil A. Analysis  
521 of 415 adverse events in dental practice in Spain from 2000 to 2010. *Med Oral Patol Oral*  
522 *Cir Bucal*. 2014;19(5):e500-5.
- 523 48. Hiivala N, Mussalo-Rauhamaa H, Tefke HL, et al. An analysis of dental patient safety  
524 incidents in a patient complaint and healthcare supervisory database in Finland. *Acta*  
525 *Odontol Scand*. 2016;74(2):81-9.
- 526 49. Obadan EM, Ramoni RB, Kalenderian E. Lessons learned from dental patient safety case  
527 reports. *J Am Dent Assoc*. 2015;146(5):318-26 e2.
- 528 50. Hiivala N, Mussalo-Rauhamaa H, Murtomaa H. Patient safety incidents reported by  
529 Finnish dentists; results from an internet-based survey. *Acta Odontol Scand*.  
530 2013;71(6):1370-7.
- 531 51. Institute of Medicine, Committee on Quality of Health Care in America. Crossing the  
532 quality chasm: A new health system for the 21st century: National Academy Press; 2001.
- 533 52. Frankel A, Haraden C, Federico F, et al. A framework for safe, reliable, and effective care.  
534 White paper. Institute for Healthcare Improvement and Safe & Reliable Healthcare.  
535 Cambridge, MA 2017.
- 536 53. Institute for Healthcare Improvement. Open School Course from the Dental Quality  
537 Alliance (DQA) 2018 [Available from:  
538 [http://www.ihp.org/education/IHIOpenSchool/Courses/Pages/Dental-Quality-Alliance-](http://www.ihp.org/education/IHIOpenSchool/Courses/Pages/Dental-Quality-Alliance-DQA.aspx)  
539 [DQA.aspx](http://www.ihp.org/education/IHIOpenSchool/Courses/Pages/Dental-Quality-Alliance-DQA.aspx).
- 540 54. Yu A, Flott K, Chainani N, et al. Patient safety 2030. London, UK: NIHR Imperial Patient  
541 Safety Translational Research Centre. 2016.
- 542 55. Hollnagel E. Safety-I and safety-II: the past and future of safety management: CRC Press;  
543 2018.
- 544 56. Hebballi NB, Ramoni R, Kalenderian E, et al. The dangers of dental devices as reported in  
545 the Food and Drug Administration Manufacturer and User Facility Device Experience  
546 Database. *J Am Dent Assoc*. 2015;146(2):102-10
- 547 57. Department of Health. Provisional publication of Never Events reported as occurring  
548 between 1 April and 31 December 2016. London: NHS; 2017 31 January 2017.
- 549 58. Pinsky HM, Taichman RS, Sarment DP. Adaptation of airline crew resource management  
550 principles to dentistry. *J Am Dent Assoc*. 2010;141(8):1010-8.
- 551 59. Perea-Perez B, Santiago-Saez A, Garcia-Marin F, et al. Proposal for a 'surgical checklist'  
552 for ambulatory oral surgery. *International journal of oral and maxillofacial surgery*.  
553 2011;40(9):949-54.
- 554 60. Christman A, Schrader S, John V, Zunt S, et al. Designing a safety checklist for dental  
555 implant placement: a Delphi study. *J Am Dent Assoc*. 2014;145(2):131-40.
- 556 61. Diaz-Flores-Garcia V, Perea-Perez B, Labajo-Gonzalez E, et al. Proposal of a "Checklist"  
557 for endodontic treatment. *J Clin Exp Dent*. 2014;6(2):e104-9.
- 558 62. Porto GG. Safety by design: ten lessons from human factors research. *J Healthc Risk*  
559 *Manag*. 2001;21(4):43-50.
- 560 63. Bailey E, Tickle M, Campbell S, et al. Systematic review of patient safety interventions in  
561 dentistry. *BMC Oral Health*. 2015;15(1):152.
- 562 64. Obinata K, Satoh T, Towfik AM, et al. An investigation of accidental ingestion during  
563 dental procedures. *J Oral Sci*. 2011;53(4):495-500.

- 564 65. Ensaldo-Carrasco E, Carson-Stevens A, Cresswell K, Bedi R, Sheikh A. Developing  
565 agreement on never events in primary care dentistry: an international eDelphi study. *Br*  
566 *Dent J.* 2018;224(9):733.
- 567 66. World Health Organization. Medication Errors: Technical Series on Safer Primary Care.  
568 Geneva, 2016.
- 569 67. World Health Organization. Medication Without Harm - Global Patient Safety Challenge  
570 on Medication Safety. Geneva, 2017.
- 571 68. Glasziou P, Straus S, Brownlee S, et al. Evidence for underuse of effective medical  
572 services around the world. *Lancet.* 2017;390(10090):169-77.
- 573 69. Berwick DM. Avoiding overuse-the next quality frontier. *Lancet.* 2017;390(10090):102-4.
- 574 70. Lewis RQ, Fletcher M. Implementing a national strategy for patient safety: lessons from  
575 the National Health Service in England. *Qual Saf Health Care.* 2005;14(2):135-9.
- 576 71. The Safer Care Primary Expert Working Group. Safer Primary Care: A Global Challenge.  
577 Switzerland: World Health Organization; 2012.
- 578 72. Cresswell KM, Panesar SS, Salvilla SA, et al. Global research priorities to better  
579 understand the burden of iatrogenic harm in primary care: an international Delphi  
580 exercise. *PLoS Med.* 2013;10(11):e1001554.
- 581 73. Bates DW, Evans RS, Murff H, et al. Detecting adverse events using information  
582 technology. *J Am Med Inform Assoc.* 2003;10(2):115-28.
- 583 74. Melton GB, Hripcsak G. Automated detection of adverse events using natural language  
584 processing of discharge summaries. *J Am Med Inform Assoc.* 2005;12(4):448-57.
- 585 75. Commission of European Dentists. Resolution on Patient Safety. 2008.
- 586 76. Renton T, Master S. The complexity of patient safety reporting systems in UK dentistry.  
587 *Br Dent J.* 2016;221(8):517-24.