

# DZZ

3 | 2019  
1. VOLUME

## INTERNATIONAL

German Dental Journal International – [www.online-dzz.com](http://www.online-dzz.com)  
International Journal of the German Society of Dentistry and Oral Medicine

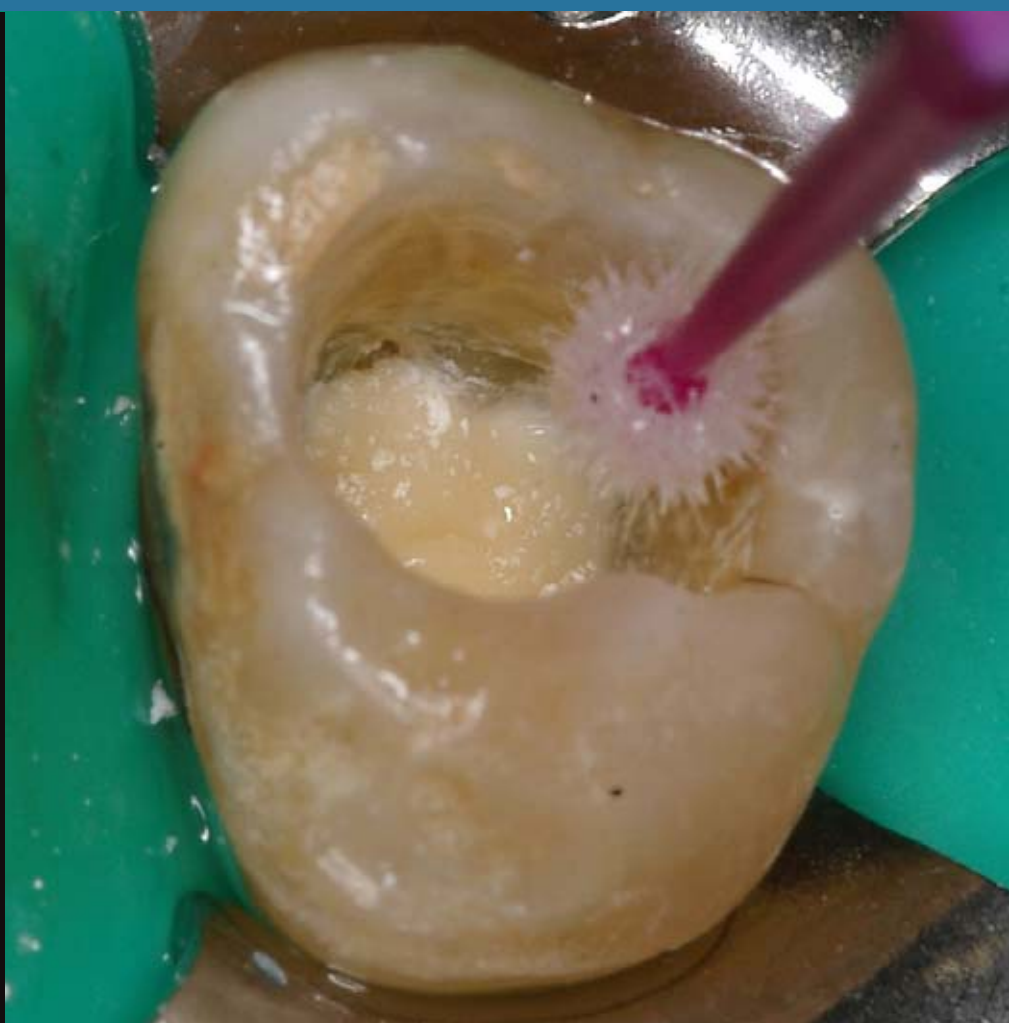
Pulpotomy in  
permanent teeth

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Understanding and  
improving care:  
Use of routine data

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Needs-based care:  
Illusion or reality?



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 Deutscher  
Ärzteverlag

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# Pulpotomy in permanent teeth



## Background

Pulpotomies are primarily carried out as a measure to maintain vitality of juvenile permanent teeth whose roots have not yet fully developed. The indications range from partial pulpitis to complex crown fractures to pulp polyps [7]. This therapy is usually not applied in permanent teeth with fully developed roots and irreversible pulpitis, due to the alleged poor regenerative capacity of the pulp. In this case, a pulpectomy is the treatment of choice. In the last few years, several studies were published that investigated the success rates of pulpotomies as a measure to maintain vitality of permanent teeth, specifically that of teeth with carious-exposed pulps and pain symptoms.

A new therapy approach pursued by some authors is the conservation of vitality of teeth with pulpitis. The following provides a short overview of the up-to-date literature on this topic. Though, currently, only very few studies exist on the therapeutic success of a pulpotomy as an alternative to a pulpectomy in permanent teeth with fully developed roots.

## Statement

### Reviews

Aguiar et al. [1] compared the success rate of partial pulpotomies, coronal pulpotomies and direct capping. They were able to show that direct capping is inferior in therapeutic effect to both types of pulpotomy due to its large variations of success rate. The partial pulpotomy showed success rates of 94,6 % in teeth with open root apices and

90,6 % in teeth with closed root apices. This was higher than the success rates in teeth treated with a coronal pulpotomy, which were 91,4 % and 85,9 %, respectively.

In 2014, Yazdani et al. [10] published a “Health technology assessment” on pulpotomies with calcium enriched mixture (CEM) in permanent teeth with irreversible pulpitis. They assessed the shortterm and longterm success of the treatment, as well as the organizational and economical aspects of the procedure. In addition, the reliability of the method was examined in comparison to a root canal treatment. In summary, authors evaluated the pulpotomy as a valid method with high therapeutic success similar to a root canal procedure. Therefore, from a socio-economic viewpoint, the authors concluded that pulpotomy is preferable to a pulpectomy.

Akhlaghi et al. [2] investigated the therapeutic success of 4 different approaches of maintaining pulp vitality: indirect capping, direct capping, partial pulpotomy and coronal pulpotomy. No inclusion or exclusion criteria were defined for the studies selected. The partial pulpotomy with subsequent pulp capping using calcium hydroxide presented a success rate of 91–100 % after 2 years. With regard to the clinical outcome, the results did not differ significantly to those of the partial pulpotomy with mineral trioxide aggregate (MTA; 95,2–99,8 %). The 2-year success rate of the coronal pulpotomy was similar at 87,5–100 % (calcium hydroxide) and 90–100 % (MTA).

Alqaderi et al. [3] examined the success rate of coronal pulpotomies

in vital permanent teeth with fully developed roots and carious-exposed pulp. On average, the success rates were over 90 %. In addition, the impact of direct capping materials and restorative materials on treatment success was analyzed. The results showed higher success rates for MTA (95 % after 1 year; 93 % after 2 years) than for calcium hydroxide (92 % after 1 year; 88 % after 2 years). Teeth that were treated with amalgam fillings showed better results after 1 year (success rate of 95 %) but worse results after 2 years (success rate of 92 %) in comparison to teeth that were treated with composite fillings (success rates of 91 % after 1 year and 93 % after 2 years).

## Clinical studies

Asgary et al. [4] published a retrospective study on pulpotomies with subsequent calcium hydroxide pulp capping as an alternative to root canal treatment. Pulpotomies were performed in 567 permanent teeth with symptomatic or asymptomatic pulpitis (carious-exposed pulp, no pain symptoms). 273 cases were evaluated with a follow-up after 1, 2, 3, 4, 5 and 10 years. The success rates were 89 % after 1 year, 75 % after 5 years and 63 % after 10 years.

Asgary et al. [6] investigated the impact of various capping materials on the success rate of pulpotomies. A coronal pulpotomy with subsequent pulp capping using MTA or calcium-enriched mixture (CEM) was performed in 244 permanent molars that showed the clinical signs of an irreversible pulpitis (patients aged 9–65 years). Following treatment, the teeth were sealed tempo-

rarily. After 7 days, they were restored with amalgam fillings. The clinical success rate of teeth restored with MTA was 98,9 % after 2 years and 98,1 % after 5 years.

Taha et al. [9] treated 50 vital permanent molars (patient age < 20 years) with fully developed roots, deep carious lesions and clinical signs of irreversible pulpitis (provided that hemostasis was possible within 6 minutes after pulp exposure). 27 teeth were treated with white ProRoot MTA (Dentsply, Tulsa OK) and 23 teeth were treated with a calcium hydroxide compound (Dycal, Dentsply Caulk, Milford, DE). The success rates of MTA after 6 months, 1 year and 2 years were at 84 %, 83 % and 85 %, respectively. The success rates of calcium hydroxide compound (Dycal) after 6 months, 1 year and 2 years were 62 %, 55 % and 43 %, respectively. Therefore, the authors recommend MTA as suitable capping material.

