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## REVIEW

# SYNCOPE IN DENTAL PRACTICES: A SYSTEMATIC REVIEW ON AETIOLOGY AND MANAGEMENT



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## ABSTRACT

### Introduction

This systematic review aimed to give an overview of the current evidence surrounding the aetiology and management in terms of treatment and prevention of syncope in dental practices. Alongside the occurrence, the practitioner's competence, and the association between syncope and local anaesthetics were discussed.

### Methods

An electronic search in EMBASE, Web of Science, PubMed, Cochrane databases and a hand search were performed by 2 independent reviewers to identify studies up to November 2019. Eligibility criteria were applied and relevant data was extracted. Inclusion criteria covered all types of dental treatment under local anaesthesia or conscious sedation performed by a wide range of oral health care workers in their practices. Risk of bias of the included studies was assessed using the methodological tools recommend by Zeng et al.<sup>1</sup> No restrictions were made to exclude papers from qualitative analysis based on risk of bias assessment.

### Results

The search yielded a total of 18 studies for qualitative analysis. With the exception of one prospective cohort study, all articles were considered having a high risk of bias. Meta-analysis showed that dentists encountered on average 1.2 cases of syncope per year. The male gender (RR = 2.69 [1.03, 7.02]), dental fear (RR = 3.55 [2.22, 5.70]), refusal of local anaesthesia in non-acute situations (OR = 12.9) and the use of premedication (RR = 4.70, [1.30, 16.90]) increased the risk for syncope. Treatment and prevention were underreported as both were solely discussed in one study. The supine recovery position with raised legs and oxygen administration (15l/min) was presented as an effective treatment. The Medical Risk-Related History (MRRH) system was proposed as prevention protocol, yet this protocol was ineffective in reducing incidence rates ( $p = 0.27$ ). The majority of dentists (79.2%) were able to diagnose syncope, yet most (86%) lacked the skills for appropriate treatment. Only 57,6% of dental practices were equipped with an oxygen cylinder.

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### KEYWORDS

Syncope, Fainting, Systematic review, Risk factor, Treatment, Prevention

Abbreviation: MRRH, medical-risk-related history; ESC, European Society of Cardiology; ECG, electrocardiogram; VVS, vasovagal syncope; BLS, basic life support; AED, automated external defibrillator; RCT, randomized clinical trial; CCT, controlled clinical trial; ARHQ, agency for healthcare research and quality; PRISMA, preferred reporting items for systematic reviews and meta-analyses; GRADE, the grading of recommendations assessment development and evaluation; LA, local anaesthesia; NSAIDs, nonsteroidal anti-inflammatory drug; CVD, cardiovascular diseases; IDAF-4C-Index of dental anxiety and fear; MQ, mutilation questionnaire; DAS, dental anxiety scale; GFS, gear fear scale; VAS, visual analogue scale; CPR, cardiopulmonary resuscitation; RR, risk ratio; OR, odds ratio.

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### Conclusions

Syncope is the most common emergency in dental practices. Nonetheless, the vast majority of dentists do not seem competent nor prepared to manage this emergency. Psychogenic factors seem to play an important role in provoking syncope. Placing the patient in a supine reclined position with raised legs in combination with the administration of oxygen seems effective for regaining consciousness. Although valuable in many aspects, risk assessment by medical history taking is not proven to result in fewer episodes. The strength of these conclusions is low based on GRADE guidelines.<sup>2</sup>

## INTRODUCTION

Dentists face a broad range of medical emergencies in their practices. Syncope frequently fades out in the long listing of — more life-threatening — emergencies such as epileptic insults and cardiac arrests. Nonetheless, in Germany, it accounts for up to 84% of reported emergencies in dentistry.<sup>3</sup>

Syncope is a symptom characterized by transient loss of both consciousness and postural tone. An episode occurs rapidly and the patient recovers quickly (<2 min).<sup>4</sup> The classification of syncope by the European Society of Cardiology (ESC) is based on the leading cause: (1) reflex syncope (e.g. vasovagal), (2) syncope due to orthostatic hypotension and (3) cardiac syncope.<sup>5</sup> Whereas the cause is generally benign, the latter is potentially life-threatening as it may lead to fatal cardiovascular events.<sup>6</sup>

Vasovagal syncope (VVS), known as common faint, is a neurally mediated syndrome associated with hypotension and relative bradycardia due to cerebral hypoperfusion (>20%).<sup>4,7</sup> Early clinical symptoms, also presyncope, are facial pallor, sweating, nausea and warmth. This phenomenon usually occurs when a patient is positioned upright for a prolonged time or when subjected to emotional stress, pain or medical settings.<sup>4</sup> Vasovagal syncope may occur in every age group. A bimodal age distribution with a peak incidence at the age of 20–29 years and 70–79 years is suggested.<sup>8</sup> In Belgium, 34.3% of the dentists have encountered a vasovagal episode during their career.<sup>9</sup> On the other hand, in a Croatian survey, up to 57.4% of the dentists have reported this complication.<sup>10</sup> The frequent occurrence in dental practices may be partially explained by psychogenic factors, such as dental fear, inducing emotional stress and pain. Fear of the dentist as a person, the dental setting or treatment affects 10–15% of the population.<sup>11–14</sup> Especially dental procedures including the use of local anaesthesia can be emotionally challenging from a patient's perspective.

Malamed<sup>15</sup> proposes early intervention by placing the patient in a supine position with feet elevated 10° whilst maintaining an open airway in order to reinstate cerebral per-

fusion. On the other hand, more recent guidelines on first aid by the European Resuscitation Council suggest placing the patient in a side-lying recovery position as this facilitates maintenance of an open airway and decreases the risk of aspiration.<sup>16</sup> However, when the victim fails to breathe normally, a cardiac arrest can be suspected and the Basic Life Support/Automated External Defibrillator (BLS/AED) Algorithm should be initiated. Nevertheless, prevention remains crucial as some patients suffer recurrent syncopal episodes. Thus, assessing a patient's risk based on medical history may be interesting.<sup>6</sup>

Dentists and other oral health care workers have an important role to play since they are responsible for: (1) preventing episodes from (re)occurring, (2) diagnosing and differentiating between banal or severe incidents and (3) acting adequately to regain one's consciousness. In most clinical situations however, dental practitioners don't feel confident handling such medical emergencies.<sup>10,17–19</sup> Low confidence in managing emergencies is associated with insufficient training or education.<sup>20</sup> The common absence of a blood pressure monitor, electrocardiogram (ECG) monitor or an on-site specialist in dental practices poses an additional challenge to the practitioner.

