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ORIGINAL RESEARCH

Impact of Mandatory Preoperative Dental Screening on Infective Endocarditis in Patients Undergoing Surgical Valve Replacement

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ABSTRACT

BACKGROUND Guidelines recommend preoperative dental screening (PDS) prior to surgical valve replacement (SVR) to reduce risk of prosthetic valve infective endocarditis (IE). Nonetheless, limited data support these recommendations.

OBJECTIVES The objective of this study was to investigate the impact of mandatory preoperative dental screening (MPDS) on risk of IE in patients undergoing SVR.

METHODS Patients undergoing SVR in Western Denmark from 2020 to 2022 were included in this observational study. Patients were considered based on 2 applied PDS practices: MPDS, and no routine referral to preoperative dental screening (NPDS). Data were retrieved from Danish registries and adjudicated using medical records. The primary endpoint was incidence of IE. Secondary endpoints were all-cause mortality, and the composite endpoint of IE and all-cause mortality.

RESULTS A total of 1,207 patients undergoing SVR were included. Of 805 patients in the MPDS, 93% (n = 751) underwent subsequent PDS, compared to 5% (n = 21) among 402 patients in the NPDS. Patients in the MPDS were older with higher rates of coexisting comorbidities. During a median follow-up of 2.6 years, 3.3% (n = 40) developed IE. The IE incidence rate for MPDS and NPDS was 16.0 (95% CI: 11.3-22.6) and 8.0 (95% CI: 4.0-16.0) per 1,000 person-years, respectively. Mortality rate was higher in MPDS (2-year mortality: 6.2% (95% CI: 4.7-8.1) vs 2.8% (95% CI: 1.6-5.0). Differences in IE rates, all-cause mortality but not composite endpoint were abolished in 370 propensity score-matched patients.

CONCLUSIONS Risk of IE was low regardless of PDS practice. MPDS prior to surgery did not alter the risk of IE or all-cause mortality in patients undergoing SVR in Denmark. (JACC Adv. 2025;4:101571) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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ABBREVIATIONS AND ACRONYMS

CIED = cardiac implantable electronic device

IE = infective endocarditis

MPDS = mandatory preoperative dental screening

NPDS = no routine referral to preoperative dental screening

PDS = preoperative dental screening

SVR = surgical valve replacement

TAVI = transcatheter aortic valve implantation

Infective endocarditis (IE) is associated with high mortality and morbidity.[1] Patients with a prosthetic left-sided valve are considered at high-risk for developing IE with a yearly incidence rate of 1% in tertiary centers,[2] affecting about 5% patients over 10 years.[3] Consequently, European Society of Cardiology[4] and American Heart Association[5] guidelines strongly recommend that potential sources of dental sepsis should be eliminated at least 2 weeks prior to implantation of a prosthetic valve, unless the procedure is urgent. These recommendations are not based on randomized trials but mainly based on registries describing the incidence of IE in patients undergoing surgical valve replacement (SVR). Recently, we demonstrated that routine preoperative dental screening (PDS) with subsequent elimination of potential sources of dental sepsis prior to intervention did not alter the risk of IE in patients undergoing transcatheter aortic valve implantation (TAVI). While this procedure is much less invasive than SVR, the approximate risk of IE in these 2 procedures is similar.[6]

In Western Denmark, 3 tertiary centers performing SVR have implemented 2 different dental screening practices during the last years. One consisting of mandatory preoperative dental screening (MPDS) with additional elimination of sources of dental sepsis, and another with no routine referral to preoperative dental screening (NPDS).

Thus, the aim of this study was to investigate the impact of different PDS practices on the risk of IE in patients undergoing SVR in Western Denmark.

METHODS

STUDY DESIGN, POPULATION, AND DATA SOURCE. This population-based observational study reflects the population of Western Denmark, encompassing 3 out of 5 Danish regions (North, Central, and South), which together represent over 50% of the total Danish population (DK statistic). Western Denmark includes 3 of the 4 national tertiary centers performing SVR, Aarhus University Hospital, Aalborg University Hospital, and Odense University Hospital. While Aalborg and Odense have performed MPDS for decades, Aarhus University Hospital has not performed PDS during the last 4 years.

We included all patients undergoing left-sided SVR, either aortic valve replacement, mitral valve replacement, or a combination of both, from January 2020 to April 2022, excluding those with a history of cardiac surgery, acute surgery including active IE, or with a history of IE <90 days. Patients were categorized in 2 groups according to institutions based on PDS protocols. Group one, treated at Aarhus University Hospital, was not subjected to a routine PDS protocol (NPDS group). Group 2, treated at Aalborg/Odense University Hospital, was subject to MPDS (MPDS group). The frequency of PDS implementation in each group will be detailed.

PDS as well as oral surgical procedures were considered if they occurred within 6 months prior to SVR and up to 1 month following the procedure. Prophylactic antibiotics were not administered prior to PDS unless patients underwent tooth extraction or other oral surgical procedures, PDS was performed following SVR, or they were at high risk of IE. All patients were followed until death or the end of the follow-up period in November 2023, whichever came first. Detailed information on data source is presented in the supplemental material, page 3. IE was coded according to International Classification of Diseases-10 criteria (I011, I33 I376, I38, I39, I423, Z035D). All cases of IE and new cardiac implantable electronic devices (CIEDs) were further adjudicated by review of medical records.

