How long do direct restorations placed within the general dental services in England and Wales survive?

F. J. T. Burke[1] and P. S. K. Lucarotti[2]

IN BRIEF

- The interval to re-intervention on a tooth provides a measure of the survival of a restoration.
- Large amalgam restorations survive for shorter periods of time than single-surface restorations, of which 58% survive without re-intervention at 10 years.
- Of directly-placed restorations, glass ionomers perform least well.

RESEARCH

Aim It is the aim of this paper to consider the factors associated with the need for re-intervention on direct-placement restorations placed within the general dental services of England and Wales. **Methods** A large age-stratified sample of adult patients and their dental intervention were tracked over 11 years to December 2001. For each tooth treated with a direct restoration the subsequent history of intervention on that tooth was consulted, and the next date of intervention, if any could be found in the extended data set, was obtained. The distribution of times to re-intervention for different types of restoration in different circumstances was obtained using Kaplan-Meier survival analysis. **Results** Data for over 80,000 different adult patients were analysed, of whom 46% were male and 54% female. A total of 503,965 restoration placements were obtained from the data over a period of 11 years. Single surface amalgam restorations were found to have the longest survival – 58% at ten years, and glass ionomer the shortest – at 38% at ten years. **Conclusions** Small amalgam restorations have longer survival times before re-intervention than large amalgam restorations such as MOD. Composite and glass ionomer restorations perform less well than amalgam restorations. Restorations placed by older dentists and restorations placed in older patients have shorter time to re-intervention. Patients who changed dentist were found to have restorations which performed less well than those placed in patients who did not change dentist.

INTRODUCTION

Satisfactory survival of dental restorations is central to the achievement of patient satisfaction and to the fulfilment of clinical governance, let alone satisfying third party funders, such as the National Health Service in the UK, and maintaining confidence in the dental profession. One measure of the performance of a dental restoration is the time interval from placement until the next intervention on the same tooth: the longer the interval, the better the performance is perceived to be. Randomised controlled clinical trials may be considered to be the gold standard in the evaluation of the performance of dental materials, but these are few and far between in restorative dentistry. Studies employing calibrated observers, using standard examination protocols in cohort studies, are relatively common in the evaluation of the performance of dental materials in the clinical situation, but the results of such trials, sometimes from a selected population in a dental hospital, cannot be readily generalised to what happens in dental practice. Assessments of the performance of restorations placed under the conditions prevailing in general dental practice may therefore be considered to be of value as indicators of the performance of materials and techniques in the real world, in other words, effectiveness rather than efficacy. This paper reports such performance.

The Dental Practice Board (DPB), now known as the NHS Business Services Authority (Dental Services Division), previously held administrative data for dental treatments provided in the general dental services (GDS) of England and Wales. These records covered every course of dental treatment – about 35 million each year. Within each course of treatment each individual treatment item was recorded, together with the mouth position of each tooth treated. Also recorded for each course were the identity of the dentist, that of the patient, and the dates of start and end. This paper summarises previously published data on survival of directly-placed restorations,[1-5] obtained from a large representative sample of patients treated in the GDS of England and Wales between 1991 and 2001. The data consist of items gleaned from the payment claims submitted by GDS dentists to the DPB in Eastbourne, Sussex.

METHODS

Details of the patients included in this study have already been published.[1] The data consisted of all those records containing directly placed restorations which related to courses of treatment with last

[1*,2]Primary Dental Care Research Group, University of Birmingham School of Dentistry, St.Chad's Queensway, Birmingham, B4 6NN
*Correspondence to: Professor F. J. T. Burke
Email: f.j.t.burke@bham.ac.uk

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date on the claim after 31 December 1990 and with date of acceptance after September 1990 and before January 2002, and which were scheduled for payment between January 1991 and March 2002 inclusive. The restoration records were further restricted to those which related to courses of treatment starting on or after the patient's 18th birthday. For all patients with at least one such restoration record, the data were extended to include all treatment records on any of the payment schedules from January 1991 to March 2002. For each tooth treated with a direct restoration the subsequent history of intervention on that tooth was consulted and the next date of intervention, if any could be found in the extended data set, was obtained. Thus a data set was created of direct restorations with their dates of placement and their dates, if any, of re-intervention.