Hitherto, the literature giving an overview of the topic of syncope within dentistry are predominantly narrative reviews published in the 1990s or even earlier.<sup>21–23</sup> Besides, the management of syncope is repeatedly discussed alongside many other emergencies encountered in dental practices.<sup>24</sup> Consequently, the set-up of this review is to focus solely on syncope as a frequent medical emergency occurring in a dental setting.

Three clinical questions were formulated, using the PICO framework, which read as follows:

1. Do psychogenic factors as compared to non-psychogenic factors result in a higher risk of syncope during dental office visits?
2. In a patient suffering from syncope during dental office visits, is placing the patient in a side-lying recovery position as compared to a supine position more effective to regain a patient's consciousness?
3. Will risk assessment based on medical history result in fewer episodes of syncope during dental office visits?

The objective of this study was to give a systematic overview of the current evidence (01/1990–11/2019) surrounding the aetiology and management of syncope in dental practices by answering the above-mentioned focused research questions via an electronic and hand literature search. Alongside, the occurrence of syncope, the practitioner's knowledge/competence, and the association between syncope and local anaesthesia were analysed. The outcomes were reported using the PRISMA framework.<sup>25</sup>

## MATERIALS AND METHODS

### Information Sources and Search Strategy

An electronic literature search as well as a hand search was independently performed by 2 reviewers (IH and LS) to identify eligible studies. The electronic search was conducted in PubMed, Web of Science, EMBASE and Cochrane databases until November 2019 using following search terms:

Patient Dental offices [MeSH Terms] OR Dental office OR Dentist OR Dentists [MeSH Terms] OR Dental care [MeSH Terms] OR Dental hygienists [MeSH Terms] OR Dental hygienist OR Dental health services [MeSH Terms] OR General practice, dental [MeSH

Terms] OR Dental practice OR Dental facilities [MeSH Terms] OR Dental facility OR Dental clinics [MeSH Terms] OR Dental clinic

Outcome Syncope [MeSH Terms] OR Syncope OR Syncopal episode OR Convulsive syncope OR Situational syncope OR Unconsciousness [MeSH Terms] OR Unconscious OR Vertigo, syncopal [MeSH Terms] OR Hypotension, orthostatic [MeSH Terms] OR Hyperventilation [MeSH Terms] OR Faint OR Fainting OR Dizzy OR Dizziness OR Collapse OR Drop attack

The final search block combined these search items as follows: Patient AND Outcome. After removing the duplicates, the 2 reviewers (IH and LS) independently screened all records based on exclusion and inclusion criteria. First, studies were excluded based on title level, afterwards on abstract level and finally the remaining studies were assessed for eligibility on full-text level.

Discrepancies were resolved by mutual agreement. A Cohen's kappa coefficient at title and abstract level was calculated to measure interobserver agreement in the selection of eligible studies.

As for hand searching, all reference lists of studies included by electronic search and secondary literature on the topic were checked for cross-references. Next, following journals were searched manually: European Journal of Oral Sciences and International Dental Journal. Finally, as an attempt to obtain grey literature, researchers who published on the topic of syncope were contacted.

### Eligibility Criteria

#### Inclusion criteria

- Patients visiting private or community dental practices
- Patients undergoing dental/oral treatment or surgery under local anaesthesia, inhalation sedation or oral sedation

- Treatment by dentists, dental hygienists, oral surgeons or other oral health care workers
- Prospective clinical studies (RCTs, CCTs), cross-sectional studies, prospective and retrospective cohort studies and case series
- Articles in English
- Studies reporting on syncope or presyncope
- Studies reporting on the knowledge of dental clinicians on handling and diagnosing syncope

#### Exclusion criteria

- Patients undergoing dental/oral treatment or surgery in general or university hospitals
- Patients presenting to the emergency department
- Dental treatment under general anaesthesia, unconscious sedation or intravenous sedation
- Secondary literature
- Letters to the editors
- Case reports
- Literature published before 1990

### Data Extraction

One reviewer (IH) extracted all relevant data from the included papers. A second reviewer (LS) was consulted when ambiguities arose. Remaining uncertainties were resolved by an extern expert (LAM). The corresponding authors were contacted to obtain any missing or incomplete data.

