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a quality improvement study

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Preoperative oral hygiene recommendation before open-heart surgery: patients' adherence and reduction of infections: a quality improvement study

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ABSTRACT

Aim To implement recommendations for oral hygiene before elective open-heart surgery in a thoracic surgery ward and to evaluate whether the number of patients who needed to be treated with antibiotics postoperatively was reduced.

Background Healthcare systems are challenged to implement initiatives that reduce the development of nosocomial infections, to offer patients a safe and cost-efficient treatment and to reduce the use of antibiotics. Previous interventions have focused on staff behaviour in reducing postoperative infections. In this study, patients were recommended to carry out oral hygiene as recommended in a clinical guideline.

Methods A quasiexperimental design with a control and an intervention group was used. Information on adherence to the recommendation was collected at admission. All medical information and prescriptions of antibiotics were obtained from patients' medical records. Data were reported as intention to treat.

Results Altogether 972 patients (506 controls and 466 interventions) were included in the study. Of the intervention patients, 405 (86.9%, 95% CI 83.3 to 89.8) reported that they had adhered to the oral hygiene recommendation. 64 (12.6%) control patients and 36 (7.7%) in the intervention group (p=0.015) were treated with antibiotics postoperatively.

Conclusions It was feasible to involve patients in a programme for oral hygiene and thereby reduce the number of patients needing antibiotics after open-heart surgery and this might contribute to reducing costs.

INTRODUCTION

Over recent decades hospital-acquired infections have received more attention as they are leading to higher mortality, longer hospitalisation and increased use of healthcare resources. The European Union estimates that approximately 2.6 million new cases occur every year.[1] The technological advances made in the treatment of many diseases and disorders are often undermined by the transmission of infections within healthcare settings, particularly those caused by antimicrobial-resistant, disease-causing microorganisms.[2] Thus, it is a challenge for healthcare systems to implement initiatives that reduce the development of infections and so reduce the use of antibiotics and thus offer patients high-quality care that is safe and cost-efficient.

Open-heart surgery is a major surgical procedure, one that improves functional status, relieves angina and dyspnoea, increases maximal exercise capacity and improves the patient's quality of life.[3] Postoperative infections are still considered to be a serious complication as up to 5% of patients need treatment for major infections after open-heart surgery,[4 5] even though surgery is carried out using antibiotic prophylaxis.[4] Infections increase the use of antibiotics and the risk of development of antimicrobial resistance (AMR), which is widely recognised as a serious threat to global public health. Reducing prescription of antimicrobials, therefore, is one of the most common strategies that have been pursued to reduce AMR, and prescription of antimicrobials is one of the most commonly measured interventions.[6] Another strategy is to reduce the number of nosocomial infections (NI) as they are significant contributors to patient morbidity and mortality. In general, it is estimated that the rate of NIs can be reduced by between 10% and 70% depending on the setting, baseline infection rate or type of infections.[7] Thoracic surgery, mechanical ventilation and/or admission to an intensive care unit are known to increase patients' risk for nosocomial respiratory tract infection.[8] Most NIs acquired following thoracic surgery affect the respiratory tract.[9] Respiratory tract infections increase the mortality rate during hospital stay but also the long-term survival rate.[10] Interventions to prevent infections

have mainly focused on staff behaviour change, particularly in the context of multimodal prevention strategies.[11] However, more studies have documented the effects of involvement of patients in reducing the risk of postoperative infection by adhering to preoperative oral hygiene regimes with toothbrush and/or mouth rinse before planned surgery.[8 12 13] A meta-analysis pooling the results for existing evidence found that the relative risk (RR) of developing a lower respiratory tract infection was 0.54 (95% CI 0.42 to 0.7) based on randomised controlled trial studies including 1677 patients.[14] Based on these findings a Danish Clinical Guideline was published recommending patients to perform systematic oral hygiene, starting at home from 2 days before scheduled surgery, continuing on the morning of surgery and ending on the morning after surgery.[15]

