

## ANTIBIOTIC PROPHYLAXIS IN GENERAL ORAL HEALTH CARE

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**ANTIBIOTIC PROPHYLAXIS IN**  
**GENERAL ORAL HEALTH CARE**

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The perspective of decision making

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*To my mother Barbara*

## LIST OF PAPERS

This thesis is based on the following papers, which are referred to by their Roman numerals:

- I Ellervall E, Vinge E, Rohlin M, Knutsson K. Antibiotic prophylaxis in oral health care – the agreement between Swedish recommendations and evidence. (Submitted to *Br Dent J* 2009).
- II Ellervall E, Björklund F, Rohlin M, Vinge E, Knutsson K. Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners. *Acta Odontol Scand* 2005;63:321–29.
- III Ellervall, Brehmer B, Knutsson K. How confident are general dental practitioners in their decision to administer antibiotic prophylaxis? A questionnaire study. *BMC Med Inform Decis Mak* 2008;8:57.
- IV Ellervall E, Brehmer B, Knutsson K. Risk judgment by general dental practitioners: rational but uninformed. (Submitted to *Med Decis Making* 2009).

Papers II and III are reproduced with the permission of Acta Odontologica Scandinavica and BioMed Central Medical Informatics and Decision Making.

## **ABSTRACT**

In Sweden, pharmaceutical committees in the counties devote resources to recommendations aimed at supporting optimal medication for patients. These recommendations include oral health care, with advice on when to administer antibiotic prophylaxis in connection with dental procedures to prevent infectious complications in patients with specific medical conditions. There has been much discussion about the use of antibiotic prophylaxis in oral health care and the evidence that the recommendations are based upon is questioned. When using antibiotics, there exist risk of adverse events such as skin rashes, diarrhoea or life-threatening anaphylactic reactions as well as the risk of developing resistant bacterial strains. With this background the use of antibiotics should be minimised.

The objectives of this thesis were to: 1) evaluate the evidence in the literature for the use of antibiotic prophylaxis in oral health care, and the agreement between Swedish recommendations and evidence, 2) examine general dental practitioners' (GDPs') administration strategies of antibiotic prophylaxis,

and the agreement between GDPs' administration strategies and recommendations, 3) examine GDPs' confidence in their decisions on administration of antibiotic prophylaxis and 4) examine GDPs' assessment of risk in their decisions on administration of antibiotic prophylaxis.

The method for the first objective was a systematic literature review of scientific studies. The systematic approach included defined inclusion and exclusion criteria, pre-defined protocols for data extraction and quality assessment of studies, as well as an overall evaluation of the quality of evidence. For the other objectives a questionnaire study was conducted. The questionnaire comprised eight simulated cases of patients with different medical conditions. We included conditions for which antibiotic prophylaxis should be administered when performing dental procedures according to recommendations, and conditions for which antibiotic prophylaxis should not be administered. For each medical condition three different dental procedures (scaling, tooth removal and root canal treatment) were presented. These dental procedures could cause bleeding to various degrees. The questionnaire was sent to 200 randomly selected GDPs in Skåne and Örebro counties. The response rate was 51% (101/200). The GDPs were asked to answer whether they would administer antibiotic prophylaxis, how confident they were in their decisions and their assessment of the risk of complications if antibiotic prophylaxis was not administered.

The results are summarised in the following most important key points:

- According to evidence, there exist no medical condition for which antibiotic prophylaxis should be used
- Swedish recommendations include several medical conditions for which antibiotic prophylaxis should be used
- There was a large variation in GDPs' administration strategies

- Agreement between GDPs' administration strategies and recommendations was low
- GDPs were highly confident about their decisions, regardless of whether they administered antibiotic prophylaxis or not, and regardless of whether their decisions were according to recommendations or not
- GDPs' risk assessments were rational but uninformed, i.e. they administered antibiotic prophylaxis in a manner that was consistent with their risk assessments, but their risk assessments were overestimated and inaccurate in terms of the actual risks.

In conclusion:

According to evidence, there exist no medical condition for which antibiotic prophylaxis should be used. Still, Swedish recommendations include several medical conditions for which antibiotic prophylaxis should be used. To avoid the risk of adverse events and of developing resistant bacterial strains, Swedish recommendations should be more evidence-based. GDPs varied greatly in their administration strategies and their decisions exhibited low agreement with recommendations. This shows that the decisions of GDPs are less than optimal and should be improved. The high confidence that GDPs expressed in their decisions, along with their overestimated and inaccurate risk assessments, might serve as potential barriers to behavioural modifications. Previous research suggest that it is very difficult to implement recommendations to change the behaviour of clinicians. Current knowledge about successful implementation strategies is limited. Changing GDPs' decisions about administration of antibiotic prophylaxis is likely to be very difficult.

## POPULÄRVETENSKAPLIG SAMMANFATTNING

I Sverige ger läkemedelskommittéerna i landstingen ut rekommendationer för att stödja optimal användning av läkemedel till patienter. Rekommendationerna inkluderar råd om när antibiotika bör användas i förebyggande syfte (antibiotikaprofylax) i tandvården. Detta kan vara aktuellt i samband med tandingrepp för att förebygga infektioner hos patienter med specifika medicinska tillstånd, t.ex. hjärtklaffsprotos, diabetes eller njurtransplantat. Vid användning av antibiotika finns risker för oönskade reaktioner hos patienten i form av hudutslag, diarréer men även livshotande allergiska reaktioner. På samhällsnivå finns risk att bakterier blir resistenta mot antibiotika. Med bakgrund av detta bör det finnas en strävan efter att minimera användning av antibiotika.

I denna avhandling har syftet varit att 1) utvärdera de vetenskapliga bevisen i litteraturen för att använda antibiotikaprofylax i tandvården, samt överensstämmelsen mellan rekommendationer från läkemedelskommittéerna och vetenskapliga

bevis, 2) studera tandläkares användning av antibiotikaprofylax och hur väl de följer rekommendationer, 3) studera tandläkares säkerhet i sina beslut om att ge antibiotikaprofylax och 4) studera tandläkares riskbedömningar i sina beslut om att ge antibiotikaprofylax.

Metoden för det första syftet var en systematisk litteraturöversikt av vetenskapliga studier. Det systematiska tillvägagångssättet inkluderade definierade inklusions- och exklusionskriterier för studierna, på förhand definierade granskningsprotokoll av studiernas kvalitet, samt en övergripande kvalitetsbedömning av de vetenskapliga bevisen. För resterande syften genomfördes en enkätundersökning. Enkäten innehöll åtta simulerade patientfall med olika medicinska tillstånd, inklusive tillstånd där antibiotikaprofylax bör ges enligt rekommendationer och tillstånd där antibiotika inte bör ges. Enkäten skickades till 200 slumpmässigt utvalda allmäntandläkare i två landsting i Sverige, Skåne och Örebro läns landsting. Svarsfrekvensen var 51% (101/200). Tandläkarna fick svara på om de skulle ge antibiotikaprofylax, hur säkra de var i sina beslut och hur de bedömde risken för komplikationer om antibiotikaprofylax inte användes.

Resultaten kan sammanfattas i följande punkter:

- Det saknas vetenskapliga bevis som stödjer användning av antibiotikaprofylax
- Rekommendationerna inkluderade flera medicinska tillstånd där antibiotikaprofylax bör ges
- Det fanns en stor variation i tandläkarnas sätt att använda antibiotikaprofylax
- Tandläkarna följde rekommendationer i liten omfattning
- Tandläkarna hade hög säkerhet i sina beslut, oavsett om de gav antibiotikaprofylax eller ej och oavsett om deras beslut var i enlighet med rekommendationer eller ej
- Tandläkarnas riskbedömningar var rationella men byggde på

bristande kunskap, dvs. de gav antibiotikaprofylax på ett konsekvent sätt utifrån sina riskbedömningar, men riskbedömningarna var överskattade och felaktiga jämfört med de verkliga riskerna.

#### Slutsatser:

Det saknas vetenskapliga bevis för att använda antibiotikaprofylax i tandvården. Trots det inkluderar rekommendationerna en mängd medicinska tillstånd. För att minimera användning av antibiotika, bör rekommendationer stramas upp för att vara mer i överensstämmelse med vetenskapliga bevis. Nästa problem var tandläkarnas stora variation i sina beslut och att de endast i liten omfattning följde rekommendationer. Detta visar att besluten inte är optimala och att de bör förbättras. Potentiella hinder för en sådan förbättring kan vara att tandläkarna var väldigt säkra i sina beslut och att de gjorde överskattade och felaktiga riskbedömningar. Tidigare forskning visar att det är mycket svårt att implementera rekommendationer för att förändra beteende hos sjukvårdspersonal. Troligen skulle det innebära stora utmaningar i att lyckas förändra tandläkares sätt att använda antibiotikaprofylax.

# INTRODUCTION

## **Antibiotic prophylaxis in general oral health care**

There has been much discussion about the use of antibiotic prophylaxis in general oral health care. Many recommendations for rational use have been published in Sweden (1,2) and in other countries (3,4), but they are ambiguous and unclear (5). Dental procedures induce a transient bacteremia that can cause complications such as infective endocarditis, late joint infections, sepsis and local infections in patients with specific medical conditions (5). Endocarditis is defined as "inflammation of the inner lining of the heart (endocardium), the continuous membrane lining the four chambers and heart valves" (6). The medical conditions for which antibiotic prophylaxis is warranted have not been clearly established. There is also insufficient knowledge about the risk that bacteremia from dental procedures cause infectious complications, the risk of adverse events from antibiotics and the risk of developing resistant bacterial strains. For a long time, recommendations have been based on anecdotal reports and consensus. Thus, the evidence that the recommendations are based upon is

questionned.

Evidence-based medicine is a systematic process in which scientific literature is searched, scrutinised, and evaluated (7). As lined up above, there is a lack of knowledge of the efficacy of antibiotic prophylaxis to prevent endocarditis and other infectious complications. Further, the use of antibiotics can cause adverse events in a number of patients, and in rare cases life-threatening anaphylactic reactions. In addition, overuse of antibiotics can cause unwanted changes in the microbiological environment and accelerate the development of bacterial resistance. To avoid ineffective or potentially harmful administration of antibiotics, systematic reviews of the available evidence should be the basis for all recommendations regarding antibiotic prophylaxis.

Some of the medical conditions that are considered for antibiotic prophylaxis in recommendations from various Swedish counties (1,2) are very common in the Swedish population (Table 1). As a result, many patients treated in general dental practice could be considered for administration of antibiotic prophylaxis.

*Table 1. Proportion of specific medical conditions in Sweden.*

<u>Medical condition</u>	
Type 1 diabetes mellitus	Prevalence in 2005: 30,000 (8)
Type 2 diabetes mellitus	Prevalence in 2005: 250,000 (8)
Kidney transplant	Prevalence in 2007: 4,300 (9)
Heart valve prosthesis	Incidence in 2007: 2,000 (10)
Hip prosthesis	Incidence in 2007: 14,000 (11)

### **Clinical decision making in general oral health care**

Clinical decision making involves a number of complex tasks. Whether a clinician is defining a disease, making a diagnosis, se-

lecting a procedure, observing outcomes, assessing probabilities, assigning preferences, or putting it all together, many uncertainties arise that are complicated to handle. Because the tasks inherent to clinical decision making are poorly understood, clinicians unsurprisingly tend to arrive at different conclusions (12).

Within the area of antibiotic prophylaxis in oral health care, where there is uncertainty about the risks and where recommendations are ambiguous and unclear, it could be expected that there would be a large variation in dentists' administration of antibiotic prophylaxis. Previous studies of the administration of antibiotic prophylaxis by general dental practitioners (GDPs) found evidence of overuse (13,14). Given the existing uncertainty in this clinical area, dentists might have a high level of personal uncertainty in their decisions. To our knowledge, no previous studies have been published that examine dentists' certainty/confidence in their treatment decisions. Furthermore, assumptions can be made that there may be a wide disparity in dentists' assessments of risk in their decisions. In medical science, risk can be defined as: "the probability that an event will occur. It encompasses a variety of measures of the probability of a generally unfavourable outcome" (15). Deciding whether to administer antibiotic prophylaxis is a dichotomous decision. Before making a decision, dentists need to make judgments. Such judgments should include the risks associated with administering or not administering antibiotic prophylaxis. The knowledge in the literature contains only limited data about these probabilities. Clinicians are probably most concerned about the risk of complications that may arise if antibiotic prophylaxis is not administered.

## **AIMS**

The studies presented in the separate papers (I-IV) were carried out with the following aims:

- To evaluate the evidence for the use of antibiotic prophylaxis in oral health care, and the agreement between Swedish recommendations and evidence (paper I).
- To examine GDPs' administration strategies of antibiotic prophylaxis, and the agreement between GDPs' administration strategies and recommendations (paper II).
- To examine GDPs' confidence in their decisions on administration of antibiotic prophylaxis (paper III).
- To examine GDPs' assessments of risk in their decisions on administration of antibiotic prophylaxis (paper IV).

## MATERIAL AND METHODS

### **Systematic review (Paper I)**

We conducted a systematic review to evaluate the evidence in the literature. The specific medical conditions of interest were: cardiac condition, transplant, medical implant and compromised immune system due to disease or medication. PubMed was searched by combining the MeSH-term “antibiotic prophylaxis” and “dentistry”. The search was limited to publications in English, studies in humans, with an abstract and with an entry date in the period from 1st of January 1996 to 9th of February 2009. This database search yielded 275 abstracts. The abstracts of the articles were included or excluded according to specific inclusion and exclusion criteria. The reference lists from all included publications were then searched to identify additional publications. The trial flow of the number of included/excluded publications is presented in figure 1.

All included publications (n=186) were read in full-text and data were extracted by using a pre-defined protocol. All relevant publications (n=20) were interpreted using a pre-defined protocol. The most common reason for exclusion was the lack of a control group of patients. In the end, one primary study

was included for evaluation of evidence. The evaluation of the evidence was determined to be high, moderate, low or very low in accordance with the GRADE system (16).

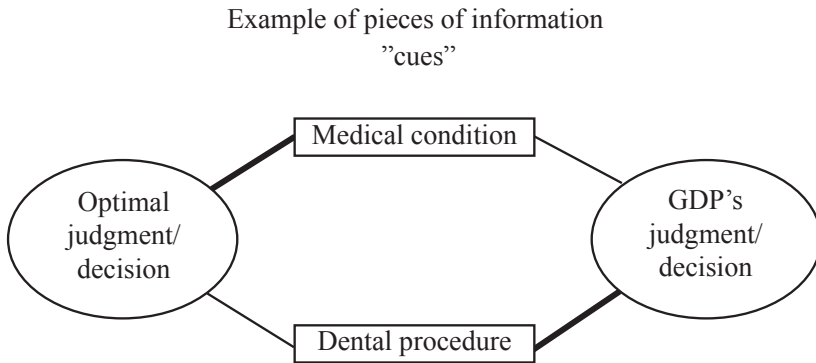


Figure 1. Trial flow of the number of included/excluded publications.

### Theoretical model (paper II-IV)

There are a number of theories on human cognitive decision making processes or mental models. Social Judgment Theory (SJT), one of these theories, focuses on the actual decision made in rela-

tion to a well-defined task and on how the available information is used to reach that judgment (figure 2). Judgment is a cognitive process a priori a decision, e.g. a clinician who combines information that result in a decision. Decision is a choice, e.g. a treatment choice that could alter the status of the patient.



*Figure 2. Model used in Social Judgment Theory: Brunswik's lens model modified from a paper by Wigton (17). The cues are the pieces of information that are considered in the judgment/decision, i.e. the medical condition and the dental procedure. The varying thicknesses indicate that the cues considered by a GDP in making a judgment/decision differ from the optimal judgment/decision. Thus, the judgment/decision by a GDP might not lead to the optimal judgment/decision.*

### **Questionnaire and telephone interview study (Papers II-IV)**

A computer-generated randomisation procedure selected 200 GDPs from two Swedish counties, Skåne and Örebro, to participate in the study. The two counties were chosen because their recommendations differed according to the medical conditions that were included. The counties were also chosen because their demographic characteristics in terms of population, area, and number of dentists per capita were similar. The GDPs were selec-

ted from the membership register of the Swedish Dental Association (which included approximately 88% of all licenced dentists in Sweden in 2003). The response rate was 51% (101/200).

The share of male respondents was 57% and of female respondents 43%. This distribution reflected the distribution of female and male dentists in the membership register of the Swedish Dental Association. The mean age of the respondents was 48 years (range 26-64). The mean number of years of professional experience as GDPs was 20 years (range 1-44). Approximately 60% of the respondents worked in the Public Dental Service and 40% in private dental service.

There were no significant differences between respondents and non-respondents regarding sex, age or place of work (public/private dental service) ( $p>0.05$ ), analysed with the chi-square test. Thus, the respondents could be considered representative of the initial sample of GDPs who had been randomly selected for participation. To permit a further evaluation of the non-respondents, we constructed an abbreviated version of the questionnaire comprising three of the medical conditions and sent it to ten of the non-respondents. Three responses were received and their administration strategies presented a variation corresponding to the respondents.

A postal questionnaire in combination with a structured telephone interview was used. Initially, an inquiry was sent to GDPs asking whether they were willing to participate in the study. The inquiry included an introductory letter, a document of consent to participate, and a reply-paid envelope. Two reminders were sent to non-respondents. Informed consent was obtained from all participants. Data were collected between January and June 2003. The Ethics Committee at Lund University in Sweden approved the study (LU 305-02).

### *Cases presented in the questionnaire*

The questionnaire comprised eight simulated cases of patients with different medical conditions, including conditions for which antibiotic prophylaxis might be considered when performing dental procedures according to recommendations (1-4,18,19). The questionnaire was tested by two GDPs and modified according to their suggestions before the final version was developed.

The patient cases comprised the following medical conditions:

1. Type 1 diabetes mellitus, insulin-dependent, well controlled.
2. Type 2 diabetes mellitus, medicating with oral antidiabetic agents, well controlled.
3. Type 1 diabetes mellitus, insulin-dependent, not well controlled.
4. Moderate hypertension, medicating with beta-receptor antagonist.
5. Myocardial infarction 3 months ago, medicating with ACE-inhibitor, beta-receptor antagonist, low-dose aspirin, and simvastatin.
6. Kidney transplant 3 years ago, medicating with immunosuppressive and beta-receptor antagonist for moderate hypertension, well controlled without complications.
7. Heart valve prosthesis, medicating with warfarin.
8. Hip prosthesis, replacement performed 3 years ago.

For each medical condition, the following dental procedures were presented:

- A. Scaling lingually in the lower jaw (probing pocket depth between 2-3 mm).
- B. Surgery, for example removal of an asymptomatic tooth.
- C. Root canal treatment due to pulp exposure as a result of caries (the pulp is vital).

These dental procedures were selected to represent interventions that could produce gingival bleeding. Root canal treatment (procedure C) *per se* is not generally considered to cause gingival bleeding and require antibiotic prophylaxis. But placement of rubber dam clamps may cause gingival bleeding and thus generate bacteremia (20).

In figure 3, an example of the cases presented in the questionnaire is provided (including one of the medical conditions and one of the dental procedures).

<p><b>Patient with type 1 diabetes mellitus, insulin-dependent, not well controlled.</b>          (The GDPs were instructed not to take conditions other than the medical condition into consideration)</p>	
1.	If you would scale lingually in the lower jaw (the probing pocket depth is between 2-3 mm), would you administer antibiotic prophylaxis? <input type="checkbox"/> yes <input type="checkbox"/> no
2.	How confident are you that your decision to administer/not administer antibiotics is correct? Indicate with a cross:
	Not confident  —————  Very confident
3.	If you chose to administer antibiotics:
	-which drug would you administer?.....
	-what would be the duration of the treatment?.....
	-when would you begin treatment?.....
4.	How significant is the risk for complications if <b>not</b> administering antibiotics? Indicate with a cross:
	Insignificant risk  —————  Very significant risk

Figure 3. One of the cases presented to the GDPs.

### *Analysis of questionnaire and statistics*

*Paper II:* The administration strategies of GDPs were studied by examining whether or not antibiotic prophylaxis was administered (question no. 1 in figure 3). If GDPs chose to administer antibiotics, they were asked to specify what antibiotic regimen

they proposed (question no. 3 in figure 3). Differences between Skåne and Örebro counties in the decisions about whether or not to administer antibiotic prophylaxis was analysed using Fisher's exact test ( $p=0.05$ ). Inter-observer variation in GDPs' decisions about whether or not to administer antibiotics for different dental procedures within each medical condition was analysed with McNemar's test ( $p=0.05$ ).

*Paper III:* The GDPs were asked to assess on a 100-millimetre visual analogue scale (VAS) how confident they were in their decisions (question no. 2 in figure 3). The assessments were measured to the nearest millimetre where 0 mm represented the end-point "not confident" and 100 mm the end-point "very confident". Differences in confidence assessments between GDPs who would administer antibiotic prophylaxis and GDPs who would not, was analysed using Independent Samples t-test ( $p=0.05$ ). Differences in confidence assessments between men and women, between GDPs working in the Public Dental Service and private dental service, between ages and between GDPs with varying numbers of years of professional experience was also analysed, using a multiple linear regression ( $p=0.05$ ). For each GDP, an  $R^2$ -value was calculated presenting the extent to which variation in GDPs' confidence assessments could be explained by the factors medical condition and dental procedure (two-way ANOVA analysis). In the  $R^2$ -analysis, we also evaluated whether the factors significantly explained each GDPs' variation in confidence.

