

Prevention of Infective Endocarditis of Oral Origin in Children: A Call for Pediatric Dentists–Pediatric Cardiologists' Collaboration in Egypt

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ABSTRACT

Aim: To assess knowledge and practices of some Egyptian pediatric dentists and pediatric cardiologists/cardiac surgeons regarding prevention of infective endocarditis (IE) from oral origin in children.

Materials and methods: Pediatric dentists or pediatric cardiologists/cardiac surgeons having their practice in Egypt were conveniently selected. An online questionnaire was constructed for each specialty practitioner in English using a web-based platform. Each survey tool collected data about demographics, knowledge, and practices concerning the prevention of IE of oral origin. Surveys were disseminated to potential respondents using direct messaging or posting surveys' links on high-traffic areas (blogs, groups, or pages) of commonly known social media platforms.

Results: Two-hundred and thirty-nine pediatric dentists and 71 pediatric cardiologists/cardiac surgeons' responses were included in analysis. Some shortage in oral health knowledge and deviations in management protocol from known guidelines were evident in cardiologists' responses, whereas 66.2 and 64.8% reported encountering IE of oral origin or canceling a cardiac surgery due to oral infection, respectively. Most pediatric dentists (65.7%) rely on physician referral before managing children at risk of IE despite following recognized guidelines for IE prevention which may reflect difficulty in understanding such guidelines. Ninety percent of children with heart diseases visit a dentist due to oral complaint and not for checkup.

Conclusion: Identification of disparities and pitfalls in management of children with heart diseases, if appropriately addressed by pediatric dentists and cardiologists, may reduce the risk of IE from an oral origin.

Clinical significance: Health education of both specialists and development of national guidelines based on national epidemiology and clinical experience of cardiologists are strongly needed to decrease oral disease burden, allow for a consensus of patient management, and minimize the need for cross-referral, thus facilitating dental management without undue delays.

Keywords: Cardiac surgeons, Cardiologists, Dentists, Infective endocarditis, Pediatric.

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INTRODUCTION

Infective endocarditis (IE) is a serious life-threatening condition caused by bacterial infection of the cardiac epithelium. IE is a rare condition, yet its mortality rate ranges from 20 to 30%. In children, congenital heart diseases (CHD) are the most common risk factor for IE.¹

Infection from an oral origin was reported to be associated with 14–20% of IE cases, with gram-positive streptococci accounting for 50% of these infections. Viridans streptococci, the most predominant oral cavity commensals, were implicated as the leading causative microorganism of IE especially of the subacute type.^{2–5} Bacteremia induced by invasive dental procedures can be a major cause for IE from oral origin; however, a negative history of previous dental procedures with or without the presence of oral infections was reported in many IE cases.^{4,5}

Noninvasive dental procedures, such as chewing, toothbrushing, and flossing, and oral foci of infection such as periodontal diseases or gingival abscess have been also claimed as potential sources of spontaneous bacteremia. The presence of periodontal diseases due to poor oral hygiene may increase the risk for bacteremia through inflamed gingival blood vessels or pocket formation.^{2–4} Moreover, *Enterococcus faecalis* have been implicated as the third most common pathogen causing IE following streptococci and *Staphylococcus aureus*. *E. faecalis* is also a common oral inhabitant which is isolated in high numbers in cases of periodontal diseases and necrotic dental

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pulpas with or without a gingival abscess.⁵ Therefore, a shift toward oral-health promotion and prevention of oral disease should be recognized as a prime management strategy in patients at risk of IE.

National guidelines for prevention of IE are based on clinical and basic evidence as well as national epidemiological surveys. The guidelines of the American Heart Association (AHA) and European Society of Cardiologists (ESC) precisely described individuals at highest risk of IE as well as dental procedures with highest risk of bacteremia to conserve antibiotic prophylaxis to those in most

need.^{6,7} However, guidelines for preventing IE sometimes vary when it comes to prescribing prophylactic antibiotics or identifying people at risk.⁸

Promoting oral health in children at risk of IE mandates collaboration of both pediatric dentists and pediatric cardiologists/surgeons so that both practitioners can provide proper dental/medical care based on the right knowledge and skills. Agreements on management protocols between both specialties can also reduce confusions while providing dental/medical services by both providers. Few reports exist about the knowledge and practices of pediatric cardiologists and dentists to promote cardiac patients' oral health and prevent IE of oral origin.⁹⁻¹² Thus, the present study aimed to assess the knowledge and practices of a group of Egyptian pediatric dentists and pediatric cardiologists/cardiac surgeons regarding prevention of IE of oral origin.