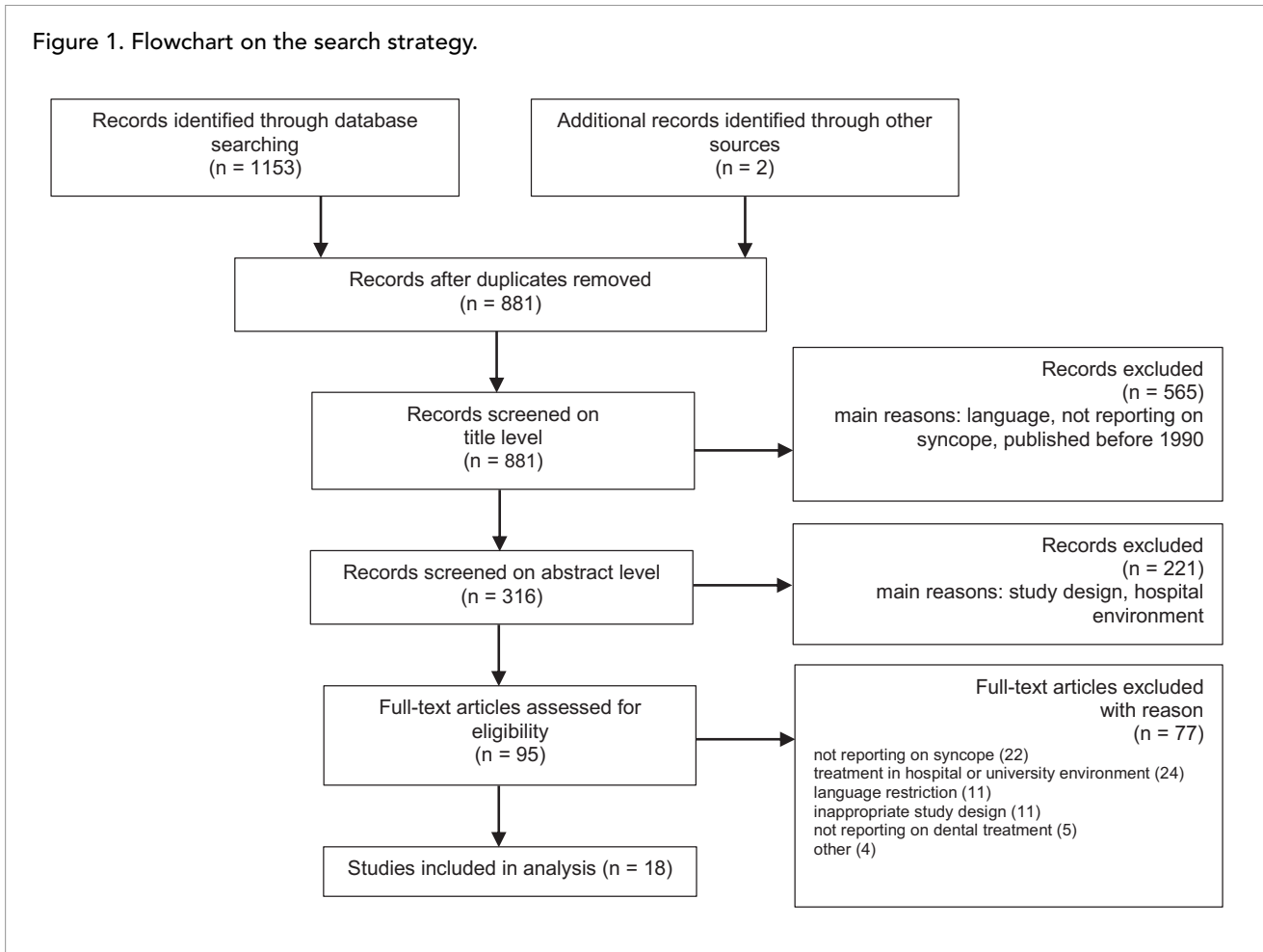
### Risk of Bias Assessment

A quality assessment of the included studies was carried out by the same 2 reviewers (IH and LS). The Agency for Healthcare Research and Quality (AHRQ) Methodology Checklist was used to evaluate cross-sectional studies.<sup>26</sup> Case series were rated using the checklist by Moga et al.<sup>27</sup> Aforementioned checklists included respectively 11 and 18 methodological criteria, screening for selection bias (1), measurement bias (2) and reporting bias (3). All criteria were rated as low (+), unclear (U), high (-) risk of bias or non-applicable (NA). The Newcastle-Ottawa Scale was utilized for cohort studies.<sup>28</sup> Selection (1) and comparability (2) as well as outcome reporting (3) were evaluated using a star-system with a maximum of 9 stars in total. When converting this scale to the AHRQ standard, the papers were rated good, fair or poor quality.<sup>29</sup> The respective methodological assessment tools were recommended by Zeng et al.<sup>1</sup> No restrictions were made to exclude papers from qualitative analysis based on risk of bias assessment.

### Statistical Analysis

Statistical pooling was performed using RevMan 5.3® (Cochrane Collaboration, Oxford, UK). Overall risk ratios (RRs), odds ratios (ORs) and 95% confidence intervals (CIs)

Figure 1. Flowchart on the search strategy.



were calculated, using a random-effect model (DerSimonian & Laird estimator). Heterogeneity of the studies was assessed with the inconsistency index ( $I^2$ ) test.<sup>30</sup> The GRADE guidelines were implemented to rate the heterogeneity: <40% was defined as low, 30–60% as moderate, 50–90% as substantial and 75%–100% as considerable heterogeneity.<sup>2</sup> The overall RRs and ORs were illustrated in forest plots. The statistical significance was two-tailed and set at 0.05.

## RESULTS

### Search

The search strategy is illustrated in Figure 1. In total, 1153 records were identified by performing the database search (584 in PubMed, 395 in EMBASE, 137 in Web of Science, 37 in Cochrane). Additionally, 2 articles were found by hand searching. After duplicates were removed, 881 records remained for screening on title level. This resulted in the exclusion of 565 studies mainly because they did not report on syncope, were published before 1990 or because of the language restriction. The remaining 316 articles were screened

on abstract level. Of those 221 were excluded mainly because of their study design or because the study was conducted in hospital environment. Good inter-rater agreement was found in the selection of appropriate studies at both title and abstract level, given a Cohen’s kappa value of 0.648 ( $p < 0.001$ ) 95%CI [0.595–0.701] and 0.675 ( $p < 0.001$ ) 95%CI [0.583–0.767], respectively.<sup>31</sup> Eventually, 95 studies were assessed for eligibility on full-text level. Reasons for exclusion are listed in *Addendum T1*. The search for grey literature did not provide extra data. Ultimately, the search resulted in a total number of 18 studies eligible for analysis.

### Description of Selected Studies

The characteristics of the included studies are listed in Table 1. Data on occurrence as outcome variable was extracted from 15 studies.<sup>3,9,10,18,32-42</sup> The aetiology of fainting was discussed in 5 studies.<sup>37,38,40,42,43</sup> Smeets et al.<sup>41</sup> provided data on prevention of syncope, whereas Hardwick<sup>39</sup> proposed a treatment protocol. Lastly, 6 studies gave insight in the practitioner’s competence in diagnosing and managing syncope.<sup>3,10,18,36,44,45</sup>

Table 1. Characteristics of included studies.

Author	Study Objective	Study Design	Participants N	Mean Age (Years)	Gender (% Male)	Syncope	Analgesia (%)	Characteristics (% or other)	Management	Prevention (%)	Time Interval (Years)
Alhamad et al., 2015	Occurrence Competence	Cross-sectional	145	34	50.3	VVS					3
Armfield 2010	Occurrence Aetiology	Cross-sectional	1084	44.6	48.6	Fainting /lightheadedness		Higher dental fear (IDAF-4C > 2.5) 19.36 (209/1079)			Lifespan
Armfield et al., 2017	Occurrence Competence	Cross-sectional	596	47.6	49.2	Fainting /lightheadedness					Lifespan
Arsati et al., 2010	Occurrence Competence	Cross-sectional	498	35.6		Syncope Presyncope					1
Baluga et al., 2002	Occurrence	Case series	5018	25.4	47.2	Loss of consciousness Vasovagal reactions	LA: 100				3
Čuković-Bagić et al., 2017	Occurrence Competence	Cross-sectional	498		46.6	VVS				Medical history taking always: 51.2	Career
Daubländer et al., 1997	Occurrence Aetiology	Case series	2731	40.8	44.7	Syncope	LA: 100 Premedication: 6 (164/2731) NSAIDs: 61.5 sedatives: 20.7 AB: 6.7	Risk factors: 45.9 (1223/2664) CVD: 22.1 allergies: 19.9 metabolic diseases: 10.4			3 Treatments
Hardwick 2014	Treatment	Case series	4	42.3	50	Syncope			Supine position + oxygen		1
Khami et al., 2014	Competence	Cross-sectional	177	43	63	Syncope					/
Kishimoto et al., 2018	Competence	Case series	24			VVS					Pre and post training
Locker et al., 1997	Occurrence Aetiology	Cross-sectional	1420			Fainting Feeling faint		Dentally anxious (DAS ≥ 13 or GFS ≥ 8 or single item) 11.4 (162/1420) BI fear (MQ ≥ 9) 4.7 (67/1420) Dentally anxious + BI fear 2.2 (31/1420)			Lifespan

