

# Re-interventions after restoring teeth—Mining an insurance database



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## ABSTRACT

**Objectives:** The aim of this study was to examine re-interventions after restorative treatment.

**Methods:** The data was collected from the digital database of a major German national health insurance company. Only permanent teeth were observed. Placing a permanent restoration other than a crown regardless of involved surfaces and material was the study intervention. The data did not allow for a differentiation between fillings and inlays that were estimated only a very small portion of the restorations. Success was defined as not undergoing any restorative re-intervention with fillings or inlays on the same tooth (primary outcome) and assessed with Kaplan-Meier survival analyses over four years. An additional analysis was conducted rating “crowning” and “extraction” of respective teeth as target events. Differences were tested with the Log-Rank-test. A multivariate Cox regression analyses was carried out.

**Results:** A total of 17,024,344 restorations placed in 4,825,408 anterior teeth and 9,973,177 posterior teeth could be traced. Focussing on the primary outcome re-intervention, the cumulative four-year success rate was 69.9% for one surface restorations, 74.8% for two surface restorations, 66.6% for three surface restorations and 61.0% for four surface and more extended restorations. These differences were significant ( $p < 0.0001$ ). Focussing on all three target events re-intervention, crowning and extraction, the cumulative four-year success rate was 66.1% for one surface restorations, 67.5% for two surface restorations, 63.0% for three surface restorations and 55.8% for four surface and more extended restorations. The number of restoration surfaces as well as the tooth position remained significant in the multivariate Cox regression.

**Conclusions:** The sustainability of restorative dental treatment under the terms and conditions of the German national health insurance system shows room for improvement. From a public health perspective, special focus should be laid on primary and secondary prevention to minimize the restorative treatment need.

**Clinical significance statement:** This study shows that re-interventions are observed regularly after restorative treatment. Therefore, preventive and restorative strategies should be revisited and optimised.

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## 1. Introduction

Caries is still one of the most prevalent diseases in dentistry worldwide. The unrecoverable loss of tooth structure caused by caries causes high costs for dental treatment in a long-term

perspective. From the perspective of patients as well as from a public health perspective the sustainability of treatment is an important aspect in dentistry. There are treatment options that generally provide good sustainability because of their high long-term success or survival rates, for example single crowns [1]. Regarding dental fillings and inlays, published success or survival rates differ. Especially when focussing on outcomes from general practice, data are rare.

Clinical studies and systematic reviews for different tooth types are available [2–6] mainly indicating favourable outcomes. However, it is quite obvious that results from clinical research are not representative for outcomes from general practice. There

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are results from single practices [7] and practice networks [8] delivering important data. Especially large practice based research networks (PBRN) using digital techniques for collecting data recently became an important addition to clinical research. Participating in research projects however changes attitudes and treatment decisions [9]. Therefore, results from single practices or PBRN come closer to general practice but might still not be representative. At the moment, the most reliable option for measuring outcomes directly and comprehensively from general practice can be realised in mining databases of public health care systems or public health insurances. These databases being originally created for payment of dentists, their scientific use may be often limited and methodologically restricted. However, these databases often provide treatment courses of several million patients.

Concerning restorative treatment, studies using massive data are quite rare. Highest case numbers were reached in studies conducted by Burke & Lucarotti using data from the British National Health Service [10,11]. In a four-year period, they found success rates roughly between 80% for single surface amalgam restorations and 60% for glass ionomer and composite resin restorations. A similar study based on private insurance data from the United States evaluated 300,753 patient cases [11]. Success rates ranged between 60% and 92% at seven years. Other studies analysing treatment data from public health dental offices comprise much lower case numbers [13,14].

Therefore, the aim of this study was to extend the knowledge about the sustainability of restorative treatment under general practice conditions on the basis of a large data set. This data set consists of 8.6 million members of a German national health insurance company.

## 2. Materials and methods

The study was based on routine data of a major German national health insurance company (BARMER GEK, Berlin, Germany). This insurance company publishes annual health care reports [15,16]. In this context, the study group had access to the company's data warehouse. The study design was approved by the responsible local ethics board (EK 288072015).