OUTCOMES AND MISSING DATA

We performed an analysis of the entire cohort, and a propensity score-matched group. The primary endpoint was IE. Secondary endpoints were all-cause mortality, composite endpoint of all-cause mortality and IE, and IE in the subset of patients who underwent oral surgical procedure. Diagnosis and procedure codes are reported in the Supplemental Table 1.

To clarify the completeness of data set, missing data are reported in all tables if any.

STATISTICAL ANALYSIS. Continuous data were presented as mean ± SD if normally distributed and as median (IQR) if nonnormal distributed. Categorical data were presented as proportions. Intergroup

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comparisons were done with Student's *t*-tests or Wilcoxon rank-sum test, chi-square test, or Fisher exact test, as appropriate.

Time-to-death was calculated as the time from the date of left-sided SVR to the date of death from all-causes. Time-to-event analysis included Kaplan-Meier plots, log-rank tests, and Cox Proportional Hazards regression. Proportional hazard assumptions were assessed with Schoenfeld residuals and reported if not satisfied. A multivariable model was created to evaluate the association between dental screening practice and outcome, adjusting for predefined confounders (sex, age, previous IE ≥90 days, CIEDs, new devices implanted 30 days after SVR, tooth extraction prior SVR, and type of valve replacement). Complete case analyses were performed.

Incidence rates were calculated using a method based on the Poisson distribution, and comparisons between incidence rates were performed within a Poisson regression framework. The number needed to prevent an IE case was calculated regardless of statistical significance, using the number needed to treat formula, defined as the reciprocal of the absolute risk reduction, which represents the difference in event rates between the treatment and control groups. Propensity score-matching was used to balance baseline characteristics between the 3 counties (Odense & Aalborg vs Aarhus), with a score generated in 10 categories and a caliper of 0.2.[7] Matching method is described in detail in Supplemental Table 2. Point estimates were supplemented by 95% CIs when appropriate, and a *P* value of <0.05 was considered significant. Statistical analysis was performed with STATA/IC18 (StataCorp).

RESULTS

We identified 1,528 patients who underwent left-sided SVR in Western Denmark from January 2020 to July 2022. After excluding patients with a history of cardiac surgery (n = 62), acute surgery including active IE (n = 248), or with a history of IE <90 days (n = 11), we ended up with 1,207 patients, with 805 in the MPDS group (Aalborg University Hospital: 256, Odense University Hospital: 549); and 402 in the NPDS group (Aarhus University Hospital) (Supplemental Figure 1). No patients were lost during follow-up. After thorough investigation of medical records, the dataset was 100% complete with no missing values. Compared to those in the NPDS group, patients in MPDS group were older, more symptomatic, and presented with higher comorbidity burden resulting in a higher EuroSCOREII (1.8% (IQR: 1.1%-3.0%) vs 1.2% (IQR: 0.8%-2.1%), *P* < 0.01) (**Table 1**). Most patients (n = 1,004) underwent SVR with bioprosthetic valves with no difference between groups. However, the proportion of concomitant procedures in addition to SVR varied between groups. The MPDS group had more commonly performed additional coronary bypass graft procedure (22.7%) than those in the NPDS group (14.2%), *P* < 0.01 (**Table 2**). Furthermore, the MPDS group had more frequently additional ascending aorta replacement (15.7%) vs the NPDS group (11.2%), *P* = 0.04).

In the MPDS group, 93% (n = 751) underwent PDS (median 17 [IQR: 7-36] days prior to SVR) compared to 5% (n = 21) in the NPDS (median 41 [IQR: 32-101] days). These differences resulted in a significantly higher rate of oral surgical procedures, in the MPDS group compared to the NPDS group (27.6% [n = 222] vs 2.2% [n = 9], *P* < 0.01) (Supplemental Table 4). Of these, tooth extractions specifically were performed in 27.1% (n = 218) vs 2.0% (n = 8), respectively, *P* < 0.01. All 3 centers uniformly administered a single dose of perioperative antibiotic prophylaxis, comprising Gentamicin according to weight and single dose cefuroxime 1.5 g.

OUTCOME. During a median follow-up of 2.6 years (IQR: 1.9-3.2 years), we identified 67 cases registered as IE (MPDS = 58, NPDS = 9). Following medical record review, a total of 27 cases initially registered as IE were subsequently not IE, comprising 26 cases in the MPDS group and 1 in the NPDS group. The most common reason for excluding IE as a diagnosis in our study was the inclusion of "Examination for IE" code, which are routinely employed in patients undergoing dental screening or oral surgery prior to SVR. Consequently, 13 patients underwent PDS as routine IE examinations without specific clinical indications. Other reasons for dismissing IE were mediastinitis (n = 2), fever or suspicion of IE (n = 7), and cases with bacteremia from another focus, negative trans-esophageal echocardiography, and negative positron emission tomography/computed tomography (n = 5).