*Paper IV:* The GDPs were asked to assess on a 100-millimetre visual analogue scale (VAS) their assessments of the risk of complications if antibiotic prophylaxis is not administered (question no. 4 in figure 3). The assessments of risk was measured to the nearest millimetre where 0 mm represented the end-point "insig-

nificant risk” and 100 mm the end-point “very significant risk”. Risk judgment is a cognitive process of GDPs’ assessments on the VAS. Risk assessments are the quantification of these judgments. Differences in risk assessments between GDPs who would administer antibiotic prophylaxis and those who would not was analysed, using the Independent Samples t-test ( $p=0.05$ ). Differences in risk assessments between men and women, between GDPs working in the Public Dental Service and private dental service, and between GDPs with varying numbers of years of professional experience was also analysed, using multiple linear regression ( $p=0.05$ ).

## RESULTS

### Evidence and Swedish recommendations (paper I)

*Key points:*

- According to evidence, there exist no medical condition for which antibiotic prophylaxis should be used.
- Swedish recommendations include several medical conditions for which antibiotic prophylaxis should be used.

Our systematic literature review included one primary study (21). There was no randomised controlled trial. The primary study was a case-control study of patients with specific cardiac conditions (21). Thus, no studies were included on patients with other medical conditions.

In the study by van der Meer (21) the cases and controls were not compared in the usual way, where cases receive an intervention and controls do not. The difference between cases and controls was that cases comprised patients who had or were suspected of having bacterial endocarditis as defined by von Reyn's

criteria (22). Cases were included if they had congenital heart disease, coarctation of the aorta, rheumatic and other valvular dysfunction, or mitral valve prolapse with mitral regurgitation. Controls with a cardiac lesion and increased risk of endocarditis were included. In this study (21), the authors motivated that subjects with prosthetic heart valves were excluded because 1) they probably have a much higher risk of endocarditis and are a different risk-group, and 2) there were too few patients with prosthetic valves for a case-control study. Antibiotic prophylaxis was given to some cases and some controls. The study reported a 49% protective efficacy of antibiotic prophylaxis for first-time episodes of endocarditis within 30 days of procedure (21). This result was not statistically significant. The quality of evidence was graded as low (16). Thus, there is a lack of evidence to support the use of antibiotic prophylaxis in patients with specific medical conditions to prevent infectious complications associated with dental procedures.

A total of 17/20 Swedish counties had recommendations developed by the pharmaceutical committees for the use of antibiotic prophylaxis. Thirteen counties used a joint recommendation and four counties had their own recommendation, which made a total of five recommendations that were evaluated in this study. The recommendations were current during 2008. Of these two were updated in 2008, one in 2007, one in 2005 and one in 1999. The recommendations included several medical conditions for consideration of antibiotic prophylaxis administration in connection with dental procedures. All recommendations included some cardiac conditions. There was consistency regarding the inclusion of patients with heart valve prosthesis, a previous episode of endocarditis and congenital heart disease. Some recommendations also included patients with heart valve surgery and acquired valvular disease. These are all medical conditions where there is

a lack of evidence or no evidence to support the use of antibiotic prophylaxis to prevent infectious complications.

### **Administration strategies of GDPs (paper II)**

#### *Key points:*

- There was a large variation in GDPs' administration strategies.
- Agreement between GDPs' administration strategies and recommendations was low.
- GDPs administered antibiotic prophylaxis for medical conditions that are not covered by recommendations, and failed to administer for conditions who should have antibiotic prophylaxis according to recommendations.
- GDPs were more inclined to administer antibiotic prophylaxis for tooth removal than for scaling or root canal treatment.

The GDPs' administration strategies are presented in table 2. Overall, there was no significant difference between GDPs in Skåne and Örebro counties in their decisions about whether or not to administer antibiotic prophylaxis, even though the recommendations in the two counties differed according to content, format and how they were communicated. In both counties, GDPs were generally more inclined to administer antibiotic prophylaxis to the patient with heart valve prosthesis followed by the patient with a kidney transplant than patients with other medical conditions. They were least inclined to administer antibiotic prophylaxis to the patient with moderate hypertension. GDPs were more inclined to administer antibiotic prophylaxis for tooth removal than the other dental procedures ( $p < 0.05$ ).

Table 2. Administration strategies of GDPs (n=101°) and their assessments of confidence and risk on the VAS.

Medical condition	Dental procedure	Administer antibiotics (yes)		Total		Confidence (mean)		Risk (mean)	
		Skåne (n=50)	Örebro (n=51)	Yes	No	Yes	No	Yes	No
1. Type 1 diabetes, well controlled	Scaling	-	-	-	101	-	~92	-	7
	Tooth removal	7	3	10	91	60	†89	*40	12
	Root canal treatm.	-	3	1	100	78	~93	~46	7
2. Type 2 diabetes, well controlled	Scaling	-	-	-	101	-	~92	-	7
	Tooth removal	5	1	6	95	57	†89	26	10
	Root canal treatm.	-	-	-	101	-	~92	-	7
3. Type 1 diabetes, not well controlled	Scaling	19	11	30	71	77	80	*54	16
	Tooth removal	43	34	77	24	80	72	*60	22
	Root canal treatm.	12	10	22	79	68	†78	*55	17
4. Moderate hypertension	Scaling	-	-	-	101	-	~91	-	8
	Tooth removal	1	-	1	100	54	~90	~57	10
	Root canal treatm.	-	-	-	101	-	~92	-	8
5. Myocardial infarction	Scaling	16	12	28	73	76	80	*65	15
	Tooth removal	31	23	54	47	76	79	*62	17
	Root canal treatm.	11	13	24	77	69	†81	*55	17
6. Kidney transplant	Scaling	29	21	50	46	72	78	*59	14
	Tooth removal	42	41	83	11	82	73	*63	31
	Root canal treatm.	22	17	39	56	72	73	*52	19
7. Heart valve prosthesis	Scaling	41	34	75	25	86	85	*68	17
	Tooth removal	48	49	97	1	91	~68	*72	25
	Root canal treatm.	29	34	63	37	80	80	*56	15
8. Hip prosthesis, 3 years ago	Scaling	7	3	10	91	77	84	*47	12
	Tooth removal	27	14	41	60	73	81	*48	16
	Root canal treatm.	5	7	12	89	75	84	*45	12

° = In some decisions, a few GDPs answered "would contact patient's physician" (<101).

~ = No statistical comparison was possible since there were no or too few GDPs in the yes or no groups.

† = GDPs who would not administer antibiotics were more confident than GDPs who would administer antibiotics (p<0.05).

\* = GDPs who would administer antibiotics assessed the risk as higher than GDPs who would not administer antibiotics (p<0.05).

There was low agreement between GDPs' administration strategies and recommendations in both counties. Agreement was higher for the patient with heart valve prosthesis than for the patient with type 1 diabetes that was not well controlled or for the patient with kidney transplant. However, despite the unambiguous recommendation for patients with heart valve prosthesis in both counties, four GDPs neglected to administer antibiotic prophylaxis for tooth removal and about one fourth (26 GDPs) for scaling. Inversely, a substantial percentage of GDPs administered antibiotics for medical conditions such as myocardial infarction and hip prosthesis, that are not included in recommendations. Among the GDPs who followed the recommendations for a specific medical condition, the choice of substance was often not in agreement with the recommendation, for instance GDPs administered amoxicillin although penicillin V was recommended. The majority of GDPs who selected the recommended substance also followed the recommended duration of treatment.

### **GDPs' confidence in their decisions (paper III)**

*Key point:*

- GDPs were highly confident about their decisions, regardless of whether they administered antibiotic prophylaxis or not, and regardless of whether their decisions were according to recommendations or not.

The GDPs' assessments of confidence are presented in table 2. The overall mean in for the entire sample of GDPs was 79 mm on the VAS (range 54-93 mm). Generally, GDPs expressed high confidence in all their decisions, regardless of whether they administered antibiotic prophylaxis or not ( $p>0.05$ ). There were no

significant differences between men and women, between GDPs working in the Public Dental Service and private dental service, between ages or between GDPs with varying numbers of years of professional experience ( $p > 0.05$ ).

The individual variation in GDP's assessments of confidence explained by the medical condition and dental procedure ( $R^2$ ) varied between 0.293-0.996. Based on which factors that significantly explained individual variations in confidence, the GDPs could be organised into three different classifications:

- For 46 of the GDPs (~45%), the medical condition explained the individual variation in confidence ( $p < 0.05$ ) ( $R^2$  0.607-0.996).
- For 8 of the GDPs (~8%), the dental procedure explained the variation ( $p < 0.05$ ) ( $R^2$  0.599-0.747).
- For 47 of the GDPs (~47%), neither the medical condition nor the dental procedure explained the variation ( $p > 0.05$ ) ( $R^2$  0.293-0.700).

### **GDPs' risk judgment in their decisions (paper IV)**

#### *Key points:*

- GDPs lack knowledge of which medical conditions that are considered at risk of complications.
- GDPs' risk assessments were higher for tooth removal than for scaling or root canal treatment, which indicate that they judge the risk depending of the amount of bleeding.
- GDPs' risk assessments were rational but uninformed, i.e. they administered antibiotics in a manner that was consistent with their risk assessments, but their risk assessments were overestimated and inaccurate in terms of the actual risks.

The GDPs' assessments of risk are presented in table 2. The mean risk assessment was higher for GDPs who would administer antibiotics (range 26-72 mm on the VAS), than those who would not (range 7-31 mm) ( $p < 0.05$ ). Overall, the risk assessments were higher for tooth removal than for scaling or root canal treatment. Among the GDPs who administered antibiotic prophylaxis, the highest risk assessments were for patients with medical conditions that are included in Swedish recommendations (1,2), (i.e. not well controlled type 1 diabetes, kidney transplant and heart valve prosthesis) but also for myocardial infarction. For these medical conditions, risk assessments were in the 52-72 mm range on the VAS. Among the GDPs who did not administer antibiotics, the highest mean risk assessments were in the 14-31 mm range on the VAS and were for the same medical conditions as mentioned above. Generally, there were no differences in risk assessments between men and women, between GDPs working in the Public Dental Service and private dental service, or between GDPs with varying numbers of years of professional experience ( $p > 0.05$ ).

## DISCUSSION

### **Evidence**

This research project concerns the use of antibiotic prophylaxis in oral health care. The systematic literature review found that there is a lack of evidence to support the use of antibiotic prophylaxis in connection with dental procedures to prevent infectious complications in patients with specific medical conditions. Other systematic reviews have reached the same conclusion (23-26). In our review, we also compared Swedish recommendations with evidence and found that recommendations included several medical conditions for which there is a lack of evidence or no evidence to support the use of antibiotic prophylaxis.

The discussion about this clinical area has intensified in recent years. In addition to scepticism about the value of antibiotic prophylaxis to prevent infectious complications, more attention has been given to the risk of adverse events from antibiotic prophylaxis and the risk of developing resistant bacterial strains. The systematic review by the National Institute for Clinical Excellence (NICE) evaluated not only the value of antibiotic prophylaxis, but also the risks of adverse events (25). NICE also developed recommendations based on the evidence that was found in

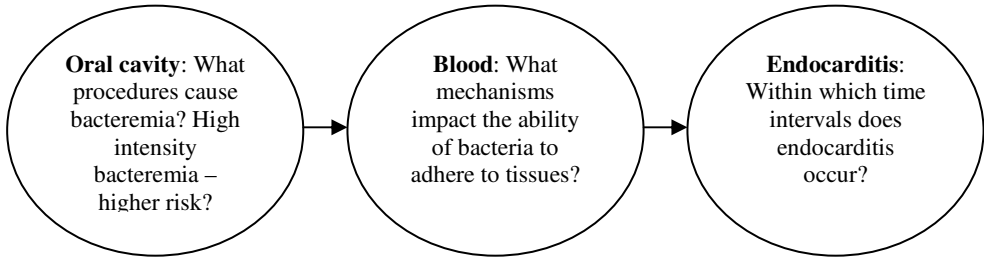
the literature. The recommendation states that antibiotic prophylaxis is not warranted for any medical conditions in connection with dental procedures. This message is radical and differs from the revised recommendations issued by the American Heart Association (AHA) in 2008 (3). As opposed to the recommendations issued by the AHA in 1997 (27), they are now limited to only a few cardiac conditions that are considered to suffer the most severe consequences of an endocarditis episode. The AHA's view stems from an unwillingness to disregard the possibility that antibiotic prophylaxis offers protective efficacy against endocarditis in patients with some specific cardiac conditions. Studies are needed to establish whether such efficacy exists. However, the question is whether it is possible to conduct studies that would improve the quality of evidence. The fact that the inclusion of all endocarditis cases in the Netherlands for two years produced only 44 appropriate cases (21) indicates the challenge. It would require large efforts to design and perform trials with adequate sample selection and size, appropriate controls and with clear outcomes. Such a study would probably need to involve several countries and centres.

There is a lack of data on the morbidity and mortality attributable to antibiotic resistance, which may explain the weak reaction from society to this threat to public health (28). Oral health care is responsible for approximately 8% of all use of antibiotics in Sweden (29). When looking at specific drugs, 25% of all penicillin V administrations are given in oral health care (29). The growing phenomenon of bacterial resistance, caused by the use and abuse of antibiotics, should not be neglected given that it has a significant impact on health care (28). At present, there is no threat of penicillin-resistant streptococcus viridans, which is the group of bacteria from the mouth that can cause endocarditis. However, the total use of penicillins and other antibiotics

leads to other resistant bacterial strains. In cases of endocarditis caused by other bacteria, an infection might be difficult to treat. The Swedish government is funding STRAMA (Strategigruppen för rationell antibiotikaanvändning och minskad antibiotikaresistens) [Swedish], a nationwide action programme to combat antibiotic resistance. The objective of STRAMA is to protect the possibility of effectively treating infections with antibiotics.

The systematic reviews that have been published in this area should lead to revisions of recommendations. NICE developed their recommendations by strictly following the evidence and state that antibiotic prophylaxis is no longer warranted (25). It is interesting that NICE chose to exclude all medical conditions. In the study by van der Meer (21), which is the only study that provides some evidence about the use of antibiotic prophylaxis in oral health care, patients with heart valve prosthesis were excluded since they were considered a different risk-group and were too few to be able to evaluate in the study (21). This means that we can not dismiss the possibility that there could be a significant protective efficacy for this group of patients. The AHA developed their recommendations based on the evidence and on the consensus among cardiologists, infectious disease specialists, dentists, epidemiologists, surgeons and others (3). Using this approach, the AHA included a few medical conditions for which arguments exist that antibiotic prophylaxis is still warranted, for example heart valve prosthesis. There is no simple answer to which approach should be chosen. Previous research suggests that recommendations developed to suit the opinions of users have a better chance for successful implementation to change clinical practice (30). This supports the view that not only evidence, but also the standpoints of authorities such as the AHA, should be included. However, the use of antibiotic prophylaxis should not be considered unharmed and it has not reduced the incidence of endocar-

ditis cases (31). There are many uncertainties about the microbiological process of bacteremia from dental procedures causing endocarditis. Figure 4 illustrates examples of various uncertainties.



*Figure 4. Examples of uncertainties in the microbiological process of bacteremia from dental procedures causing endocarditis.*

Apart from all of these uncertainties, the risk of adverse events from antibiotics must be considered. The most serious adverse reactions to antibiotics, such as anaphylaxis, occur in patients with no history of allergy (32). Anaphylaxis is a reaction that can only occur in patients that have previously been exposed to an agent, for example antibiotics. It is difficult to identify valid estimates of the risk of adverse reactions from antibiotics, since they are calculated in different ways and vary considerably. However, the NICE report (25), suggests that penicillin could result in more deaths (at least in the short term) secondary to anaphylaxis compared with a strategy of no prophylaxis.

Further, administration of antibiotic prophylaxis does not fully eliminate bacteremia. Studies have shown that parental penicillin reduced bacteremia by 84-88% after 5 minutes and by 95-97% after 30 minutes (33). Reports of how many endocarditis cases that can be associated with dental procedures differ, some report 4% (34) and others as much as 14% (35) of all cases. Spontaneous bacteremia from the oral cavity, that occur

during daily activities such as tooth brushing or flossing, result in significant bacteremia comparable to the bacteremia that arise after extraction (36), and is considered to cause a high percentage of endocarditis cases. Thus, it is reasonable to assume that the 4-14%, which are considered to be caused by dental procedures, may also be the result of spontaneous bacteremias (37). All of these arguments support the approach chosen by NICE.

Previous studies have shown that patients' oral health status correlates with the occurrence of bacteremia (38) and could influence the risk of developing endocarditis (39). Perhaps the maintenance of good oral health is more important for preventing endocarditis in patients with specific cardiac conditions than the use of antibiotic prophylaxis.

### **Clinical decision making in general oral health care**

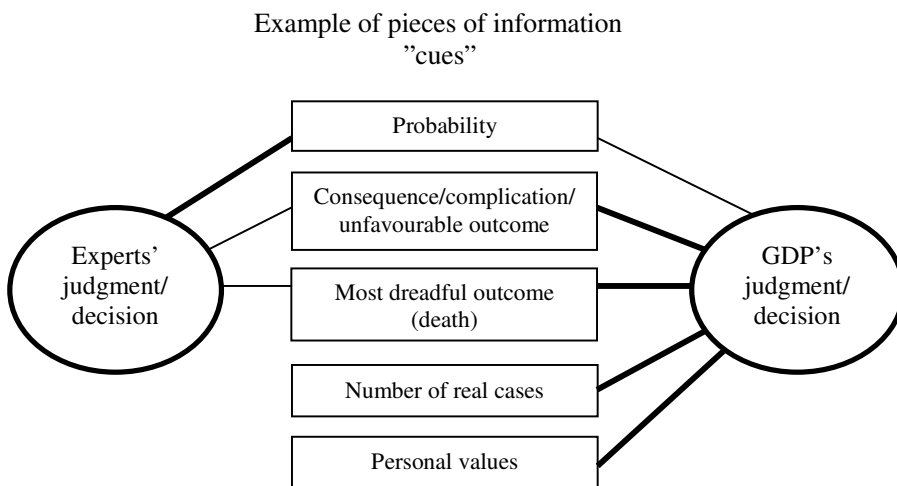
In paper II, we evaluated GDPs' administration strategies in Skåne and Örebro counties. The study found a large variation in GDPs' administration strategies of antibiotic prophylaxis. The GDPs administered antibiotic prophylaxis to patients with medical conditions that are not covered by recommendations and failed to administer antibiotics to patients who should have received antibiotic prophylaxis according to recommendations. These results indicate that GDPs' decisions are not optimal and that there is room for improvement. The methods used for disseminating/implementing recommendations differed between Skåne and Örebro counties. In Skåne, the pharmaceutical committee disseminated recommendations by mail to all GDPs working in the county. In Örebro, GDPs working in the Public Dental Service had access to recommendations on their intranet. These recommendations were also given to GDPs who had attended a seminar on antibiotic prophylaxis as part of a 4-day course in oral surgery. However, there were no differences in administration strate-

gies between GDPs in Skåne and Örebro counties, and there was low agreement with recommendations, which indicates that both recommendations and how they were disseminated/implemented had little impact on GDPs' administration strategies.

In order to change the behaviour of clinicians, it is crucial to gain a better understanding of clinical decision making processes. Papers III and IV have focused on GDPs' judgment and decision making of antibiotic prophylaxis. The study of GDPs' confidence in their decisions found an overall high confidence, regardless of whether the GDPs administered antibiotics or not, and regardless of whether their decisions were according to recommendations or not. Clinicians who are overconfident about their decisions may be less susceptible to modifications of their behaviour to incorporate more evidence-based strategies (40). The study on GDPs' risk assessments showed that they made rational assessments and administered antibiotic prophylaxis in a manner that was consistent with their risk assessments. However, their risk assessments were overestimated and inaccurate in terms of the actual risks. Among the GDPs who administered antibiotic prophylaxis, similar risk assessments were made for the patient with heart valve prosthesis and myocardial infarction, which indicate that GDPs lack knowledge about these medical conditions and the process of developing endocarditis, which is not relevant for a patient with myocardial infarction. Approximately 587,000 people in Sweden have had an episode of myocardial infarction between 1987-2005 (41), which means that a significant number of patients with this medical condition could be candidates for antibiotic prophylaxis administration in general dental practice.

Research has shown that the risks seen by people are often different from the actual risks (42). Risk judgments by those regarded as experts (for example, those who develop recommendations) focus more on probabilities and also on potential

complications (43) such as endocarditis. GDPs' risk judgments may focus more on potential complications such as endocarditis and their most severe possible outcomes (such as death) than on probabilities. Risks that have a low probability but severe consequences, such as endocarditis that may lead to death, are often overestimated (43). In figure 5, a model has been constructed to illustrate possible differences in risk judgments made by experts and GDPs.



*Figure 5. Model of risk judgment by experts vs. GDPs, modified by using the Social Judgment Theory: Brunswik's lens model (17). The cues are the pieces of information considered in making the judgment/decision. The varying thicknesses indicate that the cues considered by a GDP in making a judgment/decision differ from those of the experts. Experts are here considered as those who develop recommendations.*

Inaccurate judgments of risk should not be expected to disappear when confronted with new information, given that strong initial

views are resistant to change and influence the way new information is interpreted (42). People tend to regard new information as reliable if it is consistent with their previous beliefs and unreliable if it is inconsistent with those beliefs (42). To achieve change, clinicians must be motivated to improve their behaviour (44), and an evidence-based implementation strategy is required (45).