Fee codes and treatment dates for every single treatment step were available and allowed for tracing clinical courses on a day-count basis. Data were available for a four-year period from 01.01.2010 until 31.12.2013. Only data sets of patients that had been a member of the insurance company for the whole four-year observation period entered the analysis. Because of systematically missing data, some specific German regions had to be excluded.

The placement of a permanent dental restoration other than a crown into a permanent tooth was defined as the initial study intervention. This marks the date of study intervention for the respective tooth. The claims data did not allow for a differentiation between fillings and inlays. The insurance system concedes different additional payments depending on the type of restoration that were not accessible for analysis. Inlays, however, were estimated only a very small portion of the restorations.

Two independent survival analyses were calculated: In the first analysis, a re-intervention by placing a filling or an inlay on the respective tooth was defined as the primary outcome (primary re-intervention). This re-intervention can be a complete or partial renewal of the original restoration or a restoration independent from the original one. Within the primary outcome analysis, the occurrence of the events "crowning of the respective tooth" and "extraction of the respective tooth" was not rated as a target event but led to censoring. In a second analysis, all re-interventions were rated as target events. These re-interventions comprised the placing of a new filling or inlay in the respective tooth, the

crowning of the respective tooth or the extraction of the respective tooth. Because permanent dental restorations may be used for building up teeth to be crowned, crowning was not counted as target event within 60 days after the restoration had been placed. The respective tooth type (anterior teeth, posterior teeth) was obtained from the database. The size of the dental restoration was categorized by the number of involved tooth surfaces (one, two, three, four and more extended). For all teeth that underwent no re-intervention, the observation period ended on December 31st 2013.

Survival analyses were conducted according to the Kaplan-Meier method. Differences between survival functions were first tested with the Log-Rank-Test. Additionally, a multivariate Cox-Regression analysis was carried out. The level of significance was set to  $p < 0.05$ . Survival analyses were conducted separately for each outcome on a day count basis. The software SAS (Statistical Analysis System, SAS Institute, Cary, NC, USA) was used for data preparation. The software R (available from <http://www.r-project.org>) with the add-on package "survival" was used for statistical analyses.

## 3. Results

The study sample comprised 14,798,585 teeth with 17,024,344 restorations in 3,924,245 patients. The mean age was 51.4 years (Fig. 1). A total of 4,825,408 anterior teeth and 9,973,177 posterior teeth were traced after having undergone a study intervention. The study intervention comprised 4,539,634 one surface restorations, 6,451,138 two surface restorations, 3,840,656 three surface restorations and 2,192,916 four surface and more extended restorations.

Focussing on the primary outcome re-intervention, one surface restorations showed a cumulative success rate of 69.9% at four years. This value corresponds to an annual re-intervention rate (ARR) of 7.5%. Two surface, three surface and four surface and more extended restorations showed cumulative success rates of 74.8% (ARR = 6.3%), 66.6% (ARR = 8.35%) and 61.0% (ARR = 9.75%) at four years (Fig. 2). The respective cumulative success rates at two years were 82.8% (one surface), 85.2% (two surface), 81.1% (three surface) and 76.3% (four surface and more extended). The Log-Rank test showed a significant difference between the survival functions ( $p < 0.0001$ ). For the secondary analysis comprising all three outcomes, the four-year success rates were 66.1% for one surface restorations, 67.5% for two surface restorations, 63.0% for three surface restorations and 55.8% for four surface and more extended restorations (Fig. 3).

For the primary outcome, the mean observation period was 662.2 days for one surface restorations, 698.0 days for two surface restorations, 650.1 days for three surface restorations and 622.4 days for four and more surface restorations. The respective median values were 638 days, 707 days, 616 days and 568 days. At two years, a number of 1,974,742 one surface restorations,

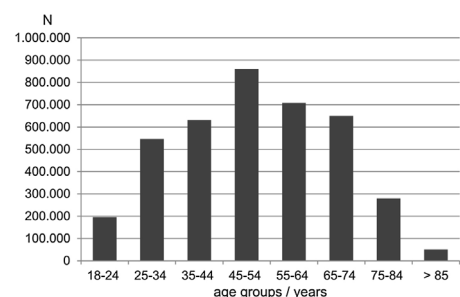


Fig. 1. Patients over age groups (yrs = years).

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