(continued on next page)

Table 1 (continued)

Author	Study Objective	Study Design	Participants N	Mean Age (Years)	Gender (% Male)	Syncopal Characteristics	Analgesia (%)	Characteristics (% or other)	Management	Prevention (%)	Time Interval (Years)
Lustig & Zusman 1999	Occurrence	Case series	1007	33.6	47.1	Syncopal	LA: 100				Treatment
Marks et al., 2013	Occurrence	Cross-sectional	548		57.8	VVS				Medical history taking always: 55.3	Career
Montebugnoli & Montanari 1999	Occurrence	Case series	8	51.2	87.5	VVS		Heart transplant: 100			Treatment
Müller et al., 2008	Occurrence Competence	Cross-sectional	620			VVS	Sedation: 21				1
Smeets et al., 1999	Occurrence Prevention	Prospective cohort	62 (ref) 215 (con)			Cerebral hypoxia Syncope	LA: 83.2			Reference group MRRH: 100 Control group medical history taking: 76	1
van Houtem et al., 2014	Occurrence Aetiology	Cross-sectional	11 213	44.3	38.8	Dizziness/fainting		Higher dental fear (DAS $\geq$ 13) 5.3 (569/11,213) Avoidance behaviour (<1x/y during 5y) 18.1 (2010/11,124)			Lifespan
Vika et al., 2006	Occurrence Aetiology	Cross-sectional	1385	18	44.4	Syncopal Presyncope	LA: 81.9	Higher dental fear ( $\geq$ 1SD above mean VAS) 16.5 (186/1127) Avoidance behaviour ( $\leq$ 40% probability of accepting LA) when in pain 6.7 (19/1130) when not in pain 3.3			Lifespan

LA = local anaesthesia. VVS = vasovagal syncope. NSAIDs = non-steroidal anti-inflammatory drugs. AB = antibiotics. MRRH = Medical Risk Related History. BI fear = Blood-Injury fear.



This selection consisted of 11 cross-sectional studies, 6 case series and 1 prospective cohort study. Taking the study participants and the study duration into account, the studies were divided into 3 groups. Firstly, studies which surveyed dentists about incidents during their career<sup>9,10</sup> or, secondly, in a certain time frame ranging from 1 year to 3 years.<sup>3,18,33,36,39,41</sup> Thirdly, studies which interviewed patients about fainting during their lifespan.<sup>32,37,38,40,43</sup> The remaining studies handled another time frame such as a fixed number of treatments<sup>35,42</sup> or a predefined number of patients.<sup>34</sup>

The present systematic review pooled data of 24,466 patients with a mean age ranging from 18 to 51.2 years old as well as 2811 oral health care workers. The proportion of men and women in the sample was equally balanced with the exception of Montebugnoli, Montanari<sup>35</sup> which included more male participants.

The studies were heterogeneous regarding the type of syncope discussed. Six studies reported on vasovagal syncope.<sup>3,9,10,18,35,45</sup> The 12 remaining studies did not specify which type of syncope was encountered. Data on cardiac syncope and orthostatic syncope in specific was not available.

The use of local anaesthesia (LA) was described in 5 out of the 18 studies.<sup>33,34,40-42</sup> Only 1 study<sup>3</sup> reported the use of sedation. Daubländer et al.<sup>42</sup> was the only study which took any premedication (NSAIDs, sedatives and antibiotics) into account. The remaining studies did not specify the use of analgesics. The sample's psychological or physical condition was recorded in nearly half of the included studies. Data on participants with a physical burden such as cardiovascular diseases (CVD), allergies or arthritis was provided in 2 studies.<sup>35,42</sup> The percentage of participants with dental fear or anxiety, blood-injury (BI) fear or avoidance behaviour was listed in 5 studies.<sup>37,38,40,42,43</sup> The tools used to describe these psychogenic factors were the Index of Dental Anxiety and Fear (IDAF-4C),<sup>46</sup> Mutilation Questionnaire (MQ),<sup>47</sup> Dental Anxiety Scale (DAS),<sup>48</sup> Geer Fear Scale (GFS),<sup>49</sup> Single Item<sup>50</sup> and Visual Analogue Scale (VAS).<sup>51</sup> Avoidance behaviour was defined at the probability of accepting local anaesthesia or the frequency of attendance. The remaining studies provided no actual data on any physical or psychological condition.

A management protocol for syncope was only mentioned in a case series by Hardwick<sup>39</sup> This protocol consists of 2 phases. The first phase is diagnosing correctly based on the patient's symptoms. The second phase is a treatment protocol consisting of 4 steps: lying the patient flat (1), raising the patient's legs (2), administering oxygen 15l/min (3) and lastly starting cardiopulmonary resuscitation (CPR) when unconscious and in absence of normal breathing (4).

Medical history taking was discussed as a strategy for prevention in 2 papers.<sup>9,41</sup> One prospective cohort study<sup>41</sup> addressed the effect of the Medical Risk-Related History (MRRH) System. This preventive protocol involved risk determination, using ASA classification, along with certain preventive measures such as aspiration and the use of nitroglycerin. The control group did not follow this preventive protocol, however 76% of the participants were accustomed to taking a medical anamnesis.

### Risk of Bias Assessment

The quality assessment of included studies is given in Table 2a, 2b and 2c.

All included cross-sectional studies were considered having a high risk of bias as none of the articles met all quality criteria. The majority of included studies did not provide information on any subject exclusions from analysis nor did they explain any missing data handled in the analysis (reporting bias). All case series were rated as high risk of bias as they did not pass each of the quality standards. Half of the case series did not use appropriate statistical tests (analytical bias) and it was often unclear whether the outcome was measured objectively (measurement bias). The cohort study<sup>41</sup> demonstrated good quality as it was rated 6 out of 9 with 3 stars in the selection domain, 1 star in the comparability domain and 2 in the outcome domain.

### Primary Outcomes

#### Occurrence

Table 3 depicts all relevant outcomes regarding occurrence of syncope in the included studies.

Nearly half (45,3%) of the practitioners reported an encounter with syncope during their career.<sup>3,9,10,18,36</sup> One third (32,6%) of all reported emergencies were assigned to syncope.<sup>3,18,33,36,41</sup> The prevalence of syncope in the included studies ranged from 0.1% to 37.5%. A total of 1327 patients fainted in one year, yielding an incidence rate of 0.07%.<sup>3,33,36</sup> Dentists encountered 1.2 cases of syncope per year.<sup>3,36,39</sup>

#### Aetiology

Table 4 summarizes all outcomes regarding the aetiology of syncope in the included studies.