MATERIALS AND METHODS

The present study was conducted in Egypt starting from June 2020 till October 2020. The required sample size was estimated using the formula: $n = \frac{(z^2 P(1-P))D}{d^2}$. The margin of error d was assumed to be 0.1, z statistic was set to 1.96 (assuming $\alpha = 0.05$), and the expected proportion (P) to 0.5, yielding a minimum sample size of 96 pediatric dentists. As for pediatric cardiologists, which is a rare medical specialty that is recently introduced to the medical field in Egypt, Egyptian online medical booking platforms such as <https://www.vezeeta.com/> were used to identify a total of 116 active practitioners in Egypt. Consequently, assuming a finite population of 116, a margin of error d of 0.1, $\alpha = 0.05$, and expected proportion of 0.5, a minimum of 53 pediatric cardiologists were needed. Online surveys assessing knowledge and practices regarding prevention of IE of oral origin were constructed in English: one for pediatric dentists and the other for pediatric cardiologists/cardiac surgeons. Inclusion criteria were practitioners being currently practicing in Egypt for at least 1 year after attaining a postgraduate's degree in the fields of interest. Both surveys were constructed via a web-based platform (Google forms). Ethical approval was obtained from institutional research ethics committee (FDASU-Rec IR200736). An explanation of the survey purpose was provided at the beginning of each survey with a statement denoting that submitting survey responses is considered a consent for participation. The survey was voluntary and anonymous, and data were confidential.

Both surveys collected data about three main areas: demographics, knowledge, and practices. The cardiologists survey included 17 closed-ended questions, while the dentists survey included 13 closed-ended questions. Additionally, three closed-ended questions assessing demographics were used at the beginning of each survey to assess eligibility. The face and content validities of both surveys were assessed by coauthors, three pediatric dentistry, and three pediatric cardiology experts prior to dissemination. The surveys were piloted by five experts in the pertinent fields to assess ease of understanding and comprehension and appropriateness of time spent to complete the survey. Pilot surveys' results were not included in the final results. Both surveys were opened for completion for 6 weeks, starting from August 12, 2020.

Different social media platforms were used as channels for surveys' dissemination. Surveys were sent to all identified respondents using direct text messages with a link to the online survey on social media applications linked to their phone numbers.

Surveys were also promoted by targeting commonly known high traffic areas (blogs, groups, or pages) on social media platforms available for computers and mobile phones such as Facebook, Messenger, and WhatsApp for both specialists of the pertinent fields. The survey link was posted or sent along with a message describing the purpose of the survey and a request to circulate the link. Influencers (eminent figures in the relevant fields in Egypt) were also asked to help in promoting the link.

R statistical analysis software version 4.0.3 for windows was used to statistically analyze data which were presented as Frequencies (NO.) and percentages (%).

RESULTS

The number of pediatric dentists who completed the survey was 275, from which 36 responses were excluded from analysis for either practicing pediatric dentistry exclusively outside Egypt (NO. = 33) or for not having an experience in pediatric dentistry (NO. = 3). Thus, 239 pediatric dentists' responses were included in the final analysis while 71 pediatric cardiologists/cardiac surgeons provided their responses. No exclusions were made for the cardiologists' responses; thus, all 71 responses were included in the analysis.

Cardiologists Practice

Table 1 represents cardiologists' practices. Most cardiologists (39.4%) checked oral health only when patient complains, while four (5.6%) reported not checking at all. The latter respondents were spontaneously directed to state the reason(s) for not checking oral health where 25% reported not checking oral health due to lack of adequate skills or because it is not their responsibility (25%) or both (50%). Referral to a dentist for oral-health assessment was mostly carried out if the child is at risk of IE (52.1%) or when patient complains (38%) while only 29.6% referred a dentist before cardiac surgeries. Time of referral for oral-health assessment before cardiac surgeries was reported by majority of cardiologists (45.1%) to be 1 month before surgeries, while 35.2% of cardiologists referred for oral-health assessment less than a week before cardiac surgeries. On the other hand, 64.8% of cardiologists reported to have a cardiac surgery canceled/delayed due to oral infections.