### **Implementation strategies**

Previous research has reported low adherence to recommendations among clinicians (14,46,47), and it has been shown that it is very difficult to implement recommendations that change their behaviour (48). Thus, it is reasonable to question when and to what extent revisions of recommendations will impact GPs' administrations of antibiotic prophylaxis.

Regardless of whether recommendations are developed by strictly following the evidence or by considering the opinions of authorities, much effort is needed to implement them in clinical practice. A successful implementation strategy must first identify potential barriers (48). Such a barrier might be that cases of endocarditis have been reported to the Medical Responsibility Board in Sweden, after which clinicians have been reprimanded for their failure to administer antibiotic prophylaxis. These decisions probably have a large impact on GPs and would be a major barrier if an attempt was made to implement recommendations stating that antibiotic prophylaxis is no longer warranted. In Sweden, recommendations on the use of antibiotic prophylaxis are issued by pharmaceutical committees, infection clinics at hospitals, the Public Dental Service and the National Board of Health and Welfare. The content of these recommendations differs according to which medical conditions are included. That might create confusion. One way to reduce the confusion would be to develop a single nationwide document. However, even if

consensus was achieved on a national level other barriers might exist in the social context, for example reactions by colleagues. Furthermore, barriers such as knowledge, attitudes and habits might exist on the individual level (48).

In clinical practice, GDPs might resist to discuss or trying to persuade a patient who wants antibiotic prophylaxis. For example if the patient's responsible physician has informed the patient about the need of prophylaxis in connection with dental procedures, although prophylaxis is not warranted, it is not easy for a dentist to persuade the patient to the contrary. In general, the public's demand for antibiotics is often perceived as being high even for conditions where there is no indication for antibiotic treatment. However, studies have shown that the public's demand is overestimated by the prescriber (49). Arguments about the general risk of developing resistant bacterial strains might be considered too abstract and irrelevant to the situation of a particular patient. Perhaps arguments that focus on the risk that the individual could be a carrier of resistant bacterial strains, which would be an obstacle to treating serious infections in the future, would have more of an impact on patients (28).

There are several steps in an implementation process, as illustrated in figure 6. The figure illustrates four major steps. Our studies are in the first and second steps. In the second step potential barriers should be identified, such as GDPs' high confidence in their decision and their inaccurate risk judgments. These barriers must be acknowledged and managed when entering the third step. When it comes to the fourth step, we must realise that current knowledge about successful implementation strategies is limited. Simple dissemination of recommendations has been found to be ineffective (50). More active implementation strategies, for example the use of educational approaches have shown effects of approximately 10% improvements in clinicians' decisions (48). It

has also been recognised that a combination of methods are more effective than using one method (50). A study in the Netherlands used an evidence-based implementation strategy and achieved improvements in dentists' knowledge regarding third molar management (51). However, clinical performance remained unchanged. This indicates that achieving successful implementation in clinical practice faces major challenges.

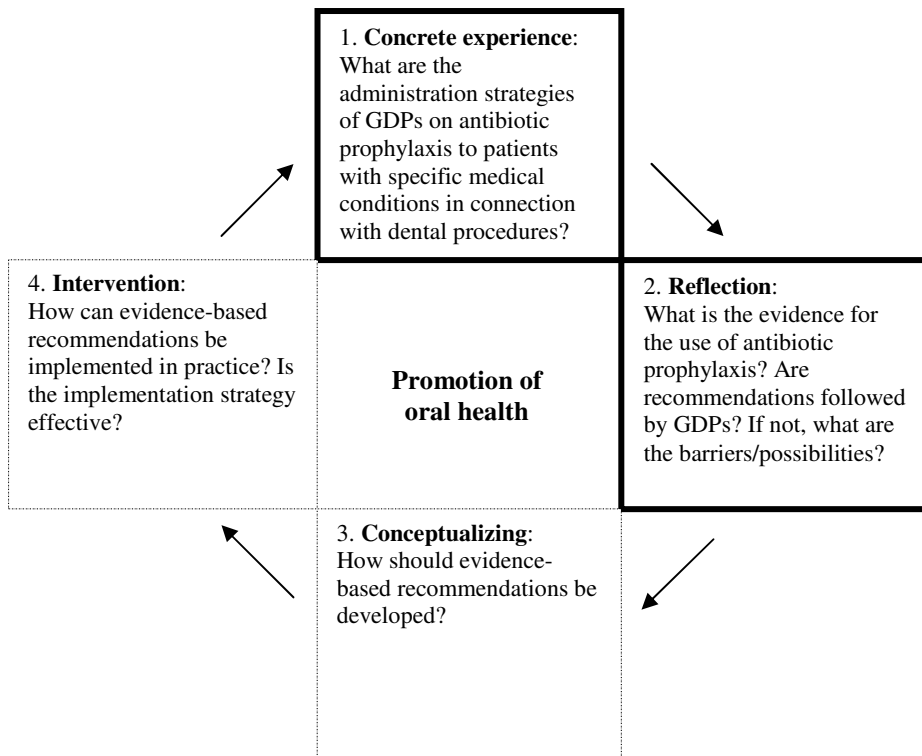


Figure 6. Model of an implementation process modified from Kolb's learning theory (52).

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## REFERENCES

1. Therapy Group of Odontology, Pharmaceutical Committee in Skåne County: Dental care – recommended drugs. Lund, Sweden; 2002.
2. Nihlson A. Antibiotics in dental care – recommendations. University Hospital in Örebro County: Sweden; 2002.
3. Wilson W, Taubert KA, Gewitz M, et al. Prevention of infective endocarditis: guidelines from the American Heart Association. *J Am Dent Assoc* 2007;138:739–45, 747–60.
4. American Dental Association; American Academy of Orthopaedic Surgeons. Advisory statement. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc* 2003;134:895–9.
5. Pallasch TJ, Slots J. Antibiotic prophylaxis and the medically compromised patient. *Periodontol 2000* 1996;10:107–38.
6. U.S. National Library of Medicine. PubMed; MeSH-term. Accessed at [www.pubmed.gov](http://www.pubmed.gov) on 23 January 2008.
7. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. *BMJ* 1996;312:71–2.

8. The National Board of Health and Welfare. The Swedish National Public Health Report 2005. Stockholm; 2005.
9. Swedish Renal Registry. Accessed at [www.kvalitetsregister.se](http://www.kvalitetsregister.se) on 3 April 2009.
10. Swedish Heart Surgery register. Annual report 2007. Stockholm; 2007.
11. Swedish Hip Arthroplasty Register. Annual report 2007. Göteborg; 2007.
12. Eddy DM. Variations in physician practice: the role of uncertainty. *Health Aff* 1984;3:74–89.
13. Jaunay T, Sambrook P, Goss A. Antibiotic prescribing practices by South Australian general dental practitioners. *Aust Dent J* 2000;45:179–86.
14. Palmer NA, Pealing R, Ireland RS, Martin MV. A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J* 2000;189:43–6.
15. U.S. National Library of Medicine. PubMed; MeSH-term. Accessed at [www.pubmed.gov](http://www.pubmed.gov) on 23 January 2008.
16. Atkins D, Best D, Briss PA, et al. Grading quality of evidence and strength of recommendations. *BMJ* 2004;328:1490.
17. Wigton RS. Applications of judgment analysis and cognitive feedback to medicine. In: Brehmer B, Joyce CRB, editors. *Human Judgment. The SJT view*. Amsterdam: Elsevier Science Publishers BV, 1988.
18. Alexander RE. Routine prophylactic antibiotic use in diabetic dental patients. *J Calif Dent Assoc* 1999;27:611–8.
19. Eigner TL, Jastak JT, Bennett WM. Achieving oral health in patients with renal failure and renal transplants. *J Am Dent Assoc* 1986;113:612–6.
20. Roberts GJ, Holzel HS, Sury MR, Simmons NA, Gardner P, Longhurst P. Dental bacteremia in children. *Pediatr Cardiol* 1997;18:24–7.

21. van der Meer JT, van Wijk W, Thompson J, Vandenbroucke JP, Valkenburg HA, Michel MF. Efficacy of antibiotic prophylaxis for prevention of native-valve endocarditis. *Lancet* 1992;339:135–9.
22. von Reyn CF, Levy BS, Arbeit RD, Friedland G, Crumpacker CS. Infective endocarditis: an analysis based on strict case definitions. *Ann Intern Med* 1981;94:505–18.
23. Oliver R, Roberts GJ, Hooper L. Penicillins for the prophylaxis of bacterial endocarditis in dentistry. *Cochrane Database Syst Rev* 2004:CD003813.
24. Lockhart PB, Loven B, Brennan MT, Fox PC. The evidence base for the efficacy of antibiotic prophylaxis in dental practice. *J Am Dent Assoc* 2007;138:458–74.
25. National Institute for Health and Clinical Excellence. Prophylaxis against infective endocarditis. Antimicrobial prophylaxis against infective endocarditis in adults and children undergoing interventional procedures. *NICE Clinical Guidelines* No. 64, 2008.
26. Oliver R, Roberts GJ, Hooper L, Worthington HV. Penicillins for the prophylaxis of bacterial endocarditis in dentistry. *Cochrane Database Syst Rev* 2008:CD003813.
27. Dajani AS, Taubert KA, Wilson W, et al. Prevention of bacterial endocarditis: recommendations by the American Heart Association. *J Am Dent Assoc* 1997;128:1142–51.
28. Cars O, Högberg LD, Murray, et al. Meeting the challenge of antibiotic resistance. *BMJ* 2008;337:726–8.
29. Apoteket International database: Medicine sales, 2006. Stockholm, Sweden.
30. Onion CW, Walley T. Clinical guidelines: ways ahead. *J Eval Clin Pract* 1998;4:287–93.
31. Strom BL. When data conflict with practice: rethinking the use of prophylactic antibiotics before dental procedures. *LDI*

- Issue Brief* 2001;6:1–4.
32. Anderson JA, Adkinson NF. Allergic reactions to drugs and biologic agents. *JAMA* 1987;258:2891–9.
  33. Baltch AL, Pressman HL, Schaffer C, et al. Bacteremia in patients undergoing oral procedures. Study following parental antimicrobial prophylaxis as recommended by the American Heart Association, 1977. *Arch Intern Med* 1988;148:1084–8.
  34. Guntheroth WG. How important are dental procedures as a cause of infective endocarditis? *Am J Cardiol* 1984;54:797–801.
  35. Bayliss R, Clarke C, Oakley C, Somerville W, Whitfield AG. The teeth and endocarditis. *Br Heart J* 1983;50:506–12.
  36. Roberts GJ. Dentists are innocent! "Everyday" bacteremia is the real culprit: a review and assessment of the evidence that dental surgical procedures are a principal cause of bacterial endocarditis in children. *Pediatr Cardiol* 1999;20:317–25.
  37. Seymour RA. Dental treatment, antibiotic cover and infective endocarditis: a major rethink. *Dent Update* 2008;35:366–88, 370.
  38. Heimdahl A, Hall G, Hedberg M, et al. Detection and quantitation by lysis-filtration of bacteremia after different oral surgical procedures. *J Clin Microbiol* 1990;28:2205–9.
  39. Daly DG, Mitchell DH, Highfield JE, Grossberg DE, Stewart D. Bacteremia due to periodontal probing: a clinical and microbiological investigation. *J Periodontol* 2001;72:210–4.
  40. Eisenberg JM: *Doctor's decisions and the cost of medical care: the reasons for doctor's practice patterns and ways to change them*. Ann Arbor: Health Administration Press; 1986.
  41. The National Board of Health and Welfare: Myocardial infarctions in Sweden 1987–2005. Stockholm; 2008.
  42. Slovic P. *The perception of risk*. London, UK: Earthscan Publications Ltd; 2000.

43. Brehmer B. Some notes on psychological research related to risk. In: Sahlin N-E, Brehmer B, eds. *Future risks and risk management*. Dordrecht: Kluwer Academic Publishers; 1994:79–91.
44. Hays RB, Jolly BC, Galdon LJ, et al. Is insight important? Measuring capacity to change performance. *Med Educ* 2002;36:965–71.
45. Grol R. Personal paper. Beliefs and evidence in changing clinical practice. *BMJ* 1997;315:418–21.
46. Ellervall E, Björklund F, Rohlin M, Vinge E, Knutsson K. Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners. *Acta Odontol Scand* 2005;63:321–9.
47. Boyle N, Gallagher C, Sleeman D. Antibiotic prophylaxis for bacterial endocarditis -- a study of knowledge and application of guidelines among dentists and cardiologists. *J Ir Dent Assoc* 2006;51:232–7.
48. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003;362:1225–30.
49. Macfarlane J, Holmes W, Macfarlane R, Britten N. Influence of patients' expectations on antibiotic management of acute lower respiratory tract illness in general practice: questionnaire study. *BMJ* 1997;315:1211–4.
50. Bero LA, Grilli R, Grimshaw JM, Harvey E, Oxman AD, Thomson MA. Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. *BMJ* 1998;317:465–8.
51. van der Sanden WJ, Mettes DG, Plasschaert AJ, Grol RP, Mulder J, Verdonchot EH. Effectiveness of clinical practice guideline implementation on lower third molar management

in improving clinical decision-making: a randomized controlled trial. *Eur J Oral Sci* 2005;113:349–54.

52. Kolb DA. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, N.J: Prentice-Hall cop; 1984.

I



# Antibiotic prophylaxis in oral health care – the agreement between Swedish recommendations and evidence

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## ABSTRACT

**Background** Almost all (17/20) Swedish counties have pharmaceutical committees that establish recommendations for the use of antibiotic prophylaxis in oral health care.

**Objective** To evaluate the evidence for the use of antibiotic prophylaxis in oral health care, and the agreement between Swedish recommendations and evidence.

**Material and methods** We conducted a systematic literature search in PubMed and the Cochrane Controlled Trials Register. The MeSH-terms "antibiotic prophylaxis" and "dentistry" were used in the database search. Abstracts were reviewed according to specific inclusion- and exclusion criteria. A total of 186 articles were read in full text by the four authors independently. Data extraction and interpretation of data was carried out using a pre-defined protocol. In the end, one case-control study was included for evaluation of evidence.

**Results** The case-control study included patients with specific cardiac conditions. The study reported a 49% protective efficacy (Odds Ratio: 0.51) of antibiotic prophylaxis for first-time episodes of endocarditis within 30 days of procedure. This result was not statistically significant. The quality of the evidence was low. No studies were evaluated on patients with other medical conditions. The recommendations included several cardiac and other medical conditions for which there is a lack of evidence or no evidence to support the use of antibiotic prophylaxis.

**Conclusions** There is a lack of evidence to support the use of antibiotic prophylaxis. To avoid the risk of adverse events from antibiotics and the risk of developing resistant bacterial strains, the use of antibiotic prophylaxis should be minimised and recommendations in Sweden should be revised to be more evidence-based.

## INTRODUCTION

Common dental procedures induce a transient bacteremia. Decisions on whether to use antibiotic prophylaxis should weigh the risk of bacteremia inducing complications against the risk of adverse events from antibiotics, such as skin rashes, diarrhoea and anaphylaxis, and the risk of developing resistant bacterial strains.<sup>1</sup> In Sweden, most pharmaceutical committees in the counties devote resources on recommendations to support the optimal medication treatment to patients in health care. These recommendations include oral health care, with advice on when to administer antibiotic prophylaxis in connection with dental procedures to prevent infectious complications in patients with specific medical conditions. Medical conditions that could be considered in these recommendations, as well as in other recommendations, are for example patients with heart valve prosthesis, hip prosthesis, and patients with compromised immune systems.<sup>2-5</sup> A few systematic reviews have evaluated the evidence for the use of antibiotic prophylaxis in connection with dental procedures in patients with cardiac conditions.<sup>6-8</sup> However, only one previous systematic review by *Lockhart et al.*<sup>9</sup> has also evaluated the evidence for other medical conditions, other than cardiac conditions. Our aim was to conduct a systematic review of the literature to evaluate the evidence for the use of antibiotic prophylaxis in oral health care, including cardiac conditions as well as other medical conditions. Further, we evaluated the agreement between Swedish recommendations from pharmaceutical committees on the use of antibiotic prophylaxis in oral health care and evidence.

## MATERIAL AND METHODS

### **Systematic review**

In order to achieve a systematic approach, the literature review was adapted according to the method described by Goodman<sup>10</sup> and comprised the following steps: 1) problem specification, 2) formulation of a plan for the literature search, 3) literature search and retrieval of publications, and 4) data extraction, interpretation of data, and evaluation of evidence from the literature retrieved.

### *Problem specification*

- What is the evidence for the use of antibiotic prophylaxis in patients with specific medical conditions (cardiac condition, transplant, medical implant or compromised immune system due to disease or medication) to prevent infectious complications associated with dental procedures?

### *Definitions*

"Antibiotic prophylaxis" is defined in the MeSH (Index Medicus: Medical Subject Headings) browser as "use of antibiotics before, during, or after a diagnostic, therapeutic, or surgical procedure to prevent infectious complications" (<http://www.ncbi.nlm.nih.gov>).

"Dental procedure" is defined as a procedure performed by an oral health caregiver, e.g. dental assistant, dental hygienist or dentist. Tooth brushing was not included in this definition.

### *Formulation of a plan and search of the literature*

In the first step, publications were searched from PubMed and the Cochrane Controlled Trials Register by combining the MeSH-term “antibiotic prophylaxis” and “dentistry”, which yielded 275 abstracts. The search was limited to publications in English, studies in humans, with an abstract and with an entry date in the period from 1<sup>st</sup> of January 1996 to 9<sup>th</sup> of February 2009. The year 1996 was chosen as the term antibiotic prophylaxis then was introduced as a MeSH-term.

In the first step, we identified relevant publications by examining all abstracts obtained from the PubMed search. The abstracts were examined independently by the four authors. The following medical conditions, that are attended in the literature for antibiotic prophylaxis in dentistry, were included:<sup>1-3</sup>

- cardiac condition
- transplant
- medical implant
- compromised immune system due to disease or medication.

Studies on decision-making, theoretical analyses, cost-effectiveness analyses, patient compliance to instructions and the use of antibiotic prophylaxis in connection with primary healing after surgical procedures were excluded.

In the second step we searched the reference lists of all included publications from the first step to identify additional publications. In this step, we only included primary studies. Thus systematic reviews, reviews, guidelines, and book chapters were excluded. There were no limits for publication date. References with a title containing the following key phrases were retrieved:

- antibiotic prophylaxis and a dental procedure
- antibiotic prophylaxis and a medical condition (as specified above)

- a dental procedure and a medical condition (as specified above).

The abstracts of these references were retrieved and examined in the same manner as the abstracts yielded from the PubMed search. The literature search and retrieval of publications is presented in Fig. 1.

#### *Data extraction and interpretation of data*

Data extraction was performed according to the protocol presented in Appendix A. Each publication was read in full-text individually by the four authors. When one of the authors considered a publication not relevant, it was discussed with the other authors to reach consensus of whether to exclude or not.

Remaining publications were then interpreted individually by the four authors according to the protocol presented in Appendix B. This protocol was developed according to "Users' guides to the medical literature. II. How to use an article about therapy or prevention".<sup>11-12</sup> Only studies with a matched control group were included.

#### *Evaluation of evidence*

Evaluation of evidence was based on study design, study quality, similarities between the patient populations, similarity of the comparison groups, size of confidence intervals, and the direction and magnitude of results of individual studies, using a modified version of the GRADE system.<sup>13</sup> The overall quality of the evidence was determined to be high, moderate, low or very low as described in the GRADE system.

## RESULTS

### Systematic literature search

As Fig. 1 presents, the PubMed search resulted in 275 abstracts. After reading the abstracts and applying the inclusion and exclusion criteria, 154 remained. The second step of the search, the hand-search of the reference lists of primary studies, reviews and guidelines, resulted in 32 additional publications. Thus, a total of 186 publications were retrieved and read in full-text.

### *Data extraction and interpretation of data*

Of the 186 publications, which were read in full-text with the aid of Appendix A, 78 were primary studies, 4 were systematic reviews, 87 were reviews, and 17 were guidelines. After data extraction and interpretation according to Appendix B, only studies on cardiac conditions remained. The most common reason for exclusion was the lack of a control group of patients. Initially, three primary studies were included.<sup>14-16</sup> None of these were randomised controlled trials. However, after further interpretation of data, two of the primary studies were excluded.<sup>14,16</sup> In these two studies, people with endocarditis that died (approximately 20% of potential cases in both studies) were excluded from the group of cases. The exclusion of these patients might have biased the results in these studies.

As presented in Table 1, the only primary study that was finally included was a retrospective case-control study.<sup>15</sup> In the study by van der Meer *et al.*<sup>15</sup> the cases and controls were not compared in the usual way, where cases receive an intervention and controls do not. The difference between cases and controls was that cases comprised patients who had or were suspected of having bacterial endocarditis as defined by von Reyn's criteria.<sup>17</sup> Cases were included if they had congenital heart disease, coarctation of the aorta, rheumatic and other

valvular dysfunction, or mitral valve prolapse with mitral regurgitation. Controls with a cardiac lesion and increased risk of endocarditis were included. In this study<sup>15</sup> the authors motivated that subjects with prosthetic heart valves were excluded because 1) they probably have a much higher risk of endocarditis and are a different risk-group, and 2) there were too few patients with prosthetic valves for a case-control study. Antibiotic prophylaxis was given to some cases and some controls (Table 1). The study<sup>15</sup> reported a 49% protective efficacy (Odds Ratio: 0.51) of antibiotic prophylaxis for first-time episodes of endocarditis within 30 days of procedure. This result was not statistically significant, as reported in the study.