The study of Vika et al.<sup>40</sup> was the sole study to provide information on the association between gender and (pre)syncope. The risk of syncope for male adolescents following dental injection was found 2.69 times higher than the risk for female adolescents. In contrast, the authors described a significantly higher risk of 77% for presyncope following treatment of female patients. None of the included studies reported on age as a possible risk factor.

Three studies investigated on psychogenic factors as a potential risk for syncope. Heterogeneity across studies was



**Table 2A. Quality assessment cross-sectional studies.**

<i>ARHQ Methodology Checklist for cross-sectional studies</i>	<i>Alhamad 2015</i>	<i>Armfield 2010</i>	<i>Armfield 2017</i>	<i>Arsati 2010</i>	<i>Čuković-Bagić 2017</i>	<i>Khami 2014</i>	<i>Locker 1996</i>	<i>Marks 2013</i>	<i>Müller 2008</i>	<i>van Houtem 2014</i>	<i>Vika 2006</i>
1. Define source of information	+	+	+	+	+	+	+	+	+	+	+
2. List inclusion and exclusion criteria for exposed and unexposed subject	+	+	+	+	+	+	+	+	+	+	+
3. Indicate time period used for identifying subjects	-	+	U	+	+	-	-	-	-	+	-
4. Indicate whether or not subjects were consecutive if not population-based	+	+	+	-	-	+	+	-	+	+	+
5. Indicate if evaluators of subjective component of study were masked to other aspects of the status of the participants	NA	-	+	+	+	U	-	+	+	-	+
6. Describe any assessments undertaken for quality assurance purposes	+	+	-	-	+	+	+	+	-	-	+
7. Explain any subject exclusions from analysis	-	NA	+	NA	-	-	-	+	-	+	+
8. Describe how confounding was assessed and/or controlled	U	+	+	-	+	+	+	+	+	+	+
9. If applicable, explain how missing data were handled in the analysis	-	-	-	U	-	+	-	-	+	-	-
10. Summarize subject response rates and completeness of data collection	+	+	+	+	+	+	-	-	+	-	+
11. Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained	-	-	-	+	-	+	-	-	+	+	-

ARHQ = Agency for Healthcare Research and Quality. (+) = low risk of bias. (-) = high risk of bias. NA = not applicable. U = unclear.

substantial, given an  $I^2$  of 76% ( $p = 0.02$ ). The overall risk ratio for fainting as a result of dental fear or anxiety across studies was 3.55 [2.22, 5.70] and the overall odds ratio was 4.01 [2.38, 6.77] (Figure 2).<sup>37,38,43</sup> Dental fear or anxiety in combination with blood injury fear increased the risk of fainting by a five-fold, when compared to dental anxiety or blood in-

jury fear alone. (RR = 4.99, [1.87, 13.30],  $p < 0.01$ ) (OR = 5.58, [1.84, 16.95],  $p < 0.01$ ).<sup>38</sup>

The influence of physical factors, such as cardiovascular diseases, allergies, metabolic diseases and pulmonary diseases, on the incidence of syncope was described by

Table 2B. Quality assessment case series.

<i>Moga et al. 2012 for Case series</i>	<i>Baluga 2002</i>	<i>Daubländer 1997</i>	<i>Hardwick 2014</i>	<i>Kishimoto 2018</i>	<i>Lustig 1999</i>	<i>Montebugnoli 1999</i>
1. Is the hypothesis/aim/objective of the study clearly stated?	+	+	-	+	+	+
2. Are the characteristics of the participants included in the study described?	+	+	+	+	+	+
3. Were the cases collected in more than one centre?	+	+	-	+	-	+
4. Are the eligibility criteria (i.e. inclusion and exclusion criteria) for entry into the study clearly stated?	+	+	U	+	+	+
5. Were participants recruited consecutively?	-	-	+	-	+	-
6. Did participants enter the study at a similar point in the disease?	U	U	U	NA	U	U
7. Was the intervention of interest clearly described?	+	+	+	+	+	+
8. Were additional interventions (co-interventions) reported in the study?	+	-	+	+	-	-
9. Are the outcome measures established a priori?	+	+	-	+	+	-
10. Were the relevant outcomes measured with appropriate objective and/or subjective methods?	+	U	-	+	U	+
11. Were the relevant outcomes measured before and after the intervention?	NA	NA	-	+	-	+
12. Were the statistical tests used to assess the relevant outcomes appropriate?	-	+	-	+	-	+
13. Was the length of follow-up reported?	+	-	U	+	-	+
14. Was the loss to follow-up reported?	NA	NA	NA	+	NA	NA
15. Does the study provide estimates of the random variability in the data analysis of relevant outcomes?	-	+	-	-	-	-
16. Are the adverse events related with the intervention reported?	+	+	+	+	+	+
17. Are the conclusions of the study supported by results?	+	+	-	+	+	+
18. Are both competing interests and sources of support for the study reported?	-	+	-	+	-	-

(+) = low risk of bias. (-) = high risk of bias. NA = not applicable. U = unclear.

Daubländer et al.<sup>42</sup> A non-significant decrease in the incidence of syncope when burdened with disease was noted. The authors also studied the effect of premedication, such as NSAIDs, sedatives and antibiotics. They concluded that patients who premedicated themselves had a higher risk of encountering syncope (RR = 4.70, [1.30, 16.90]) (OR = 4.76, [1.30, 17.48]).

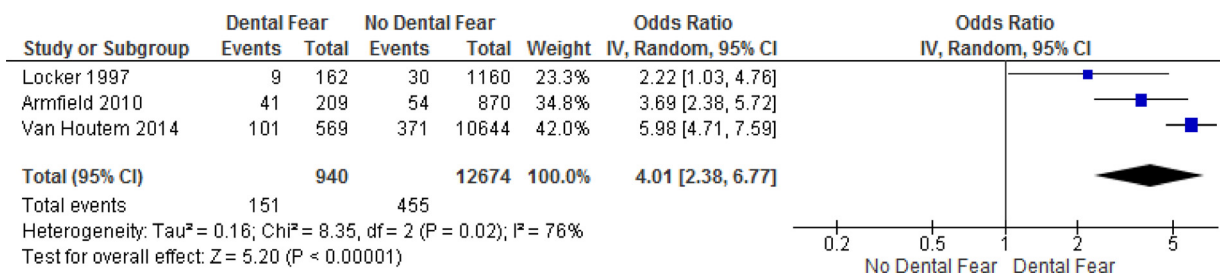
Two studies explored if there was an association between patients with a pattern of avoidance of dental care and patients who suffered from syncope in the past.<sup>37,40</sup> One study did not find any association between irregular attendance and syncope (OR = 1.0,  $p = 0.86$ ).<sup>37</sup> On the other hand, another survey suggested a strong association between refusal of local anaesthesia and a background of syncope in patients

Table 2C. Quality assessment cohort studies.