A technique for analysing incomplete survival data with individual dates of 'life' and 'death' was developed by Kaplan and Meier in 1958 (described in Collett, 1994).[6] This technique, modified by Lucarotti,[7] has been used in this work to quantify the distribution of survival times, both overall and according to the characteristics of the restoration, the patient, the dentist and date and geographical location of the surgery.

RESULTS

The sample population

Just over 80,000 different adult patients were identified (46% male and 54% female). They accounted for 719,009 claims for payment sent to the DPB, each relating to a course of treatment involving all the care and treatment necessary to secure and maintain the oral health of a patient. By these means, a total of 503,965 restoration placements were obtained from the data.[1]

Type of restoration

Figure 1 presents the survival curves to next intervention for all types of amalgam restorations, distinguished by the codes used in the GDS.[2] Figure 2 presents the survival of resin composite and glass ionomer restorations. Amalgam restorations will have been placed predominantly in load-bearing situations in posterior teeth, composite predominantly in class III and IV cavities and glass ionomer predominantly in class V cavities. It should be noted that the regulations of the GDS precluded the use of composite resin or glass ionomer for the restoration of load-bearing surfaces of posterior teeth, so the only cavities on which these materials could be used on posterior teeth were class V lesions.

Figures 1 and 2 illustrate that single surface amalgam restorations consistently have better survival than class II amalgam restorations and that glass