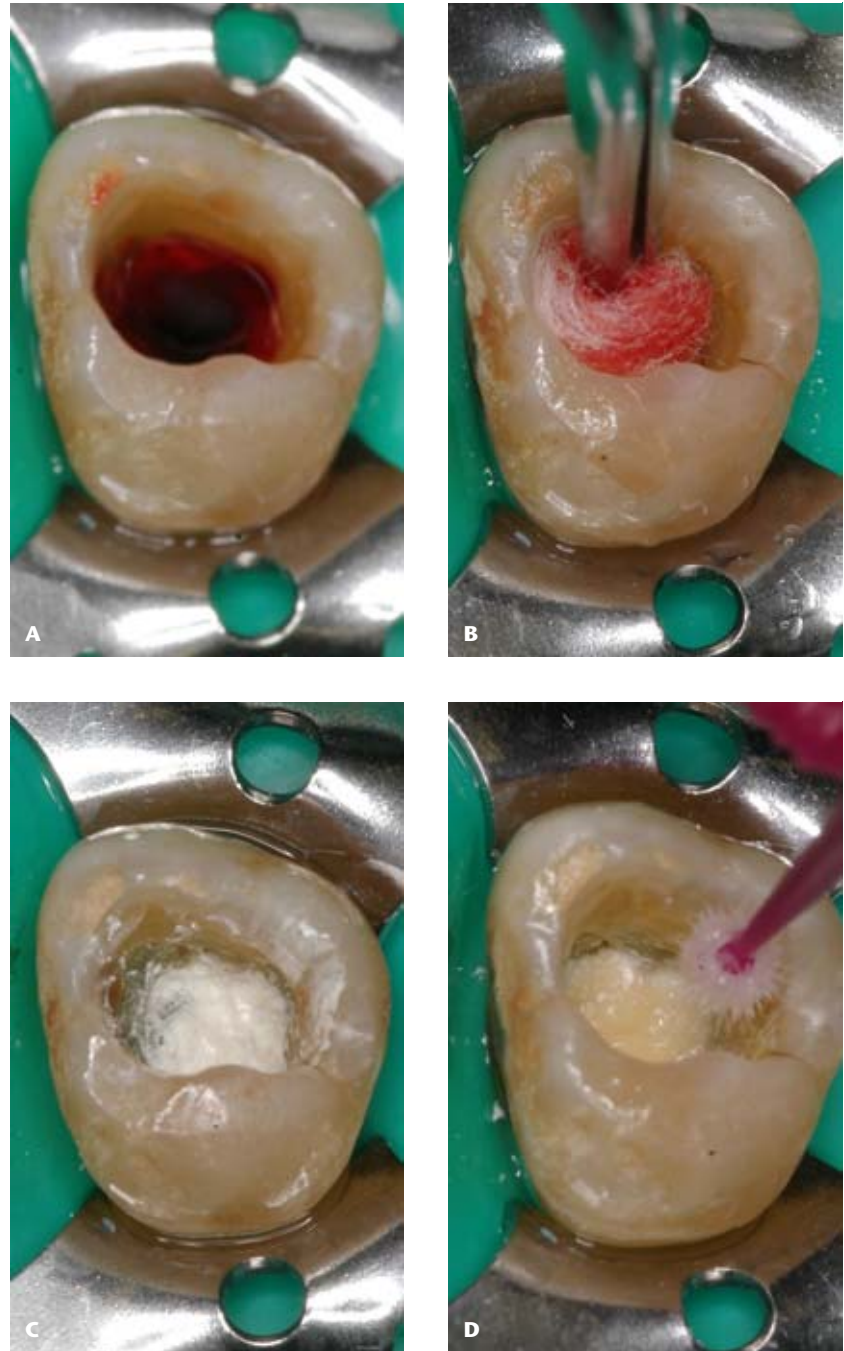
Qudeimat et al. [8] achieved a success rate of 100 % in their study of pulpotomy in permanent molars of children and teenagers (medium age:  $10,7 \pm 1,7$  years). All teeth treated showed clinical signs of irreversible pulpitis. According to the authors, 78 % of teeth showed radiographic periapical lesions.

### Case report

Asgary et al. [5] performed a pulpotomy with CEM on two maxillary molars (14 and 15; Universal Numbering System) of a 36-year old patient with irreversible pulpitis instead of pulpectomy and subsequent root canal treatment. Afterwards, the teeth were restored with amalgam restorations. After 2 years both teeth were asymptomatic and showed neither clinical nor radiographic signs of inflammation.

### Conclusion

Summarising the results of the present studies, it can be stated that pulpotomies in permanent teeth with carious-exposed pulp might be a valid alternative treatment option. From the perspective of restorative dentistry, maintaining vitality of such teeth would be desirable considering the anticipated clinical



**Figure 1A–D** Exemplary clinical procedure; **A:** Bleeding after pulpotomy under rubber dam; **B:** Hemostasis; **C:** Cover with calcium hydroxide-containing mixture; **D:** Cover with glass ionomer cement and application of adhesive

(Fig. 1A–D: V. Becker)

benefit (preservation of structural integrity). Nevertheless, the valid clinical assessment of the pulp condition, or rather the extent of inflammation is a methodical difficulty that affects the possibility of success. Furthermore, the endodontic treatment after failure could be made difficult due to new formation of dentin in the area of root canal orifices.

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(Photo: privat)

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# Dental health services research: What does it want, what can it do?

## **Abstract:**

Health services research develops, describes, clarifies, and evaluates health service processes, outcomes and relevant factors that impact on service provision. A consumer/patient focus, contextual relevance and population-relevant parameters in addition to individual-level assessments as well as multidisciplinary and multiprofessionalism are characteristic features of health services research. The relevance of health services research in Germany is increasing. Dental health services research should aim to (1) develop innovative, cross-disciplinary care concepts and to implement them, (2) consider the common risk factor approach and dentistry's role in medical services, (3) focus on consumer/patient preferences, and (4) target social and regional health inequalities. To allow methodologically robust and thematically broad evaluations, dental health services research in Germany needs to professionalize and to link with relevant actors in the healthcare system.

**Keywords:** evidence-based medicine; research levels; healthcare policy; methods; public health; effectiveness

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Translation: mt-g medical translation GmbH & Co. KG

**Citation:** Hertrampf K, Schwendicke F: Dental health services research: What does it want, what can it do? *Dtsch Zahnärztl Z Int* 2019; 1: 106–111

**Peer-reviewed article:** submitted: 18.02.2019, version accepted: 18.03.2019

**DOI.org/10.3238/dzz-int.2019.0106-0111**

### What is health services research?

Health services research is defined as “a cross-disciplinary field of research that describes and causally clarifies medical care and healthcare and its framework conditions, contributes to the development of scientifically based healthcare concepts, conducts associated research into the implementation of new healthcare concepts, and evaluates the effectiveness of healthcare structures and processes under routine conditions” [3]. Characteristic features of health services research include a strong patient orientation, focus on the contextual application and implementation of interventions, assessment not only of individual but also group or population-relevant parameters, and a multidisciplinary and multiprofessional approach [6].

Health services research is considered more of an emerging scholarly field in Germany compared to basic research and clinical research. However, over the 20 years of its existence not only has awareness of the field grown continuously but it has also become increasingly relevant. This resulted from the awareness that scientific results from basic and clinical evaluative research cannot be transferred one to one to everyday provision of healthcare, sometimes never even reaching routine practice or only with severe limitations. A level that followed clinical evaluative research was thus required that tested knowledge from previous levels under routine conditions, identified the causes of any barriers to implementation, and finally evaluated and refined interventions applied in routine healthcare.

This is based on the fact that both basic and clinically evaluative research make use of their own methods, the results of which do not necessarily lead to interventions that can be applied or which misjudge the effectiveness of interventions in routine healthcare. Clinical evaluative research thus often focuses on the efficacy of an intervention whereby the ideal (if not always entirely workable) study model is the randomized controlled trial (RCT). The results of these classic RCTs in

the field of clinical research cannot, however, provide any information about the effectiveness of interventions under routine conditions, which is subject to numerous other factors (e.g., study population, patient adherence, applicability of the intervention, sustainability). Further aspects relevant for subsequent application of an intervention in healthcare provision such as the costs of an intervention (efficiency) are only conditionally tested (and if then, often only within the special setting of a classic RCT). Such a review is necessary, however, because the effectiveness of the results of these RCTs when transferred to routine healthcare is often overestimated (the effectiveness gap; a similar thing happens when the results of basic research are transferred to clinical research). This is precisely because of the specific methods and the specific setting (highly selected patient collective, optimized application protocols, standardized and often highly sensitive outcome parameter recording, short follow-up examination periods) used in clinical research. Under routine conditions patient collectives are considerably more heterogeneous, executing studies is often more challenging due to numerous external factors, standardizing the testing of outcomes is in part more difficult and thus dependent on the investigator, and the relevant study time frames are long.