A high percentage of cardiologists (66.2%) encountered IE from oral origin in their practice. The need for antibiotic before dental procedures was the most frequently discussed issue by most cardiologists (74.6%). Although ESC guidelines were followed by most cardiologists (69%), 60.6% prescribed a single dose of antibiotic before and right after dental treatments which are mostly penicillin (81.7%).

Cardiologists Knowledge

70.4% of cardiologists identified children with heart diseases as having a high risk to dental caries. Brown/black tooth discolorations or tooth cavities were the most known clinical presentations of tooth decay by cardiologists which were 77.5% and 69%, respectively. Only 12.7% cardiologists received oral-health education sessions while oral-health topics were taught in the postgraduates' program of 29.6%. Most cardiologists (88.7%) were willing to receive an oral-health education related to their practice (Table 2).

Regarding the possible cause(s) of IE of oral origin, cardiologists selected—in a descending order—invasive dental procedure (81.7%), gingival abscess (74.6%), decayed teeth (67.6%), noninvasive dental procedures (22.5%), and toothbrushing (25.4%) (Table 2).

Table 1: Pediatric cardiologists’ “practice” data

Question	Answers	No.	%	
1. Time of assessing oral health?	Directly after diagnosis of a congenital/ acquired heart disease	14	19.7%	
	Regularly with checkups	25	35.2%	
	Only when patient complains	28	39.4%	
	I do not check oral health	4	5.6%	
2. If you don’t assess oral health, what are the reason(s)? NO. = (4)	I do not have time	0	0%	
	I do not have the skills to do an oral examination	1	25%	
	It is not my responsibility	1	25%	
	I do not have the skills and it’s also not my responsibility	2	50%	
3. When do you usually refer children with heart diseases for oral-health assessment?	Directly after diagnosis of a congenital heart disease	Yes No	18 53	25.4% 74.6%
	If the child is at risk of IE	Yes No	37 34	52.1% 47.9%
	When patient complains	Yes No	27 44	38.0% 62%
	Before cardiac surgeries	Yes No	21 50	29.6% 70.4%
	4. What type of dental specialty would you refer a patient to?	General dental practitioner	25	35.2%
		Pediatric dentist	37	52.1%
I am not sure		9	12.7%	
5. Time of dental referral before cardiac surgery?	1 month	32	45.1%	
	1 week	14	19.7%	
	Less than 1 week	25	35.2%	
6. Have you had a cardiac surgery canceled/ postponed due to oral infection?	Yes	46	64.8%	
	No	25	35.2%	
7. Have you ever encountered IE from oral origin?	Yes	47	66.2%	
	No	5	7.0%	
	I’m not sure	19	26.8%	
8. What of the following oral-health issues do you discuss with your patients?	Importance of regular checkups?	Yes No	33 38	46.5% 53.5%
	Link between oral health and cardiac disease	Yes No	39 32	54.9% 45.1%
	Necessity of antibiotic intake before dental procedures	Yes No	53 18	74.6% 25.4%
	Diet and tooth brushing	Yes No	28 43	39.4% 60.6%

(Contd...)

Table 1: (Contd...)

Question	Answers	No.	%
9. Followed guidelines for prevention of IE?	European Society of Cardiology (ESC)	49	69.0%
	American Heart Association (AHA)	15	21.1%
	National Institute for Health and Care Excellence (NICE)	6	8.5%
	Other	1	1.4%
10. How do you prescribe an antibiotic prophylaxis for invasive dental procedures?	A single dose 30–60 minutes before dental procedures	27	38.0%
	A single dose before dental procedure and another single dose right after the procedure	43	60.6%
	According to type of procedure	1	1.4%
11. Antibiotic of choice	Aminoglycosides	4	5.6%
	Cephalosporins	14	19.7%
	Lincosamide	3	4.2%
	Penicillins	58	81.7%

Pediatric Dentists Practice

Most dentists (51%) reported to rarely encounter children with CHD in their practice setting. 60.6% reported to follow the AHA guidelines, while 34.7% were not sure of IE prevention guidelines. Most dentists (65.7%) refer to cardiologists before dental treatment and rely on cardiologist to prescribe prophylactic antibiotics (71.5%) and to determine child risk to develop IE (53.1%). Most dentists were not involved in any oral health education for children with CHD (66.5%) or cardiologists (89.5%). Dentists also reported that the reasons of dental visits for children with heart diseases are mostly symptomatic decayed teeth (90%), before cardiac surgeries (33.1%), and only 15.1% are seen for regular checkups (Table 3).