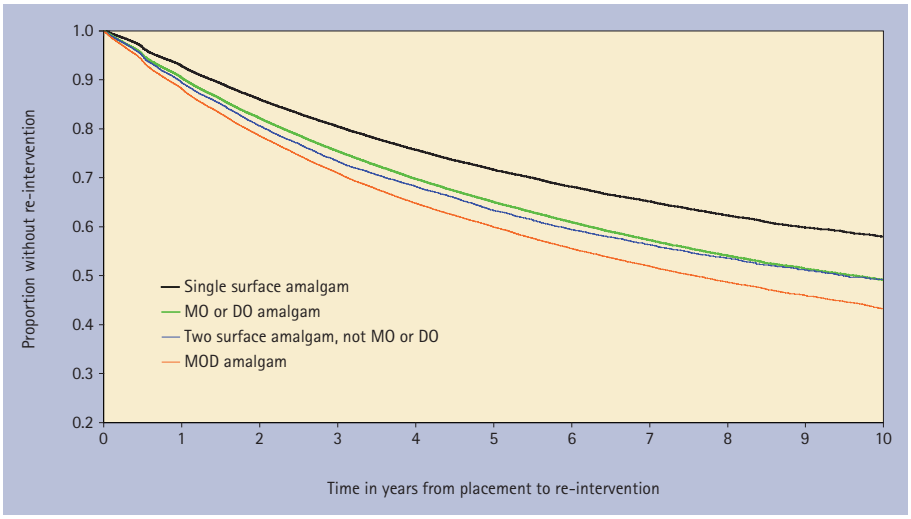

Fig. 1 Ten year survival of amalgam restorations

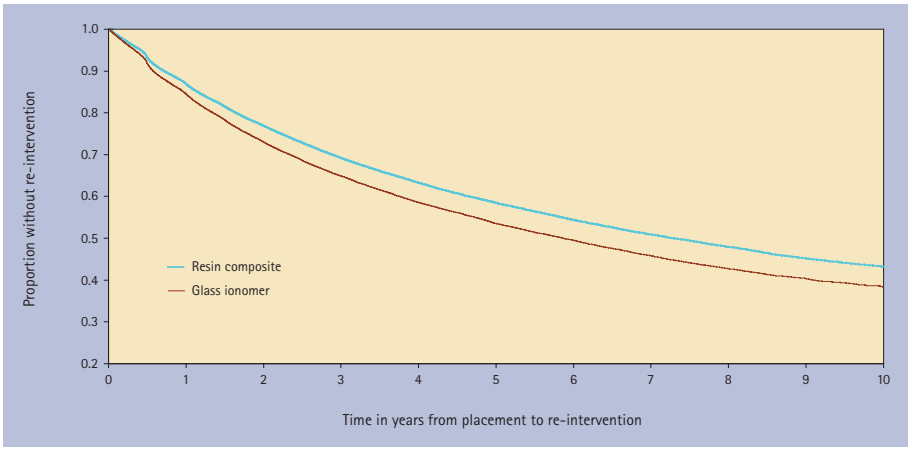

Fig. 2 Ten year survival of glass ionomer and resin composite restorations

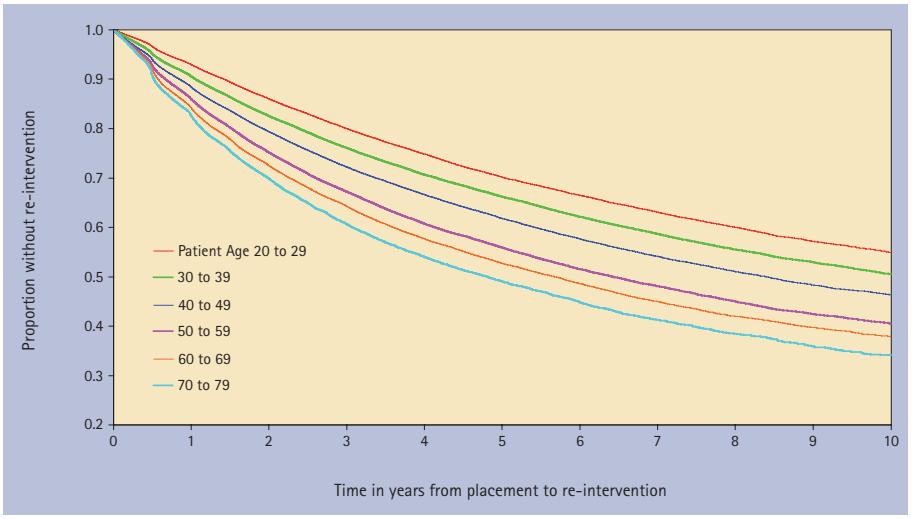

Fig. 3 Ten year survival of restorations by patient age. Adapted from reference 3 and reproduced by kind permission of Elsevier, publishers of the *Journal of Dentistry*

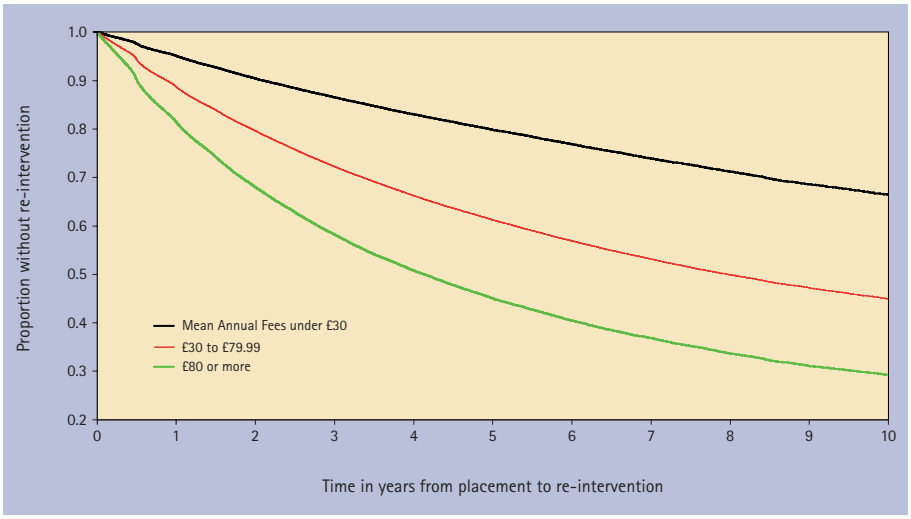

Fig. 4 Ten year survival of restorations by mean annual gross fees for patient Adapted from reference 3 and reproduced by kind permission of Elsevier, publishers of the *Journal of Dentistry*