### *Evaluation of evidence*

There were no studies on other medical conditions than on cardiac conditions. Only one study<sup>15</sup> provided evidence for the use of antibiotic prophylaxis in patients with cardiac conditions. The study by van der Meer *et al.*<sup>15</sup> included 248 patients, of which 34 received antibiotic prophylaxis. The results from this study presented a 49% non-significant protective efficacy of antibiotic prophylaxis for first-time episodes of endocarditis within 30 days of procedure. The confidence interval was large and greater than 1 (90% CI: 0.11-2.29), which indicates equal risk in the groups, and thus, no protective efficacy. Based on this, the results are uncertain. The quality of the evidence was graded as low.<sup>13</sup> Thus, there is a lack of evidence to support the use of antibiotic prophylaxis in patients with cardiac conditions to prevent infectious complications associated with dental procedures.

### **Swedish recommendations and agreement with evidence**

A total of 17/20 Swedish counties had recommendations developed by the pharmaceutical committees for the use of antibiotic prophylaxis. Three counties did not have recommendations concerning the use of antibiotic prophylaxis in oral health care. Thirteen

counties used a joint recommendation and four counties had their own recommendation, which made a total of five documents that were evaluated in this study. The recommendations were current during 2008. Of these two were updated in 2008, one in 2007, one in 2005 and one in 1999. As presented in Table 2, the recommendations included several medical conditions for consideration of antibiotic prophylaxis administration in connection with dental procedures. We have presented the medical conditions that were included in recommendations by using the exact terminologies that were used in the different documents. This means that some medical conditions, for example “not well controlled diabetes” is also included in “diabetes” or “compromised immune system”. The reason for this presentation was to illustrate the variety of terminologies that are used in recommendations. All recommendations included cardiac conditions. There was consistency regarding the inclusion of patients with heart valve prosthesis, a previous episode of endocarditis and congenital heart disease. Some recommendations also included patients with heart valve surgery and acquired valvular disease. These are all medical conditions where there is a lack of evidence or no evidence for the effectiveness of antibiotic prophylaxis to prevent infectious complications.

## **DISCUSSION**

### **Methodological considerations**

The search limitations regarding language, only including publications with abstracts, and not including unpublished data may have resulted in missing publications. We conducted a wide search, but it is always possible that there may be studies as of yet not identified.

Randomised controlled trials offer the best protection against bias. However, nonrandomised studies may also add new insights. According to a study on 45 medical topics, there is a high correlation between randomised and nonrandomised trials in their estimates of

efficacy of intervention.<sup>18</sup> Therefore, we included nonrandomised studies.

## **Evidence**

The quality of the evidence was low and we therefore conclude that there is a lack of evidence to support the use of antibiotic prophylaxis in patients with specific cardiac conditions to prevent infectious complications associated with dental procedures. This conclusion is in accordance with the results of the systematic reviews by Oliver *et al.*,<sup>6</sup> Lockhart *et al.*,<sup>9</sup> NICE<sup>7</sup> and Oliver *et al.*<sup>8</sup> However, in the study by van der Meer *et al.*<sup>15</sup> patients with prosthetic heart valves were not included. This means that we can not dismiss the possibility that there could be a significant protective efficacy for this group of patients. Although there is a lack of evidence, the American Heart Association (AHA) argues that patients who would suffer the most severe consequences of an endocarditis episode, should receive antibiotic prophylaxis.<sup>2</sup> The AHA includes the following cardiac conditions: prosthetic cardiac valve or prosthetic material used for cardiac valve repair, previous infective endocarditis, specified types of congenital heart disease, and cardiac transplantation recipients who develop cardiac valvulopathy.<sup>2</sup> NICE has taken a more radical position and no longer recommends administration of antibiotic prophylaxis.<sup>7</sup> Regarding other medical conditions there was no evidence in the literature to support the use of antibiotic prophylaxis which is also reported by Lockhart *et al.*<sup>9</sup>

It would be helpful to gain a higher level of evidence. The question is, if it would be possible to perform studies that would increase the quality of evidence. The fact that the inclusion of all endocarditis cases in the Netherlands for two years produced only 44 appropriate cases<sup>15</sup> indicates the challenge. It would require large efforts to design and perform trials with adequate sample selection and size, appropriate controls and with clear outcomes. Such a study would probably need to involve several countries and centres.

Reports of how many endocarditis cases that can be associated with dental procedures differ, some report 4%<sup>19</sup> and others as much as 14% of all cases.<sup>20</sup> Moreover, the fact that antibiotics may reduce bacteremia but not completely eliminate bacteremia<sup>21</sup> and thus can result in patients having endocarditis although antibiotics were administered appropriately,<sup>22</sup> adds to the complexity when designing future trials. Besides, when studying the risk for patients to develop endocarditis, the patients' oral health status is another variable of interest. Patients' oral health status correlates with the occurrence of bacteremia<sup>21</sup> and could influence the risk of developing endocarditis.<sup>23</sup> Spontaneous bacteremia from the oral cavity, that occur during daily activities such as chewing or tooth brushing, is considered to cause a high percentage of endocarditis cases.<sup>20</sup> Given that, it is reasonable to argue that the remaining 4-14% that are considered to be caused by dental procedures may also be caused by spontaneous bacteremias.<sup>24</sup>

## **Recommendations**

Recommendations in Sweden included several cardiac conditions and other medical conditions for which there is lack of evidence or no evidence to support the use of antibiotic prophylaxis (table 2). However, based on consensus they included cardiac conditions that are also included in AHAs recommendations updated in 2007<sup>2</sup> or were included in AHAs recommendations in 1997.<sup>25</sup> AHA is considered as a major authority and their recommendations are often the basis of other recommendations internationally. However, the recommendations also included several other medical conditions (table 2). Previous studies reported that GPs in Sweden<sup>26</sup> and England<sup>27</sup> to a large extent administer antibiotic prophylaxis to patients with medical conditions, such as renal transplants, diabetes, and prosthetic joints. Even though there is no evidence for using antibiotic prophylaxis in patients

with these medical conditions, GDPs were confident in their decisions on administration of antibiotic prophylaxis.<sup>28</sup>

In table 2, we illustrated the variety of terminologies for medical conditions that were used in recommendations. Some of the terminology might be difficult to interpret by general dental practitioners. For example it might be difficult to distinguish if a patient has a “serious kidney disease” or which conditions that could be included in “inflammatory disease”. Furthermore, some recommendations specify types of “congenital heart disease” for which antibiotic prophylaxis is warranted, for example “unrepaired cyanotic congenital heart disease“ or “repaired congenital heart disease with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device” (not presented in table 2). This terminology is probably not understood by most GDPs in Sweden, since they are not educated in the definition in different cardiac conditions and which cardiac conditions that involve deficiencies to warrant administration of antibiotic prophylaxis.

Several limitations in knowledge probably exist in GDPs’ decisions of whether or not to administer antibiotic prophylaxis. When GDPs are in doubt about whether to administer antibiotic prophylaxis, and recommendations are unclear or ambiguous, GDP might decide to administer antibiotics “just in case”. Since potential adverse events such as skin rashes and diarrhoea are not serious and anaphylaxis is a very rare consequence, GDPs might believe that they have more control over adverse events and would judge these risks as small. However, the most serious adverse reactions occur in patients with no history of allergy.<sup>29</sup> Antibiotic prophylaxis against endocarditis in connection with dental procedures may lead to a greater number of deaths through fatal anaphylaxis, than a strategy of no prophylaxis.<sup>30</sup> Further, complaints of incorrect treatment to the Swedish National Board of Health and Welfare are seldom made by patients because of over-use of an intervention, but rather concerning shortcomings of interventions. Such an attitude would result in

overutilization. There is also the dilemma that a protective efficacy that is very low on a population basis might be important to the individual patient.<sup>15</sup> More concern is also given to the growing phenomenon of bacterial resistance, which is caused by the use and abuse of antibiotics. Eventhough there is lack of data on the morbidity and mortality attributable to antibiotic resistance, we should not neglect this significant threat to public health.<sup>31</sup>

Arguments about the general risk of developing resistant bacterial strains might be considered too abstract and irrelevant to a clinician in the situation of a particular patient.

Pharmaceutical committees is the most common organization issuing recommendations in Sweden. However, there are also other recommendations issued by for example infection clinics at hospitals, the public dental health service and the Swedish National Board of Health and Welfare. Recommendations differ according to which medical conditions that are included, which might be confusing to GDPs. One way to decrease confusion might be to develop one document serving as a national recommendation. In previous studies, we have presented that GDPs lack knowledge of which medical conditions and dental procedures that could be considered for antibiotic prophylaxis administration according to recommendations.<sup>26</sup> There is a need for revisions of recommendations to be more evidence-based, but significant efforts are also needed to implement recommendations in clinical practice. A successful implementation strategy must first identify potential barriers.<sup>32</sup> However, even if consensus was achieved on a national level by developing a national recommendation document, other barriers might exist in the social context, for example reactions by colleagues. Furthermore, barriers such as knowledge, attitudes and habits might exist on the individual level.<sup>32</sup>

## **ACKNOWLEDGEMENTS**

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## REFERENCES

1. Pallasch T J, Slots J. Antibiotic prophylaxis and the medically compromised patient. *Periodontol 2000* 1996; 10: 107–138.
2. Wilson W, Taubert K A, Gewitz M, *et al.* Prevention of infective endocarditis: guidelines from the American Heart Association. *J Am Dent Assoc* 2007; 138: 739–745, 747–760.
3. American Dental Association; American Academy of Orthopaedic Surgeons. Advisory statement. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc* 2003; 134: 895–899.
4. Therapy Group of Odontology, Pharmaceutical Committee in Skåne County. *Dental care – recommended drugs*. Lund, Sweden; 2008.
5. Pharmaceutical Committee in Västerbotten County: *Therapy recommendations 2008*. Umeå, Sweden; 2008.
6. Oliver R, Roberts G J, Hooper L. Penicillins for the prophylaxis of bacterial endocarditis in dentistry. *Cochrane Database Syst Rev* 2004: CD003813.
7. National Institute for Health and Clinical Excellence. Prophylaxis against infective endocarditis. Antimicrobial prophylaxis against infective in adults and children undergoing interventional procedures. *NICE Clinical Guidelines* no. 64, 2008.
8. Oliver R, Roberts G J, Hooper L, Worthington H V. Penicillins for the prophylaxis of bacterial endocarditis in dentistry. *Cochrane Database Syst Rev* 2008: CD003813.
9. Lockhart P B, Loven B, Brennan M T, Fox P C. The evidence base for the efficacy of antibiotic prophylaxis in dental practice. *J Am Dent Assoc* 2007; 138: 458–474.
10. Goodman, C. Literature searching and evidence interpretation for assessing health care practices. Stockholm, Sweden: The Swedish Council on Technology Assessment in Health Care, 1996.

11. Guyatt G H, Sackett D L, Cook D J. Users' guides to the medical literature. II. How to use an article about therapy or prevention. A. Are the results of the study valid? Evidence-Based Medicine Working Group. *JAMA* 1993; 270: 2598–2601.
12. Guyatt G H, Sackett D L, Cook D J. Users' guides to the medical literature. II. How to use an article about therapy or prevention. B. What were the results and will they help me in caring for my patients? Evidence-Based Medicine Working Group. *JAMA* 1994; 271: 59–63.
13. Atkins D, Best D, Briss P A, *et al.* Grading quality of evidence and strength of recommendations. *BMJ* 2004; 328: 1490.
14. Imperiale T F, Horwitz R I. Does prophylaxis prevent postdental infective endocarditis? A controlled evaluation of protective efficacy. *Am J Med* 1990; 88: 131–136.
15. van der Meer J T, van Wijk W, Thompson J, Vandenbroucke J P, Valkenburg H A, Michel M F. Efficacy of antibiotic prophylaxis for prevention of native-valve endocarditis. *Lancet* 1992; 339: 135–139.
16. Lacassin F, Hoen B, Leport C, *et al.* Procedures associated with infective endocarditis in adults. A case control study. *Eur Heart J* 1995; 16: 1968–1974.
17. von Reyn C F, Levy B S, Arbeit R D, Friedland G, Crumpacker C S. Infective endocarditis: an analysis based on strict case definitions. *Ann Intern Med* 1981; 94: 505–518.
18. Ioannidis J P, Haidich A B, Pappa M, *et al.* Comparison of evidence of treatment effects in randomized and nonrandomized studies. *JAMA* 2001; 286: 821–830.
19. Guntheroth W G. How important are dental procedures as a cause of infective endocarditis? *Am J Cardiol* 1984; 54: 797–801.

20. Bayliss R, Clarke C, Oakley C, Somerville W, Whitfield A G. The teeth and endocarditis. *Br Heart J* 1983; 50: 506–512.
21. Heimdahl A, Hall G, Hedberg M, *et al.* Detection and quantitation by lysis-filtration of bacteremia after different oral surgical procedures. *J Clin Microbiol* 1990; 28: 2205–2209.
22. Durack D T, Kaplan E L, Bisno A L. Apparent failures of endocarditis prophylaxis. Analysis of 52 cases submitted to a national registry. *JAMA* 1983; 250: 2318–2322.
23. Daly D G, Mitchell D H, Highfield J E, Grossberg D E, Stewart D. Bacteremia due to periodontal probing: a clinical and microbiological investigation. *J Periodontol* 2001; 72: 210–214.
24. Seymour RA. Dental treatment, antibiotic cover and infective endocarditis: a major rethink. *Dent Update* 2008; 35: 366–388, 370.
25. Dajani A S, Taubert K A, Wilson W, *et al.* Prevention of bacterial endocarditis: recommendations by the American Heart Association. *J Am Dent Assoc* 1997; 128: 1142–1151.
26. Ellervall E, Björklund F, Rohlin M, Vinge E, Knutsson K. Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners. *Acta Odontol Scand* 2005; 63: 321–329.
27. Palmer N A, Pealing R, Ireland R S, Martin M V. A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J* 2000; 189: 43–46.
28. Ellervall E, Brehmer B, Knutsson K. How confident are general dental practitioners in their decision to administer antibiotic prophylaxis? *BMC Med Inform Decis Mak* 2008; 8: 57.

29. Anderson J A, Adkinson N F. Allergic reactions to drugs and biologic agents. *JAMA* 1987; 258: 2891–2899.
30. Wray D, Ruiz F, Richey R, Stokes T. Prophylaxis against infective endocarditis for dental procedures – summary of the NICE guidelines. *Brit Dent J* 2008; 204: 555–557.
31. Cars O, Högberg L D, Murray, *et al.* Meeting the challenge of antibiotic resistance. *BMJ* 2008; 337: 726–728.
32. Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003; 362 :1225–1230.

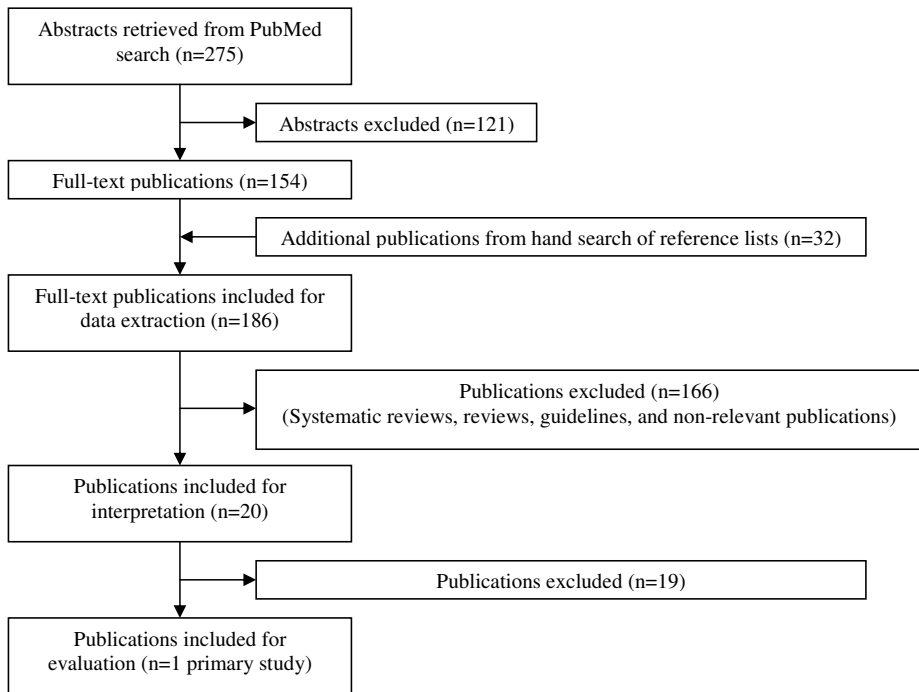
**Table 1 Data from the included study on antibiotic prophylaxis in patients with cardiac conditions in connection with dental procedures**

I <sup>st</sup> author, year, reference, country	Study design, number of subjects, (age)	Patients' medical conditions	Dental procedure	Antibiotic prophylaxis	Reported results in the study
van der Meer 1992 <sup>16</sup> The Netherlands	Retrospective, case-control n = 48 endocarditis cases (age: median 41, range 5-78) n = 200 controls without endocarditis, from cardiology department (age: median 40, range 5-80)	Native valve and cardiovascular anomalies defined in the study (prosthetic valve excluded)	44 cases and 181 controls had different procedures defined in the study (4 cases and 19 controls had other medical procedures)	8/48 cases and 26/200 controls received antibiotics according to guidelines of Netherlands Heart Foundation*	OR (follow-up period: 30 days): - first-time episode 0.51 (90% CI: 0.11-2.29) - recurrent episodes 2.13 (90% CI: 0.48-9.44)  49% protective efficacy of antibiotic prophylaxis (non-significant, CI not reported)

\*Michel M F, Thompson J, Boering G, Hess J, van Putten P L, Revision of the guidelines of the Netherlands Heart Foundation for the prevention of endocarditis. *Geneesmiddelen-bull* 1986; 20: 53-56  
OR = Odds Ratio

**Table 2 Included medical conditions for consideration of antibiotic prophylaxis administration in connection with dental procedures in Swedish recommendations (n=5) from Pharmaceutical committees compared with evidence**

Medical condition	Included in number of recommendations	Evidence
<i>Cardiac conditions:</i>		
Heart valve prosthesis	5	Lack of evidence/No evidence
Previous episode of endocarditis	5	Lack of evidence
Congenital heart disease	5	Lack of evidence
Heart valve surgery	3	Lack of evidence
Acquired valvular dysfunction	1	Lack of evidence
Coronary artery graft surgery	1	Lack of evidence/No evidence
<i>Other medical conditions</i>		
Compromised immune system	2	No evidence
Congenital immune disease	1	No evidence
Acquired immune disease	1	No evidence
Malignant blood disease	3	No evidence
Chemotherapy treatment	3	No evidence
Immunosuppressive treatment	2	No evidence
Organ transplant	2	No evidence
Serious kidney disease	2	No evidence
Inflammatory disease	2	No evidence
Rheumatoid arthritis	1	No evidence
Systemic lupus erythematosus	1	No evidence
Steroid treatment	1	No evidence
Cortison treated autoimmune disease	1	No evidence
Diabetes mellitus	1	No evidence
Not well controlled diabetes	2	No evidence
Hip prosthesis	1	No evidence
Hip prosthesis more than two years ago	2	No evidence
Previous hip prosthetic infection	1	No evidence



**Fig. 1 Trial flow of the number of included/excluded publications**



**Appendix B. Protocol for interpretation of data**

1<sup>st</sup> author:.....Publication year:.....

Title:.....

	Yes	No	Can't tell	Comments
<i>A. Are the results of the study valid?</i>				
<b>Was the assignment of subjects randomized (RCT)?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>If not, were there clearly identified control groups that were similar with respect to for example medical condition, dental procedure, antibiotic prophylaxis, sex, age?</b> Clinical controlled trial (CCT) Case-control study	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Was follow-up complete?</b> ≥ 80% of the subjects included	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Was the medical condition of the subjects adequately described?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Is the quality and the definition of the outcome adequate?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>B. What were the results?</i>				
<b>Was the data analysis appropriate?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>C. Will the results help me in caring for my patients?</i>				
<b>Can the results be applied to the subjects that are of interest in this systematic review?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Were important outcomes considered?</b> - infectious complications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Interpretation made by:

Date:

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II



ORIGINAL ARTICLE

## Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners

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### Abstract

**Objective.** To examine the strategies that general dental practitioners (GDPs) use to administer antibiotic prophylaxis and to study the agreement between the administration strategies of GDPs and local recommendations. **Methods.** Postal questionnaires in combination with telephone interviews were used. Two hundred GDPs in two Swedish counties, Skåne and Örebro, were asked to participate. The response rate was 51% ( $n=101$ ). The GDPs were presented with eight simulated cases of patients with different medical conditions for which antibiotic prophylaxis might be considered necessary when performing dental procedures (scaling, tooth removal, root canal treatment). The administration strategies of the GDPs were compared with local recommendations. **Results.** In general, the variation in the administration strategies of the GDPs was large. For two medical conditions, type 1 diabetes that was not well controlled and hip prosthesis, significantly more GDPs in Skåne than in Örebro administered antibiotic prophylaxis for tooth removal. Agreement between the administration strategies of the GDPs and local recommendations was low. Differences between the two counties were non-significant. Furthermore, within Örebro, GDPs who did not have formal access to local recommendations did not differ in their administration strategies from those who did. The choice of substance was seldom in agreement with the substance recommended, while the majority followed the recommended duration of treatment. **Conclusion.** Although recommendations existed, their impact appeared to be limited. This is significant, since the implementation of recommendations is crucial in making clinical practice more effective and in promoting the health of patients.