This resulted in 40 (3.3%) verified IE cases, with 32 in the MPDS group and 8 in the NPDS group. Additionally, there were 63 (5.2%) patient deaths, detailed in Supplemental Table 3. The IE incidence rate was 13.3 (95% CI: 9.6-17.9) per 1,000 person-years with no statistically significant differences between MPDS and NPDS groups 16.0 (95% CI: 11.3-22.6) vs 8.0 (95% CI: 4.0-16.0) (*P* = 0.07) per 1,000 person-years (**Figure 1A**, Supplemental Table 4). The 2-year risk estimation of IE was 3.5% (95% CI: 2.4%-5.1%) in MPDS and 1.9% (95% CI: 0.9%-4.0%) in NPDS. Compared to those with MPDS, survival was higher in

TABLE 1 Baseline Characteristics Unmatched and Propensity Score-Matched Cohort

	Entire Cohort			Propensity Score-Matched Cohort		
	Mandatory Preoperative Dental Screening (n = 805)	No Preoperative Dental Screening (n = 402)	*P* Value	Mandatory Preoperative Dental Screening (n = 370)	No Preoperative Dental Screening (n = 370)	Stand. Diff.
Male	591 (73.4%)	280 (69.7%)	0.17	264 (71.4%)	258 (69.7%)	0.04
Age (y)	68.3 ± 9.8	64.7 ± 11.1	<0.001	65.6 ± 10.9	66.3 ± 9.4	−0.07
Body mass index, (kg/m^2)	28.2 ± 4.9	27.5 ± 4.6	0.021	28.3 ± 5.1	27.5 ± 4.5	0.17
Body surface area (m^2)	2.0 ± 0.2	2.0 ± 0.2	0.62	2.0 ± 0.2	2.0 ± 0.2	0.07
EuroSCORE II, %	1.8 (1.1-3.0)	1.2 (0.8-2.1)	<0.001	1.4 (0.9-2.4)	1.3 (0.8-2.2)	0.11
0-4	684 (85.0%)	370 (92.0%)		330 (89.2%)	338 (91.4%)	
4-8	100 (12.4%)	28 (7.0%)	0.002	30 (8.1%)	28 (7.6%)	0.12
≥8	21 (2.6%)	4 (1.0%)		10 (2.7%)	4 (1.1%)	
Left ventricular ejection fraction (%)	54 (9)	55 (9)	0.032	55 (10)	55 (9)	−0.06
NYHA classification, I/II/III/IV	33/525/242/5	46/255/100/1	<0.001	32/243/94/1	30/244/95/1	0.02
Previous endocarditis,	12 (1.5%)	4 (1.0%)	0.48	5 (1.4%)	4 (1.1%)	0.02
Hypertension	538 (66.8%)	210 (52.2%)	<0.001	231 (62.4%)	201 (54.3%)	0.17
Atrial fibrillation	208 (25.8%)	90 (22.4%)	0.19	73 (19.7%)	87 (23.5%)	0.09
Diabetes mellitus	94 (11.7%)	24 (6.0%)	0.002	24 (6.5%)	23 (6.2%)	0.01
Dyslipidemia	449 (55.8%)	187 (46.5%)	0.002	185 (50.0%)	178 (48.1%)	0.04
Peripheral vascular disease	37 (4.6%)	6 (1.5%)	0.006	7 (1.9%)	6 (1.6%)	0.02
Smoking status, previous/active	260/193	89/74	<0.001	88/65	87/72	0.05
Creatinine clearance (ml/min)	90 ± 44	98 ± 35	0.001	96 ± 53.2	96 ± 32.1	0.003
Chronic obstructive pulmonary disease	100 (12.4%)	33 (8.2%)	0.028	41 (11.1%)	34 (9.2%)	0.06
Cardiac implantable electronic device	33 (4.1%)	9 (2.2%)	0.06	11 (3.0%)	9 (2.4%)	0.03
Valve type						
Bioprosthetic	672 (83.5%)	332 (82.6%)	0.70	307 (83.0%)	312 (84.3%)	0.04
Mechanical	133 (16.5%)	70 (17.4%)		63 (17.0%)	58 (15.7%)	
Number of procedures for current cardiac surgery						
1	386 (48.0%)	231 (57.5%)	0.008	209 (56.5%)	206 (55.7%)	0.03
2	309 (38.4%)	126 (31.3%)		122 (33.0%)	122 (33%)	
≥3	110 (13.7%)	45 (11.2%)		39 (10.5%)	42 (11.4%)	

Values are n (%), mean ± SD, or median (IQR). *P* values test for differences between groups by using Student's *t*-test for continuous variables and the chi-square test for categorical variables. Standardized differences are reported for comparisons in the matched population.

IQR = interquartile range; NYHA = New York Heart Association.

patients undergoing NPDS, with an estimated 2-year survival of 97.2% (95% CI: 95.0%-98.4%) vs 93.8% (95% CI: 91.9%-95.3%), respectively, $P = 0.02$ (Figure 1C). The 2-year composite endpoint of death or IE was 9.0% (95% CI: 7.1%-11.2%) vs 4.5% (95% CI: 2.8%-7.1%), $P < 0.01$.