Newcastle-Ottawa Scale for Cohort study

Selection		Comparability			Outcome		Total score (out of 9)		
Representativeness of the exposed cohort (maximum: ★)	Selection of the non-exposed cohort (maximum: ★)	Ascertainment of exposure (maximum: ★)	Demonstration that outcome of interest was not present at start of study (maximum: ★)	Comparability of cohorts on the basis of the design or analysis (maximum: ★★)	Assessment of outcome (maximum: ★)	Was follow-up long enough for outcomes to occur (maximum: ★)		Adequacy of follow up of cohorts (maximum: ★)	
Smeets et al., 1999	★	★	★	–	–	★	★	★	★★★★★ (6)

Figure 2. Forest plot on fainting and dental fear.



without painful symptoms (OR = 12.9).<sup>40</sup> When it involved accepting local anaesthesia for an acute problem, the association was not statistically significant (OR = 3.2, [0.74–13.87]).

**Treatment**

Out of the 18 included studies, Hardwick<sup>39</sup> was the only one to review the effect of a treatment protocol when encountering syncope in dental practices. Firstly, a correct diagnosis was made based on the observed symptoms (pale, cold, clammy, unconscious). Afterwards, to regain consciousness, the patient was positioned in a supine position with raised legs and oxygen was administered. This protocol led to an uneventful recovery of 3 out of 4 patients. One patient fainted once more while lying reclined followed by hyper-ventilation.

**Prevention**

One cohort study<sup>41</sup> reported on a preventive strategy. In the reference group, using the MRRH system, 18 cases of syncope were registered, counting for 40% of the total number of complications. The participants of control group, on the other hand, encountered 51 cases of syncope, which was 31% of the total number of emergencies. This difference, however, was not statistically significant (p = 0.27).

**Secondary Outcomes**

**Practitioner’s competence**

Table 5 depicts all relevant outcomes of the included studies concerning the practitioner’s competence. Sixteen percent of dentists ought themselves competent diagnosing syncope.<sup>45</sup> Oppositely, when presenting a fictive case, 79.2% of the dentists were able to diagnose syncope correctly.<sup>44</sup>

Three out of 6 studies questioned dentists about their self-perceived ability to manage syncope in their practices. Approximately, 64,5% of the interrogated dentists found themselves able to manage or treat syncope.<sup>10,36,45</sup> On the other hand, acceptable practices scores were noted in only 14% of general dentists.<sup>44</sup>

Subgroup analysis indicated that 79,7% of oral health care workers found themselves competent administering oxygen.<sup>3,10</sup> In absence of normal breathing and unconsciousness, only half (46,2%) of the dentists perceived themselves capable of starting CPR or following the BLS algorithm.<sup>3,18,36</sup>

As regards to emergency equipment, an oxygen cylinder was available in 57,6% of the dental practices.<sup>3,10,18</sup> Only 3.9% of the offices were equipped with an AED.<sup>3,10</sup> Alarmingly, one survey<sup>3</sup> noted that 5% of German dentists did not own any emergency equipment to provide first aid.

Table 3. Outcome of included studies: occurrence.

Author	Practitioners Reporting Syncope % (dentists/total dentists)	Syncope Proportion % (syncope/emergencies)	Incidence of Syncope N (cases/year)	Prevalence of Syncope % (cases/total patients)	Incidence Rate of Syncope N (cases/total patients/year)	Cases/Dentist/ Year
Alhamad et al., 2015	53.1 (77/145)	42.4 (254/599)	85.7			
Armfield et al., 2017				20.5 (120/584)		
Arsati et al., 2010	12.7 (63/498) syncope 54.2 (270/498) presyncope	3.17 (85/2680) syncope 29.3 (785/2680) presyncope	85 syncope 785 presyncope	0.018 (85/482,787) syncope 0.16 (785/482,787) presyncope	0.018 (85/482,787) syncope 0.16 (785/482,787) presyncope	0.17 syncope 1.58 presyncope
Baluga et al., 2002		0.16 (4/25) loss of consciousness 88 (22/25) vasovagal reactions	1.3 loss of consciousness 7.3 vasovagal reactions	0.080 (4/5018) loss of consciousness 0.44 (22/5018) vasovagal reactions	0.0266 (4/15,054) loss of consciousness 0.146 (22/15,054) vasovagal reactions	
Čuković-Bagić et al., 2017	57.4 (286/498)					
Daubländer et al., 1997				0.4 (12/2731)		
Hardwick 2014			4.0			4.0
Locker et al., 1997				3.3 (46/1420) syncope 15.4 (219/1420) feeling faint + syncope		
Lustig & Zusman 1999				0.1 (1/1007)		

(continued on next page)

Table 3 (continued)

Author	Practitioners Reporting Syncope % (dentists/total dentists)	Syncope Proportion % (syncope/emergencies)	Incidence of Syncope N (cases/year)	Prevalence of Syncope % (cases/total patients)	Incidence Rate of Syncope N (cases/total patients/year)	Cases/Dentist/ Year
Marks et al., 2013	34.3 (188/548)					
Montebugnoli & Montanari 1999				37.5 (3/8)		
Müller et al., 2008	57.7 (358/620)	83.4 (1238/1485)	1238	0.097 (1238/1,277,920)	0.097 (1238/1,277,920)	2.0
Smeets et al., 1999		23.1 (48/208) syncope 14.9 (31/208) cerebral hypoxia	48 syncope 31 cerebral hypoxia			
van Houtem et al., 2014				4.3 (472/11,213)		
Vika et al., 2006				1.7 (19/1128) syncope 15.9 (179/1128) presyncope		

Table 4. Outcome of included studies: aetiology.