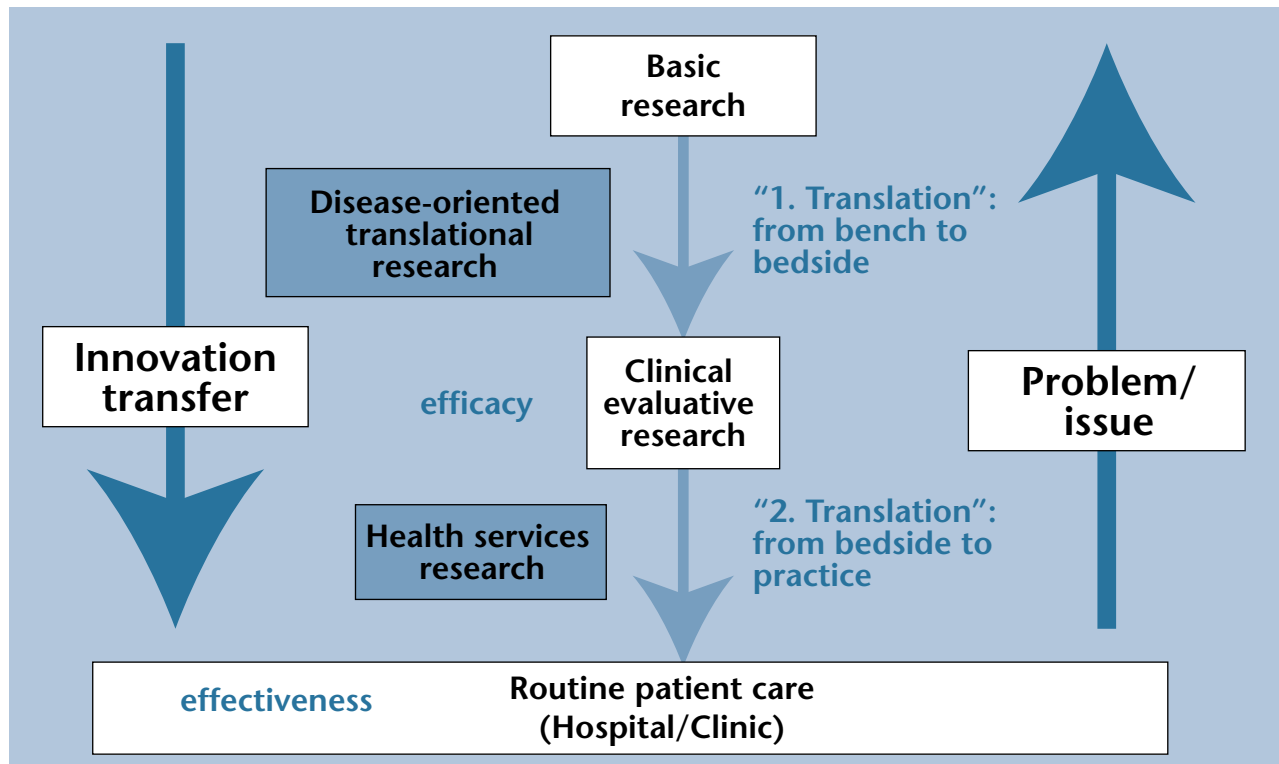
While clinical evaluative research has a high degree of internal validity due to the methods used (the results are methodologically robust), the external validity of such studies is often limited, in part because under routine conditions other patient collectives, e.g., with comorbidities, existing medications, or precarious social environments, may predominate. Such an expansion of the inclusion criteria leads, however, to heterogeneous patient collectives and considerably more complex settings (e.g., clinics instead of hospitals), consequently affecting the methodological practicability and the quality of any data collected. Therefore, these studies are very resource intensive to implement.

### What methods does health services research employ?

It thus falls onto health services research to research the “translation of scientific knowledge into the provision of healthcare in terms of its effect on the quality and efficiency from individual and socio-economic perspectives” [5]. To achieve these objectives, health services research draws on numerous methods that were not, however, specifically developed for health services research but are instead derived from other research levels. A characteristic feature, however, is the multimethodological approach of many health services research projects. This results from the diversity of the aspects to be investigated, if the aim is to describe, evaluate, causally clarify, and refine (see definition above).

Health services research thus employs methods from numerous disciplines:

- The foundation is often non-interventional studies that are characterized by long follow-up examination periods and a routine setting; claims and register data are increasingly employed among others.
- Methods from evidence-based medicine are also used such as critical appraisal of existing studies (systematic reviews, meta-analyses, meta-syntheses, health technology assessments) as well as study designs derived from clinical evaluative research (pragmatic, often cluster randomized trials).
- So that the effects of an intervention in routine practice can be comprehensively determined across sectoral boundaries, elements of quality of life research are used. Health services research incorporates patients and identifies endpoints that are reported by patients (patient-reported outcomes) or that place the focus on patients (patient-centered outcomes).
- Closely related methods from psychology and qualitative research are also used. Health services research attempts to understand how and why care is administered; quantitative research reaches its limits particularly with in-depth



**Figure 1** Various research levels must be linked for successful forwards and backwards translation.

explorations of the causes underlying healthcare measures.

- Likewise, methods from sociology and organizational sciences are used; these are often used bundled together as “implementation research” within health services research. Research aims to reveal why interventions in routine care are not applied or not applied in accordance with the recommendations; similarly, interventions are developed that increase willingness to apply measures and to improve their quality (implementation research attempts to close the second translation gap, Figure 1).
- Particularly for evaluation, health services research utilizes elements from health economics (efficiency of an intervention) and quality and safety research as well as from ethics (acceptance of an intervention, ethical implications of resource allocations).
- Finally, health services researchers must collaborate closely with clinical disciplines in dentistry and medicine (e.g., nursing research, geriatrics, etc. in the field of geriatric dentistry) in order to be able to incorporate specialist expertise.

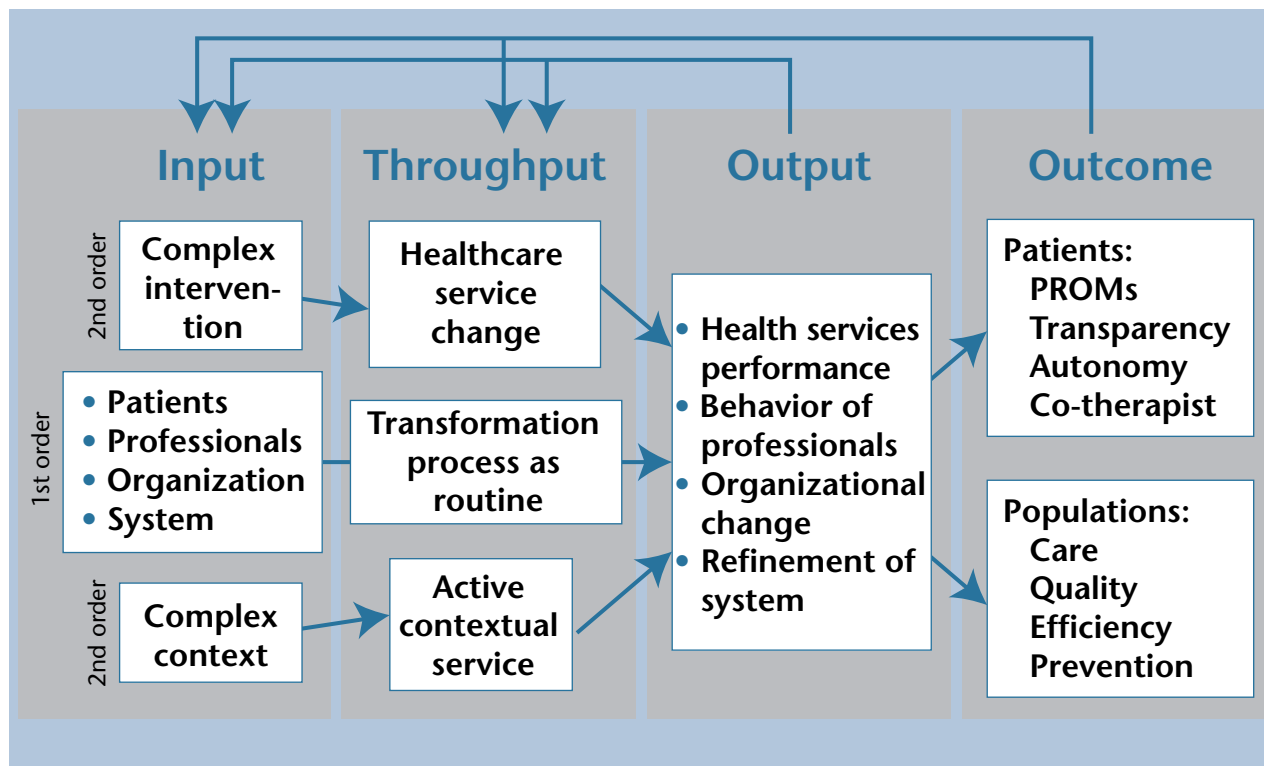
To systematize research areas, methods, and the parties concerned in health services research, Pfaff and Schrappe developed the throughput model in 2011; the model was revised and modified in 2017 [4, 7]. This model enables relevant influencing factors to be systematically and comprehensively determined for specific issues, methods to describe and modify these factors to be defined, and appropriate endpoints to be identified or operationalized (Fig. 2).

This model still comprises the four areas described below:

1. Input factors describe factors such as patients, their needs and utilization, members of associated health professions (professionals), organizations involved in the provision of health services (e.g., insurance providers), and the healthcare system (social security model, private insurance model, NHS). Material and intangible resources are also included here. In the modified throughput model (Fig. 2) these factors are described as 1st order factors and are expanded by 2nd order factors such as contextual factors, interventions, etc.