Prior to surgery, 3.5% (n = 42) had a CIED and during follow-up 9.7% (n = 113) had de novo implanted a CIED with no difference between groups (9.9% [n = 74] in the MPDS and 9.9% [n = 39] in the NPDS, $P = 0.85$). The majority of devices, accounting for 76.1% (n = 86), were implanted due to atrioventricular blockage, some of these the consequence of IE-related reoperations.

ASSOCIATION MODEL. In a univariable model, baseline characteristics associated with development of IE were a history of previous endocarditis and new CIED (Table 3). In our multivariable analysis, after adjusting for confounders, a history of previous IE and new CIED remained as the only variables associated with risk of IE.

MICROBIOLOGY. The most common microorganisms contributing to IE were *Enterococci* occurring in 28% (n = 11) of IE cases. Other species leading to IE were *Staphylococci* 25% (n = 10), and *Cutibacterium* spp.13% (n = 5), while only 5% (n = 2) were caused by *Streptococci* (Table 4).

In the subset of patients with tooth extraction, 8 (3.5%) subsequently developed IE, none linked to oral foci (*Enterococcus faecalis* [n = 2], *Staphylococcus epidermidis* [n = 1], *Staphylococcus aureus* [n = 1] *Staphylococcus haemolyticus* [n = 1], *Cutibacterium acnes* (n = 1), *Candida albicans* [n = 1], negative culture [n = 1]).

PROPENSITY SCORE-MATCHED POPULATION. A total of 370 patients with MPDS were matched 1:1 with NPDS. Table 1 shows baseline characteristics for matched patients, with no clinically significant

TABLE 2 Operative Characteristics for Unmatched and Propensity Score-Matched Cohort

	Entire Cohort			Propensity Score-Matched Cohort		
	Mandatory Preoperative Dental Screening (n = 805)	No Preoperative Dental Screening (n = 402)	*P* Value	Mandatory Preoperative Dental Screening (n = 370)	No Preoperative Dental Screening (n = 370)	*P* Value
Aortic valve replacement	733 (91.1%)	360 (89.6%)		346 (93.5)	329 (88.9%)	0.07
Bioprosthetic	612 (76.4%)	296 (82.2%)	0.60	289 (83.5%)	276 (83.9%)	0.90
Mechanical	121 (15.0%)	64 (17.8%)		57 (16.5%)	53 (16.1%)	
Isolated AVR	364 (45.2%)	222 (61.7%)	0.73	202 (58.4%)	197 (59.9%)	0.69
Mitral repair	10 (1.2%)	3 (0.8%)	0.45	3 (0.9%)	3 (0.9%)	0.95
Mitral valve replacement	56 (7.0%)	36 (9.0%)		19 (5.1%)	35 (9.6%)	
Bioprosthetic	47 (83.9%)	30 (83.3%)	0.94	15 (79.0%)	30 (85.7%)	0.52
Mechanical	9 (16.1%)	6 (16.7%)		4 (21.1%)	5 (14.3%)	0.52
Isolated MVR	17 (30.4%)	8 (22.2%)	0.46	4 (57.1%)	8 (88.9%)	0.15
Aortic and mitral valve replacement	16 (2.0%)	6 (1.5%)		5 (1.4%)	6 (1.6%)	
Bioprosthetic	13 (81.3)	6 (100%)	0.25	3 (60.0%)	0 (0%)	0.09
Mechanical	3 (18.8%)	0 (0%)		2 (40.0%)	6 (100%)	
Coronary artery bypass grafting	184 (22.9%)	57 (14.2%)	<0.001	61 (16.5%)	56 (15.1%)	0.61
Ascending aorta replacement	126 (15.7%)	45 (11.2%)	0.036	62 (16.8%)	41 (11.1%)	0.026
Root replacement	29 (3.6%)	15 (3.7%)	0.91	12 (3.2%)	12 (3.2%)	0.99
Tricuspid repair	19 (2.4%)	15 (3.7%)	0.18	5 (1.4%)	14 (3.8%)	0.036
Other procedures incl. antiarrhythmic procedures	160 (19.9%)	77 (19.2%)	0.76	58 (15.7%)	76 (20.5%)	0.09

Values are n (%). *P* values test for differences between groups by using Student's *t*-test for continuous variables and the chi-square test for categorical variables.
AVR = aortic valve replacement; MVR = mitral valve replacement.

differences between groups. Event are reported in Supplemental Table 4. There was no diference in individual endpoints at 2-year follow-up between the 2 groups (IE: MPDS 3.5% vs NPDS 2.1%, $P = 0.12$; death: MPDS 4.5% vs NPDS 2.8%, $P = 0.14$) (**Central Illustration**). While no significant difference was found in all-cause mortality (**Figure 1B**) or IE (**Figure 1D**) between groups, patients with MPDS had a higher rate of the composite endpoint at 2 years compared to those with NPDS (7.5% (95% CI: 5.2%-10.8%) vs 4.6% (95% CI: 2.8%-7.4%), respectively; $P = 0.03$) (**Figure 1F**).

