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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

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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 (Kassenzahnärztliche 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. Rädel)

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.

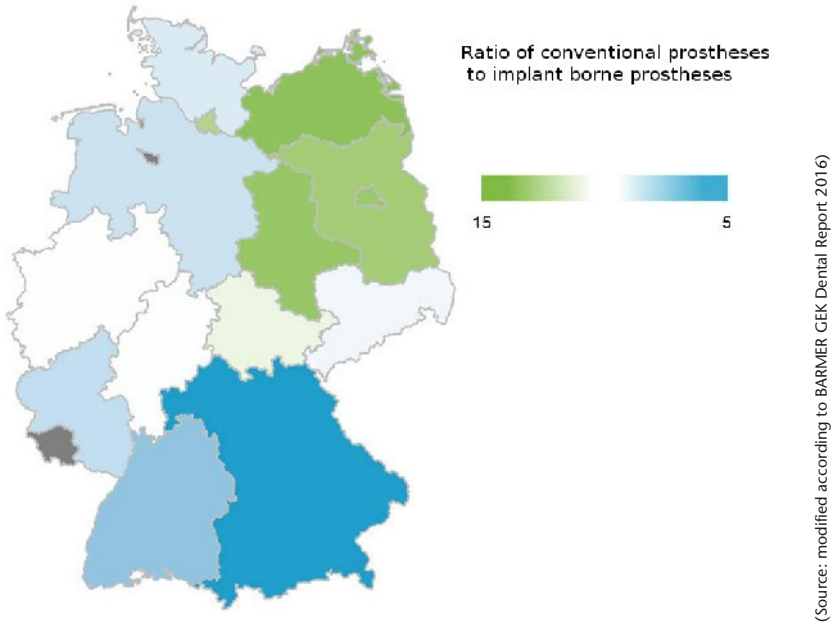

Figure 1 Regional differences represented by the ratio of standard prostheses to implant-borne prostheses in edentulous mandibles at the federal level. Distribution from green (high quotient) to blue (small quotient), without Saarland and Bremen.

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 miscoding, for example, a tooth that is 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 presenting 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

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The first author, Michael Rädel, occasionally acts as a dental advisor for BARMER.

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