2. The throughput factor describes the services such as healthcare services (e.g., preventive, diagnostic, and therapy forms), health technologies, and the context in which this health service is to be provided (because this can actively contribute to the implementation or inhibition of the service). This aspect of health services research is often emphasized because it is precisely here that improvements in the quality of care, access to care, etc. are promised. Particularly because the context (the specific patient, physician, their interaction, and the environment) plays such a major role here and the transformation of a “scientific intervention” into a routinely applied service does not automatically take place but is instead subject to many influencing factors (input), interventions to improve health services provision should be based in theory, that is, they should be based on an understanding of how they are intended to lead to better care in everyday life and which influencing factors they should take into account. They should be specific





(Tab. 1, Fig. 1 and 2: F. Schwendicke)

**Figure 2** The throughput model derived from [4, 7]. See the text for a detailed description. PROMs: patient-reported outcome measures, e.g. endpoint measures reported by patients

for a treatment and drive improvements in the care (treatment outcome) [2].

3. Output factors describe effects (e.g., of interventions) that in turn have consequences for the input factors. This may mean a concrete consequence for the patient resulting from a particular treatment measure but also consequences for organizational structures.

4. Finally, the outcome factors describe the results of the care. When considering these outcomes, it is critical which outcomes are actually welcomed by the recipient of the care, our patients, and how patients assess these outcomes. This consideration of the outcomes, their interpretation, and the resultant conclusions or recommended actions should also be discussed in light of issues such as robustness and appropriateness. Modification or expansion of the throughput model in regards to 2nd order factors adds the perspective of superior structures. In particular, the contextual service is considered, whereby the context can have a positive (improving the outcomes

of a health service) or negative (worsening) impact.

### What can health services research in dentistry in Germany achieve and how should it develop?

The opportunities for health services research in dentistry continue to be underestimated in Germany. It is necessary and essential to strengthen and expand dental care capacities and quality. A number of questions that are highly relevant for dental care, professional or health policy discussions, and improvements in dental care models and structures can only be answered using health services research.

A number of focal areas are conceivable in this regard:

- (1) Dental health services research should develop, evaluate, and monitor the implementation of innovative care concepts. In particular, research must emphasize relevant patients groups for whom routine care in Germany can only be achieved to a limited degree using established concepts, such as elderly, multimorbid, and

chronically ill patients (e.g., patients with dementia, diabetes, or other systemic organic medical conditions). These patient groups are only rarely covered by clinical evaluative research and represent a growing population group with increasingly complex needs (in part as a result of the increasing preservation of teeth) [8]. Furthermore, care concepts should be developed and evaluated that link dental and medical care. The common risk factor approach is a key aspect in this regard, able to open strategic doors for dental research and integrate the dentist more closely into ongoing provision of care [9]. Similarly, dentistry can in some cases play a key supporting role in general therapy, e.g., with periodontal therapy for diabetics; however, this does require concepts that model patient flow, adequate long-term care, appropriate remuneration, and corresponding quality indicators.

- (2) Dental health services research should focus on aspects

Publicly funded dental projects			
Prof. Dr. Stefan Listl	University Hospital Heidelberg	Dent@Prevent – Implementation of routine data & PROMS in evidence-informed intersectoral (dental) medical care	2016
Prof. Dr. Christian H. Splieth	Greifswald University Medical Department	IpKiSuN – Supportive intensive prophylaxis for children with dental rehabilitation under anesthesia	2016
OA Dr. Ghazal Aarabi	Hamburg-Eppendorf University Hospital	MuMi – Promoting oral health expertise and oral health in people from migrant backgrounds	2017
Prof. Dr. Katrin Hertrampf, MPH	Schleswig-Holstein University Hospital, Kiel Campus	MundZaRR – Oral health improvement using remotivation and reinstruction delegated by dentists accompanying care	2018

**Table 1** Dental projects that are funded by the innovation funding.

of the patient and consumer orientation. Strengthening patient autonomy and decision-making power (participatory decision making) and generally considering patient preferences is paramount here. Particularly in international comparisons, this issue has been discussed and researched very little to date in Germany. An interconnection with clinical research is also possible here, with patient-centered outcomes increasingly being incorporated into study standards (e.g., in the definition of minimum endpoints or core outcomes that studies should investigate and report for a particular dental problem) [1]. In the area of geriatric, nursing, and special needs dentistry, the incorporation of relatives is a relevant issue that has little been considered to date.

- (3) Successes in improving oral health are often emphasized in media discussions while the pronounced and in some cases even worsening social and regional disparities in the provision of healthcare are sometimes neglected. Dental health services research is in demand for issues related to the development and

evaluation of concepts to reduce these disparities. Particularly the link to public health research and other issues, such as social research and health systems research, is necessary in this regard.

- (4) The question of dental care is closely related to regional inequalities. Dental needs planning is an increasingly important issue in light of demographic polarization as well as the trend towards urbanization also of dentistry (keyword medical care centers). It may not be possible to ensure comprehensive, local, high quality care without active control. Dental health services research can help to understand which factors drive this structural change, if and how they can be modified, and how control elements can be applied, e.g., as part of cross-sectoral care concepts, in order to limit regional disparities in care.
- (5) Dental care in Germany takes place primarily in clinics; in accordance with this, health services research should take place where the care is provided. Establishing networks of clinics that carry out both outcome-re-

lated and process-related studies is an important objective. Likewise, dental health services research should increasingly utilize data from routine care. Despite the known weaknesses of secondary data, they can in part allow a deep and importantly a representative understanding of care. Similarly, a meaningful correlation allows perspectives on dental issues drawing on data from other care sectors. Collaborating with providers and statutory dentists' associations may be of use here.

To meet these requirements or to cover such a breadth of issues in a methodologically sound manner, dental health services research must be further developed in Germany. In this regard (1) changes to the university system are desirable. In many other countries (including the US, Great Britain, and the Netherlands) chairs with a health services research focus (e.g., community dental health, dental public health) contribute significantly to dental education while being institutionalized agents in the field of health services research. In Germany this has been the exception to date; independent departments for dental health services research do not exist at all. (2) Health services research should also become the focus of individual sites. This is the case only in a few university hospitals with basic and clinical research instead being paramount. With increasing federal funding (see below) and greater regard given to this field by research policy, this may possibly change; dental centers could accordingly be pioneers at individual sites, providing direction and examples. (3) There is a need for increased networking of agents in the field of dental health services research. Cooperative models from universities, clinics, social facilities, chambers, statutory associations, health insurance providers, and patient groups can have considerably greater breadth and greatly increase the impact of individual initiatives. In general, stronger links with medicine are essential; medical disciplines rarely proactively approach dentistry while at the same time they are neverthe-

less interested in possible collaborations, viewing them in a positive light. (4) Lastly, existing development opportunities must be identified and utilized. Both the German Research Foundation (DFG, without tenders) as well as the German Federal Ministry of Education and Research (BMBF, with tenders) and the Innovation Fund (promotion of health services research or the evaluation of new health services models by the Federal Joint Committee with issue-related and open-issue tenders) are available for funding. While the DFG requires that “projects seeking funding should address an underlying issue, the results of which should also be able to be translated to other problems”, BMBF and the Innovation Fund are occasionally considerably more application oriented. In all three funding streams, dentistry competes with other disciplines. Nonetheless, funding applications from dentistry have succeeded in recent years, including those made to the Innovation Fund (Tab. 1).

### Conclusions

The relevance of health services research in Germany is rising. Dental health services research should develop, evaluate, and monitor the implementation of innovative, cross-sector health services concepts. The common risk factor approach and the supportive role of dentistry for medical services may be key aspects here. Patient and consumer focus and the social and regional inequalities in care should also be given priority. To meet these requirements or to cover such a breadth of issues in a methodologically sound manner, dental health services research must be further developed in Germany by, among other means, professionalization and increased networking of

agents in dental health services research and successfully raising competitive third-party funds.

### Conflicts of interest:

The authors declare that there is no conflict of interest within the meaning of the guidelines of the International Committee of Medical Journal Editors.

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# Understanding and improving care: Use of routine data

## Introduction:

The majority of dental care in Germany is provided by dentists contracting with national health insurance companies. Although the oral health of the German population is steadily improving a comprehensive description and assessment of the care provision is difficult. However, such analyses are fundamental for potential changes in the care delivery process. The aim of this article is to outline the method of routine data analysis as an essential tool for dental care research, thereby illustrating the potential for research using these data.

## Method/Results:

Routine data analyses are research analyses based on data originally collected for other purposes. In the dental context, claims data can illustrate the spectrum of treatment provided. In cooperation with a large German national health insurance company, longitudinal analyses were carried out based on the essential components of dental treatments implemented. Additionally, routine data was used to evaluate system changes and to consider regional differences in treatments. Typical analyses are presented and critically considered. The nature of the database results in methodological restrictions of routine data analyses. The interpretation of the results is also limited because comparative studies and expected values are often missing. Nevertheless, despite these drawbacks, routine data analysis is an important method that leads to a better understanding of care provision. Previously unattainable insights into real care processes are now possible, providing data and results that could not otherwise be generated.