**Key Words:** Drug prescriptions, health planning guidelines, physiological effects of drugs, premedication

### Introduction

Average life spans in developed countries have continuously increased, and the proportion of adults over 65 years of age has tended to grow [1]. In a population in which a substantial proportion are elderly, the number of medically compromised patients, for example patients with valvular heart disease [2] and patients with prosthetic joint replacement [3], increases, as does the need for medical care [1]. In these patients, dental procedures can cause complications such as bacterial endocarditis [4] or late joint infections [5].

Common dental procedures frequently induce transient bacteremia. To prevent complications from transient bacteremia, antibiotic prophylaxis may be necessary. Decisions on whether or not to use

antibiotic prophylaxis should weigh the risk of a bacteremia inducing complications against the risk of adverse reactions to antibiotics and the risk of developing resistant bacterial strains [6]. Antibiotics are the most common medication prescribed by dental practitioners [7]. Even though many guidelines for the rational use of antibiotic prophylaxis have been published, recommendations often conflict [8]. From this perspective, it is not surprising that evidence of overuse has been found in previous studies on antibiotic prophylaxis administered by general dental practitioners (GDPs) [8,9]. This could imply that even though guidelines exist the administration strategies of dental practitioners could be expected to vary considerably and thus not always be in agreement with the published guidelines. This is inappropriate, however, considering

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the risk of adverse reactions and antibiotic resistance [10].

The aim of this study was to examine the administration strategies of GDPs, that is, whether antibiotic prophylaxis is administered for selected medical conditions and dental procedures and which antibiotic regimen is proposed. The second aim was to study the agreement between the administration strategies of the GDPs and the current published local recommendations.

## Material and methods

### *Selection of respondents*

In a computer-generated randomization procedure, 100 GDPs were selected from each of two counties in Sweden, Skåne and Örebro, a total of 200 GDPs. The two counties were selected because recommendations for the administration of antibiotic prophylaxis differed. These counties were also selected because their demographic characteristics regarding population, area, and number of dentists in relation to the population were similar. The selection of GDPs was made through the membership register of the Swedish Dental Association (which includes ~88% of all licenced dentists in Sweden).

The age distribution of the respondents in Skåne County and Örebro County was equal (mean 48 years, range 26–64 years), as was the professional experience of the GDPs (mean 20 years, range 1–44 years). In both counties, more respondents worked in the public dental health service (~60%) than in the private dental health service (~40%).

The sex distribution of the GDPs varied. In Skåne County, the number of male respondents (52%) was almost equal to the number of female respondents (48%). In Örebro, male respondents (63%) considerably outnumbered female respondents (37%). These distributions reflected the total number of female and male dentists in each of the counties according to the membership register of the Swedish Dental Association. Fifty-five percent (110/200) of the GDPs took part in the study. Nine questionnaires were not returned, leaving 101/200 (51%) respondents for analysis. There were no significant differences between respondents and non-respondents regarding age, place of work (public/private dental health service), or sex ( $p > 0.05$ ) analyzed with the chi-square analysis.

### *Questionnaire and telephone interview*

A postal questionnaire in combination with a structured telephone interview was used. Initially, an inquiry was sent to the GDPs asking whether they were willing to participate in the study. The inquiry included an introductory letter, a document of consent to participate, and a reply-paid envelope. Two reminders were sent to non-responding GDPs.

The confidentially coded questionnaire was sent about a week prior to the telephone interview to the GDPs who had agreed to participate. The GDPs were interviewed at a date and time of their convenience. The telephone interviews (performed by EE) averaged 10–20 min in length. The interviewer began each interview by asking whether the respondent had reviewed the questionnaire and if there were any questions about it. The respondent was asked if he or she had understood how the questionnaire was to be filled in. Then, each case and adherent questions were attended. The completed questionnaire was then returned. Data were collected between January and June 2003.

### *Cases presented in the questionnaire*

The questionnaire comprised eight simulated cases of patients with different medical conditions for which antibiotic prophylaxis might be considered necessary when performing dental procedures [14–17]. The questionnaire was tested by two GDPs and modified (clarifying questions and extended with one case) before the final version was developed.

The patient cases comprised the following medical conditions:

1. Type 1 diabetes mellitus, insulin-dependent, well controlled.
2. Type 2 diabetes mellitus, medicating with oral anti-diabetic agents, well controlled.
3. Type 1 diabetes mellitus, insulin-dependent, not well controlled.
4. Moderate hypertension, medicating with beta-receptor antagonist.
5. Myocardial infarction 3 months ago, medicating with ACE inhibitor, beta-receptor antagonist, low-dose aspirin, and simvastatin.
6. Kidney transplant 3 years ago, medicating with immunosuppressive and beta-receptor antagonist for moderate hypertension, well controlled without complications.
7. Heart valve prosthesis, medicating with warfarin.
8. Hip prosthesis, replacement performed 3 years ago.

Following these patient cases, the GDPs were instructed not to take conditions other than the medical condition into consideration.

For each medical condition, three types of dental procedures were presented: A. Scaling lingually in the lower jaw (the probing pocket depth is between 2 and 3 mm); B. Surgery, for example removal of an asymptomatic tooth; C. Root canal treatment of tooth 13 due to pulp exposure as a result of caries (the pulp is vital).

For each dental procedure, the GDPs were asked to consider the following questions, see example in Fig. 1.

<p><b>Case 1. Patient with type 1 diabetes mellitus, insulin-dependent, well controlled</b> (The GDPs were instructed not to take conditions other than the medical condition into consideration)</p> <ul style="list-style-type: none"> <li>• If you would scale lingually in the lower jaw (the probing pocket depth is between 2 and 3 mm), would you administer antibiotics? <input type="checkbox"/> yes <input type="checkbox"/> no</li> <li>• If you chose to administer antibiotics: <ul style="list-style-type: none"> <li>– Which drug would you administer?.....</li> <li>– What would be the duration of the treatment?.....</li> <li>– When would you begin treatment?.....</li> </ul> </li> </ul>
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Figure 1. One of the cases presented to the GDPs.

*Published local recommendations in the two counties in 2003*

Published recommendations in Skåne County and Örebro County differed in which medical conditions were considered for administration of antibiotic prophylaxis and in the antibiotic regimen recommended. In both counties, however, the recommendations stated that antibiotic prophylaxis is indicated primarily in dental procedures that could produce gingival bleeding such as scaling, extraction, or surgery [11,12]. The format of the recommendations and how they were communicated also differed between the counties.

The “Pharmaceutical Committee” of Skåne County had developed and distributed recommendations by mail to all GDPs working in the county. The recommendations that were applicable to the medical conditions in this study included for which conditions antibiotic prophylaxis should be administered, which substance to administer, and duration of treatment [11]:

- *patient with diabetes, not well controlled*: penicillin V, minimum 3–5 days
- *patient with kidney transplant*: penicillin V, minimum 3–5 days
- *patient with a heart valve prosthesis*: amoxicillin, single dose

In Örebro County, GDPs had access to recommendations through two different media. GDPs working in the public dental health service had access to recommendations on their intranet. These recommendations were also given to GDPs who had attended a seminar on antibiotic prophylaxis as part of a 4-day course in oral surgery. The recommendations that were applicable to the medical conditions in this study included for which conditions antibiotic prophylaxis should be administered, which substance to administer, and duration of treatment [12]:

- *patient with diabetes, not well controlled*: penicillin V, 7–10 days
- *patient with kidney transplant*: penicillin V, 7–10 days
- *patient with a heart valve prosthesis*: amoxicillin, single dose

- *patient with a joint prosthesis (for example, hip or knee)*: no prophylaxis when more than 2 months has passed since the replacement surgery.

In Örebro County, 11 respondents (of the GDPs working in private dental health service) had no formal access to recommendations through intranet or in a seminar.

To ensure accurate interpretation of the recommendations in both Skåne County and Örebro County, the content was reviewed by the authors (EE, KK, EV) along with the chairman of the Odontology Working Group of the “Pharmaceutical Committee” of Skåne County.

*Analysis of agreement with local recommendations*

Three levels were used to determine whether the administration of antibiotics by the GDPs was in agreement with local recommendations: (1) the decision to administer antibiotics (yes/no), (2) which drug to administer, and (3) the duration of treatment. All GDPs would begin antibiotic treatment 1–2 h before the dental procedure, which is in agreement with local recommendations and therefore this is not presented in the results. The questionnaire did not ask about dosage, since this can easily be looked up in “FASS” (Swedish National Drug Formulary).

The type of drug to administer was divided into substances in accordance with FASS. For duration of treatment, the answers were of four different groups: single dose, 1–3 days, 3–5 days, and 7–10 days. In the analysis, these answers were classified into two categories: “prophylactic regimen”, to prevent bacteremia (for durations <3 days), and “treatment regimen”, to achieve primary healing, and/or to prevent a local infection or spread of infection (for durations between 3 and 10 days).

*Statistics*

Differences between Skåne County and Örebro County in the decisions made by the GDPs about whether or not to administer antibiotic prophylaxis for each medical condition and each dental procedure

were analyzed with Fisher's exact test. Within each county, differences in the decisions made by the GDPs about whether or not to administer antibiotics for different dental procedures within each medical condition were analyzed with McNemar's test. Differences between recommendations on whether or not to administer antibiotics and the decisions made by the GDPs were analyzed with Fisher's exact test. The level of significance was 0.05 in all statistical tests.

## Results

During the telephone interviews, a few GDPs stated that if they had not previously encountered the medical condition in their practice, they would need to contact the patient's physician for advice about antibiotic administration. Since this was not an alternative given in the questionnaire, the interviewer agreed that the GDPs could write "would contact patient's physician" as a response in the questionnaire. This alternative was selected by three GDPs for the patient with a heart valve prosthesis and by seven GDPs for the patient with a kidney transplant.

### *Administration strategies*

Table I describes the administration strategies of the GDPs. Overall, there was no significant difference between GDPs in Skåne County and in Örebro County in their decision on whether or not to administer antibiotic prophylaxis when analyzed for each medical condition and each dental procedure. However, there were two exceptions. These were when tooth removal was performed in the patient with type 1 diabetes that was not well controlled and in the patient with a hip prosthesis, where more GDPs in Skåne than in Örebro would administer antibiotic prophylaxis ( $p < 0.05$ ). In the case with the hip prosthesis, the differences between the counties could be explained by the existing recommendation in Örebro County stating that antibiotics should not be administered to patients with hip prosthesis when more than 2 months had passed since replacement surgery. Generally, in both counties, the GDPs were most inclined to administer antibiotic prophylaxis in the patient with heart valve prosthesis, followed by the patient with a kidney transplant, compared to patients with other medical conditions. The GDPs were least inclined to administer antibiotic prophylaxis to the patient with moderate hypertension.

The GDPs' choice of substance was most often either amoxicillin or penicillin V. Clindamycin was seldom chosen, and then almost solely by GDPs in Skåne County. The most frequently proposed duration of treatment was a single dose or 7–10 days. Durations of 1–3 days or 5–7 days were seldom selected.

Table II presents the GDPs' decisions on whether to administer antibiotic prophylaxis for the different dental procedures within each medical condition. With the exception of the patient with type 2 diabetes that

was well controlled and the patient with moderate hypertension, there was a difference depending on which dental procedure was to be performed ( $p < 0.05$ ). The GDPs were more inclined to administer antibiotic prophylaxis for tooth removal compared to other procedures ( $p < 0.05$ ). When scaling and root canal treatment were compared, the GDPs were more inclined to administer antibiotics for scaling in the patient with type 1 diabetes that was not well controlled and in the patient with a heart valve prosthesis ( $p < 0.05$ ).

### *Agreement between GDPs' administration strategies and recommendations*

Table III presents the administration strategies of the GDPs and their agreement with local recommendations. Generally, the agreement on whether or not to administer antibiotics was low. There were no differences between the GDPs in Skåne County and in Örebro County in the agreement of their administration strategies with what was recommended ( $p > 0.05$ ). Agreement was higher for the patient with heart valve prosthesis than for the patient with type 1 diabetes that was not well controlled or for the patient with a kidney transplant. However, despite the unambiguous recommendation for patients with heart valve prosthesis in both counties, four GDPs neglected to administer antibiotic prophylaxis for tooth removal and about one-fourth (26 GDPs) neglected this recommendation for scaling. Inverse, a substantial proportion of the GDPs administered antibiotics for medical conditions that are not considered in need of prophylaxis according to recommendations, for example, myocardial infarction and hip prosthesis that had not been performed in the recent past. Among the GDPs who followed the recommendations for a certain medical condition, the choice of substance was often not in agreement with what was recommended, especially for the medical conditions where penicillin V was recommended. Of the GDPs who followed the recommendations to administer and selected the recommended substance, a majority also followed the recommended duration of treatment.

When comparing the group of GDPs who had access to local recommendations with the group who had no formal access in Örebro County, the only difference was in the number of GDPs who administered antibiotics to the patient with myocardial infarction ( $p < 0.05$ ). The recommendations did not cover this medical condition. Yet, more GDPs with access to the County's recommendations chose to administer antibiotics than GDPs without access.

## Discussion

### *The methodological approach*

Our study comprises responses from 101 GDPs, which is about 10% of all GDPs practicing in Skåne County

Table I. Administration strategies of GDPs for patients with different medical conditions when performing dental procedures analyzed on three levels: number of GDPs who would administer antibiotics, their choice of substance, and duration of treatment. For an exact description of the medical conditions, see Material and Methods section

Medical condition	Dental procedure	Administer antibiotics		Choice of substance		Duration of treatment	
		Skåne (n=50)	Örebro (n=51)	Skåne	Örebro	<3 days	3–10 days
1. Type 1 diabetes, well controlled	Scaling						
	Tooth removal	7	3	amoxicillin	3	1	4
				penicillin V	3	2	5
2. Type 2 diabetes, well controlled	Root canal treatment		1	clindamycin	1		1
				penicillin V		1	1
	Scaling						
3. Type 1 diabetes, not well controlled	Tooth removal	5	1	amoxicillin	2		2
				penicillin V	2	1	3
	clindamycin	1		1			
4. Moderate hypertension	Root canal treatment			amoxicillin	9	8	17
				penicillin V	8	3	2
	Scaling	19	11	clindamycin	2		2
5. Myocardial infarction	Tooth removal*	43	34	amoxicillin	15	20	34
				penicillin V	26	14	4
	clindamycin	2		1			
6. Kidney transplant	Root canal treatment	12	10	amoxicillin	7	4	11
				penicillin V	5	6	2
	Scaling						
7. Heart valve prosthesis	Tooth removal	1		clindamycin	1		1
	Root canal treatment						
8. Hip prosthesis, 3 years ago	Scaling	16	12	amoxicillin	12	11	22
				penicillin V	4	1	2
	Tooth removal	31	23	amoxicillin	26		42
penicillin V				4	19	2	
9. Hip prosthesis, 3 years ago	Root canal treatment	11	13	clindamycin	1	3	2
				amoxicillin	8	1	20
	penicillin V	3	13	1			
10. Hip prosthesis, 3 years ago	Scaling	29	21	amoxicillin	22	18	39
				penicillin V	7	3	5
	Tooth removal	42	41	amoxicillin	26	22	45
penicillin V				15	19	5	
11. Hip prosthesis, 3 years ago	Root canal treatment	22	17	clindamycin	1		1
				amoxicillin	15	15	30
	penicillin V	7	2	4			
12. Hip prosthesis, 3 years ago	Scaling	41	34	amoxicillin	37	34	70
				penicillin V	3		2
	Tooth removal	48	49	clindamycin	1		1
amoxicillin				42	46	86	
13. Hip prosthesis, 3 years ago	Root canal treatment	29	34	penicillin V	4	3	1
				clindamycin	2		1
	amoxicillin	26	34	60			
14. Hip prosthesis, 3 years ago	Scaling	7	3	amoxicillin	7	3	10
				penicillin V	20	12	30
	Tooth removal*	27	14	amoxicillin	6	2	4
penicillin V				1		1	
15. Hip prosthesis, 3 years ago	Root canal treatment	5	7	clindamycin	1		1
				amoxicillin	5	7	12

\* Difference between GDPs in the two counties on whether to administer antibiotic prophylaxis ( $p < 0.05$ ).

and Örebro County. Fifty-one percent of the GDPs selected agreed to participate in this study, which can be compared to similar studies with response rates between 20% and 60% [8,9,13]. One reason for the rather low response rate could be the time-consuming

method of collecting answers that comprised a questionnaire in combination with a telephone interview. This combination of methods was aimed to increase the validity of the results. The approach required more effort and time on the part of the

Table II. Difference between numbers of GDPs administering antibiotic prophylaxis for three different dental procedures in patients with different medical conditions in Skåne ( $n=50$ ) and Örebro ( $n=51$ )

Medical condition	Dental procedure	Skåne	Örebro
1. Type 1 diabetes, well controlled	Scaling – Tooth removal*	0.016	n.s.
	Tooth removal* – Root canal treatment	0.016	n.s.
	Scaling – Root canal treatment	†	n.s.
2. Type 2 diabetes, well controlled	Scaling – Tooth removal	n.s.	n.s.
	Tooth removal – Root canal treatment	n.s.	n.s.
	Scaling – Root canal treatment	†	†
3. Type 1 diabetes, not well controlled	Scaling – Tooth removal*	0.000	0.000
	Tooth removal* – Root canal treatment	0.000	0.000
	Scaling* – Root canal treatment	0.039	n.s.
4. Moderate hypertension	Scaling – Tooth removal	n.s.	†
	Tooth removal – Root canal treatment	n.s.	†
	Scaling – Root canal treatment	†	†
5. Myocardial infarction	Scaling – Tooth removal*	0.002	0.035
	Tooth removal* – Root canal treatment	0.000	0.012
	Scaling – Root canal treatment	n.s.	n.s.
6. Kidney transplant	Scaling – Tooth removal*	0.001	0.000
	Tooth removal* – Root canal treatment	0.000	0.000
	Scaling – Root canal treatment	n.s.	n.s.
7. Heart valve prosthesis	Scaling – Tooth removal*	n.s.	0.000
	Tooth removal* – Root canal treatment	0.000	0.000
	Scaling* – Root canal treatment	0.002	n.s.
8. Hip prosthesis, 3 years ago	Scaling – Tooth removal*	0.000	0.001
	Tooth removal* – Root canal treatment	0.000	0.016
	Scaling – Root canal treatment	n.s.	n.s.

\* The dental procedure for which significantly more GDPs administered antibiotics ( $p < 0.05$ ).

† No statistical comparison was possible since no GDPs chose to administer antibiotics for these procedures.

Table III. Administration strategies of GDPs in agreement with local recommendations for patients with different medical conditions when performing dental procedures in Skåne ( $n=50$ ) and Örebro I ( $n=40$ ). One group of GDPs in Örebro County had no formal access to recommendations, Örebro II ( $n=11$ ). The administration strategies of the GDPs in Örebro County I and II are compared. Three levels in administration strategies were analyzed: number of GDPs who would administer antibiotics, their choice of substance, and duration of treatment

Medical condition	Dental procedure/ strategy	Skåne ( $n=50$ )	Örebro I ( $n=40$ )	Örebro II ( $n=11$ )
Type 1 diabetes, not well controlled	Scaling/ yes	19	9	2
	penicillin V	8	3	
	treatment duration <sup>ab</sup>	6	2	
	Tooth removal/ yes	43	29	5
	penicillin V	26	14	
	treatment duration <sup>ab</sup>	24	10	
Kidney transplant	Scaling/ yes	29	16	5
	penicillin V	7	3	
	treatment duration <sup>ab</sup>	2	2	
	Tooth removal/ yes	42	33	8
	penicillin V	15	18	1
	treatment duration <sup>ab</sup>	12	14	1
Heart valve prosthesis	Scaling/ yes	41	28	6
	amoxicillin	37	28	6
	single dose	37	27	6
	Tooth removal/ yes	48	38	11
	amoxicillin	42	35	11
	single dose	39	34	11

<sup>a</sup> Minimum 3–5 days (Skåne County).

<sup>b</sup> 7–10 days (Örebro County I).

respondents compared to written answers in a questionnaire.

The analysis of the non-respondents revealed no differences in age, place of work (public/private dental health service), or sex compared to the respondents. It is reasonable to assume that the variation in administration strategies within this population of GDPs could be, not smaller, but perhaps even more extensive in a larger population.

The medical conditions were not randomly selected from a population of patients, but were selected to demonstrate expected differences in administration strategies by the GDPs. Type 1 diabetes that was not well controlled, kidney transplant, heart valve prosthesis, and hip prosthesis are medical conditions for which there are indications and recommendations to administer antibiotic prophylaxis [14–17]. In patients with moderate hypertension or patients with type 1 or type 2 diabetes that is well controlled, dental colleagues had expressed uncertainty concerning whether or not to administer antibiotic prophylaxis. For these medical conditions, no clear-cut indications exist. As the medical conditions were not randomly selected, a statistical comparison between the administration strategies of the GDPs related to medical conditions would have been irrelevant.