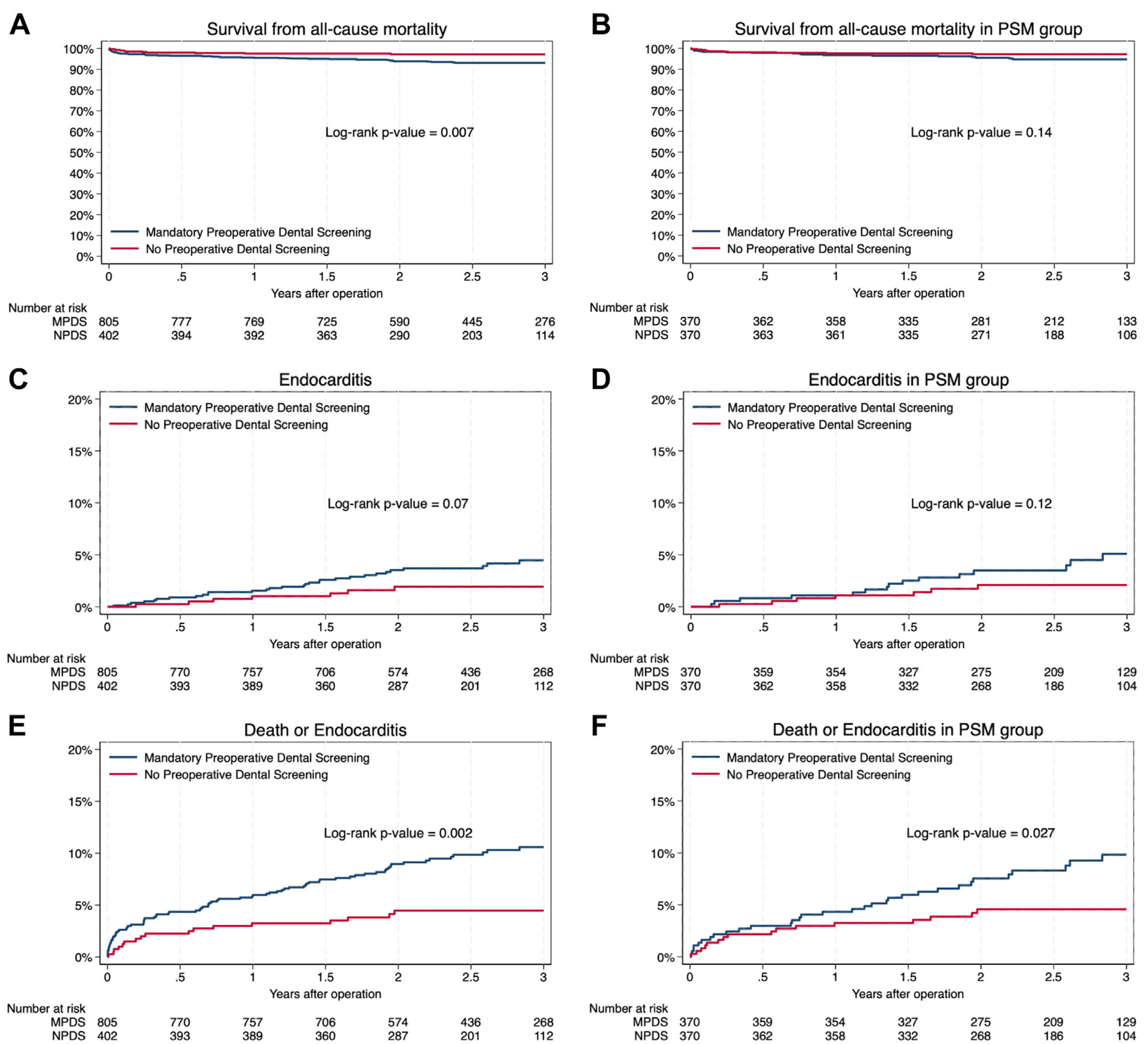
DISCUSSION

This comprehensive nationwide registry study comparing 2 practices of different PDS, we found that MPDS, with subsequent elimination of potential sources of dental sepsis, failed to reduced risk of IE after SVR. The number of events in our analysis were limited; however, this is the first study examining different PDS practices in patients undergoing SVR.

The European Society of Cardiology[4] and American Heart Association/American College of Cardiology[5] advocate for PDS to eliminate potential dental infection sources before cardiac valve surgery, aiming to reduce prosthetic valve endocarditis, primarily caused by *Streptococci*. The interplay between oral health and the outcomes of cardiac valve procedures was initially proposed a century ago by Lewis and Grant,[8] which gained further support a decade later, after Okell and Elliot showed that 75% of individuals experienced transient bacteremia subsequent to tooth extraction.[9]

Two decades ago Hakeberg et al[10] challenged this perspective, finding in their study of 253 Swedish patients undergoing valve surgery, a nonsignificant elevation in the incidence of sepsis/endocarditis among patients who underwent dental treatment before surgery, compared to those who had their oral health evaluated after surgery. Recently, we demonstrated that MPDS with eradication of potential dental sources of infection did not alter the risk of IE in patients undergoing TAVI. We considered that this partially could be the consequence of the less invasive nature of TAVI and that the Danish population might have an a priori good dental hygiene. Still, 22% of patients in the MPDS group underwent oral surgical procedures and 15% dental extraction prior to TAVI, a rate that nearly doubled in present study (27% for dental extraction and 28% oral surgical procedures). The discrepancy observed in dental extraction rates may attribute to a higher proportion of denture use in patients referred for TAVI but could also be the consequence of lack of standardized dental screening protocols.[11] This situation may lead to the adoption of more aggressive protocols for SVR compared to TAVI, as suggested by our 2 studies. Our current findings,