## Conclusions:

The understanding of dental care provision under a national health insurance model is currently still rudimentary. However, this understanding is an impetus for improvement. The presented results based on routine data are the first milestones towards a comprehensive description of the reality of care.

**Keywords:** health service research; outcomes; "Dental care/medical insurance model"; system changes; routine data; secondary data; data mining; quality

### Dental care in Germany

Most dental treatment in Germany takes place under the funding of national health insurance companies (Krankenkassen). In 2017, according to calculations by the association of the substitute insurances (Verband der Ersatzkassen ([vdek]), 87.2 % of the German population were members of the national health insurance system [38]. The annual utilization rate of dental services by insured persons, adjusted for age and gender, was 71.5 % in 2016 [26].

The range of dental services offered by the German dentists within this insurance system is very comprehensive by international standards. Other nations, including Western industrialized countries, often only provide for basic dental care under their national health insurances and there are also substantial variations in welfare benefits between them [2]. Dental treatment is often only partly reimbursed. In contrast, the German health care system even subsidizes comprehensive prosthetic rehabilitations. The range of services can therefore be rated as very good.

On the other hand, an extensive range of services alone is not an indicator for the delivery of quality care.

### Objective: to improve care

Continual improvement, embracing changes and customizing dental care by recognizing new insights and changing needs are important characteristics challenging all stakeholders in the health insurance system. However, such a system can only be understood and improved after an objective assessment has first been undertaken. The question of how well the present dental care insurance system in Germany really functions, can only be answered to a very limited extent with the current findings.

### Previous findings and data sources

The oral health of the German population has improved significantly over the last decades. For example, caries incidence and edentulism were significantly reduced in large parts of the population. This is demonstrated by regularly published German Oral

Health Studies [14, 20, 21]. Such improvements are sometimes traced back to good quality dental care. However, scientifically this conclusion is an overinterpretation, because causality cannot be inferred from cross-sectional studies. On closer examination, there is also a range of external factors, such as fluoride containing toothpastes and smoking cessation, that may be having an impact. Unfortunately at present, there is no evidence for these. The yearbooks of the federal dental insurance schemes association (Kasenzahnärztliche Bundesvereinigung [KZBV]) and the federal dental association (Bundeszahnärztekammer [BZÄK]) publish performance figures for dental care every year [2, 15]. Therefore, quantitatively the delivery of dental treatments is relatively well analyzed. But, to extrapolate these data qualitatively is unsuitable. Ultimately, it must be stated that data on conventional dental treatment outcomes is sparse. The need for targeted dental care research to examine this further is becoming imperative.

### Routine data analysis

Since the mid-1990s and aided by increasing digitization, a method for analyzing care delivery emerged under the broad concept of routine or secondary data analysis. Routine data is data that is generated during care delivery without any primary scientific purpose. It can be further analyzed later with a scientific intent hence the term secondary data. This is not a new idea because retrospective studies that have evaluated clinical documentation and ledgers are well established. What is new, however, is the scope of such analyses, made possible by new computer technology and digital databases. Terms such as “big data” or “data mining” are currently in vogue. In the dental field, it is above all the claims data that has become the focus of scientific interest. Claims data not only illustrates specific dental care performance analyses but it can also be monitored over time. The extensive range of services offered by conventional dental care is advantageous, because it provides a relatively comprehensive picture

when looking into the black box of everyday practice.

### International studies

Internationally, there are only a few examples in which dental care was analyzed using routine data. A basic problem with this is that in only very few countries it is possible to comprehensively investigate dental treatment within the framework of a public health care system. Notably, Burke and Lucarotti, analyzed and published early data from the National Health Service (NHS) in the United Kingdom [3–9, 19]. They extensively analyzed the outcome of fillings, crowns and root canal treatments but this database is now closed so further analyses are not possible. There are also some sporadic studies from Taiwan using routine data to analyze dental care outcomes concerning endodontic and periodontal treatments [10, 11]. Similarly, in Sweden dental insurance data is being evaluated but little has been published internationally [24]. Claims data from private insurance plans in the USA has been analyzed to evaluate the outcomes of endodontic treatments [36]. The results were better than expected with dental survival rates of 97 % at 8 years. This contrasts with a 2009 systematic review reporting dental success rates of 83 % after 4–6 years [37] and another 2008 review describing widely differing average success rates of between 31 % and 96 % [22]. Although there is still a difference between success and survival rates, these extremely good results are based on a discussable methodology. It is also considered that the insured population sample cannot be assumed to be representative for the U. S. population. Due to the unique characteristics of individual health care systems, transferring results to be applicable for Germany seems to be not possible.

### Routine data analysis in respect of dental care under the medical insurance model

For several years, our research group has been dealing with routine data analyses for dental care provided under the German national health

Treatment type	Primary endpoint (follow-up)	Number of cases (teeth/patients)	Maximum monitoring time (years)	Survival/success rates	Survival/success variables that are statistically significant
Direct pulp capping	Retreatment (root canal therapy)	148,312	3	71.6 %	Age group (P < 0.0001) Number of tooth roots (P < 0.001)
Filling treatments	Retreatment	14,798,585	4	74.8 % – 55.8 %	Number of filling surfaces (P < 0.0001) Tooth position (P < 0.0001)
Endodontic treatment	Retreatment: (root canal therapy or apicectomy or extraction)	556,067	3	84.3 %	Pretreatment tooth vitality (P < 0.001) Number of roots (P < 0.001)
Apicectomy	Extraction	93,797	3	81.6 %	Tooth type (P < 0.0001) Age group (P < 0.0001) Sex (P < 0.0001)
Periodontal treatment	Extraction	415,718	4	63.8 %	With/without treatment (P < 0.0001)

**Table 1** Overview of longitudinal results of analyses using routine data.  
(Tab. 1: M. Rädcl)

insurance system. In cooperation with a large German health insurance company, essential areas and treatments could be analyzed. The results were published as part of annual dental reports [25–29]. Especially pertinent aspects have also been published internationally [30–35]. The following are selected points that illustrate the potential of routine data analysis in the field of dentistry.

### – Longitudinal Outcome Analysis

Investigated so far: Analyses of the outcome of root canal fillings, apicectomies, direct pulp capping, fillings and periodontal treatments. An overview is shown in Table 1. Primary treatments and follow-up treatments were tracked based on fee codes on a daily basis. The relevant tooth nomenclature and/or affected tooth surfaces were also recorded as appropriate. Survival analyses using the methods of Kaplan and Meier were calculated. Target events were dependent on the treatments and included a re-intervention and/or the

extraction of the relevant tooth. A rough overview of case numbers and results is also shown in Table 1.

### – The impact of system changes on dental care supply

Changes in the health care system result in changes in the care provided. These may be desirable or undesirable. Routine data can be potentially used to track treatment processes over time, permitting contemporary or subsequent evaluations. In recent years, several adjustments have been made to the Standardized Remuneration for Dental Services (BEMA), in order to facilitate or improve access to treatment for those patients who have special care needs. Subsequent evaluation of relevant routine data showed a significant increase in charging of these new treatment fee codes [27]. However, the expected increase in demand for treatment from insurance members with special needs has not been found. It could therefore be concluded that the adjustments made within the BEMA led

to an improvement in terms of access, diagnostic and preventive care, but not with regard to dental treatment undertaken.

### – Detection of regional effects and differences in care

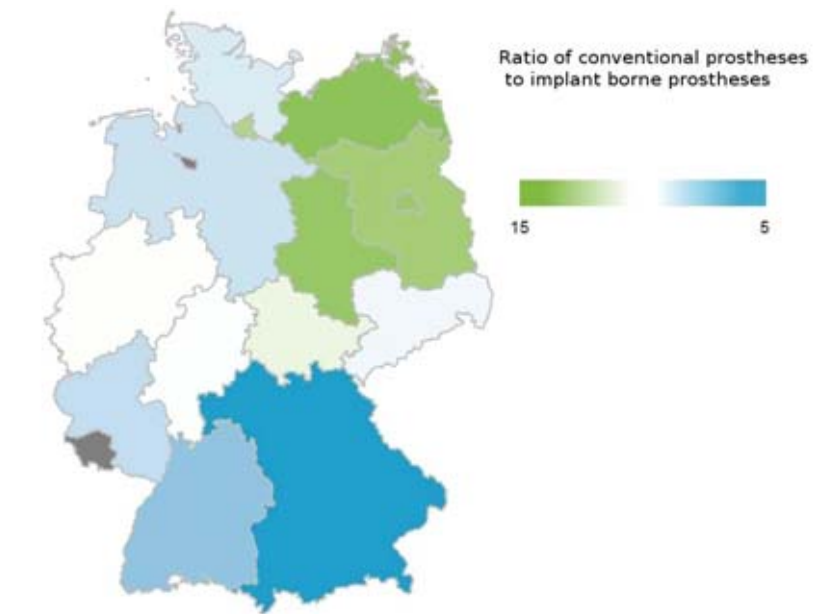
Due to the limited number of cases, total and comprehensive applicability of epidemiological studies is not suitable for smaller regions. Excepting comparisons between old and new federal states, comparative analyses between different German regions are usually not possible because of the limited number of cases available. The DMS studies provide representative data for Germany [14, 20, 21]. However, due to the high number of observable cases in routine data, this makes it possible to partially analyze the health care provision down to the district level. When examining specific regional differences, for example, very different distributions of implant restorations in edentulous patients were noted [25]. Figure 1 shows clearly the distribution of the ratio between con-

ventional prostheses (KZV billed i.e. directly billed to the insurance) and implant-supported prostheses (directly billed privately to the patient) for edentulous lower jaws at the federal level in 2014. Bremen and the Saarland had to be excluded because of reduced case numbers.