The dental procedures, that is, scaling, tooth removal, and root canal treatment, were selected to represent interventions that could produce gingival bleeding in various degrees and for which indications for the administration of antibiotics exist [18]. However, for root canal treatment, the indications are different. If the diagnosis is apical periodontitis, evidence supporting antibiotic prophylaxis exists since bacteremia occurs in about 20% of these patients during root canal treatment [19]. In the case described in this study, the pulp was vital and the diagnosis was pulpitis. In such cases, no evidence for prophylactic antibiotics exists.

### Results

The variation in the administration strategies of GDPs was large. These findings are similar to those in a previous Scandinavian study including GDPs prescription on patients with a previous history of endocarditis [20]. Large variations in health care have been reported for many decades [21]. As for the use of antibiotics, previous studies have found that generous general medical practitioners administered three times as much or more antibiotics than more restrictive practitioners [22,23]. Although simple educational programs were implemented, general practitioners retained their positions as generous or restrictive medical practitioners [23]. Generally, more GDPs administered antibiotic prophylaxis for the procedure of tooth removal compared to scaling. These results indicate that GDPs seem to judge the risk of complication differently for these procedures. Bacteremia occurs when gingival bleeding

is present, independent of the procedure. Thus, many common interventions in the oral cavity produce bacteremia, including toothbrushing, scaling, and removal of a tooth [18].

The GDPs' agreement with the published recommendations varied. They were in agreement with recommendations for the patient with heart valve prosthesis but not for the patient with type 1 diabetes that was not well controlled or the patient with a kidney transplant. Even when the GDPs proposed antibiotic prophylaxis for these two patients, the duration was often not in agreement with the recommendations. The GDPs administered antibiotics for <3 days to prevent bacteremia, which is different from the recommendation stating that the intention is to prevent a local infection with antibiotics until primary wound healing occurs, at least 3–5 days [11]. In patients with a heart valve prosthesis, however, the majority of GDPs chose to administer antibiotics for <3 days to prevent bacteremia, which is in agreement with recommendations [11,12]. These results suggest that GDPs may have better knowledge about the administration of antibiotics in patients with "locus minoris resistentiae".

The GDPs seldom chose the antibiotic substance that was recommended. Our results suggest low cost-effectiveness of the regimen in some patients, as the antibiotics cannot be expected to have the intended effect.

The risk of adverse reactions to antibiotics should always be considered, however, figures on the rate of drug-induced anaphylaxis vary widely. It has been suggested that 1 in every 2700 hospitalized patients suffers drug-induced anaphylaxis, and that the rate of fatal anaphylaxis of penicillin is 0.002% in the general population [24]. In a large international case-control study of anaphylaxis in a hospital population, the incidence of severe anaphylaxis to most analgesics and antibiotics was in the range 5–15 cases per 100 000 exposed. For parenteral penicillin it was 32 per 100 000 exposed patients (95% confidence interval 11–92), but for oral penicillin no cases were identified. For oral amoxicillin the incidence was 6.0 (95% confidence interval 2.4–15) [25].

To help and support GDPs in a rational use of antibiotic prophylaxis, many recommendations have been published, both nationally [11,12] and internationally [16,17]. In Sweden, national therapeutic guidelines are usually based on consensus among specialists in the field. The Swedish recommendations on antibiotic prevention in dental practice dated from 1988 [26], and have been widely adopted. In some counties, leading experts have involved local Pharmaceutical Committees to make guidelines based on the recommendations. The original source was not always cited, and the message might have been altered over time. Over the years, the view on preventive use of antibiotics has changed. The increasing focus on benefit-risk assessments in medicine, and the growing

problem with multi-resistant bacterial strains, calls for more strict use of antibiotics. In 2003, revised guidelines for endocarditis prophylaxis were issued by the Swedish Societies of Specialists in Infectious Diseases, Dentists and Cardiologists [27]. However, these guidelines do not include non-cardiac indications for antibiotic prophylaxis. The recommendations of the two Swedish counties in this study were similar regarding three medical conditions and which substance to administer, but different as to the duration of treatment. This suggests that developing recommendations for the administration of antibiotic prophylaxis is difficult, perhaps due to the absence of solid evidence [28]. Unfortunately, recommendations may give conflicting advice or advice that is hard to interpret to gain rational treatment strategies of when to administer antibiotic prophylaxis and which regimen should be used. Aside from the weak evidence to support the recommendations, difficulties in interpretation may arise between the description of the medical condition and the actual patient, which might indicate that actual conditions of the patients in clinical practice are more complex than the medical conditions described in the recommendations. Many GDPs administered antibiotic prophylaxis for medical conditions that are not considered in need of prophylaxis according to local recommendations. Inverse they fail to administer antibiotics for medical conditions that are considered in need of prophylaxis according to recommendations, for example heart valve prosthesis. The results from this study suggest that there could also be other factors influencing the decisions of GDPs, for example, the clinicians' knowledge, attitudes, or habits [29], which could explain their inverse behaviour in comparison to the recommendations.

The recommendations were not found to have any impact in this study, that is, the population that did not have access to recommendations did not differ from the populations that did have access. As the population not having formal access to recommendations in the study was small, our results must be interpreted with care. This lack of success in implementing recommendations in health care is common [30]. Simple dissemination of recommendations has been found to be ineffective, although more active implementation strategies, for example, the use of educational approaches, have had some effect [31,32]. In this study, however, the strategy of both distribution and an educational approach used in Örebro County was not more effective than simple distribution of recommendations used in Skåne County.

In conclusion, our study adds to the present scientific literature that recommendations for administration of antibiotic prophylaxis are not implemented by GDPs in their practice in these counties. This is significant, since the implementation of such recommendations is crucial in making clinical practice more effective and promoting the health of patients.

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## References

- [1] World Health Organization. Global review on oral health in ageing societies. Kobe (Japan): WHO Kobe Centre; 2002.
- [2] World Health Organization. The world health report 2002: reducing risks, promoting healthy life. Geneva (Switzerland): World Health Organization; 2002.
- [3] Brindley HH. Total joint replacement. *Clin Geriatr Med* 1985;1:401-6.
- [4] Strom BL, Abrutyn E, Berlin JA, Kinman JL, Feldman RS, Stolley PD, et al. Dental and cardiac risk factors for infective endocarditis. A population-based, case-control study. *Ann Intern Med* 1998;129:761-9.
- [5] Jacobson JJ, Schweitzer S, DePorter DJ, Lee JJ. Antibiotic prophylaxis for dental patients with joint prostheses? A decision analysis. *Int J Technol Assess Health Care* 1990;6:569-87.
- [6] Pallasch TJ, Slots J. Antibiotic prophylaxis and the medically compromised patient. *Periodontol* 2000;10:107-38.
- [7] Ciancio S, Reynard A, Zielesny M, Mather M. A survey of drug prescribing practices of dentists. *N Y State Dent J* 1989;55:29-31.
- [8] Jaunay T, Sambrook P, Goss A. Antibiotic prescribing practices by South Australian general dental practitioners. *Aust Dent J* 2000;45:179-86.
- [9] Palmer NA, Pealing R, Ireland RS, Martin MV. A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J* 2000;189:43-6.
- [10] Turnridge J. Antibiotic use or misuse? *Med J Aust* 1997;167:116-7.
- [11] Therapy Group of Odontology. Dental care - recommended drugs. Pharmaceutical Committee, Skåne County; 2002.
- [12] Nihlson A. Antibiotics in dental care - recommendations. University Hospital in Örebro: Sweden; 2002.
- [13] Epstein JB, Chong S, Le ND. A survey of antibiotic use in dentistry. *J Am Dent Assoc* 2000;131:1600-9.
- [14] Alexander RE. Routine prophylactic antibiotic use in diabetic dental patients. *J Calif Dent Assoc* 1999;27:611-8.
- [15] Eigner TL, Jastak JT, Bennett WM. Achieving oral health in patients with renal failure and renal transplants. *J Am Dent Assoc* 1986;113:612-6.
- [16] Dajani AS, Taubert KA, Wilson W, Bolger AF, Bayer A, Ferrieri P, et al. Prevention of bacterial endocarditis: recommendations by the American Heart Association. *J Am Dent Assoc* 1997;128:1142-51.
- [17] American Dental Association; American Academy of Orthopaedic Surgeons. Advisory statement. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc* 1997;128:1004-8.
- [18] Roberts GJ, Holzel HS, Sury MR, Simmons NA, Gardner P, Longhurst P. Dental bacteremia in children. *Pediatr Cardiol* 1997;18:24-7.
- [19] Heimdahl A, Hall G, Hedberg M, Sandberg H, Söder PÖ, Tunér K, et al. Detection and quantitation by lysis-filtration of bacteremia after different oral surgical procedures. *J Clin Microbiol* 1990;28:2205-9.

- [20] Preus HR, Albandar JM, Gjermo P. Antibiotic prescribing practices among Norwegian dentists. *Scand J Dent Res* 1992;100:232-5.
- [21] Wennberg JE. Practice variation: implications for our health care system. *Manag Care* 2004;13 (9 Suppl):3-7.
- [22] Steffensen FH, Schönheyder HC, Sørensen HT. High prescribers of antibiotics among general practitioners – relation to prescribing habits of other drugs and use of microbiological diagnostics. *Scand J Infect Dis* 1997;29:409-13.
- [23] Cars H, Håkansson A. To prescribe – or not to prescribe – antibiotics. District physicians' habits vary greatly, and are difficult to change. *Scand J Prim Health Care* 1995;13:3-7.
- [24] Neugut AI, Ghatak AT, Miller RL. Anaphylaxis in the United States: an investigation into its epidemiology. *Arch Intern Med* 2001;161:15-21.
- [25] International Collaborative Study of Severe Anaphylaxis. Risk of anaphylaxis in a hospital population in relation to the use of various drugs: an international study. *Pharmacoepidemiol Drug Saf* 2003;12:195-202.
- [26] Cars O, Nord CE, Nordbring F. Prevention of endocarditis with antibiotics. *Lakartidningen* 1988;85:1046-7.
- [27] National Board of Health and Welfare. Guidelines for Cardiac Care 2004. Support for Decisions in Setting Priorities. Stockholm (Sweden): National Board of Health and Welfare; 2004.
- [28] Blomgren J, Høgevik H. Antibiotic prophylaxis of endocarditis. *Tandlakartidningen* 2004;13:48-51.
- [29] Grol R. Personal paper. Beliefs and evidence in changing clinical practice. *BMJ* 1997;315:418-21.
- [30] Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. *Med Care* 2001;39 (8 Suppl 2):ii46-54.
- [31] Bero LA, Grilli R, Grimshaw JM, Harvey E, Oxman AD, Thomson MA. Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. *Cochrane Effective Practice and Organization of Care Review Group*. *BMJ* 1998;317:465-8.
- [32] Smith WR. Evidence for the effectiveness of techniques to change physician behavior. *Chest* 2000;118 (2 Suppl):S8-17.







Research article

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## How confident are general dental practitioners in their decision to administer antibiotic prophylaxis? A questionnaire study

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### Abstract

**Background:** Common dental procedures induce bacteremia. To prevent infectious complications from bacteremia in patients with specific medical conditions, antibiotic prophylaxis is considered. Recommendations are often unclear and ambiguous. In a previous study we reported wide variations in general dental practitioners' (GDPs') administrations of antibiotic prophylaxis. We hypothesized that within such a conflicting clinical area, decisions are made with a high level of personal uncertainty. This study examined GDPs' confidence in their decisions and analyzed the extent to which case-related factors might explain individual variations in confidence.

**Methods:** Postal questionnaires in combination with telephone interviews were used. The response rate was 51% (101/200). There were no significant differences between respondents and non-respondents regarding sex, age, or place of work. The GDPs were presented to patient cases of different medical conditions, where some should receive antibiotic prophylaxis according to recommendations when performing dental procedures that could cause gingival bleeding. The GDPs assessed on visual analogue scales how confident they were in their decisions. The extent to which case-related factors, medical condition and dental procedure, could explain individual variation in confidence was analyzed.

**Results:** Overall the GDPs exhibited high confidence in their decisions regardless of whether they administered antibiotic prophylaxis or not, or whether their decisions were in accordance with recommendations or not. The case-related factors could explain between 30–100% of the individual variation in GDPs' confidence. For 46%, the medical condition significantly explained the individual variation in confidence. However, for most of these GDPs, lower confidence was not presented for conditions where recommendations are unclear and higher confidence was not presented for conditions where recommendations are more clear. For 8% the dental procedure significantly explained the variation, although all procedures could cause bacteremia. For 46% neither the medical condition nor the dental procedure could significantly explain the individual variation in confidence.

**Conclusion:** The GDPs presented high confidence in their decisions, and the majority of GDPs did not present what could be considered a justified varied level of confidence according to the clarity of recommendations. Clinicians who are overconfident in their decisions may be less susceptible to modifications of their behavior to more evidence-based strategies.

## Background

Common dental procedures induce transient bacteremia. To prevent infectious complications from transient bacteremia in patients with specific medical conditions, antibiotic prophylaxis is considered. Decisions on antibiotic administration should weigh the risk of bacteremia inducing complications against the risk of adverse reactions to antibiotics and the risk of antibiotic resistance [1]. Studies have reported wide variations in general dental practitioners' (GDPs') administration strategies of antibiotic prophylaxis [2,3]. Within medical and oral health care there are wide variations in clinicians' decisions about treatment [4]. Further, the constant flow of information and technologies being developed makes it reasonable to assume that variations in care will continue to increase [5].

Medical uncertainty contributes to the significant variability in clinical practice [4]. Uncertainty could be divided into three different types [6]. The first results from clinicians having incomplete knowledge of the situation. The second is due to limitations of present medical knowledge. The third is a combination of the first two, where there is difficulty distinguishing between personal lack of knowledge and limitations in current knowledge [6]. Within this clinical area there is lack of evidence for the effectiveness of antibiotic prophylaxis [7,8], which could affect clinicians' personal confidence in their decisions.

Even though many guidelines for the rational use of antibiotic prophylaxis have been published, recommendations are often unclear and ambiguous [9]. In a previous study, we reported wide variations in GDPs' administration strategies of antibiotic prophylaxis [2]. For medical conditions where recommendations are unclear, for example not well-controlled diabetes and kidney transplant, the GDPs varied in their administration strategies. However the GDPs also varied in their decisions for medical conditions where recommendations are more clear, for example heart valve prosthesis [2]. Even though large variations in treatment strategies exist, it has been reported that the majority of clinicians believe that their colleagues would make similar decisions as themselves, thus assuming the existence of broad consensus [10,11]. Obviously there seem to be an opposition between the real situation and the clinicians' understanding of it. Dentists' assessments of indications for treatment options have been studied, i.e. how strong they judge the indication is to perform a certain treatment [10,12-14]. But to our knowledge, no previous studies have been published that present dentists' confidence in their treatment decisions.

There are a number of theories on human cognitive processes or mental models. One model is the Social Judgment Theory (SJT). This model focuses on the actual

decision made in relation to a well-defined task requiring judgement and on how the judges (i.e. the GDPs) use the available information – "cues" (i.e. medical condition and dental procedure) – to reach that decision [15]. Our aim was to examine, with the use of the SJT, the confidence of GDPs in their decisions on administration of antibiotic prophylaxis to patients with different medical conditions and to analyze the extent to which case-related factors, medical condition and dental procedure, might explain individual variation in confidence.

Within such a conflicting clinical area, with wide variation in GDPs' administration strategies for different medical conditions and dental procedures [2] and where recommendations are unclear [16,17], the following hypothesis guided the design of the study:

- Decisions are made with a high level of personal uncertainty and therefore GDPs will present low confidence in their decisions (values below 30 mm on a visual analogue scale was considered as low confidence, and values above 70 mm was considered as high confidence).
- No significant differences in confidence assessments will be found between men and women, between GDPs working in Public Dental Service and private dental service, between ages or between GDPs with varying years of professional experience. This hypothesis was based on results from studies where no differences in judgements were found by clinicians with varying years of professional experience [10,11].
- Since recommendations are unclear for many medical conditions, the individual variation in confidence will largely be explained by the medical condition. All the included dental procedures could directly or indirectly cause gingival bleeding, which would indicate that if antibiotic administration is considered for one procedure it should also be considered for the other procedures and thus the confidence should be equal for all the procedures. However, our earlier study presented that GDPs differed in their decisions depending on which procedure they performed. Therefore, we assumed that the dental procedures would also explain the individual variation in confidence.

## Methods

### Setting and participants

In a computer-generated randomization procedure, 200 GDPs from two regions in Sweden were selected to participate in the study. The response rate was 51% (101/200). The share of male respondents was 57% and of female respondents 43%. These distributions reflect the distributions of female and male dentists in the membership register of the Swedish Dental Association. The mean age of

the respondents was 48 years (range 26–64 years). The mean number of years of professional experience as GDPs was 20 years (range 1–44 years). More respondents worked in the Public Dental Service (60%) than in private dental service (40%).

There were no significant differences between respondents and non-respondents regarding sex, age, or place of work (public/private dental service) ( $P > 0.05$ ), analyzed with the chi-square test. Thus, the group of respondents could be considered representative of the initial sample of GDPs who had been randomly selected for participation.

#### Data collection procedure and variables assessed

A postal questionnaire in combination with a structured telephone interview was used. Informed consent was obtained from all participants. Initially, an inquiry was sent to the GDPs asking whether they were willing to participate in the study. The inquiry included an introductory letter, a document of consent to participate, and a reply-paid envelope. Two reminders were sent to non-responding GDPs. We also applied other steps that are described in guidelines on how to improve response rates to postal questionnaires, for example using a short questionnaire to enhance the likelihood of receiving more responses [18]. The present study is the second part of a more extensive questionnaire study on administration strategies of antibiotic prophylaxis by GDPs. Data were collected between January and June 2003. The Ethics Committee at Lund University in Sweden approved the study (LU 305-02).

The questionnaire comprised eight simulated cases of patients with different medical conditions. The questionnaire was tested by two GDPs and modified (clarifying questions and extended with one case) before the final version was developed. These were the medical conditions:

1. Type 1 diabetes mellitus, insulin-dependent, well controlled.
2. Type 2 diabetes mellitus, medicating with oral anti-diabetic agents, well controlled.
3. Type 1 diabetes mellitus, insulin-dependent, not well controlled.
4. Moderate hypertension, medicating with beta-receptor antagonist.
5. Myocardial infarction 3 months ago, medicating with ACE inhibitor, beta-receptor antagonist, low-dose aspirin, and simvastatin.

6. Kidney transplant 3 years ago, medicating with immunosuppressive and beta-receptor antagonist for moderate hypertension, well controlled without complications.

7. Heart valve prosthesis, medicating with warfarin.

8. Hip prosthesis, replacement performed 3 years ago.

For each medical condition, three types of dental procedures were presented:

A. Scaling lingually in the lower jaw (probing pocket depth between 2 and 3 mm).

B. Surgery, for example, removal of an asymptomatic tooth.

C. Root canal treatment due to pulp exposure as a result of caries (the pulp is vital).

These dental procedures were selected to represent interventions that could produce gingival bleeding. Root canal treatment (dental procedure C) *per se* is not generally a procedure that is considered to cause gingival bleeding and require antibiotic prophylaxis. But placement of rubber dam clamps may cause gingival bleeding and thus generate bacteremia [19].

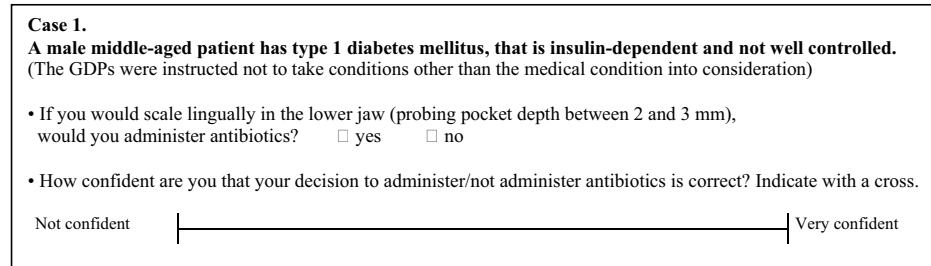
For each case, the GDPs were asked to consider the questions presented in Figure 1. The medical condition and the dental procedure were the "cues", i.e. the information in each case that we analyzed. Other information in the case presentations, for example age, was constant.

There is lack of evidence for administrating antibiotic prophylaxis [7,8]. However, recommendations exist and are often based on consensus and not on evidence. According to our interpretation of local recommendations [16,17] the GDPs would be expected to administer antibiotic prophylaxis to patients with not well-controlled diabetes, kidney transplant, and heart valve prosthesis. They could be expected to administer antibiotics for all three procedures, since they all could cause gingival bleeding.

#### Data analysis

Each GDP's assessment of confidence in a decision was measured to the nearest millimetre on a visual analogue scale (VAS) where 0 mm represented the end-point "not confident" and 100 mm the end-point "very confident".

Differences in confidence assessments between GDPs who would administer antibiotic prophylaxis and GDPs who would not, were analyzed with Independent Samples t-test ( $P = 0.05$ ). Differences in confidence assessments between men and women, between GDPs working in



**Figure 1**  
**One of the cases presented to the GDPs.**

Public Dental Service and private dental service, between ages and between GDPs with varying years of professional experience was analyzed using a multiple linear regression.

For each GDP, we calculated an R<sup>2</sup>-value presenting the extent to which variation in GDPs' confidence assess-

ments could be explained by the factors medical condition and dental procedure (two-way ANOVA analysis). In the R<sup>2</sup>-analysis, we also evaluated whether the factors significantly explained each GDPs' variation in confidence. Based on which of the factors that significantly explained the GDPs' variation in confidence we organized the GDPs into different classifications.