Evidence transfer is a process that helps communicate or convey the results of research or evidence, or brings evidence to the forefront. It is focused on ensuring people are aware of, have access to and understand evidence.[16] In this case to draw on new methods helping patients to understand and prepare for the upcoming surgical procedure and recovery.[17] Through preoperative education healthcare workers provide information to patients to assist them to understand about their surgery, minimise worry and make patients adhere to recommendation. Preadmission interventions with a clear focus on single interventions have the strongest effect in preventing postoperative complications such as infections.[14 18]

Thus, the aim of this study was to implement the recommendation of oral hygiene before open-heart surgery in a thoracic surgical ward and to evaluate whether this could reduce the number of patients who needed to be treated with antibiotics postoperatively.

METHODS

This quality improvement study was carried out at the Department of Thoracic Surgery (DTS), University Hospital of Aalborg, Denmark, and included patients over the age of 18 years admitted for elective open-heart surgery from 1 April 2013 to 31March 2017. All patients consecutively admitted in this period were included. We did not exclude any patients as oral hygiene could benefit patients regardless of linguistic barriers or ethnicity.

Design

We used a quasiexperimental design. Patients admitted from April 2013 to March 2015 were historical control patients and were not instructed to change their oral hygiene behaviour before admission. Patients admitted from April 2015 to the end of March 2017 received information on how and when to start to do oral hygiene before admission. At admission, patients in the oral hygiene group were asked whether oral hygiene had been performed as recommended. If this information was missed at admission patients were contacted by phone after discharge. All medical information was obtained from patients' medical records.

Standard antibiotic prophylaxis

All patients were given gentamicin 5 mg/kg ×1 (maximum 500 mg) and cefuroxime 1.5 g intravenously—preferably at least 30 min before skin incision, to maximise plasma and tissue concentration. Cefuroxime was continued for 48 hours. On the day of the operation cefuroxime was given 3, 8 and 16 hours after initial dose regardless of the duration of the procedure. On the first postoperative day cefuroxime was administered three times (morning, midday and evening). In case of allergies to gentamicin or cefuroxime—vancomycin 1 g ×2 was given along with Ciproxin 600 mg ×2 for 24 hours. The same antibiotic regime was administered whether it was bypass, valve surgery or combined procedures.

There was no change in the department prophylactic antibiotic regime prior to the project and no changes occurred during the project period.

Recommendation for oral hygiene

In the clinical guideline there is the following recommendation: 'Patients who are scheduled for thoracic surgical procedure are strongly recommended to carry out systematic oral hygiene'[15] (p 1). Specifically, patients were recommended to brush their teeth four times a day and to perform mouth rinse four times a day using chlorhexidine gluconate 0.12%—starting 2 days before planned surgery and continuing to 1 day after it.[15]

Implementation of oral hygiene recommendation

The stakeholders of this project were the DTS and the Danish Centre of Clinical Guidelines–Clearinghouse (CFKR). A steering group was established. The members of this group were: the leader of the ward, the leader of the project and the director of CFKR. The steering group appointed a project group that on a day-to-day basis was responsible for the progress of the project and the project group reported to the steering group at least once a month. CFKR provided the project leader for the project and DTS provided a daily project manager. External funding was provided by the Danish Ministry of Health and by the Region North in Denmark, and by CFKR. The project leader was employed at CFKR as CFKR was responsible for managing funding and for reporting the results of the implementation process.

The project manager's responsibilities were collection of data, to facilitate the daily progress of the project, to inform all relevant staff, to check hospital activity lists for eligible patients and to obtain data from patients' medical records.

The project leader's responsibilities were to identify local barriers, and for developing information relevant to patients, relatives, primary healthcare (PHC) staff and hospital staff.

Before admission, all patients received a leaflet informing them of the surgical procedure, how to best

prepare for surgery, how to prevent postoperative complications and average length of stay (LOS). This leaflet had no information about oral hygiene. The project group analysed the recommendation before translating it into information relevant to patients, relatives, PHC staff and hospital staff. Based on this analysis it was decided to inform patients via the existing information leaflet and to develop a website. The website was divided into three domains: 'Information for patients and relatives', 'Information for staff at hospital wards' and 'For people with special interests'. All users of the website had access to all areas via www.kliniskinfo.dk.