Pediatric Dentists Knowledge

Invasive dental procedures (92.5%), gingival abscess (66.9%), and a tooth with deep caries (36.4%) were regarded as the most frequent causes of IE from an oral origin selected by dentists. More than 50% of dentists reported noneligibility of pulp therapies in permanent and primary teeth while 32.2 and 28.9% regarded vital pulp therapy as safe in permanent and primary teeth, respectively. One month before surgery was selected by most dentists (43.9%) as the appropriate time for elimination of oral foci of infection before cardiac surgeries. Most dentists (67.8%) reported that children with rheumatic heart disease require antibiotic prophylaxis, whereas 36% reported that “all children with CHD” require antibiotic prophylaxis and 28.5% considered “children with rheumatic fever without a heart disease” as also in need of antibiotic prophylaxis (Table 4).

DISCUSSION

The present study showed that although 70.4% of cardiologists recognized children with heart diseases as having a higher risk of developing tooth decay, 39.4% reported to check oral health only when the patient complains, and few (5.6%) reported not checking oral health at all for not having the skills or for considering that this



Table 2: Pediatric cardiologists' "knowledge" data

Question	Answers	No.	%
1. Risk of tooth decay in children with heart diseases compared to healthy children?	Higher risk	50	70.4%
	Not different	10	14.1%
	Lower risk	3	4.2%
	I do not know	8	11.3%
2. How usually a tooth decay looks like?	Brown/black tooth discolorations	55	77.5%
	Tooth cavities	49	69.0%
	Chalky white discolorations	8	11.3%
	I am not sure	6	8.5%
3. Were there oral-health education sessions held at your practice facility?	Yes	9	12.7%
	No	62	87.3%
4. Was the importance of oral health in patients with heart diseases taught in your postgraduates' program?	Yes	21	29.6%
	No	50	70.4%
5. Do you wish to be offered oral-health education related to your field of practice?	Yes	63	88.7%
	No	8	11.3%
6. IE of oral origin can be caused by:			
	Chewing	Yes	6
	No	65	91.5%
Toothbrushing	Yes	18	25.4%
	No	53	74.6%
A decayed tooth	Yes	48	67.6%
	No	23	32.4%
Gingival abscess	Yes	53	74.6%
	No	18	25.4%
Invasive dental treatment	Yes	58	81.7%
	No	13	18.3%
Noninvasive dental procedure	Yes	16	22.5%
	No	55	77.5%

is not their responsibility or both. Others (19.7%) reported to check oral health only after diagnosis of a heart disease or regularly with checkups (35.2%). Olderog-Hermiston et al.⁹ reported that 71% of pediatric cardiology clinics did not perform oral health education or screening possibly due to financial, manpower, and time constraints and that provision of oral health education material, assessment forms, and training may be of assistance.

Children with CHD usually have a high prevalence of unmet dental needs¹³⁻¹⁵ and are considered at an increased risk for dental caries either as a direct consequence of their medications and high carbohydrates intake or indirectly because of child and parental dental anxiety, focused attention on child's medical problem, or financial constraints leading to a delay in seeking dental treatment.^{16,17} Collectively, these events make those children at risk of dental caries and gingival diseases; two conditions that can be potential sources of bacteremia either during treatment or spontaneously without any intervention.^{18,19}

The current study revealed that low dental referral was practiced by cardiologists where 52.1% refer if the child is at risk of IE and 25.4% refer directly after diagnosis of a CHD. Even when patients complain