**Table 1: GDPs' (n = 101) administration strategies and their assessments of confidence**

Medical condition	Dental procedure	Administer antibiotics			Confidence (mean)	
		Yes	No	Total	Yes	No
Type 1 diabetes, well-controlled	Scaling	-	101	101	-	<92
	Tooth removal	10	91	101	60	99
	Root canal treatment	1	100	101	78	<93
Type 2 diabetes, well-controlled	Scaling	-	101	101	-	<92
	Tooth removal	6	95	101	57	99
	Root canal treatment	-	101	101	-	<92
Type 1 diabetes, not well-controlled	Scaling	30	71	101	77	80
	Tooth removal	77	24	101	80	72
	Root canal treatment	22	79	101	68	97
Moderate hypertension	Scaling	-	101	101	-	<91
	Tooth removal	1	100	101	54	<90
	Root canal treatment	-	101	101	-	<92
Myocardial infarction	Scaling	28	73	101	76	80
	Tooth removal	54	47	101	76	79
	Root canal treatment	24	77	101	69	91
Kidney transplant	Scaling	50	46	96	72	78
	Tooth removal	83	11	94	82	73
	Root canal treatment	39	56	95	72	73
Heart valve prosthesis	Scaling	75	25	100	86	85
	Tooth removal	97	1	98	91	<68
	Root canal treatment	63	37	100	80	80
Hip prosthesis, 3 years ago	Scaling	10	91	101	77	84
	Tooth removal	41	60	101	73	81
	Root canal treatment	12	89	101	75	84

The GDPs assessed their confidence on visual analogue scales (VAS), where 0 mm represented the end-point "not confident" and 100 mm the end-point "very confident". Measurements were made to the nearest millimetre.

<sup>a</sup> = A few GDPs answered "would contact patients' physician".

<sup>b</sup> = GDPs who would not administer antibiotics were more confident compared to GDPs who would administer antibiotics (P < 0.05).

<sup>c</sup> = No statistical comparison was possible since there were no or too few GDPs in the yes or no groups.

## Results

Table 1 presents GDPs' administration strategies of antibiotic prophylaxis and their assessments of confidence, according to GDPs who would administer antibiotics and GDPs who would not. The overall mean in confidence assessments for the entire sample of GDPs was 79 mm on the VAS and the range was 54–93 mm. Generally, the GDPs presented high confidence in all their decisions regardless of whether they administered antibiotic prophylaxis or not ( $P > 0.05$ ). There were a few exceptions. In both cases with patients with well-controlled diabetes, GDPs who would not administer antibiotics were more confident than GDPs who would administer antibiotics for the procedure of tooth removal ( $P < 0.05$ ). In the patient with not well-controlled diabetes and the patient with an episode of myocardial infarction, GDPs who would not administer antibiotics were more confident than GDPs who would administer antibiotics for the procedure of root canal treatment ( $P < 0.05$ ).

There were no significant differences in confidence assessments between men and women, between GDPs working in Public Dental Service and private dental service, between ages or between GDPs with varying years of professional experience ( $P > 0.05$ ).

The individual variation in GDP's assessments of confidence explained by the medical condition and dental procedure ( $R^2$ ) varied between 0.293–0.996 (Table 2). Based on which factors that significantly explained individual variation in confidence, the GDPs were organized into three different classifications:

- For 46 of the GDPs (~45%), the medical condition explained the individual variation in confidence ( $P < 0.05$ ) ( $R^2$  0.589–0.996). However only 7 of the GDPs (~15%) presented what could be considered a justified varied level of confidence, i.e. lower confidence for conditions where recommendations were unclear and higher confidence for conditions where recommendations were more clear.
- For 8 of the GDPs (~8%), the dental procedure explained the variation ( $P < 0.05$ ) ( $R^2$  0.599–0.747). Nearly all the GDPs administered antibiotics for the procedure of tooth removal. Their confidence in the decision for tooth removal was lower than for scaling and root canal treatment, although all three procedures could cause bacteremia.
- For 47 of the GDPs (~47%), neither the medical condition nor the dental procedure explained the variation ( $P > 0.05$ ) ( $R^2$  0.293–0.700).

## Discussion

### Methodological considerations

The 51% response rate in our study can be compared to response rates of 20–60% reported in similar studies [3,9,20]. One reason for the rather low response rate in this study could be that the method of collecting answers, a questionnaire and a telephone interview, was considered time-consuming for the respondents. But the sample could be considered representative for the GDPs who were randomly selected to be included in this study, since there were no differences between respondents and non-respondents regarding sex, age, or place of work.

The GDPs made their decisions about paper cases instead of actual patients. Although the use of paper cases have been criticised [21], the method is practical and has been validated [22,23]. To make cases realistic and vivid to respondents, it is important to include details in the presentation of the patients [24]. In our case presentations, we deliberately narrowed the information to focus on the medical condition and the dental procedure. The reason for this was that we were only interested in the clinicians' decision-making process, elucidating their knowledge when administrating antibiotic prophylaxis and thus we wanted to exclude the "noise" from patients' preferences and other information. Furthermore, the medical condition and the dental procedure is also the information that recommendations are based upon. However, we acknowledge that our presentation of the cases was not very vivid and this is a limitation of our study.

The GDPs were asked to express their confidence in their decisions concerning each of the medical conditions and dental procedures using the VAS. The VAS has been reported as an appropriate method for measuring GDPs' and oral surgeons' assessments of the strength of the indication to remove third molars, since it has a high reliability. The mean correlation coefficient of intra-examiner reliability was 0.72 for the GDPs and 0.84 for oral surgeons [25]. When we asked the GDPs "How confident are you that your decision to administer/not administer antibiotics is correct?" (see question in Figure 1), we did not mean correctness in relation to recommendations or evidence. We meant the GDP's own personal viewpoint of correctness related to each case. In the telephone interviews, we tried to ensure that our intention was understood. However, we can not be certain that this was accomplished since respondents' interpretation of questions varies [26]. Further, the study was descriptive and we did not examine the GDPs' cognitive process since we did not ask them to vocalise their thoughts when they assessed their confidence on the VAS.

**Table 2: GDPs' individual variation in their confidence assessments, explained by the factors medical condition and dental procedure (R<sup>2</sup>)**

GDP	R <sup>2</sup>	Medical condition	Dental procedure	GDP	R <sup>2</sup>	Medical condition	Dental procedure
1	0.407			52	0.700		
2	0.398			53	0.598		
3	0.798	*		54	0.419		
4	0.450			55	0.973	*	
5	0.689		*	56	0.783	*	
6	0.691	*		57	0.669		*
7	0.569			58	0.632	*	
8	0.758	*		59	0.491		
9	0.714		*	60	0.337		
10	0.394			61	0.732	*	
11	0.942	*		62	0.538		
12	0.910	*		63	0.807	*	
13	0.527			64	0.632		
14	0.687	*		65	0.472		
15	0.506			66	0.735	*	
16	0.794	*		67	0.955	*	
17	0.757	*		68	0.688		*
18	0.445			69	0.459		
19	0.307			70	0.444		
20	0.812	*		71	0.386		
21	0.611		*	72	0.747		*
22	0.824	*		73	0.729		*
23	0.586			74	0.600		
24	0.626			75	0.645	*	
25	0.809	*		76	0.613	*	
26	0.373			77	0.725	*	
27	0.391			78	0.864	*	
28	0.741	*		79	0.480		
29	0.381			80	0.677	*	
30	0.996	*		81	0.293		
31	0.350			82	0.863	*	
32	0.638	*		83	0.607		
33	0.605			84	0.316		
34	0.478			85	0.548		
35	0.402			86	0.610	*	
36	0.739	*		87	0.375		
37	0.691	*		88	0.607	*	
38	0.772	*		89	0.985	*	
39	0.599		*	90	0.655	*	
40	0.559			91	0.732	*	
41	0.357			92	0.635	*	
42	0.975	*		93	0.589	*	
43	0.443			94	0.481		
44	0.842	*		95	0.888	*	
45	0.565			96	0.366		
46	0.502			97	0.654	*	
47	0.587			98	0.560		
48	0.387			99	0.744	*	
49	0.930	*		100	0.739	*	
50	0.483			101	0.870	*	
51	0.742	*					

\* P < 0.05

**Considerations of the results**

The results from our study showed that GDPs presented an overall high confidence in their decisions, regardless of whether they chose to administer antibiotics or not, or

whether their decisions were according to recommendations or not. Thus our first hypothesis, that GDPs will present low confidence in their decisions, could be rejected. Studies on clinicians' confidence in their judge-

ments and decisions are sparse. In judgements on diagnosis, results show that clinicians' are generally very confident that their diagnoses are correct although they are often inaccurate [27]. In treatment decisions, clinicians presented high confidence although they varied in their decisions and no consensus existed on which decision was optimal [28]. These results are confirmed by our findings.

The GDPs' high confidence could be questioned since evidence for the administration of antibiotic prophylaxis is inexplicit for many of the medical conditions discussed in this study [7,8]. If translated into "real-life situations", high confidence could be explained by GDPs who wish to avoid acknowledging uncertainty in their decisions, because it might increase patients' anxiety and could affect the relationship between the clinician and the patient [29]. It might also be less time-consuming to administer antibiotics in cases where there is doubt instead of discussing or trying to persuade the patient. Many patients probably feel that they are being cared for when they receive a concrete intervention, whose purpose is to prevent complications. By doing an intervention that diminishes their uncertainty and satisfies the patient, the GDPs justify their high confidence assessments. Reports of incorrect treatment to the Swedish National Board of Health and Welfare are seldom made by patients because of over-use of an intervention, but rather concerning shortcomings of interventions. Furthermore, the results from this study agree with the theory of "professional certainty", which states that clinicians are very certain/confident that their practice is correct, irrespective of how much it differs from that of others [30].

Although the GDPs generally presented high confidence in their decisions, there were a few exceptions where GDPs who would not administer antibiotics were more confident than GDPs who would. These results were revealed for the two patients with well controlled diabetes and the patient with an episode of myocardial infarction. Approximately 300 000 people in Sweden have diabetes [31] and 587 000 people have had an episode of myocardial infarction between 1987–2005 [32]. Based on these figures, all GDPs are familiar with these patients in their practice. GDPs that were more confident in their decisions might have reflected on their practice for these patients and chose not to administer unnecessary antibiotic prophylaxis. Perhaps, GDPs that were less confident in their decision lacked knowledge that such patients would not benefit from antibiotic prophylaxis.

We found no significant differences in confidence assessments when analyzing the background variables (sex, age, years of professional experience, and place of work). This could imply that other characteristics, perhaps personal-

ity, could explain the GDPs' individual variation in confidence.

Our second hypothesis, assuming that the medical condition would largely explain GDPs' variation in confidence but also that the dental procedure would explain variation in confidence, could be accepted. The case-related factors could explain between 30–100% of the individual variation in GDPs' confidence. For some of the GDPs, the medical condition significantly explained the variation in confidence. It could be expected that the varied level of confidence for these GDPs was justified if they assessed lower confidence for conditions where recommendations are unclear and higher confidence for conditions where recommendations are more clear. However, for only 15% of these GDPs the variation in confidence followed that principle.

For other GDPs, the dental procedure significantly explained the variation. These GDPs almost only administered antibiotics for the procedure of tooth removal. Their confidence in the decision for tooth removal was lower than for scaling and root canal treatment. Perhaps the GDPs were unaware or uncertain of the fact that bacteremia occurs when gingival bleeding is present, independent of the severity of the procedure [19]. So, although they lacked confidence in this decision they preferred to be on the safe side and therefore chose to administer antibiotics for the procedure of tooth removal, which is the most invasive procedure of the three.

Finally, for some GDPs neither the medical condition nor the dental procedure significantly explained the variation in confidence. These GDPs could be considered inconsistent. But that does not mean that they did not rely on any of the factors, even though they did not do so in a significant way.

Our third hypothesis, that there would be no differences in confidence between men and women, between GDPs working in Public Dental Service and private dental service, between ages or between GDPs with varying years of professional experience, was confirmed. To be able to grasp more personal characteristics, such as reasons and processes behind GDPs' behaviors, in-depth interviews should be performed to collect qualitative data [33]. Still, our results presenting an overall high confidence in GDPs' administration strategies of antibiotic prophylaxis is surprising. Generally no consideration is taken, as far as we could explore, to concerns that evidence is lacking or that recommendations are unclear in their expressed confidence.

There has been a public discussion in this field and recommendations have recently changed [34–36]. It is logic to

assume that this would make GDPs confused and could impact the GDPs' current confidence in their decisions. However, since this study revealed an overall high confidence among the GDPs regardless of whether their decisions were in accordance with recommendations or not, we are not convinced that the changes will influence GDPs' confidence in their decisions.

### Conclusion

The GDPs presented high confidence in their decisions, regardless of whether or not they chose to administer antibiotics, or whether their decisions were according to recommendations or not. The case-related factors (medical condition and dental procedure) could explain between 30–100% of the individual variation in GDPs' confidence. However only 7 of all the GDPs (~15%) presented what could be considered a justified varied level of confidence, i.e. lower confidence for conditions where recommendations were unclear and higher confidence for conditions where recommendations were more clear. Clinicians who are overconfident that their decision is correct may be less susceptible to modifications of their behavior to more evidence-based strategies [37]. Knowledge about the processes of human change is limited [38]. Research on clinicians' beliefs, attitudes, and judgements is therefore needed to discover how successful interventions can be implemented. This research must also take into account that health care delivery is becoming increasingly complex [38].

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

EE collected and analyzed the data, and wrote the manuscript. BB was a consultant during the study and was involved in the analyses and interpretation of the results. KK was supervisor, and contributed to the analyses and writing. All authors read and approved the final manuscript.

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### References

- Pallasch TJ, Slots J: **Antibiotic prophylaxis and the medically compromised patient.** *Periodontol* 2000 **19**, 107-138.
- Ellervall E, Björklund F, Rohlin M, Vinge E, Knutsson K: **Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners.** *Acta Odontol Scand* 2005, **63**:321-329.
- Palmer NA, Pealing R, Ireland RS, Martin MV: **A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England.** *Br Dent J* 2000, **189**:43-46.
- Eddy DM: **Variations in physician practice: the role of uncertainty.** *Health Aff (Millwood)* 1984, **3**(2):74-89.
- Marinho VC, Richards D, Niederman R: **Variation, certainty, evidence, and change in dental education: employing evidence-based dentistry in dental education.** *J Dent Educ* 2001, **65**:449-455.
- Katz J: **Why doctors don't disclose uncertainty.** In *Professional judgment. A reader in clinical decision making* Edited by: Dowie J, Elstein A. Cambridge: Cambridge University Press; 1988:544-565.
- Oliver R, Roberts GJ, Hooper L: **Penicillins for the prophylaxis of bacterial endocarditis in dentistry.** *Cochrane Database Syst Rev* 2004, **2**:CD003813.
- Lockhart PB, Loven B, Brennan MT, Fox PC: **The evidence base for the efficacy of antibiotic prophylaxis in dental practice.** *J Am Dent Assoc* 2007, **138**:458-474.
- Jaunay T, Sambrook P, Goss A: **Antibiotic prescribing practices by South Australian general dental practitioners.** *Aust Dent J* 2000, **45**:179-186.
- Rawski AA, Brehmer B, Knutsson K, Petersson K, Reit C, Rohlin M: **The major factors that influence endodontic retreatment decisions.** *Swed Dent J* 2003, **27**:23-29.
- Knutsson K, Ohlsson B, Troein M: **Clinicians' management strategies for patients with dyspepsia: a qualitative approach.** *BMC Gastroenterol* 2005, **5**:15.
- Knutsson K, Lysell L, Rohlin M: **Dentists' judgment strategies on prophylactic removal of mandibular third molars.** *J Dent Res* 2000, **79**:1989-1995.
- Liedholm R, Knutsson K, Lysell L, Rohlin M: **Mandibular third molars: oral surgeons' assessment of the indications for removal.** *Br J Oral Maxillofac Surg* 1999, **37**(6):440-443.
- Lysell L, Brehmer B, Knutsson K, Rohlin M: **Judgement on removal of asymptomatic mandibular third molars: influence of the perceived likelihood of pathology.** *Dentomaxillofac Radiol* 1993, **22**:173-177.
- Brehmer A, Brehmer B: **What have we learned about human judgment from thirty years of policy capturing?** In *Human Judgment. The SJT view* Edited by: Brehmer B, Joyce CRB. Amsterdam: Elsevier Science Publishers; 1988:75-114.
- Therapy Group of Odontology, Pharmaceutical Committee in Skåne County: **Dental care – recommended drugs** Lund, Sweden; 2002.
- Örebro University Hospital in Skåne County: **Antibiotics in dental care – recommendations** Örebro, Sweden; 2002.
- Edwards P, Roberts I, Clarke M, DiGiuseppi C, Pratap S, Wentz R, Kwan I: **Increasing response rates to postal questionnaires: systematic review.** *BMJ* 2002, **324**:1183.
- Roberts GJ, Holzel HS, Sury MR, Simmons NA, Gardner P, Longhurst P: **Dental bacteremia in children.** *Pediatr Cardiol* 1997, **18**:24-27.
- Epstein JB, Chong S, Le ND: **A survey of antibiotic use in dentistry.** *J Am Dent Assoc* 2000, **131**:1600-1609.
- Jones TV, Gerrity MS, Earp J: **Written case stimulations: do they predict physicians behavior?** *J Clin Epidemiol* 1990, **43**:805-815.
- Kirwan JR, Chaput de Saintonge DM, Joyce CR: **Clinical judgment analysis.** *Q J Med* 1990, **76**:935-949.
- Peabody JW, Luck J, Glassman P, Dresselhaus TR, Lee M: **Comparison of vignettes, standardized patients, and chart abstraction: a prospective validation study of 3 methods for measuring quality.** *JAMA* 2000, **283**:1715-1722.
- Neff J: **Interaction versus hypothetical other: The use of vignettes in attitude research.** *Sociology and social research* 1979, **64**:105-125.
- Lysell L, Brehmer B, Knutsson K, Rohlin M: **Rating the preventive indication for mandibular third-molar surgery. The appropriateness of the visual analogue scale.** *Acta Odontol Scand* 1995, **53**:60-64.
- Fischhoff B: **What forecasts (seem to) mean.** In *Judgment and decision making: An interdisciplinary reader* 2nd edition. Edited by: Connolly T, Arkes HR, Hammond KR. Cambridge: Cambridge University Press; 2000:353-377.
- Friedman CP, Gatti GG, Franz TM, Murphy GC, Wolf FM, Heckerling PS, Fine PL, Miller TM, Elstein AS: **Do physicians know when their diagnoses are correct? Implications for decision support and error reduction.** *J Gen Intern Med* 2005, **20**:334-339.
- Baumann AO, Deber RB, Thompson GG: **Overconfidence among physicians and nurses: the 'micro-certainty, macro-uncertainty' phenomenon.** *Soc Sci Med* 1991, **32**:167-174.
- Hayward R: **Balancing certainty and uncertainty in clinical medicine.** *Dev Med Child Neurol* 2006, **48**:74-77.

30. Evans RG: **The dog in the night-time: medical practice variations and health policy.** In *The challenges of medical practice variations* Edited by: Andersen TF, Mooney G. London: Macmillan; 1990:117-152.
31. The National Board of Health and Welfare: *Health in Sweden: The National Public Health Report 2005.* Stockholm 2005.
32. The National Board of Health and Welfare: *Myocardial infarctions in Sweden 1987–2005.* Stockholm 2008.
33. Mason J: *Qualitative researching* London: Sage; 1997.
34. Gould FK, Elliott TS, Foweraker J, Fulford M, Perry JD, Roberts GJ, Sandoe JA, Watkin RW: **Guidelines for the prevention of endocarditis: report of the Working Party of the British Society for Antimicrobial Chemotherapy.** *J Antimicrob Chemother* 2006, **57**:1035-1042.
35. Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddour LM, Levison M, Bolger A, Cabell CH, Takahashi M, Baltimore RS, Newburger JW, Strom BL, Tani LY, Gerber M, Bonow RO, Pallasch T, Shulman ST, Rowley AH, Burns JC, Ferrieri P, Gardner T, Goff D, Durack DT, American Heart Association: **Prevention of infective endocarditis: guidelines from the American Heart Association.** *J Am Dent Assoc* 2008, **139** Suppl:3S-24S.
36. Wray D, Ruiz F, Richey R, Stokes T, Guideline Development Group: **Prophylaxis against infective endocarditis for dental procedures – summary of the NICE guideline.** *Br Dent J* 2008, **204**:555-557.
37. Eisenberg JM: *Doctor's decisions and the cost of medical care: the reasons for doctor's practice patterns and ways to change them* Ann Arbor: Health Administration Press; 1986.
38. Kanouse DE, Kallich JD, Kahan JP: **Dissemination of effectiveness and outcomes research.** *Health Policy* 1995, **34**:167-192.

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# IV



## **Risk judgment by general dental practitioners: rational but uninformed**

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## ABSTRACT

**Background.** Decisions by dentists about whether to administer antibiotic prophylaxis to prevent infectious complications in patients with specific medical conditions involve judgments of risks. Recommendations for the rational use have been published.

However, several studies have shown that dentists present low adherence to recommendations and wide variations in administration strategies have been reported.