Information for patients and relatives

This domain contained information tailored to patients and relatives, but staff in PHC could use the information to support patients regarding the importance of oral hygiene before open-heart surgery.

Information videos for patients and relatives were produced. They explained 'Why increased oral hygiene before open-heart surgery' and the message was presented by a surgeon, and 'How to perform oral hygiene', which was presented by a patient. An information leaflet for patients, giving the same information as in the videos, was produced together with a checklist to report when oral hygiene was performed at home. A reminder service through text messages to mobile phones was available for patients who wished to make use of it. Patients' adherence to the recommendation and the number of patients needing antibiotics on the fifth postoperative day were recorded and summarised for every second month during the first 6 months of the implementation period. Thereafter, data were summarised every 6 months. Six evaluation cycles in total were carried out.

Staff were kept informed during regular staff meetings for allied health staff and medical staff and information was repeated on video and was available on the homepage.

For people with special interests a short resume of the clinical guideline and the full clinical guidelines were available and could be downloaded from the website.

Data from the medical records

The following information was obtained from patients' medical records: type of surgery, perfusion time, comorbidity (chronic obstructive pulmonary disease [COPD], diabetes mellitus [DM]), health behaviour (daily smoking, daily intake of alcohol), body mass index (BMI), prescription of antibiotic on fifth postoperative day and reason for the prescription, and LOS. LOS was measured from admission to discharge even in cases where patients were admitted on a Friday, went home during the weekend and had surgery on Monday or if planned surgery was postponed for organisational reasons.

Statistical analysis

All data were processed in SPSS V.23. Data are presented as intention to treat. Ratio-scaled data are reported as means and SD for normal distributed data. The F-test has been carried out to check for distribution. Otherwise, results are given as frequencies and differences between groups have been checked by x^2 test. A CI of 95% has been calculated for all data. P<0.05 was considered significant.

Power analysis

The number of patients who needed to participate was calculated based on the findings in a study reporting infection rates after coronary artery bypass graft (CABG) surgery performed in 42 hospitals in 13 European countries.[9] Alpha was set to 0.05, beta to 0.2 and the expected reduction in infection rate was 40% based on the findings in meta-analysis.[14] The calculation showed that a total of 918 patients were needed: 459 patients in the control group and 459 in the intervention group. As the hospital performs approximately 230–250 elective open-heart procedures each year it was decided to include all patients having surgery for a period of 2 years in each group.

Patient and public involvement

Patients were not involved in planning this implementation study. Patients have been interviewed about participating their view on the recommendation. This will be published elsewhere.

Ethical consideration

By Danish legislation this project was considered to be quality improvement study and thus it was not necessary to obtain written consent from patients. The study was approved by the local ethical committee and by the Danish Data Protection Agency under file numbers 2008-58-0028/2012-58-0015 and 2015-44.

RESULTS

Altogether 972 patients were admitted for elective open-heart surgery and included in the study. The characteristics of the patients are provided in table 1. No differences were detected between the controls, except for the number of patients having COPD, as significantly more patients in the intervention group (p=0.017) had that diagnosis at admission.

Of the patients in the intervention group, 405 (86.9%, 95% CI 83.3 to 89.8) reported that they had adhered to the oral hygiene recommendation as described. The adherence rates for each of the six cycles were: (1) 90.1%, (2) 89.2%, (3) 83.4%, (4) 85.3%, (5) 87.2% and (6) 86.5%.

There were no differences in adherence to the oral care procedure at home related to gender (p=0.16), age (p=0.65), smoking habits (p=0.84), consumption of alcohol (p=0.75), type of surgery (p=0.41) or BMI (p=0.56).