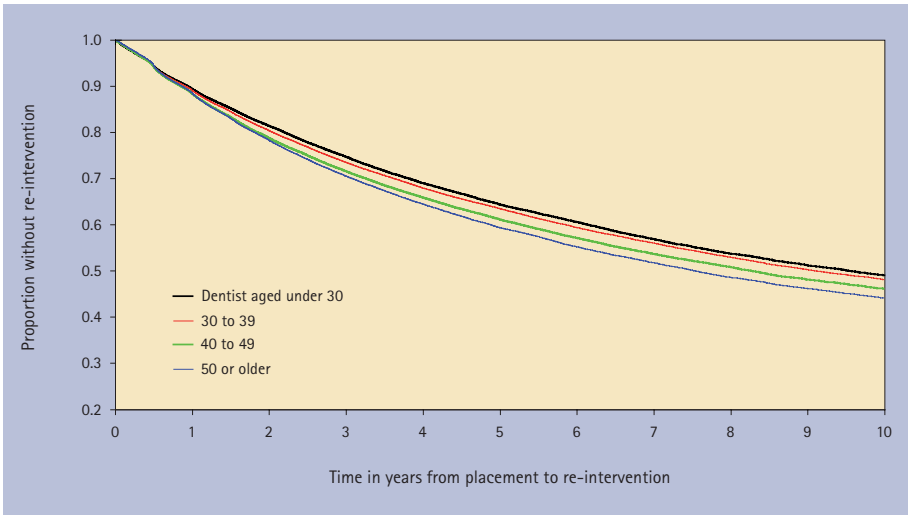

Fig. 5 Ten year survival of restorations by dentist age. Adapted from reference 4 and reproduced by kind permission of Elsevier, publishers of the *Journal of Dentistry*

ionomer restorations perform less well than other restoration types (p <0.0001). Further analysis of the data has indicated, for composite resin restoration of incisors and canine teeth, that when the incisal angle is involved there is an associated reduction in median survival of around two years, but survival is much better if only the incisal edge is restored.[2] For amalgam and composite restorations, dentine pins may be placed with the aim of enhancing the retention of a restoration, but the presence of such additional treatment is also associated with shorter expected time to re-intervention.[2]

Regarding patient factors,[3] older patients have restorations with a shorter interval to re-intervention (p <0.001) (Fig. 3), but patient gender was found to be of little significance. Analysis of the data has indicated that the charge-paying status of the patient had a statistically significant but small effect ((p <0.001), with survival for charge-payers being slightly higher throughout the observation period.[3] Furthermore, patients who attend more frequently and have a higher annual spend on treatment have restorations which survive less well (p <0.001). Finally, it is apparent from previous work[3] that patients who change dentist have restorations which perform less well than those who remain with the same dentist.

Regarding dentist factors,[4] the age of the dentist who placed the original restoration appears to be related to the interval to re-intervention, with older dentists having shorter intervals from placement of restorations to re-intervention (p <0.001) (Fig. 5). Country of qualification seems not to be relevant within Europe in terms of direct-placement restoration survival, but dentists who qualified outside Europe appear to achieve different restoration survival times from dentists who graduated from dental schools in Europe.[4]

DISCUSSION

This paper has presented survival times, to next intervention, of restorations placed within the General Dental Services in England and Wales. More detailed expositions of the findings have already been published.[1-5] The database utilised is the largest ever developed for assessment of restoration survival. As such, some factors are lost which might be available for a smaller cohort study, such as actual type of restorative material used (for example resin-modified glass ionomer or conventional glass ionomer, microfilled or hybrid composite, admixed or spherical amalgam alloy), but the weight of numbers in this representative sample assures the validity of the findings. Re-intervention on a previously restored tooth is statistically associated with the original restoration, but it is generally possible that there is no causal connection – the re-intervention may have been required in response to a circumstance unrelated to the origin restoration. For example, a first molar tooth with an existing occlusal amalgam restoration may receive a second occlusal amalgam restoration, but it may be in a different site.[8]

It must be remembered that this is essentially an observational study of a natural population. The associations between different factors and the survival times of restorations reflect the particular clinical circumstances in which restorations of different types are placed, as well as correlations between factors. Nevertheless, they provide a reliable picture of the likely sequence of, and intervals between, events occurring to typical patients within the general dental services of England and Wales.