Table 3: Pediatric dentists' "practice" data

Question	Answers	No.	%	
1. Frequency of encountering a child with congenital/rheumatic heart disease in your practice?	Several times a week	7	2.9%	
	Several times a month	30	12.6%	
	Several times a year	79	33.1%	
	Almost daily	1	0.4%	
	Rarely	122	51.0%	
2. Followed guidelines for IE prevention?	ESC	5	2.1%	
	NICE	6	2.5%	
	AHA	145	60.6%	
	I am not sure	83	34.7%	
3. Do you refer a child with congenital/acquired heart disease to pediatric cardiologists for consultation before dental treatment?	Yes, all children with congenital/acquired heart diseases	157	65.7%	
	Yes, only children at risk of IE	66	27.6%	
	No, I don't refer patients	16	6.7%	
4. If a prophylactic antibiotic is needed, who prescribes it?	The pediatric cardiologist	171	71.5%	
	I prescribe it myself	68	28.5%	
5. How do you consider a child as having a risk for IE?	I ask parents	33	13.8%	
	According to physician consultation	127	53.1%	
	According to guidelines	79	33.1%	
6. Involvement in oral health education for children with CHD?	Yes	80	33.5%	
	No	159	66.5%	
7. Involvement in oral health education for pediatric cardiologists?	Yes	25	10.5%	
	No	214	89.5%	
8. Dental visits reasons for children with CHD:				
	Asymptomatic decayed tooth	Yes	48	20.1%
		No	191	79.9%
	Symptomatic decayed teeth	Yes	215	90%
		No	24	10%
	Before cardiac surgeries	Yes	79	33.1%
		No	160	66.9%
	Regular for checkups	Yes	36	15.1%
	No	203	84.9%	

of a dental problem, only 38% would refer to a dentist. Oliver et al.,¹¹ in a survey of Canadian and American cardiologists, also showed that oral-health assessment was employed by cardiologists or through dental referral by 28% of cardiologists after diagnosis of a heart condition usually at the age of 1 year, or when patient complains (20%) and 8% never assessed oral health. This suggests that cardiologists may be unaware of the importance of establishing a dental home by the first year of age especially for those children with special health-care needs.^{20,21}

Low dental referral was also reflected by dentists in the present study, of whom nearly 50% reported to rarely encounter children with cardiac diseases at their practice, whereas 90% agreed that children with CHD usually seek dental treatment when having symptomatic teeth. In line with our results, Nakano and Ooshima¹⁰ showed that 30% of general dentists in Japan reported not to

Table 4: Pediatric dentists' "knowledge" data

Question	Answers	No.	%
1. IE of oral origin can be caused by:	Chewing	Yes No	3 1.3% 236 98.7%
	Toothbrushing	Yes No	36 15.1% 203 84.9%
A tooth with deep caries	Yes No	87 36.4% 152 63.6%	
	Gingival abscess	Yes No	160 66.9% 79 33.1%
Invasive dental treatment	Yes No	221 92.5% 18 7.5%	
	Noninvasive dental procedure	Yes No	37 15.5% 202 84.5%
2. In your opinion, which of the following is safe in children at risk of IE in case of permanent teeth?	Vital pulp therapy	77 32.2%	
	Nonvital pulp therapy	14 5.9%	
	Both vital and nonvital are safe	20 8.3%	
	Neither is safe	128 53.6%	
3. In your opinion, which of the following is safe in children at risk of IE in case of primary teeth?	Vital pulp therapy	69 28.9%	
	Nonvital pulp therapy	16 6.7%	
	Both vital and nonvital are safe	14 5.9%	
	Neither is safe	140 58.5%	
4. When should oral foci of infection be eliminated before cardiac surgeries in children at risk IE?	1 month before surgery	105 43.9%	
	1 week before surgery	65 27.2%	
	Less than a week before surgery	20 8.4%	
	Time does not matter	49 20.5%	
5. Whom of the following do you think requires antibiotic prophylaxis?	All children with congenital heart diseases	Yes	86 36.0%
		No	153 64%
	Children WITH rheumatic heart disease	Yes	162 67.8%
		No	77 32.2%
	Children with rheumatic fever WITHOUT rheumatic heart disease	Yes	68 28.5%
		No	171 71.5%
	Children with prosthetic valve	Yes	4 1.7%
		No	235 98.3%
	I do not know	Yes	22 9.2%
		No	217 90.8%

encounter patients at risk of IE at their practice, while nearly two-thirds reported to encounter several patients per year.