**Objective.** To examine general dental practitioners' (GDPs') assessments of the risk of complications if not administering antibiotic prophylaxis in connection with dental procedures in patients with specific medical conditions. **Methods.** Postal questionnaires in combination with telephone interviews. Risk assessments were made on visual analogue scales (VAS), where 0 mm represented "insignificant risk" and 100 mm "very significant risk". **Results.** Response rate: 51%. The mean risk assessments were higher for GDPs who administered antibiotics (range 26-72 mm on the VAS) than those who did not (range 7-31 mm) ( $P < 0.05$ ). Generally, GDPs made higher risk assessments for patients with medical conditions that are included in local recommendations than those with conditions that are not included. Overall, risk assessments were higher for tooth removal than for scaling or root canal treatment. **Conclusions.** GDPs' risk assessments were rational but uninformed. They administered antibiotics in a manner that was consistent with their risk assessments. However, their risk assessments were overestimated and inaccurate in terms of actual risks. Inaccurate judgments of risk should not be expected to disappear in the presence of new information. To achieve change, clinicians must be motivated to improve behaviour and an evidence-based

*implementation strategy is required. **Key words:** antibiotic prophylaxis; decision making; judgment; risk assessment.*

## INTRODUCTION

Decisions by dentists about whether to administer antibiotic prophylaxis to prevent infectious complications in patients with specific medical conditions are dichotomous decisions. Before making a decision, dentists need to make judgments. Such judgments should include the risks associated with administering or not administering antibiotic prophylaxis. In medical science, risk can be defined as: “The probability that an event will occur. It encompasses a variety of measures of the probability of a generally unfavourable outcome”.<sup>1</sup>

There is an element of risk inherent in clinical decisions.<sup>2</sup> The risks may include the probability of an infection if antibiotic prophylaxis is not administered, the probability of adverse events from antibiotics, and the probability of developing antibiotic resistance. The knowledge in the literature of these probabilities is limited<sup>3,4</sup> and thus there is uncertainty surrounding these decisions. Recommendations for the rational use of antibiotic prophylaxis have been published to provide support for these decisions, but most recommendations are based on consensus rather than scientific evidence. Several studies have shown that dentists present low adherence to recommendations<sup>5,6</sup> and wide variations in general dental practitioners’ (GDPs’) administration strategies of antibiotic prophylaxis have been reported.<sup>5,7,8</sup> Our aim was to examine GDPs’ assessments of the risk of complications if not administering antibiotic prophylaxis in connection with dental procedures in patients with specific medical conditions.

## METHODS

### Setting and participants

A computer-generated randomization procedure selected 200 GDPs from two Swedish counties to participate in the study. The response rate was 51% (101/200). The GDPs were selected from the membership register of the Swedish Dental Association (which included approximately 88% of all licenced dentists in Sweden in 2003). The share of male respondents was 57% and of female respondents 43%. These distributions reflect the distributions of female and male dentists in the membership register of the Swedish Dental Association. The mean age of the respondents was 48 (range 26-64). The mean number of years of professional experience as GDPs was 20 (range 1-44). More respondents worked in the Public Dental Service (60%) than in private dental service (40%).

There were no significant differences between respondents and non-respondents regarding sex, age or place of work (public/private dental service) ( $P > 0.05$ ), analyzed with the chi-square test. Thus, the group of respondents could be considered representative of the initial sample of GDPs who had been randomly selected for participation. To permit a further evaluation of the non-respondents, we constructed an abbreviated version of the questionnaire comprising three of the medical conditions and sent it to ten of the non-repondents. Three responses were received and their administration strategies presented a variation corresponding to the respondents.

## Data collection procedure

A postal questionnaire in combination with a structured telephone interview was used. Informed consent was obtained from all participants. The questionnaire and telephone interview method were described in detail in a previous study.<sup>9</sup> Data were collected between January and June 2003. The Ethics Committee at Lund University in Sweden approved the study (LU 305-02).

The questionnaire comprised eight simulated cases of patients with different medical conditions, including conditions for which antibiotic prophylaxis might be considered when performing dental procedures:<sup>10-13</sup>

1. Type 1 diabetes mellitus, insulin-dependent, well controlled.
2. Type 2 diabetes mellitus, medicating with oral anti-diabetic agents, well controlled.
3. Type 1 diabetes mellitus, insulin-dependent, not well controlled.
4. Moderate hypertension, medicating with beta-receptor antagonist.
5. Myocardial infarction 3 months ago, medicating with ACE inhibitor, beta-receptor antagonist, low-dose aspirin, and simvastatin.
6. Kidney transplant 3 years ago, medicating with immunosuppressive and beta-receptor antagonist for moderate hypertension, well controlled without complications.
7. Heart valve prosthesis, medicating with warfarin.
8. Hip prosthesis, replacement performed 3 years ago.

For each medical condition, three types of dental procedures were presented:

- A. Scaling lingually in the lower jaw (probing pocket depth between 2 and 3 mm).
- B. Surgery, for example, removal of an asymptomatic tooth.
- C. Root canal treatment due to pulp exposure as a result of caries (the pulp is vital).

These dental procedures were selected to represent interventions that could produce gingival bleeding. Root canal treatment (procedure C) *per se* is not generally a procedure that is considered to cause gingival bleeding and require antibiotic prophylaxis. But placement of rubber dam clamps may cause gingival bleeding and thus generate bacteremia.<sup>14</sup>

For each case, the GDPs were asked to consider the questions presented in Figure 1. Each GDP's assessment of risk in a decision was measured to the nearest millimetre on a visual analogue scale (VAS) where 0 mm represented the end-point "insignificant risk" and 100 mm represented "very significant risk". Risk judgment is a cognitive process of GDPs' assessments on the VAS. Risk assessments are the quantification of these judgments.

### **Data analysis**

Differences in risk assessments between GDPs who would administer antibiotic prophylaxis and those who would not were analyzed with the Independent Samples t-test ( $P = 0.05$ ). Differences in risk assessments between men and women, between

GDPs working in the Public Dental Service and private dental service, and between GDPs with varying numbers of years of professional experience were analyzed using multiple linear regression. Statistical analyses were performed using SPSS (version 14).

## RESULTS

Table 1 presents GDPs' administration of antibiotic prophylaxis and their assessments of the risk of complications if antibiotics are not administered. The results showed that the mean risk assessment was higher for GDPs who would administer antibiotics (range 26-72 mm on the VAS), than those who would not (range 7-31 mm) ( $P < 0.05$ ). The only exception was for tooth removal in the patient with type 2 diabetes that is well controlled. Overall, the GDPs' risk assessment were higher for tooth removal than for scaling or root canal treatment. Among the GDPs who administered antibiotic prophylaxis, the highest risk assessments were for patients with medical conditions that are included in local recommendations in Sweden<sup>15-16</sup> (i.e. not well controlled type 1 diabetes, kidney transplant and heart valve prosthesis) but also for myocardial infarction. For these medical conditions, risk assessments were in the 52-72 mm range on the VAS. Among the GDPs who did not administer antibiotics, the highest mean risk assessments were in the 14-31 mm range on the VAS and were for the same medical conditions. Generally, there were no differences in risk assessments between men and women, between GDPs working in the Public Dental Service and private dental service, or between GDPs with varying numbers of years of professional experience ( $P > 0.05$ ).

## DISCUSSION

### **GDPs' risk judgments**

The GDPs' risk assessments were generally higher for patients with medical conditions that are included in local recommendations than for those with conditions that are not. Risk assessments were also higher for tooth removal than scaling or root canal treatment. The GDPs were more inclined to administer antibiotics when their risk assessments were higher. In that sense, their decisions could be considered rational.

However, the GDPs appear to have generally overestimated the risk of complications. The potential complication in patients with heart valve implant is endocarditis. The estimated incidence of endocarditis in connection with dental procedures without antibiotic prophylaxis is 1 in 46 000.<sup>17</sup> Assessments of the risk of complications by GDPs who would administer antibiotic prophylaxis for the patient with heart valve prosthesis were in the 56-72 mm range on the VAS. That is clearly an overestimate and far from accurate in terms of actual risks. The risk assessments should be much closer to zero. Research has shown that the risks seen by people are often different from the actual risks.<sup>18</sup> Risk judgments by those seen as experts (for example, those who construct recommendations) focus more on probabilities and also on potential complications<sup>19</sup> such as endocarditis. GDPs' risk judgments may focus more on potential complications such as endocarditis and their most severe possible outcomes (such as death) than on probabilities. Risks that have a low probability but severe consequences, such as endocarditis that may lead to death, are often overestimated.<sup>19</sup> This could explain the GDPs' relatively high risk judgments. Another explanation for the fact that GDPs tend to overestimate risk in these patients may be that cases of

endocarditis have been reported to the Medical Responsibility Board in Sweden, after which clinicians have been reprimanded for their failure to administer antibiotic prophylaxis. That has been reported in journals, which may have caused GDPs to focus and overestimate the number of endocarditis cases and thus overestimate the risks.

Recommendations (that are based on consensus and not on evidence) state that antibiotic prophylaxis is warranted for this medical condition, but it is an interesting finding that GDPs' risk assessments are highly overestimated.

For the other medical conditions included in this study, the mean risk assessments by GDPs who administered antibiotic prophylaxis were in the 26-65 mm range on the VAS. There are several potential complications that GDPs may have in mind for these patients. Among them are serious complications such as late joint infections, kidney rejection, and sepsis or mild complications such as local infections. The literature lacks scientific evidence for the use of antibiotic prophylaxis in patients with these medical conditions<sup>4</sup>, and they are increasingly excluded from recommendations. However, many recommendations still include some of the conditions (such as not well controlled type 1 diabetes, kidney transplant and hip prosthesis) as potentially requiring antibiotic administration. Such recommendations are based on consensus rather than scientific evidence.

Decisions by clinicians are sometimes considered irrational if they have not been based on adequate information.<sup>20</sup> However, if their decisions are based on insufficient knowledge, they are not necessarily irrational. Among the GDPs who administered antibiotic prophylaxis similar risk assessments were made for the patient with heart valve prosthesis and myocardial infarction, which indicate that GDPs lack knowledge about these medical conditions and the process of developing endocarditis which is not

relevant for a patient with myocardial infarction. Overall, risk assessments by GDPs were higher for tooth removal than for scaling or root canal treatment. This indicates that these GDPs lack knowledge that bacteremia occurs when gingival bleeding is present, independent of the procedure. Many common interventions in the oral cavity – including tooth brushing, scaling, and tooth removal – produce bacteremia.<sup>14</sup>

The evidence for the use of antibiotic prophylaxis has been questioned. The National Institute for Clinical Excellence (NICE) in the UK recently revised its recommendations and now states that antibiotic prophylaxis is not warranted for any medical condition.<sup>21</sup> Research indicates that inaccurate risk judgments should not be expected to disappear in the presence of new information, given that strong initial views are resistant to change and influence the way new information is interpreted.<sup>18</sup> People tend to regard new information as reliable if it is consistent with their previous beliefs and unreliable if it is inconsistent with those beliefs.<sup>18</sup> A previous study that we conducted suggested that GDPs tend to be very confident about their decisions concerning the administration of antibiotics.<sup>9</sup> Thus, it is reasonable to assume that new information may not have much of an impact on their assessments and decisions. Research has shown that risk judgments is correlated with both probabilities and evaluations of the severity of potential consequences.<sup>22</sup> However, the demand for risk reduction is strongly related to the estimated severity of consequences and very weakly related to the probability.<sup>22</sup> This suggests that people will not be influenced very much by probability data or by statements that the risks are small.<sup>19</sup> Having the capacity to change implies that the clinician has insight into personal weaknesses and that motivation to improve behaviour is present.<sup>23</sup> Furthermore, an evidence-based implementation strategy is required.<sup>24</sup>

## Limitations

The 51% response rate in our study can be compared to the response rates of 20-60% reported in similar studies.<sup>7,8,25</sup> One reason for the rather low response rate may be that the method of collecting answers – a questionnaire and a telephone interview – was considered time-consuming for the respondents. Nevertheless, the sample could be considered representative of the GDPs who were randomly selected for inclusion in this study, given that there were no differences between respondents and non-respondents regarding sex, age or place of work. Furthermore, since our evaluation of the non-respondents showed that there was a variation in their administrations corresponding to the respondents, we have no reason to believe that the answers in this group would be very different than those from the respondents.

The GDPs made their decisions about paper cases instead of actual patients. Although the use of paper cases has been criticised,<sup>26</sup> the method is practical and has been validated.<sup>27,28</sup> The GDPs were asked to make their risk assessments using the VAS, which often serves as a measure of pain and quality of life.<sup>29</sup> However the VAS is also considered reliable in other areas, such as measuring assessments by GDPs and oral surgeons concerning the strength of the indication to remove third molars prophylactically.<sup>30</sup>

Our study was limited to GDPs' assessment of the risk of complications if antibiotics are not administered. We did not study their assessments of the risk of adverse events from antibiotics. Since potential adverse events such as skin rashes and diarrhoea are not serious and anaphylaxis is a very rare consequence, GDPs might

believe that they have more control over adverse events and would judge these risks as small.

## **Conclusions**

The GDPs' risk assessments were generally higher for patients with medical conditions that are included in local recommendations than for those with conditions that are not. Risk assessments were also higher for tooth removal than scaling or root canal treatment. The GDPs administered antibiotics in a manner that was consistent with their risk assessments. In that sense the GDPs were rational. However, they were uninformed since their risk judgments were overestimated and inaccurate in terms of actual risks. Inaccurate judgments of risk should not be expected to disappear in the presence of new information. To achieve change, clinicians must be motivated to improve their behaviour and an evidence-based implementation strategy is required.

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## REFERENCES

1. U.S. National Library of Medicine. PubMed. Accessed at [www.pubmed.gov](http://www.pubmed.gov) on 23 January 2008.
2. Pablo AL, Sitkin SB, Jemison DB. Acquisition decision-making processes: the central role of risk. *Journal of Management*. 1996;22:723-46.
3. Oliver R, Roberts GJ, Hooper L. Penicillins for the prophylaxis of bacterial endocarditis in dentistry. *Cochrane Database Syst Rev*. 2004;CD003813.
4. Lockhart PB, Loven B, Brennan MT, Fox PC. The evidence base for the efficacy of antibiotic prophylaxis in dental practice. *J Am Dent Assoc*. 2007;138:458-74.
5. Ellervall E, Björklund F, Rohlin M, Vinge E, Knutsson K. Antibiotic prophylaxis in oral health care: administration strategies of general dental practitioners. *Acta Odontol Scand*. 2005;63:321-9.
6. Boyle N, Gallagher C, Sleeman D. Antibiotic prophylaxis for bacterial endocarditis -- a study of knowledge and application of guidelines among dentists and cardiologists. *J Ir Dent Assoc*. 2006;51:232-7.
7. Palmer NA, Pealing R, Ireland RS, Martin MV. A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J*. 2000;189:43-6.
8. Jaunay T, Sambrook P, Goss A. Antibiotic prescribing practices by South Australian general dental practitioners. *Aust Dent J*. 2000;45:179-86.
9. Ellervall E, Brehmer B, Knutsson K. How confident are general dental practitioners in their decision to administer antibiotic prophylaxis? *BMC Med Inform Decis Mak*. 2008;8:57.

10. Alexander RE. Routine prophylactic antibiotic use in diabetic dental patients. *J Calif Dent Assoc.* 1999;27:611-8.
11. Eigner TL, Jastak JT, Bennett WM. Achieving oral health in patients with renal failure and renal transplants. *J Am Dent Assoc.* 1986;113:612-6.
12. Dajani AS, Taubert KA, Wilson W, Bolger AF, Bayer A, Ferrieri P, et al. Prevention of bacterial endocarditis: recommendations by the American Heart Association. *J Am Dent Assoc.* 1997;128:1142-51.
13. American Dental Association; American Academy of Orthopaedic Surgeons. Advisory statement. Antibiotic prophylaxis for dental patients with total joint replacements. *J Am Dent Assoc.* 1997;128:1004-8.
14. Roberts GJ, Holzel HS, Sury MR, Simmons NA, Gardner P, Longhurst P. Dental bacteremia in children. *Pediatr Cardiol.* 1997;18:24-7.
15. (Therapy Group of Odontology, Pharmaceutical Committee in Skåne County: Dental care – recommended drugs. Lund, Sweden; 2002)
16. Nihlson A. Antibiotics in dental care – recommendations. University Hospital in Örebro County: Sweden; 2002.
17. Duval X, Alla F, Hoen B, Danielou F, Larrieu S, Delahaye F, et al. Estimated risk of endocarditis in adults with predisposing cardiac conditions undergoing dental procedures with or without antibiotic prophylaxis. *Clin Infect Dis.* 2006;42:102-7.
18. Slovic P. The perception of risk. London, UK: Earthscan Publications Ltd; 2000.
19. Brehmer B. Some notes on psychological research related to risk. In: Sahlin N-E, Brehmer B, eds. Future risks and risk management. Dordrecht: Kluwer Academic Publishers; 1994:79-91.

20. Poses RM, Cebul RD, Wigton RS. You can lead a horse to water--improving physicians' knowledge of probabilities may not affect their decisions. *Med Decis Making*. 1995;15:65-75.
21. Wray D, Ruiz F, Richey R, Stokes T, Guideline Development Group. Prophylaxis against infective endocarditis for dental procedures – summary of the NICE guideline. *Br Dent J*. 2008;204:555-7.
22. Sjöberg L. Consequences of perceived risk: demand for mitigation. *J Risk Res*. 1999;2:129-49.
23. Hays RB, Jolly BC, Galdon LJM, McCrorie P, McAvoy PA, McManus IC, et al. Is insight important? Measuring capacity to change performance. *Med Educ*. 2002;36:965-71.
24. Grol R. Personal paper. Beliefs and evidence in changing clinical practice. *BMJ*. 1997;315:418-21.
25. Epstein JB, Chong S, Le ND. A survey of antibiotic use in dentistry. *J Am Dent Assoc*. 2000;131:1600-9.
26. Jones TV, Gerrity MS, Earp J. Written case stimulations: do they predict physicians behavior? *J Clin Epidemiol*. 1990;43:805-15.
27. Kirwan JR, Chaput de Saintonge DM, Joyce CR. Clinical judgment analysis. *Q J Med*. 1990;76:935-49.
28. Peabody JW, Luck J, Glassman P, Dresselhaus TR, Lee M. Comparison of vignettes, standardized patients, and chart abstraction: a prospective validation study of 3 methods for measuring quality. *JAMA*. 2000;283:1715-22.
29. Wolf E. Chronic orofacial pain. Understanding patients from two perspectives: the clinical view and the patient's experience. *Swed Dent J Suppl*. 2006;181:9-69.

30. Lysell L, Brehmer B, Knutsson K, Rohlin M. Rating the preventive indication for mandibular third-molar surgery. The appropriateness of the visual analogue scale. *Acta Odontol Scand.* 1995;53:60-4.

**Table 1** GDPs' ( $n = 101^*$ ) administration of antibiotic prophylaxis, their assessments of risk on the VAS and an analysis of differences in mean risk between GDPs who administered antibiotics and those who did not.

Medical condition	Dental procedure	Administer antibiotics		Risk (mean)		<i>P</i>
		Yes	No	Yes	No	
1. Type 1 diabetes, well controlled	Scaling	-	101	-	7	‡
	Tooth removal	10	91	40	12	0.00†
	Root canal treatm.	1	100	46	7	‡
2. Type 2 diabetes, well controlled	Scaling	-	101	-	7	‡
	Tooth removal	6	95	26	10	0.08
	Root canal treatm.	-	101	-	7	‡
3. Type 1 diabetes, not well controlled	Scaling	30	71	54	16	0.00†
	Tooth removal	77	24	60	22	0.00†
	Root canal treatm.	22	79	55	17	0.00†
4. Moderate hypertension	Scaling	-	101	-	8	‡
	Tooth removal	1	100	57	10	‡
	Root canal treatm.	-	101	-	8	‡
5. Myocardial infarction	Scaling	28	73	65	15	0.00†
	Tooth removal	54	47	62	17	0.00†
	Root canal treatm.	24	77	55	17	0.00†
6. Kidney transplant	Scaling	50	46	59	14	0.00†
	Tooth removal	83	11	63	31	0.00†
	Root canal treatm.	39	56	52	19	0.00†
7. Heart valve prosthesis	Scaling	75	25	68	17	0.00†
	Tooth removal	97	1	72	25	0.05†
	Root canal treatm.	63	37	56	15	0.00†
8. Hip prosthesis, 3 years ago	Scaling	10	91	47	12	0.01†
	Tooth removal	41	60	48	16	0.00†
	Root canal treatm.	12	89	45	12	0.00†

\* = For some decisions, a few GDPs answered "would contact the patient's physician" (< 101).

‡ = No statistical comparison was possible since there were no or too few GDPs in the yes or no groups.

† = GDPs who would administer antibiotics assessed the risk higher than those who would not ( $P < 0.05$ ).

**Case 1. Patient with type 1 diabetes mellitus, insulin-dependent, not well controlled.**

(The GDPs were instructed not to take conditions other than the medical condition into consideration)

- If you would scale lingually in the lower jaw (the probing pocket depth is between 2 and 3 mm), would you administer antibiotics?     yes     no

- How significant is the risk for complications if **not** administering antibiotics? Indicate with a cross.

Insignificant risk    |\_\_\_\_\_|    Very significant risk

*Figure 1. One of the cases presented to the GDPs.*