FIGURE 1 Kaplan-Meier Plot of Primary and Secondary outcomes



Kaplan-Meier plot demonstrating survival from all-cause mortality in the entire cohort (A) and the matched cohort (B). The incidence of infective endocarditis in the entire cohort (C) and the matched cohort (D). The incidence of the combination of endocarditis or all-cause mortality in the entire cohort (E) and the matched cohort (F). MPDS = mandatory preoperative dental screening; NPDS = no routine referral to preoperative dental screening; PSM = propensity score-matched.

consistent with previous research, indicate no significant reduction in postoperative IE risk in patients undergoing MPDS, despite higher dental procedure rates.[12] Although, we recognize that IE pathogens originating from the oral cavity were few. While our observations imply that our previous findings also apply to patients undergoing more invasive interventions as SVR, the high oral surgical procedure rate in the present study could question the good dental status of Danish patients and our previous hypothesis. However the latter may also reflect a possible overcautious PDS approach in open heart surgery,[12] as described by Kolk et al[13] in a comparatively smaller study, where even a cautious protocol led to oral surgery in 75% of cases. Another potential explanation for the unclear effect of MPDS, could be that repeated mechanical manipulations of the periodontium such as tooth brushing, flossing, and

TABLE 3 Cox Proportional Hazards Model Between Covariables and Risk of Infective Endocarditis for Unmatched Cohort at Follow-Up

	Univariable Analyses		Multivariable Analysis	
	HR (95% CI)	*P* Value	HR (95% CI)	*P* Value
No preoperative dental screening	0.59 (0.29-1.20)	0.15	0.55 (0.26-1.19)	0.13
Male	1.87 (0.83-4.24)	0.13	1.99 (0.87-4.53)	0.13
Age, per y	0.99 (0.96-1.01)	0.32	0.98 (0.95-1.00)	0.09
Body mass index, per kg/m^2	1.00 (0.94-1.07)	0.98		
Body surface area, per m^2	1.78 (0.43-7.44)	0.43		
EuroSCORE II, per %	1.01 (0.86-1.18)	0.92		
Left ventricular ejection fraction, per %	0.99 (0.96-1.02)	0.43		
NYHA functional class, I-II vs III-IV	1.59 (0.85-3.00)	0.15		
Previous endocarditis	6.88 (2.11-22.4)	0.001	7.72 (2.29-26.0)	0.001
Hypertension	0.67 (0.36-1.25)	0.21		
Atrial fibrillation	1.04 (0.51-2.13)	0.91		
Diabetes mellitus	1.04 (0.37-2.93)	0.94		
Dyslipidemia	0.66 (0.35-1.24)	0.20		
Peripheral vascular disease	-	-		
Smoking status, no & previous vs active	1.03 (0.49-2.17)	0.93		
Creatinine clearance	1.00 (0.99-1.01)	0.85		
Chronic obstructive pulmonary disease	0.42 (0.10-1.75)	0.24		
Cardiac implantable electronic device	-	-		
New cardiac implantable electronic device[b]	4.01 (2.04-7.88)	<0.001	3.98 (1.99-7.93)	<0.001
Oral surgery prior valve replacement	1.06 (0.49-2.30)	0.89		
Tooth extraction prior valve replacement[a]	1.10 (0.50-2.38)	0.82	0.95 (0.42-2.17)	0.91
Valve replacement				
Aortic valve replacement	1.00	-		
Mitral valve replacement	2.30 (0.96-5.50)	0.06	2.11 (0.86-5.17)	0.10
Aortic and mitral valve replacement	1.73 (0.24-12.7)	0.59	1.89 (0.25-14.14)	0.53

Values are presented as HRs with 95% CIs. *P* values assess the statistical significance of the HR. [a]Proportional hazards assumption for Cox regression was not met [b]Patients with cardiac implantable electronic device prior to surgery are not included.

Abbreviation as in Table 1.

mastication may be more significant contributors to streptococcal-related IE than single invasive dental surgery.[14-16]

In our study, dental screening occurred approximately 2 weeks prior to SVR, which included oral surgery in approximately half of these before surgery. Although some of our patients underwent elimination of potential dental sepsis foci later than the recommended 2 weeks, we were not able to demonstrate this specific threshold as clinically relevant, as no increased risk of IE was seen in those undergoing dental surgery less than 14 days prior to SVR. In line with this a recent smaller-scale study found no difference in the incidence of IE following the updated guidelines in Northern Ireland for oral surgery, accepting dental screening within 2 weeks before surgery.[17] Furthermore, a significant U.S. study involving 8 million people with Commercial/ Medicare-Supplemental insurance identified a notable connection between dental procedures and increased IE risk in high-risk patients, especially within the first 30 days following the procedure, it's crucial to note that this applied only to those not given antibiotic prophylaxis.[18]