Author	Gender (Male-Female)	Psychogenic Factors	Physical Factors	Pre-Medication	Avoidance Behaviour
Armfield 2010		Dental fear RR = 3.16 [2.17, 4.61] ( $p < 0.001$ ) OR = 3.69 [2.38, 5.72] ( $p < 0.001$ )			
Daubländer et al., 1997			RR = 0.52 [0.16, 1.70] OR = 0.52 [0.16, 1.70]	RR = 4.70 [1.30, 16.90] OR = 4.76 [1.30, 17.48]	
Locker et al., 1997		Dental anxiety RR = 2.15 [1.04, 4.44] OR = 2.22 [1.03, 4.76] BI fear RR = 2.31 [0.84, 6.36] OR = 2.39 [0.82, 7.00] Both RR = 4.99 [1.87, 13.30] ( $p < 0.01$ ) OR = 5.58 [1.84, 16.95] ( $p < 0.01$ )			
van Houtem et al., 2014		Dental fear RR = 5.09 [4.16, 6.24] ( $p < 0.01$ ) OR = 5.98 [4.71, 7.59] ( $p < 0.01$ )			OR = 1.0 ( $p = 0.86$ )
Vika et al., 2006	Fainting RR = 2.69 [1.03, 7.02] OR = 2.73 [1.03, 7.24] Nearly fainting RR = 0.56 [0.42, 0.76] OR = 0.51 [0.36, 0.72]				When in pain OR = 3.21 [0.74–13.87] When not in pain OR = 12.9 [NR]

RR = risk ratio. OR = odds ratio. BI fear = Blood-Injury fear.

### Syncope and local anaesthesia

In three case series syncope was considered an adverse reaction to local anaesthesia. None of the authors described syncope as a clinical presentation of an allergic reaction to local anaesthetics.<sup>33,34,42</sup>

## DISCUSSION

The aim of this systematic review on the topic of syncope was to identify risk factors (1), assess the effectivity of a side-lying recovery position (2) and to evaluate risk assessment (3). The review was based on 18 studies which reported on the occurrence, aetiology, treatment or prevention of syncope.

This review ratified syncope being the most common emergency in dental practice as it accounts for 32.6% of reported

emergencies.<sup>3,18,52-54 33,36</sup> Dentists must be wary as they encounter approximately 1.2 cases of syncope per year.<sup>3,36,39</sup> The actual number of incidents per dentists per year might be lower since Smeets et al.<sup>41</sup> noted a remarkably lower incidence than the remainder. This cohort study was the sole study to differentiate between syncope and presyncope. Furthermore, this study was rated of good quality as opposed to Hardwick<sup>39</sup> and Arsati et al.<sup>36</sup>

Male patients were found to have an increased risk of fainting. However, females were more susceptible to presyncope.<sup>40</sup> The study focused on a sample of 18-year-old patients, thus rendering questionable external validation. Literature beyond the dental profession suggests that women are more likely to be affected by both syncope and presyn-

**Table 5. Outcome of included studies: practitioner's competence.**

<i>Author</i>	<i>Ability to Diagnose Syncope</i>  <i>% capable (dentists/total dentists)</i>	<i>Ability to Manage Syncope</i>  <i>% capable (dentists/total dentists)</i>	<i>Ability to use Emergency Skills for Syncope</i>  <i>% capable (dentists/total dentists)</i>	<i>Availability of Equipment for Syncope</i>  <i>% (dentists/total dentists)</i>
Alhamad et al., 2015			44.8 (65/145) <sup>a</sup> performing CPR	oxygen: 78.6 (114/145)
Arsati et al., 2010		77.1 (384/498) <sup>a</sup>	43.0(214/498) <sup>a</sup> performing CPR	
Čuković-Bagić et al., 2017		54.4 (271/498) <sup>a</sup>	56.8 (283/498) <sup>a</sup> administering oxygen	oxygen masque: 43.6 (266/498) oxygen: 33.7 (168/498) aed: 6.4 (32/498)
Khami et al., 2014	79.2 (134/170) <sup>b</sup>	14.0 (24/170) <sup>c</sup>		oxygen + masque: 64 (106/165)
Kishimoto et al., 2018	16 (4/24) <sup>a</sup>	14 (3/24) <sup>a</sup>		
Muller et al., 2008			98 (608/620) <sup>a</sup> administering oxygen 49 (304/620) <sup>a</sup> BLS algorithm	oxygen: 72 (446/620) aed: 2 (12/620) no equipment: 5 (31/620)

CPR = CardioPulmonary Resuscitation. BLS = Basic Life Support. AED = automated external defibrillator.

<sup>a</sup> = self-perceived.

<sup>b</sup> = correct diagnosis on fictive test.

<sup>c</sup> = correct treatment on fictive test (score 3,4 or 5).

cope.<sup>8,55</sup> None of the included authors reported on peak incidences at certain ages.<sup>37,38,43</sup> Psychogenic factors were identified as a major risk factor for syncope during dental treatment. When a patient indicated fear of the dentist and the dental environment, the risk of fainting during treatment increased significantly (3.55 [2.22, 5.70]).<sup>37,38,43</sup> When afraid of blood or injury the risk increased even further.<sup>38</sup> This is in line with earlier literature proposing psychogenic factors as a risk factor for syncope.<sup>56</sup> Females were more prone to dental fear ( $p < 0.0001$ ) which could explain the increased risk for presyncope.<sup>38</sup> The highest risk ratio for fainting or dizziness was noted in Van Houtem et al.<sup>37</sup> Notably more female participants were enrolled in this study. Despite providing the largest sample size, this survey was highly biased as the completeness of data collection and the handling of missings were unclear. The association between the refusal of local anaesthesia and fainting emphasized the significance of psychogenic factors in the aetiology of fainting in dental practices.<sup>40</sup> Furthermore, patients who premedicated themselves were at higher risk for syncope.<sup>42</sup> The involved medication mainly comprised NSAIDs (60%) and sedatives (20%). Interestingly, oral surgeons and periodontists routinely prescribe such types of medication prior to surgical procedures.

However, no direct link between surgical treatments and a higher incidence of fainting was found. The use of sedatives, on the other hand, is associated with dental fear which is proven to be a risk factor for syncope.

The evidence on treatment of syncope in dental offices was scarce. None of the authors described the side-lying recovery position in order to regain the patient consciousness. Hardwick<sup>39</sup> advocated a supine-lying recovery position with raised legs and the administration of oxygen. From clinical point of view, a supine position is more convenient during dental treatment as a dental chair facilitates the patient lying dorsally reclined. More research is needed to evaluate the effect of a side-lying recovery in a dental setting as it improves airway patency and the passive drainage of fluids.<sup>16,57,58</sup>

Risk assessment by means of medical history taking (MRRH) was proven to be an ineffective prevention protocol in this review.<sup>41</sup> Nonetheless, recording medical history remains important as it points out risk factors for dental treatment. Recording previous syncopal episodes is equally important as research shows that the likelihood of syncope is more than five times higher when a patient fainted the previous year.<sup>4</sup> A detailed medical history also helps to differentiate



between epileptic seizures and syncope as both can provoke myoclonic jerks.<sup>59</sup> Physical counterpressure maneuvers (crossing legs, hand grip or arm tension) can be used during dental treatment as a preventive method in patients who are known to be triggered by the dental environment. These techniques are also proven effective when premonitory symptoms occur.<sup>60</sup>