Significantly fewer patients had been prescribed antibiotics on the fifth postoperative day in the intervention group (p<0.015) compared with the number of patients who had received antibiotics in the control group (table 2). The rates of prescribing antibiotics for each of the six cycles were: (1) 8.4%, (2) 7.3%, (3) 7.9%,

Table 1 Characteristics of patients participating in the study in the control group and intervention group

	Control n=506	Intervention n=466
Gender		
Male % (95% CI)	71.5 (67.5 to 75.4)	72.3 (67.4 to 75.9)
Female % (95% CI)	28.5 (24.5 to 32.4)	27.7 (23.6 to 31.7)
Age (year)		
Mean/SD (95% CI)	67.6/10.9 (66.9 to 68.5)	67.4/10.5 (66.4 to 68.4)
Surgery		
CABG % (95% CI)	38.1 (33.8 to 42.7)	31.5 (27.3 to 35.1)
CABG+valve % (95% CI)	9.7 (7 to 12)	7.7 (5.3 to 10.1)
Valve % (95% CI)	45.6 (41.2 to 49.9)	55.5 (51.0 to 60.0)
Other % (95% CI)	6.6 (4.4 to 8.7)	7.7 (5.3 to 10.1)
Perfusion time (min)		
Mean/SD (95% CI)	116.3/37.4 (112.9 to 119.6)	114.8/42.5 (110.9 to 118.7)
Nutrition, BMI (m^2)		
Mean/SD (95% CI)	27.8/4.7 (27.4 to 28.2)	28.0/5.6 (27.5 to 28.5)
Smokers % (95% CI)	14.7 (11.6 to 17.8)	14.2 (11.0 to 17.4)
Daily intake of alcohol % (95% CI)	5.0 (3.1 to 6.9)	4.9 (2.9 to 6.8)
Diabetes mellitus		
Type I (95% CI)	1.4 (0.4 to 2.4)	1.5 (0.4 to 2.6)
Type II (95% CI)	19.4 (15.9 to 22.8)	18.0 (14.4 to 21.5)
COPD (95% CI)	2.9 (1.4 to 4.3)	6.0 (3.8 to 8.1)
LOS (95% CI)	10.7/7.6 (10.0 to 11.6)	8.6/4.7 (8.1 to 9.0)

BMI, body mass index; CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; LOS, length of stay.

(4) 7.7%, (5) 7.8% and (6) 7.5%. The risk of needing antibiotics on the fifth postoperative day was RR=0.65 (95% CI 0.48 to 0.96) and the number needed to treat (NNT) was 22.0 patients, relative risk reduction (RRR) was 0.52 and the absolute risk reduction (ARR) was 0.042 for patients in the intervention group, and for patients who had adhered to the procedure RR=0.49 (95% CI 0.31 to 0.77) and NNT was 15.9, RRR was 1.01 and ARR was 0.063, compared with patients in the control group.

BMI was higher for those receiving antibiotics, 29.4 (4.9) vs 27.8 (5.1) (p=0.004). Perfusion time was 114.7 (49.5) min for those receiving antibiotics versus 115.6 (38.7) min for non-receivers (p=0.835), and the age for patients receiving antibiotics was 67.7 (10.8) vs 67.4 (10.7) for non-receivers (p=0.803). The LOS was significantly longer for patients receiving antibiotics on the fifth postoperative day, 16.1 (11.7) days vs 8.9 (5.4) days for patients not receiving antibiotics (p=0.000).

Table 2 Number of patients receiving antibiotic on fifth postoperative day, and the reason for prescribing antibiotics

	Control n=506	Intervention n=466
Receiving antibiotic		
On fifth postoperative day (95% CI)	64/12.6% (9.9 to 15.9)	36/7.7% (5.5 to 10.5)
Reason for prescribing antibiotic		
Airway infection (95% CI)	24/4.7% (3.1 to 7.0)	12/2.6% (1.3 to 4.5)
Superficial surgical		
Site infection (95% CI)	19/3.8% (2.3 to 5.8)	14/3.0% (1.5 to 5.0)
Deep surgical site		
Infection (95% CI)	6/1.2% (0.5 to 2.6)	2/0.4% (0.1 to 1.5)
Urinary tract		
Infection (95% CI)	2/0.04% (0 to 0.14)	1/0.02% (0 to 0.12)
Other infections* (95% CI)	13/2.6% (1.4 to 4.4)	4/0.9% (0.2 to 2.2)

*Other infections: endocarditis, pericarditis, chronic infection in the hip, no specific focus for infection, increase in infection parameters.