In addition, in our study CIED emerged as a notable risk factor. Although the association between CIED and IE is well-established due to the inherent risks linked to the device and leads,[19,20] multiple CIEDs in our cohort were implanted after IE-related cardiac surgery. It is thus also possible that the link between CIED and IE is correlational rather than causal. None of the patients who had a CIED implanted prior to the SVR developed IE. While the observations by Lewis and Grant[8] implicated streptococcal species as a cause of IE from dental foci, recent papers have emerged demonstrating that also *Enterococci* species form part of the oral flora of contemporary patients with the potential to spread hematogenic from dental foci.[21,22] It is thus interesting that the present study revealed few *Streptococci* IE cases but one-third of IE cases attributed to *Enterococci* species. While *Enterococci* can occasionally be part of the oral flora,

TABLE 4 Distribution of Endocarditis Cases by Bacterial Type Depending on Dental Screening Group for Entire and Propensity Score-Matched Population

	Entire Cohort			Propensity Score-Matched Cohort	
	Total (n = 40)	Mandatory Preoperative Dental Screening (n = 30)	No Preoperative Dental Screening (n = 10)	Mandatory Preoperative Dental Screening (n = 16)	No Preoperative Dental Screening (n = 8)
Candida albicans	1 (2.5%)	1 (3.3%)	0	0	0
Enterococcus facium	1 (2.5%)	1 (3.3%)	0	1 (6.25%)	0
Enterococcus faecalis	10 (25%)	5 (16.7%)	5 (50%)	2 (12.5%)	4 (50%)
Neisseria species	1 (2.5%)	1 (3.3%)	0	0	0
Cutibacterium acnes	4 (10%)	3 (10%)	1 (10%)	1 (6.25%)	0
Cutibacterium avidum	1 (2.5%)	1 (3.3%)	0	1 (6.25%)	0
Pseudomonas aeruginosa	1 (2.5%)	1 (3.3%)	0	0	0
Staphyloccocus aureus	6 (15%)	5 (16.7%)	1 (10%)	2 (12.5%)	1 (12.5%)
Staphyloccocus epidermidis	3 (7.5%)	3 (10%)	0	3 (18.75%)	0
Staphylococcus haemolyticus	1 (2.5%)	1 (3.3%)	0	0	0
Streptococcus mitis	2 (5%)	1 (3.3%)	1 (10%)	1 (6.25%)	1 (12.5%)
Negative culture	9 (22.5%)	7 (23.3%)	2 (20%)	5 (31.25%)	2 (25%)

Values are n (%).

the majority of *Enterococci* IE cases are likely associated with urogenital and intestinal origins, especially in the elderly. Even if enterococcal infections were presumed to originate from the oral cavity, our findings suggest that MPDS may have a limited effect on reducing enterococcal IE. The role of the oral cavity in enterococcal IE has yet to be fully understood.

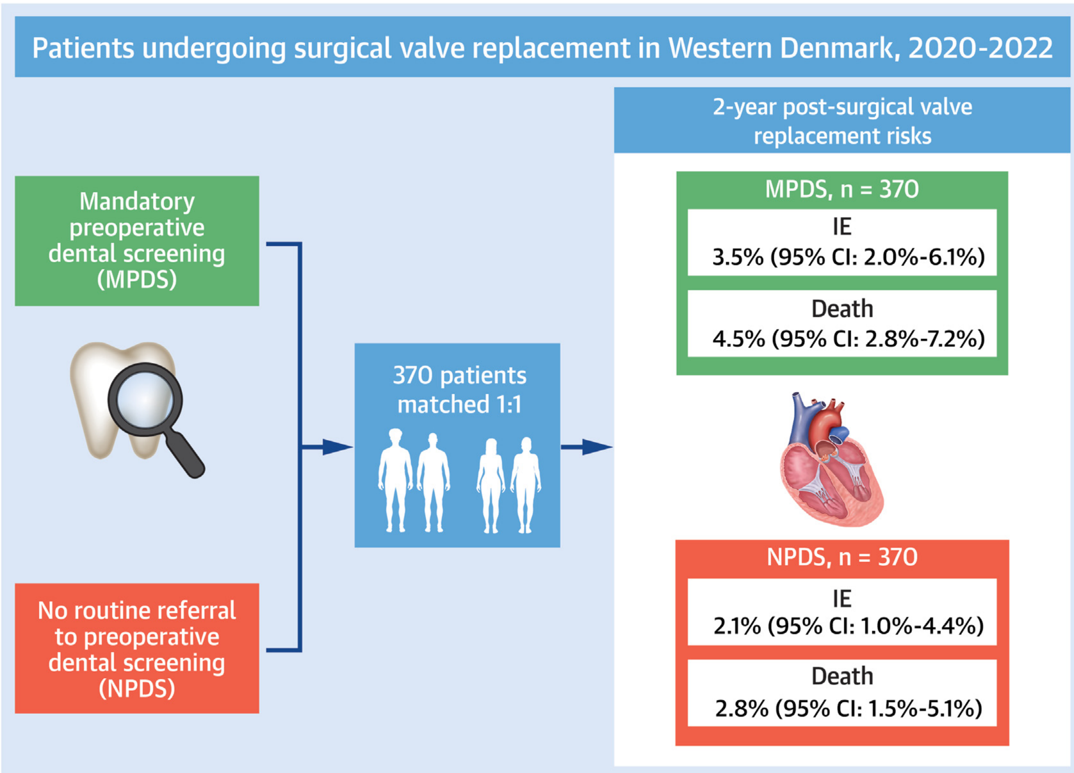
Although our study shows no substantial link between MPDS, dental extraction, and postoperative IE risk in patients undergoing SVR in Western Denmark, the traditionally strong emphasis on oral health in Denmark must be considered. We believe that the low risk of IE in patients with high-IE risk undergoing dental procedures under relevant antibiotic prophylaxis indicates that dental surgery can be performed safely after cardiac surgery and may contribute to the lack of association between MPDS with elimination of potential dental sepsis foci in our study. This suggests that the significance of MPDS may vary in regions with suboptimal oral health. Consequently, it is plausible that certain patients with poor dental health could benefit from PDS. Thus, future research on in this important topic should be encouraged.