Results showed that the frequently discussed oral health issue by most cardiologists (74.6%) was antibiotic intake before invasive procedures. Although this might be the most significant issue from

a cardiologist's perspective, invasive dental procedures are usually a late stage in the process of dental disease, and from a dental perspective, diet counseling, toothbrushing, regular dental checkups, and oral-health and cardiac-health link are also important topics to discuss to prevent oral diseases at first place. Conversely, most North American cardiologists (92%) discussed the link between oral and cardiac health, while age of the first dental visit, diet, importance of oral hygiene and toothbrushing were discussed by 55, 44, and 33%, respectively.¹¹ This may be generally related to a better oral-health knowledge in developed countries compared to developing ones. Interestingly, one investigation showed that parents of children with CHD can be more receptive to oral-health counseling when delivered by the cardiac team and that if cardiologists have told parents that dental caries is related to IE, children with CHD would have had lower caries experience.²² Moreover, knowing the full visual clinical presentations of common oral diseases as gingivitis and tooth decay from early to advanced lesions will enable cardiologists to alert parents at an early stage of disease development where management is less invasive and thus safer. Most cardiologists in the current study agreed that tooth stains (77.5%) and cavities (69%) are signs of dental caries, not knowing that chalky white enamel discolorations (selected by only 11.3%) are also in fact the earliest signs of tooth decay. These data together emphasize the importance of providing oral-health education for cardiologists.

Yet, the current results revealed that few efforts were made by dentists to promote oral health of children with CHD, where only 10.5 and 33.5% reported offering relevant oral-health education for cardiologists and children with heart diseases, respectively. Additionally, only 29.6% of cardiologists reported that oral-health topics were taught in their postgraduates' program, leaving such vulnerable children with risk of oral-health literacy. Thus, it was not surprising that 66.2% of cardiologists reported to encounter IE of oral origin.

Remarkably, 64.8% of cardiologists reported canceling/ delaying a cardiac surgery due to an oral infection and that only 29.6% cardiologists refer for oral-health assessment before cardiac surgeries where 54.9% refer less than 1 month prior to surgery. In North America, 44 and 83% of pediatric cardiologists reported referral for dental assessment before cardiac surgeries or cancellation of a cardiac surgery due to oral disease, respectively.¹¹ In Brazil, Coutinho et al.¹² found that 45% of investigated cardiologists recommended dental assessment before cardiac surgeries. This highlights the need for an active participation of both practitioners once a CHD is diagnosed.

Oral examination is considered a fundamental part of preoperative assessment before cardiac surgeries to prevent IE or prosthetic vascular graft infections.²³ One month is usually recommended to give a chance for completing all necessary dental treatments and to give ambient time for healing and prevention of reinfection should any oral surgeries are to be performed.²³ Additionally, a 2-week interval is recommended between several prophylaxis episodes.⁴ ESC urged that all potential foci of infection should be eradicated >2 weeks before implanting an intracardiac foreign material.⁷ Others even recommended dental referral 3 months before elective cardiac surgeries to optimize treatment plans without putting much pressure on patients or dentists.²⁴

Antibiotic prophylaxis before dental procedures in patients at risk for IE is still a point of debate. Some recommend starting antibiotics just 30–60 minutes before dental procedures,^{6,7,25} while others argue that such regimen may promote antibiotic resistance and that the risks outweigh the benefits.^{26,27} In the



present study, 60.6% of cardiologists prescribed antibiotic as a single dose 30–60 minutes before dental procedures as well as a single dose right after the procedure which is not consistent with international guidelines. The clinical experience of cardiologists may judge those children to have different immunological status, level of oral hygiene, as well as local drugs that may have different potency which may account for the national variation in practices of surveyed cardiologists. Poor oral hygiene is regarded a significant factor when considering antibiotic prophylaxis.^{28,29} Some authors stated that antibiotic prophylaxis should be considered regardless of the patients' risk of IE especially in those with poor oral hygiene.²⁹ While ESC guidelines identified clinical judgment of professionals as a significant factor in patients' management along with current evidence,⁷ others stated that IE has a multifactorial origin; bacteremia is the initial requirement, but other factors should be considered as the oral-health status, oral hygiene, and the individual's defense mechanisms.³⁰