The prevalence of prescribing antibiotics on the fifth postoperative day was not higher in the group of patients who smoked (p=0.551), had a daily intake of alcohol (p=1.0), had DM (p=1.0) and were diagnosed with COPD (p=1.0).

It was reported that 36 patients were treated for airway infection after surgery. The difference between the control and the intervention group was not significant (p=0.07) (table 2). From the hospital records 17 patients had been treated for a deep sternum infection in the period from 1 March 2013 to the end of March 2017. Eight patients had been undergoing elective open-heart surgery: six patients were in the control group and two patients were in the intervention group (p<0.05) (table 3).

Of the 405 patients who adhered to the recommendation, 25 (6.2%, 95% CI 4.0 to 9.0) received antibiotics on the fifth postoperative day versus 11 (18.0%, 95% CI 9.4 to 30.0) of patients in the intervention group who did not adhere to the recommendation (p<0.012).

DISCUSSION

This study evaluated patients' adherence to recommendation from a clinical guideline recommending preoperative oral hygiene before planned open-heart surgery. The recommendation was implemented to reduce the number of patients developing NI during the hospital stay and needing antibiotics postoperatively.

Evidence-based initiatives to reduce the use of antibiotics and prevent antibacterial resistance have been an issue for healthcare for many years. Governments around the world have been experimenting with different policy interventions, such as regulating where antibiotics can be sold, restricting the use of last-resort antimicrobials and launching public awareness programmes.[6] Despite control efforts, the burden of healthcare-associated infections in Europe is high and leads to around 37 000 deaths each year.[11] In a systematic review, 10 crucial elements for the organisation of effective infection prevention programmes in hospitals were identified: organisation of infection control at the hospital level; bed occupancy, staffing, workload and employment of pool or agency nurses; availability of and ease of access to materials and equipment and optimum ergonomics; appropriate use of guidelines; education and training; auditing, surveillance and feedback; multimodal and multidisciplinary prevention programmes that include behavioural change; engagement of champions; and positive organisational culture.[11] These components comprise manageable and widely applicable ways to reduce healthcare-associated infections and improve patient safety.[11] None of these elements focus on actively involving patients in the prevention of postoperative infections.

In this study the clinical guideline was considered to have been fully implemented as all patients referred for elective open-heart surgery were informed about the importance of systematic oral hygiene before admission to hospital. The challenge was to make patients adhere