To give an example. In Mecklenburg-Western Pomerania for every implant-supported complete lower denture there are about 14,8 conventional lower dentures as compared to the ratio in Bavaria where it is 5,3. This demonstrates a significant difference in dental treatment provision. Such regional differences within the medical insurance system, can only be analyzed at the individual insurance provider level (Kassen) and not at the association level (KZV), as was the case in this example.

### Methodological limitations

In contrast to the results of clinical studies, the results of routine data analyses are much more difficult to generate and to interpret. Numerous methodological constraints limit the scientific possibilities or otherwise must be taken into account when interpreting the results. A significant limiting factor is the database. Working with secondary data only allows the inspection of existing data. This contrasts with clinical studies. These can be set up and designed to address specific questions and issues. Measuring instruments and parameters can be preselected. Exactly the opposite situation prevails here. It is the availability of secondary data that determines which questions can be answered. The data foundation under these circumstances is more uncertain than deliberately collected study data. It is to be assumed that the number of billing errors, incorrect data entries and mistakes are unknown. Their magnitude varies depending on the reference level and the consequences relative to the treatment regimen. For example, the mix-up of a single filling surface in a tooth appears proportionally more likely compared to the “wrong” side of the jaw or the “wrong” insured person. When there are only a few teeth remaining, the risk of mis-coding, for example, a tooth that is



**Figure 1** Regional differences represented by the ratio of standard prostheses to implant-borne prostheses in edentulous mandibles at the federal level. Distribution from green (high quotient) to blue (small quotient), without Saarland and Bremen.

(Source: modified according to BARMER GEK Dental Report 2016)

to be extracted, correspondingly increases. Nevertheless, as far as the current data is concerned, it can be assumed that such errors and mix-ups do not have any significant influence on the corresponding results. Here, it becomes advantageous that there is such a large number of cases, sometimes extending into the range of a few million interventions [34]. But, it should be remembered that these high case incidences also mean that even very small variations between different groups or treatment protocols can be reflected in statistically significant differences. Therefore when significances are recognized, they must be carefully interpreted, to decide whether they are indicating any corresponding clinical relevance [1, 17]. The statistical significance found in routine data analyses using large numbers of cases is currently topical and the subject of critical discussions as to whether they are even suitable for the evaluation of results.

In the course of the analyses, some of the known clinical correlations in the study could be reproduced. For example, it can be expected that endodontic treatment will show a better outcome with vital teeth than that with initially pres-

enting non-vital teeth [16]. This correlation becomes evident in the results of the routine data analysis [33] and therefore reinforces the plausibility of the analysis methods. This plausibility check appears important against the background that dental claims data usually does not include any diagnoses. Fee codes and treatment histories are often used as surrogates for diagnoses and findings. If implausible results or trends become apparent during the course of routine data analyses, then the database should be subject to an in-depth review. In some cases, data errors, transmission errors or varying documentation patterns are detected, which in the worst case scenario must lead to discarding the entire analysis in order not to jeopardize the validity of the results. The monitoring times of the present analyses are currently limited due to technical reasons. The quality of data collected consecutively goes beyond a purely retrospective analysis. Principally, it does not allow to conclude any direct causal relationships. This means that as the monitoring time increases, so does the probability that the primary treatment being observed and a subsequent target event will be not directly related. For example, when a

tooth is extracted after a root canal treatment, there is a higher probability that other unrelated factors (for example, a coexisting periodontal condition) led to this extraction, when the observation period is longer.

### Interpretation of the results

Interpreting the results obtained from a secondary data analysis is often challenging. Seldom are there expected values or international comparative figures. Direct comparisons with clinical studies is also unsuitable because in everyday practice their results cannot be easily replicated. One speaks of the efficacy-effectiveness-gap. This is the gap between study results and those that are actually attainable in clinical practice [23]. The detailed awareness, description and narrowing of this gap is one of the main goals of dental health service research. Knowledge regarding the size of this efficacy-effectiveness-gap can be the starting point for a strategic policy, the formulation of quality objectives and indicators, together with outlining guidelines for dental care.

Even if potential comparisons to other studies seem possible, it is often very difficult to assess the relevant results. For example, our results regarding endodontic therapy were within a range that could be expected in terms of available national and international data. For other treatments, the results were more questionable in that they were less favorable than expected. These included amongst other things extensively filled teeth (involving three or more surfaces) that had a retreatment rate of more than 40 % after only 4 years [34].

It becomes apparent that the assessment of care is challenging, as demonstrated by the present results. It is even more difficult to evaluate system changes and considering their strategic effects becomes problematic. This is because relevant target events are often not available for routine data analyses. Numerous measures have been taken in recent years in order to improve dental care. Examples are the inclusion of resin bonded bridges into the standard treatment plan in 2016 [18] or, lastly,

the introduction of specific fee codes for special needs patients [13]. Did these activities improve the standard of dental care? In the first case, the decision to expand the standard care was made on the basis of the best available evidence [12]. However, whether the good results from clinical trials can be transferred to clinical reality is not confirmed. In the second case, findings on the effects in this area are still inadequate [27]. Therefore, on the one hand, accompanying health service research appears to be necessary for the implementation of any system changes, in coordination with the utilization of routine data. On the other hand, system improvements over the long term will only be possible through a comprehensive definition of quality in all its various dimensions. Our present results provide a solid foundation towards these aims.

Even when results often allow only a limited interpretation because of methodological constraints, they retain relevance from the point of view of dental care research. This is because they allow insights into actual, real care delivery processes that were previously inaccessible. These insights and these results could not have otherwise been generated.

### Conclusion

The understanding of dental care provision under the German national health insurance system is currently still rudimentary. However, this understanding is an impetus for improvement. The presented results based on routine data are the first milestones towards a comprehensive description of the reality of care. However, more initiatives to define and assess quality directly are required in order to sustain and further develop the dental health care delivery.

### Sponsors/Conflict of Interest

The presented routine data analyses were supported by BARMER. The first author, Michael Rädél, occasionally acts as a dental advisor for BARMER.

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(Photo: private)

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# Needs-based care: Illusion or reality?

## **Abstract:**

Dental care in Germany is in the midst of transitioning. This includes a changed epidemiological baseline situation and with that different treatment needs. Additionally, the supply side (dentists) is undergoing a structural change. To ensure appropriate care under these altered conditions, measures of different strategies can be applied. This article is aimed to clarify (a) what evidence is available today to answer this question, (b) how we are going to assess future demand and (c) what essential parameters of future development need to be taken into consideration in order to adjust dental health care so that optimal health can be achieved on a population level. An approach to answering this question in the current state of needs-based dental care in Germany should be made with three key statements. Thesis 1: Currently, it can be assumed that restorative care on a population level is needs-based. However, periodontal care does not seem to meet the needs. Thesis 2: Due to the demographic change, a high treatment demand can furthermore be expected, despite a declining burden of disease in dentistry. Thesis 3: International educational measures, financial intervention, regulatory strategies and/or personal and professional offers of support are discussed as possible control elements to ensure appropriate care in the future.

**Keywords:** care research; dentistry; demand; epidemiology; demand planning

## Introduction

In 2010, almost 23 billion Euros were spent on oral health in Germany [12]. Two thirds fell into the dentists' service sector, about a quarter fell into the dental technicians' sector and the rest referred to retail products of the general oral health economy. It is assumed, that the total revenue will increase to 27 billion Euros in the year 2030. Even though the dentists' service sector merely makes up 6,5 % of the total expenditures under the conditions of statutory health insurance [10], there is a lot of money available for dental health care. Even when Germany's supply system compensates tooth loss with a low threshold for artificial teeth in cases of social hardship, it has to be recognized that the prevalence of diseases is a significant social gradient [8], as shown in most chronic and lifestyle-related diseases. These socio-medical aspects of unequal living and health conditions are not specific to dentistry but rather of fundamental nature and need a broad-based approach. To this effect, public health approaches such as group prophylaxis are discussed and applied in preventive dentistry. They center around so-called upstream measures, intended to be achieved by people in their social environment. This article, however, deals with dental care and thus the dental practice, which is referred to as the last aspect of the healthcare system concerning healthcare research. Key objectives of healthcare research is a learning system of continuous improvement of patient orientation, quality and economic efficiency. These three goals can also be considered as the triad of healthcare research. The main characteristic is described as the efficacy of health relevant products and services under everyday conditions. It is termed relative effectiveness. This is contrasted with clinical research, which determines the efficacy under ideal conditions, and its target is referred to as absolute efficacy. The resulting gap between achievable (relative) effectiveness under everyday conditions and achievable (absolute) effectiveness under artificial experimental conditions is described as the effectiveness gap in treatment re-

search. This is the core when it comes to researching why therapies in everyday care at times show different effects than in clinical research [9]. It is part of the analysis of appropriate care to take into account the effectiveness gap, which has been identified using methods of care research. This article goes on to discuss further contributing aspects.