Although most surveyed cardiologists and dentists reported to follow guidelines that are similar in their recommendations (ESC and AHA, respectively), 65.7% of dentists refer to a pediatric cardiologist before dental treatment, 53.1% rely on cardiologists to identify children at risk of IE or to prescribe the needed antibiotic prophylaxis (71.5%). This may be due to lack of dentists' knowledge that allows proper diagnosis of the patient condition and thus the need for antibiotics and/or unreliable history reporting by parents. Moreover, as many cardiologists may prescribe antibiotics in a way that differs from that in guidelines (before as well as after dental procedures), dentists may find that referral for a cardiologist is the best practice that will guarantee the patient safety. In Japan, 60% of general dentists referred for a physician to identify risk for IE and dental procedures that may promote that risk, whereas only 20% refer to guidelines. This was related to a possible low promotion of guidelines among dentists or difficulty in discriminating systemic conditions associated with IE. Thus, it was recommended to increase dentists' awareness and understanding of such guidelines since IE is a life-threatening condition.¹⁰

The current results showed that mostly both practitioners agreed on the most common causes for IE from an oral origin (Tables 2 and 4). Few also regarded noninvasive dental procedures, like toothbrushing and chewing as potential sources. It was reported that although invasive dental procedures introduce oral bacteria to the bloodstream, the cumulative effect of prolonged bacteremia from chewing, brushing, and flossing may have a greater risk of IE which cannot be prevented by antibiotics.³¹ One study reported that bacteremia has a 3- to 4-fold greater risk of detection after toothbrushing in healthy adults with poor oral hygiene and that incidence of bacteremia was directly related to oral bacterial load and gingival inflammation severity.²

An important, however rare, and usually unnoticed source of bacteremia is asymptomatic decayed teeth. Few reports described asymptomatic decayed primary or permanent teeth as a source of unexplained fever in healthy or ill individuals due to bacteremia from an asymptomatic chronic abscess related to the decayed teeth.^{32,33} This highlights the need for dental treatment even in the absence of complaint especially in individuals at risk of IE.

Results also revealed that most pediatric dentists regarded vital and nonvital pulp therapies in primary (58.5%) and permanent (53.6%) teeth as unsafe in children at risk of IE while the rest of dentists reported that vital pulp therapy is safer than nonvital pulp therapy in both dentitions.

The NHS stated that dental management must be radical to eliminate any possible oral foci of infection and recommended against any vital or nonvital pulp therapies in primary teeth as well as any biological caries management approaches.¹⁶ This was supported by other authors who recommended that extraction is preferred over pulp therapy especially in primary teeth.¹⁷ On the other hand, management of decayed permanent teeth was left for the dentists' evaluation of their prognosis considering the patients' risk of IE.^{16,17}

However, a survey of American Association of People with Disabilities members showed that most pediatric dentists preferred extraction of primary teeth with irreversible pulpitis, while pulpotomy was preferred for teeth with reversible pulpitis in patients with CHD.³⁴ This may be related to the high success rates of pulpotomy of primary teeth, given that a good case selection is achieved, and to spare the child widespread tooth extractions in case of multiple decayed teeth which may have adverse outcomes on child's mastication, growth, speech, and psychological development.

Up to the authors' knowledge, this survey is the first to assess practices and knowledge related to prevention of IE of oral origin in children in Egypt. A limitation of the current study was the absence of formal databases of pediatric dentists or pediatric cardiologists/cardiac surgeons practicing in Egypt. Thus, precise identification of the counts, emails, or contacts of both practitioners could not be achieved. Consequently, direct messaging as well as social media platforms were used to disseminate and circulate both surveys, and thus, an accurate response rate could not be estimated.

CONCLUSIONS

The current study identifies disparities and pitfalls in management of children with heart diseases, which if appropriately addressed by pediatric dentists and cardiologists may reduce the risk of IE from an oral origin. Specially formulated guidelines are needed regarding IE prevention based on national epidemiology to avoid conflicts between cardiologists and other health-care providers. Oral-health education of pediatric cardiologists and children at risk of IE is strongly needed due to the high oral disease burden and health-related risks.

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