Despite syncope being the most common emergency, as few as 14% of general dentists were capable of correctly managing syncope when presented a fictive case.<sup>45</sup> Dentists tend to overestimate their managing skills for syncope. This review indicates that dentists may not be prepared for such emergencies. Only half of dental practices were equipped with an oxygen cylinder and 1/5 dentists did not find themselves competent to administer oxygen.<sup>3,10,18,45</sup> Notwithstanding, the outcome of syncope being generally favourable, half of the dentists did not perceive themselves capable performing CPR when needed.<sup>3,18,36</sup> Alarming, only a small number (3.9%) of practices were equipped with an AED.<sup>3,10</sup> Simulation training can improve oral health care workers' abilities in managing syncope and other emergencies.<sup>45</sup>

Syncope is often misinterpreted as an allergic response to local anaesthesia. This misdiagnosis complicates further treatment involving local anaesthesia. Therefore, fainting should rather be considered a side effect, as it is not proven part of the clinical presentation of an allergic reaction.<sup>33</sup>

### Limitations

When interpreting the results of this systematic review, the following limitations need to be taken into account. First, according to the definition formulated by the ESC, syncope is a transient loss of consciousness and postural tone.<sup>5</sup> Presyncope precedes syncope. In a large part of included studies, it was unclear whether presyncope was -wrongly- classified under the heading of syncope.<sup>3,9,10,18,32,35,37,42,46</sup> Moreover, studies were heterogeneous regarding the terminology used to indicate presyncope (cerebral hypoxia, feeling faint, vasovagal reactions) or syncope (fainting, loss of consciousness). Thus, making it difficult to interpret incidence and prevalence rates.

Secondly, this review consisted of studies in which either dentists diagnosed the patient based on clinical symptoms or patients reported their self-diagnosis. With the exception of one cohort study,<sup>41</sup> the diagnosis and the underlying cause were not verified by an internist or anaesthesiologist. Therefore, diagnostic accuracy within studies may be questionable. Hence the lack of data on cardiac and orthostatic syncope within the dental field.

Thirdly, a significant limitation of the present review was the exclusion of studies conducted in hospital environment as a considerable amount of papers on aetiology, prevention and management were excluded.

Lastly, all cross-sectional and case series were considered having a high risk of bias mainly due to reporting, analytical and measurement bias. Consequently, the strength of the reported conclusions is low based on GRADE guidelines.<sup>2</sup> More research on the topic of syncope, especially treatment and prevention, in dental practices is needed.

### Clinical Implications

- watch out for prodromal symptoms (sweating, dizziness, paleness) and advise physical counterpressure maneuvers such as leg crossing and arm tension
- when syncope occurs: place the patient in a supine position with raised legs (or side-lying) and administer oxygen (15l/min)
- an oxygen cylinder and masks or Ambu bags should be available in every practice
- simulation courses are advised to boost diagnosing and treatment skills
- medical history taking with attention to previous episodes of fainting is necessary
- explore the patient's past experiences and fears and invest in a trusting relationship

### CONCLUSION

Syncope is the most common emergency in dental practices with 1.2 cases of syncope per dentist per year. Nonetheless, the vast majority of dentists do not seem sufficiently competent to manage this emergency. Addressing the predefined PICO questions, following answers were formulated. Psychogenic factors play a bigger role in provoking syncope than non-psychogenic factors such as demographic (age, sex) or physical factors (CVD, allergies). In order to regain a patient's consciousness, a supine reclined position with raised legs in combination with oxygen administration seems effective. However, more research on a side-lying recovery position is needed. Although recording medical history remains important as it points out risk factors for dental treatment and warns for recurring episodes, risk assessment by medical history taking is not proven to result in fewer episodes. The strength of these conclusions is low based on GRADE guidelines as all studies except one were highly biased.

### ADDENDUM

ADDENDUM T1 Reasons for exclusion

<i>Innapropriate Study Design</i>	<i>Not Reporting on Syncope</i>	<i>Treatment in Hospital or University Environment</i>	<i>Language Restriction</i>	<i>Not Reporting on Dental Treatment</i>	<i>Other</i>
Armfield & Milgrom, 2011	Annequin et al., 2000	Albelaihi et al., 2017	Findler et al., 2002	Jenerowicz et al., 2014	Girdler & Smith 1999
Brooks & Francis, 2006	Budin et al., 2014	Akifuddin & Katoon 2015	Galili et al., 2002	Karademir et al., 2011	Keur et al., 1999
Busschots & Milzman 1999	Chang et al., 2016	Al-khodair et al., 1996	Garfunkel et al., 2002	Michowitz et al., 2019	Locker et al., 1996
Collange et al., 2010	Chapman, 1997	Benbow & Crentsil, 2004	Gunera-Saad et al., 2007	Milman et al., 2019	Oliveira et al., 2010
DiSogra & Meece, 2019	Coplans & Curson, 1993	Cheung et al., 2011	Hoxha 2019	Tedeschi et al., 2015	
Fiske et al., 2002	Cunningham et al., 2013	Collado et al., 2008	Kaidashev et al., 2017		
Fletcher 1992	Duane et al., 2014	D'Aiuto et al., 2018	Kanto et al., 2005		
Hendron, 2015	Ferendiuk et al., 2014	De Jongh et al., 1998	Noguchi & Amemiya, 2002		
Kufta et al., 2018	Fuertes-González & Silvestre, 2014	De Leeuw et al., 2005	Timerman et al., 2010		
Timerman et al., 2014	Fukai et al., 2009	Gbotolorun et al., 2012	Tohda, 1995		
van Houtem, 2017	Keene et al., 2003	Gilchrist et al., 2011	Toyosato et al., 2005		
	Kilic et al., 2014	Gilchrist et al., 2011			
	Kleinhauz et al., 1993	Goldstein et al., 1994			
	Lokken & Rust, 1998	Gupta et al., 2017			
	Mattschoss et al., 2009	Hand et al., 2011			
	Moore et al., 2004	Jadhav et al., 2019			
	Padrino-Barrios et al., 2015	Jodalli & Ankola, 2012			
	Pihlstrom et al., 1999	Manani et al., 2005			
	Roccia et al., 2003	Potter et al., 2014			
	Scott et al., 2004	Rood, 2000			
	Seo et al., 2017	Sambrook et al., 2011			
	Yilmaz et al., 2014	Smereka et al., 2019			
		Smereka et al., 2019			
		Umek et al., 2019			

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