## What is needs-based?

A characterizing feature of democratic societies is a general egalitarian approach. In Germany, this principle of equal living conditions is rooted in the constitution (Article 72, Paragraph 2). With this in mind, the topic of dental and medical needs-based justice, or rather the deviations such as over-, under- and misdirected supply, gain health political and social relevance; such as in some rural regions, when the aspired equal living conditions can not be guaranteed because of inadequate health care. In order to counter this, planning guidelines for medical and dental care are determined. In Germany, the guidelines for planning demand-driven dental care are set by the Joint National Committee (G-BA). It is the supreme decision-making body of the conjoint self-administration of physicians, dentists, psychotherapists, hospitals and health care funds.

According to the demand-planning dentist guideline from 2016, the term of needs-based care is operationalized as a ratio: in metropolitan areas of the old states, the ratio of one dentist to 1280 residents represents the general standard (100 %), whereas in other areas in Germany, the ratio is at a general standard with 1:1680. The guidelines do not specify how these ratios were determined. Criteria for under- and over supply are derived from a specific target/actual comparison. Undersupply in dentistry is assumed, when the need exceeds the level of dental treatment by more than 100 v. H., and the general needs-based degree of care is exceeded by 10 v. H. This regulation is obligatory for contracted dental care in Germany, however, these reference values are not the only possibility to identify the needs and this process can be critically questioned from the

perspective of epidemiologic supply. It appears necessary to consider different expectations on dental health care demands in regions with a younger demographic structure (e.g. Freiburg im Breisgau, with an average age of 39,8 years) compared to regions with an older population structure (e.g. Dessau, with an average age of 49,5 years). This then raises the question of how the mere ratio comparison of available dentists per population is sufficient without considering the (regional) morbidities in the future.

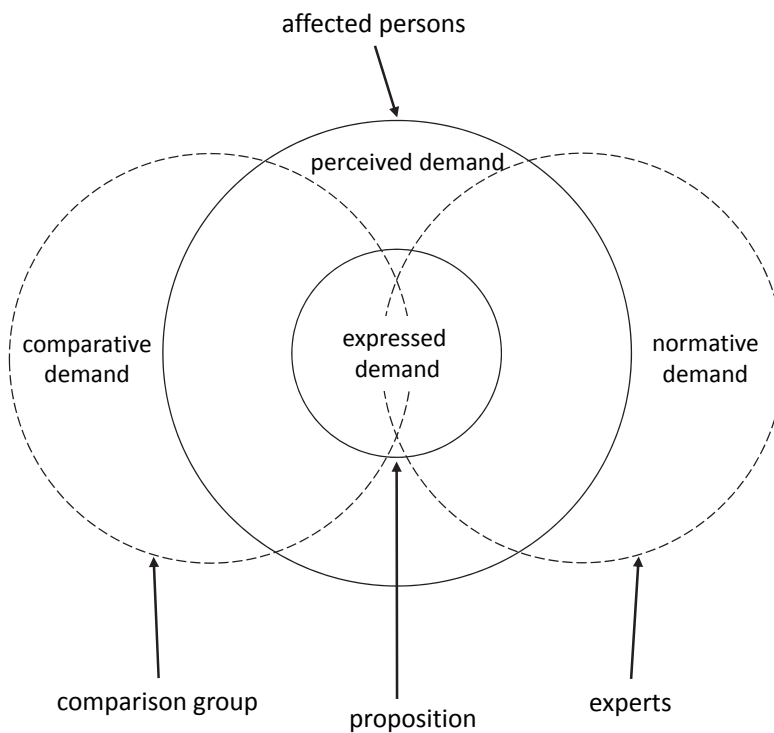
The German Council of Experts defines needs-based justice in the report "Needs-based care – perspectives for rural regions and selective performance areas" as follows: "Needs-based justice forms a normative concept and consequently, every policy holder or citizen receives health care with qualitative and quantitative regard to his needs, according to the most objective criteria possible" [16]. Needs-based justice includes medical indication, and goes even beyond. In health care research a distinction is made between demand-induced ("need-dentistry") and wish-fulfilling dentistry ("want-dentistry"). This focuses in on the issue of needs-based justice in relation to sociological discourse.

According to Bradshaw [2], 4 types of social demands are distinguished (Fig. 1):

- Normative demand: This demand is defined by experts and therefore dependent on their respective position.
- Perceived demand: It is characterized by the individual and is based on an expression of intention.
- Expressed demand: It is the executed perceived demand and depends on the actual supply.
- Comparative demand: It can be used to show comparisons between different populations. The treatment of different regional morbidities can therefore be determined with comparative demand.

## Aim of the article

Needs-based justice can therefore be looked at under vastly different premises. This article is aimed to clarify (a) what evidence (data) is avail-



**Figure 1** Taxonomy of social demands (according to [2])

able today to answer this question, (b) how we are going to assess future demand and (c) what essential parameters of future development need to be taken into consideration in order to adjust dental health care so that optimal health can be achieved on a population level. It should be noted that this article argues on a meta level and that the pooled health data used does not allow any conclusions on a micro-level, or individual health care.

### Main theses

According to the current state of appropriate dental health care in Germany, an approach to this question is laid out using the following three theses. This analysis includes the two main diseases, caries and periodontitis.

- Thesis 1: Currently, it can be assumed that restorative care on a population level is needs-based. However, periodontal care does not seem to meet the needs.

Treatment demand relating to caries is regularly determined epidemiologically within the German Oral Health Studies. The current treatment demand results from the decayed

component of the DMF index and includes teeth with established caries lesions. These are shown epidemiologically as primary lesions or caries on restoration margins.

Furthermore, the level of refurbishment can be determined from the data, by calculating the ratio of filled teeth to decayed teeth plus filled teeth ( $FT/[DT+FT] \times 100$ ). The level of refurbishment is 100 % at maximum and therefore suitable to detect deficiency.

However, it must be said that it cannot depict oversupply (e.g. level of refurbishment of  $> 100$  %), although one can argue that a level of refurbishment of  $< 100$  % per se should not indicate an oversupply on a macroscopic level. In permanent teeth a current treatment demand of  $DT = 0,5$  teeth is shown across all age groups. The level of refurbishment is different for each respective age group: In children (12-year-olds) it is at 74,6 %, which is a low value compared to other age groups. This is surprising because children undergo regular dental check-ups in schools as part of group prophylaxis so that treatment can be initiated even in children that are not monitored regu-

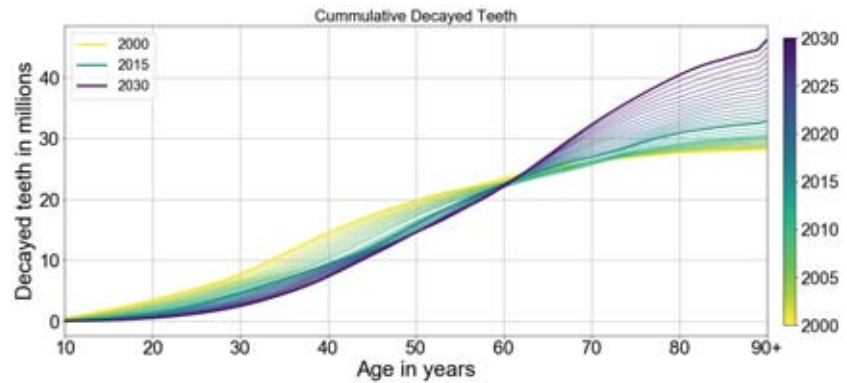
larly and only have complaint-based dental check-ups. The level of refurbishment is 93,7 % in young adults (35- to 44-year olds), which is essentially the age group of these children's parents, and 90,6 % in young senior citizens (65- to 74-year olds). In older senior citizens (75- to 100-year olds), it is lower at 83,0 %. This group, however, includes people requiring long-term care whose (oral) health is generally worse in comparison to people of the same age who are capable of caring for themselves. The level of refurbishment in older senior citizens requiring long-term care is 69,2 % [8]. The assessment was more difficult for periodontitis, which is partly due to the fact that neither diagnostic criteria of periodontal health nor criteria evaluating the success of a treated periodontitis existed in the classification of periodontal diseases from 1999 [1]. This changed with the current classification of 2018 [6], however, so far no epidemiological studies have been conducted using this classification. Based on the DMS data, it was extrapolated that 11 million people in Germany suffer from severe periodontitis [4]. In total, 1.1 million periodontitis treatment cases were charged to statutory health insurance in 2017 [10]. However, it is not clear how high the percentage of people with severe periodontitis, who have already undergone a successful systematic periodontitis treatment, really is. Therefore, an accurate statement on needs-based periodontitis treatment cannot be made. It can probably be assumed that there is no oversupply. The Barmer Zahnreport from 2017 gives more information [13]: On average, a quarter of policy holders make use of periodontal diagnostic services and 1,8 % of policy holders make use of therapeutic services. The question arises if epidemiology and treatment are currently well coordinated. Currently, in restorative and prosthetic dental treatments at system level (data not shown), the treatments correspond to the epidemiological findings to a large extent, which is why this discrepancy in periodontal treatment is surprising. From the viewpoint of treatment research, it should be

noted that the periodontal treatment line is defined scientifically, however, the statutory health insurance catalogue of services only contains the central treatment phase. Especially the lifelong, supportive periodontal therapy can only be made use of in private dental care. It can be assumed that this therapeutic inconsistency contributes to the discrepancy of periodontal epidemiology and treatment.