The results indicate that single surface amalgam restorations survive better (58% of these surviving ten years) than larger restorations (43% for an MOD amalgam). In this respect, the results

of the present study confirm the view from a systematic review of restoration longevity[9] that amalgam is a material which provides predictable, satisfactory durability. However, it was not possible to directly compare the performance of amalgam and resin composite in load-bearing surfaces of posterior teeth because the GDS regulations (under which auspices the data for this study were obtained) preclude the use of resin composite in such situations.

Glass ionomer, which also may not be placed in load-bearing situations under GDS regulations, performed less well than amalgam – with only 38% of glass ionomer restorations surviving without re-intervention after ten years. Additionally, further analysis of the data has shown that teeth with glass ionomer restorations, when they have a re-intervention, tend to receive an amalgam or composite restoration, whereas amalgam and composite restorations tend to be replaced by another restoration of the same type.[10] However, despite the poorer performance of glass ionomer and composite restorations, there could be a hope that these restorations will be placed in minimal intervention cavities which result in little or no loss of tooth substance for retentive features, using the adhesive properties of these materials (when composite is used with a dentine bonding agent).

The inclusion of a pin within a restoration has been shown to be associated with reduced survival of the restoration. However, this is unlikely to be the full picture. Dentine pins may be considered to be an indicator rather than a cause, given that they are placed in cavities which are already large and/or lacking in innate retention form. It could therefore be considered that pin placement is an association with extensive cavity preparation rather than a cause of premature failure. Similar comments may apply to composite restorations involving an incisal angle. The reduced time to re-intervention of these restorations, when compared with restorations not involving an incisal angle, may simply be an indication of the extent of the restoration rather than a failure of retention.

The results of this study indicate that older patients have restorations which survive less well to re-intervention than younger patients. This may not be considered surprising, since the older generations in the UK have had much greater incidence of restorative intervention than the younger generations[11] and have received restorations in situations where, today, a 'wait and see' approach would be considered. As teeth become more heavily restored as patients age, the potential for cusp fracture may be considered to increase,[12,13] leading to larger and larger restorations and the potential need for crowns or extractions when the tooth cannot be restored. Gross annual spend on treatment may be considered a proxy for high treatment need. Figure 4 indicates that patients with a high annual spend on treatment have restorations with substantially reduced survival. These patients also attend more frequently,[3] presumably because of lost restorations or pain.

Older dentists have been found to place restorations which survive less well than those placed by younger dentists. The reasons for this are more difficult to ascertain. They may well treat generally older patients, but previous work has shown that this does not fully explain this finding.[4] It may be that younger dentists, recently graduated from dental school, are in the forefront of new teaching on materials and techniques while older dentists may have more entrenched ideas. It may also be related to different attitudes to the clinical situations where intervention is considered necessary. Further analysis of the reasons for this finding is indicated.

With any funding scheme, or indeed within any dental practice, there is always a question on whether a re-intervention was necessary. While this depends on the education of the clinician, it also depends on the probity systems available within the payment system. Within the GDS in England and Wales, there existed a team of *circa* 50 reference dental officers whose principal duties were the assessment of treatment carried out by GDS dentists, backed up by the computational and statistical expertise within the DPB. At no time was there evidence of systematic abuse of the system, which, being a fee-per-item method of remuneration, might encourage overtreatment by an unscrupulous dentist. The results of the present study may therefore be considered validated by the probity system in place and therefore represent a true assessment of restoration longevity within the GDS in England and Wales.

Lastly, from the point of view of the life of the tooth rather than just that of the restoration, the type of re-intervention becomes important. For the patient and the third party funder, value for money becomes important. In this regard, when the fee payable before the demise of the GDS fee-per-item method of payment system for a class I restoration is considered (£7.50) and when it is considered that the survival of this restoration is 58% at ten years, the cost to patients in England and Wales must be considered excellent value. This is reflected in many other aspects of the analysis of the database used in this study[1-5] and may be considered to compare favourably with the cost effectiveness of other treatment systems for which details are available.[14]

CONCLUSIONS

Small amalgam restorations, such as class I, have longer survival times at ten years before re-intervention (58%) than large amalgam restorations such as MOD (43%). Composite and glass ionomer restorations perform less well than amalgam restorations. Pin placement is associated with shorter survival times of restorations. Restorations placed by older dentists, and restorations placed in older patients, survive less well.

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