Table 3 Reasons for prescribing antibiotics distributed by type of surgery

	CABG n=340		CABG+valve n=85		Valve n=489		Other surgical procedures n=58	
	Cont n=193	Intv n=147	Cont n=49	Intv n=36	Cont n=230	Intv n=259	Cont n=34	Intv n=24
Prescribed antibiotic on fifth postoperative day (95% CI)	33/17.1% (12.1 to 23.2)	16/10.4% (6.4 to 17.1)	9/18.4% (8.8 to 32.0)	3/8.3% (1.8 to 22.5)	17/7.4% (4.4 to 11.6)	11/4.2% (2 .5 to 7.5)	5/14.7% (5.0 to 31.1)	0/0% (0.0 to 14.2)
Airway infection (95% CI)	14/4.7% (2.2 to 8.1)	2/1.4% (0.2 to 4.8)	2/4.1% (0.5 to 14.0)	1/2.8% (0.1 to 14.5)	8/3.5% (1.5 to 6.7)	7/2.7% (1.1 to 5.5)	0/0% (0 to 10.3)	0/0% (0.0 to 14.2)
Superficial surgical site infection (95% CI)	13/6.7% (3.6 to 11.2)	9/7.5% (3.8 to 13.0)	1/2.0% (0.1 to 10.9)	1/2.8% (0.1 to 14.5)	4/1.5% (0.5 to 4.4)	4/1.5% (0.4 to 3.9)	1/2.9% (0.1 to 15.3)	0/0% (0.0 to 14.2)
Deep surgical site infection (95% CI)	5/2.6% (0.8 to 5.9)	2/1.6% (0.2 to 5.5)	1/2.0% (0.1 to 10.9)	0/0% (0.0 to 9.7)	0/0% (0.0 to 1.6)	0/0% (0.0 to 1.4)	0/0% (0.0 to 10.3)	0/0% (0.0 to 14.2)
Urinary tract infection (95% CI)	1/0.5% (0.0 to 2.9)	0/0% (0.0 to 2.5)	1/2.0% (0.1 to 10.9)	1/2.8% (0.1 to 14.5)	0/0% (0.0 to 1.6)	0/0% (0.0 to 1.4)	0/0% (0.0 to 10.3)	0/0% (0.0 to 14.2)
Other infections (95% CI)	0/2.1% (0.6 to 5.2)	3/2.0% (0.4 to 5.8)	4/8.2% (2.3 to 19.6)	0/0% (0.0 to 9.7)	5/2.2% (0.7 to 5.0)	0/0% (0.0 to 1.4)	4/0% (0.0 to 10.3)	1/4.2% (0.1 to 21.1)

Other infections: endocarditis, pericarditis, chronic infection in the hip, no specific focus for infection, increase in infection parameters.
CABG, coronary artery bypass graft; Cont, controlgroup; Intv, intervention group (measured as intention to treat).

to the recommendation. Patients awaiting open-heart surgery have expressed the view that waiting for surgery is stressful.[19] They are troubled by anxiety, uncertainty and symptoms of distress and they need support from caregivers to manage their self-care successfully.[19 20] Open-heart surgery is an important intervention for patients as the procedure relieves angina and improves patients' quality of life,[21] but the adherence to advice can be variable, depending on patients' awareness of the severity of their disease.[22] Inability to adapt to the situation may result in increased anxiety.[23 24] Uncertainty and anxiety are associated with deterioration of functional status and it is anticipated that each patient will have a unique presentation of symptoms of distress and a correspondingly unique psychological response.[25] Anxiety level is influenced by family members as well as stories heard from friends or acquaintances who had also experienced CABG.[26]

The patient's physical and psychological status was considered when planning the information strategy in this implementation study. We focused on translating evidence into relevant and instructive information based on the material that could be understood by patients and their relatives and was available to patients when they needed it. Written information in the form of a leaflet improves patients' knowledge and reduces confusion especially if provided before admission.[25] Procedures demonstrated in videos are found to be more effective in increasing patients' knowledge that just verbal description of the procedure and demonstrating the procedure increases the reported outcome.[25] Furthermore, patients had the possibility to receive a text message when they were supposed to start on the oral procedure and every time they had to carry out oral hygiene. Text messaging is effective and improves outcomes when it is tailored to the target group.[26] Findings reveal that significant proportions of older adults already use mobile technology, are willing to engage in the existing mobile interventions for health reasons and have positive attitudes towards mobile technology.[27]

In a trial the patients were supposed to start oral hygiene 2 days before planned surgery.[12] They performed oral hygiene for 1.9 (1.2) days indicating a degree of adherence of less than 50% of the intended time.[12] In our study, 86.9% of the patients reported that they had completely adhered to the oral hygiene recommendation. This indicates that it is feasible and not a mental strain for patients to perform oral hygiene as recommended and that the information strategy was effective. This is in line with findings reported in a meta-analysis.[28] Several simple interventions appeared to improve adherence to short-term regimes.[28] It was not possible in our study to identify subgroups of patients who did not adhere to the oral care recommendation and identify whether we could improve our way of informing patients.