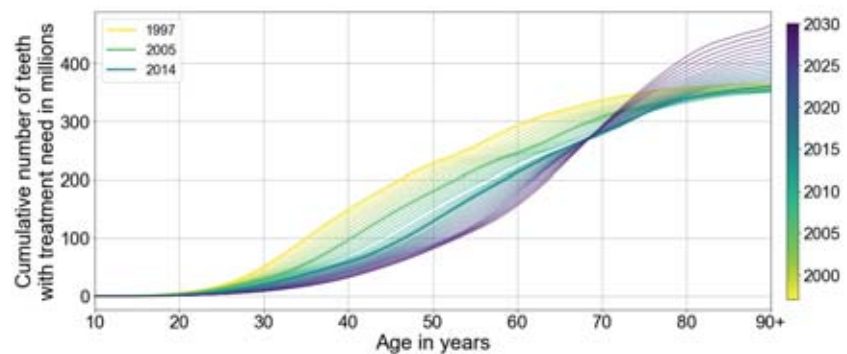
- Thesis 2: Due to the demographic change, a high treatment demand can furthermore be expected despite a declining burden of disease in dentistry.

The epidemiological trend monitoring of DMS studies from the past 2 decades allows further morbidity prognosis. When considering the demographic development, it can then be estimated what treatment needs are to be expected in the year of 2030, for instance [7]: A decline of up to 50 % in burden of disease is to be expected in all age groups for dental caries. This can generally lead to a further decline of restorative treatment needs, however, the effect will not be as pronounced as the epidemiological morbidity dynamic appears, because caries cumulates as a chronic disease at an older age and its effect accounts for so called morbidity compression. The number of DMFT-teeth in Germany will presumably decline from 870 million in 2014 to 740 million in 2030 (Fig. 2). Additionally, population-wide there are about 100 million root surfaces that have had caries, but the morbidity dynamic can be evaluated as relatively stable [14]. This trend, however, is different in periodontitis: Generally, we expect a further decline in periodontitis. Due to the demographic change and the increase in tooth conservation, a rise in periodontium needing treatment will arise. In 2014 around 365 million teeth were affected by periodontitis in Germany and we assume this number will rise to 100 million teeth by 2030 [15] (Fig. 3).

- Thesis 3: International educational measures, financial intervention, regulatory strategies and/or personal and professional offers of support are dis-



**Figure 2** Prognosis of teeth needing cariological treatment in Germany until 2030. The depiction shows a prevalence turnover at about 60 years; prior to that, less cariously damaged teeth are expected until 2030, after that, an increase can be expected that accumulates in all age groups in 2030 and will account for around 464 million carious teeth in Germany (according to [7]).



**Figure 3** Prognosis of teeth needing periodontal treatment in Germany until 2030. The depiction shows a prevalence turnover at about 70 years; prior to that, less periodontally damaged teeth are expected until 2030, after that, an increase can be expected that accumulates in all age groups in 2030 and will account for around 464 million carious teeth in Germany (according to [15]).

cussed as possible control elements to ensure appropriate care in the future.

Just as we have shown, the morbidity dynamic in combination with double dynamization of age (people are living longer and the proportion of older people in the total population continuous to rise steadily) does not automatically mean that the dental supply needs will decline substantially. Therefore, sustainable financing is necessary in this sector in order to ensure the level of service in the future. It seems appropriate to contemplate control mechanisms. The population projection of the Federal Office of Statistics showed regional differences in age composition of the population for 2030. Oral diseases exhibit age-specific characteristics.

Thus, treatment planning based solely on ratios of dentists per population is not ideal long-term in order to plan appropriate regional care. In addition to morbidity-related risk structure compensation determined by the patients, it seems worth discussing to bear in mind the supply side and consider the dentists' ages. The average age of actively working dentists in Germany is 48,6 years and in some states, such as Brandenburg, Sachsen-Anhalt and Thüringen, it is 50 years, which indicates that a generational change can be expected on the supply side in the years to come [11]. This will come into effect especially in the new states, because of the unprecedented wave of dentists who set up their practices during Germany's unification 30 years ago,

Strategy	Measures
Educational measures	Preferential admission of students of rural regions
	Relocate education packages to rural regions
	Relocate training institutions to rural regions
Financial interventions	Discounted student loans tied to the obligation to practice in rural areas
	Specific reward and budgets
Regulatory strategy	Quota licensing (needs of admission)
	Increased admission and/or foreign recruitment of dentists to meet demand
	Mobile supply
Personal and professional support	Financial and infrastructural incentive in practice relocation to rural regions
	Assistance with recruitment and career planning
	Familiar services, involving local communities, offering of suitable practice space

**Table 1** Global strategies and examples of motivational measures by dentists to become involved also in rural regions (from: [5])

which means that many of the dentists will give up their occupation around the same time. Thus, the planning of future care can not only be oriented on headcount of dentists, but also the actual offer and their working hours. This would also take into consideration the growing number of dentists working part-time.

In this context it should be noted, that even though dental practices also open up in rural regions, metropolitan areas are extremely appealing in establishing a practice. Rural communities, smaller and medium-size towns who have a lower resident population are at a disadvantage regarding the establishment of new dental practices [11]. The control capabilities of the dentists' association, however, are limited ever since the SHI Competition Re-enforcement Law from 2007 lifted the admission of needs for dentists and

introduced the freedom of establishment. Nevertheless, the report "Needs-based control of healthcare by the Council of Experts" came to the conclusion, that in order to ensure comprehensive, high quality outpatient care, the establishment of contracted dentists has to be facilitated in areas, where the upcoming retirement of many contracted dentists becomes apparent, to successfully ease the transition period [16]. Furthermore, it is debated if financial incentive, such as a "surcharge for rural dentists" could possibly improve the situation further. Ultimately, morbidity-oriented compensation is discussed, to set incentive for high treatment quality. Besides regulation strategies, there are other possible measures already being tested. This can be classified in three categories [5]: Educational measures, financial intervention, and personal and professional support strategies.

An overview of the strategies used so far is listed in Table 1. Due to the individual societal conditions or the organisation of the health care systems, not all of the mentioned measures are transferable to other countries. However, they demonstrate that their efficacy has been reviewed alio loco, or at the very least first experiences concerning the desired efficacy.

## Conclusions

Dental care in Germany is in the process of transitioning. This is a result of the morbidity dynamic, which is unusual for chronic diseases and indicates that considerable potential for preventive measures was raised in the past. As a result of the chronic-cumulative character, the burden of disease extends to a more advanced age. This will change the supply needs further. Through different legislature procedures in health care, a transition in practice structures is also noticeable on the supply side. Additionally, regional generation changes among dentists is expected. After all, it will be closely monitored to see if dental health care develops similarly to general medicine, which affects the security of supply in rural regions. Various measures and strategies can be used to ensure appropriate care under these altered conditions. These include educational-, financial-, regulatory-, personal- and professional support measures.

## Conflict of interest

The author A. Rainer Jordan states, that he is employed by the National Association of Statutory Health Insurance Dentists. He is unrestricted in the processing of research projects and scientific reporting and states that there is no conflict of interest.

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**DZZ International**  
**German Dental Journal International**

**Publishing Institution**

International Journal of the German Society of Dentistry and Oral Medicine/Deutsche Gesellschaft für Zahn-, Mund- und Kieferheilkunde e. V. (Zentralverein, gegr. 1859), Liesegangstr. 17a, 40211 Düsseldorf, Phone: +49 2 11 / 61 01 98 – 0, Fax: +49 2 11 / 61 01 98 – 11

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**Publisher**

Deutscher Ärzteverlag GmbH  
 Dieselstr. 2, 50859 Köln;  
 Postfach 40 02 65, 50832 Köln  
 Phone: +49 2234 7011-0; Fax: +49 2234 7011-6508  
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**Frequency**

6 times a year

**Layout**

Linda Gehlen

**Account**

Deutsche Apotheker- und Ärztebank, Köln,  
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 IBAN: DE 2830 0606 0101 0110 7410,  
 BIC: DAAEEDDD,  
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1. Volume

ISSN 2627-3489

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