STUDY LIMITATIONS. We acknowledge that there are various limitations present within this study. These limitations include the nonrandomized design, unmeasured confounders, and selection bias. We believe the latter may be limited given that the choice of PDS reflects differences in institutional practice. The categorization into MPDS and NPDS groups reflects these practices, introducing a confounding variable, despite the uniform antibiotic protocol across all centers. Although a directed acyclic graph was not applied, we prioritized predefined clinical variables aligned with established risk models,[23] considering the size of the cohort and number of events.

This complexity hinders our ability to distinctly discern the impacts attributable to the dental screening procedure from those related to hospital practices, including potential variations in antibiotic regimens. Consequently, differences may not be solely attributable to the effects of MPDS. Although we do not have data on the type of dental screening procedure approach, types of oral pathology identified, or dental surgical procedures performed by our institutions, Rao et al were not able to demonstrate that different approaches lead to a different rate of IE.[24] Furthermore, this is an exclusive Danish study, and therefore, the findings and conclusions may not necessarily be applicable to other settings.

The Kaplan-Meier method might overestimate IE incidence as it does not account for competing risks like mortality. Thus, we also examined a combined endpoint of IE and death. Finally, given the limited number of IE events, caution is advised in interpreting the models. PDS's protective capability against IE is limited to oral pathogens, a notable limitation as

CENTRAL ILLUSTRATION Impact of Mandatory Preoperative Dental Screening on Infective Endocarditis in Patients Undergoing Surgical Valve Replacement



Krasniqi L, et al. JACC Adv. 2025;4(2):101571.

While there was no diference in individual endpoints at 2-year follow-up between groups (infective endocarditis: mandatory preoperative dental screening 3.5% vs no routine referral to preoperative dental screening 2.1%, $P = 0.12$; death: mandatory preoperative dental screening 4.5% vs no routine referral to preoperative dental screening 2.8%, $P = 0.14$), patients with mandatory preoperative dental screening had a higher rate of the composite endpoint at 2 years compared to those with no routine referral to preoperative dental screening (mandatory preoperative dental screening 7.5% vs no routine referral to preoperative dental screening 4.6%, $P = 0.027$). IE = infective endocarditis.

few cases were attributable to oral sources in our study. Due to low event numbers, excluding nonoral pathogen IE cases from analysis is likely not feasible.

Our incidence rate exceeded those previously reported in Denmark;[25] however, we uniquely incorporated adjudicated cases which includes cases with suspected IE, and more importantly exclusively encompassed patients undergoing SVR. While the low incidence of IE in our study suggests an underpowered analysis for assessing the impact of dental screening on IE rates, it is noteworthy that the crude number needed to treat was paradoxically increased with PDS and approximately 50. This indicates that every 50 patients undergoing MPDS, there is an additional case of IE compared to those not receiving PDS. We hypothesize that this may be attributed to notable differences in patient selection criteria for SVR across groups, leading to a higher albeit not statistically significant risk of IE in the MPDS group.

Lastly, our study lacks detailed data on after oral surgical procedures and long-term quality of life. Considering the nature of PDS, we believe future studies should be encouraged to extend beyond IE rates and to also include potential deleterious consequences of MPDS.

CONCLUSIONS

Mandatory PDS followed by the removal of dental sepsis sources was not associated with reduced risk of

IE or all-cause mortality in patients undergoing left-sided SVR when compared to targeted screening. In this Danish analysis, prevalence of pathogens from the oral cavity was very low, limiting an additional impact of PDS.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: In patients undergoing surgical valve replacement, mandatory preoperative dental screening which most often includes dental extraction did not reduce the risk of infective endocarditis compared to patients with no routine referral preoperative dental screening.

TRANSLATIONAL OUTLOOK: Future studies should not only to focus on risk of infective endocarditis but also to include potential deleterious consequences of mandatory preoperative dental screening.

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KEY WORDS infectious endocarditis, preoperative dental screening, valve replacement

APPENDIX For the Data Source and STROBE Statement as well as supplemental tables, and a figure, please see the online version of this paper.