In a meta-analyses of the effect of oral hygiene in critically ill surgical patients, nosocomial pneumonia was reduced by 34% (OR 0.66, 95% CI 0.51 to 0.85)[29] and in patients before open-heart surgery it was estimated that oral hygiene would reduce the number of NI by 35% (RR 0.65, 95% CI 0.55 to 78), lower respiratory tract infections by 52% (RR 0.48, 95% CI 0.36 to 0.92) and deep surgical site infections by 60% (RR 0.40, 95% CI 0.27 to 0.84).[14] In this study, the number of patients needing antibiotics on the fifth postoperative day was reduced by 34% in the intervention group, and by 50% in the group of patients who reported they had adhered to the recommendation. A reduction was registered in all types of infections, even though the changes, due to the low number of infection in total, were too low to be significant, as power calculation had been based on a higher incidence of NI.

Strengths and limitations

The strength of this implementation study is that the procedure that was implemented was based on evidence presented in a clinical guideline. The number of patients was calculated based on previous research. Patients in the control group were included based on the list drawn from the hospital; as these lists document the department's activities it is unlikely that patients were missed. Patients in the intervention group were allocated to the study when they were referred for surgery and all names were later checked with the hospital's electronic record in order to check if any patients had been overlooked.

Data on the prescription of antibiotics were drawn from the individual patient medical record. As all antibiotics had to be prescribed and the reason for the prescription has to be documented in the medical record before antibiotics are administered and signed for by the nurses, it is very unlikely that patients in need of antibiotics have been overlooked. The reason for prescribing antibiotics was based on the physicians' clinical judgement. The decision could be based on X-ray, blood test and clinical symptoms, we have not compared the prescription with recommended criteria for the respective infections. The purpose of this implementation study was not to test physicians' accuracy in identifying infection but to test whether fewer patients were prescribed antibiotics when they had adhered to the oral hygiene recommendation. Some infections might have been misclassified by the physicians, but this misclassification must be the same in both the control group and intervention group. Furthermore, it has been reported that physicians could judge the occurrence of pneumonia more accurately in comparison to making the diagnosis based on established criteria after open-heart surgery.[30]

Information on patients' adherence to the recommendation was collected from the patients at admission. Patients were asked to fill out a questionnaire. If this was missed patients were contacted by phone shortly after discharge. If patients could not be reached they were classified as not having performed the procedure. The results show a reduction in frequency of prescribing antibiotics for the intervention group which included patients who adhered and did not adhere to the recommendation, and a further reduction in the group that reported to adhere

to the recommendation. As intention-to-treat analysis has been applied to the data both patients adhering and not adhering are included in this analysis and the further reduction of infections in patients who reported that they adhered must be considered as valid. Patient adherence was monitored throughout the study. Adherence was above 85% and quite stable for 2 years which indicates the recommendation has been implemented in clinical practice.

No other intervention to reduce the prescription of antibiotics was introduced during the study period. The changes in the need for antibiotics on the fifth postoperative day were reduced immediately after introducing the oral hygiene recommendation and remained constant during the study period. If changes in the prescription of antibiotics were due to other intervention one might have expected a gradual reduction in the prescription pattern.

Implications for practice

In Denmark approximately 3000 patients are undergoing elective open-heart surgery each year. Based on the estimates from meta-analysis[14] and the degree of adherence reported in this study a reduction in postoperative use of antibiotic from 12.5% to 7.7% might be expected. This could contribute to reducing the number of patients needing antibiotics on the fifth postoperative day from 375 to 231 patients.

CONCLUSION

Patients adhered to the recommendation of oral hygiene before open-heart surgery and the number of patients needing antibiotic on the fifth postoperative day was significantly reduced. It was feasible to involve patients in a programme for oral hygiene and thereby reduce the number of patients needing antibiotics after open-heart surgery and this might contribute to reducing costs.

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Contributors PUP: planning, conducting and reporting the project. AT: planning and conducting the project. JES: planning and reporting the project. MB: reporting the project.

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Competing interests None declared.

Patient consent for publication Not required.

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Provenance and peer review Not commissioned; externally peer reviewed.

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