



Published in final edited form as:

*J Am Dent Assoc.* 2011 June ; 142(6): 622–632.

## Practitioner, patient, and caries lesion characteristics associated with type of material used to restore carious teeth: findings from The Dental PBRN

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### Abstract

**Background**—The authors conducted a study to identify factors associated with material use by dentists in The Dental Practice-Based Research Network (DPBRN) when placing the first restoration on permanent tooth surfaces.

**Methods**—A total of 182 DPBRN practitioner-investigators provided data on 5,599 posterior teeth with caries. Practitioner-investigators completed an enrollment questionnaire that included the dentist's age, gender, practice workload, practice type, and years since graduation. When a consented patient presented with a previously un-restored carious surface, practitioner-investigators recorded patient and tooth characteristics.

**Results**—Amalgam was used more often than direct resin-based composite (RBC) for posterior carious lesions. Practitioner/practice characteristics (years since graduation and type of practice); patient characteristics (gender, race, age, and dental insurance); and lesion characteristics (tooth location and surface, pre-and post-operative depth) were associated with the type of restorative material used.

**Conclusions**—There are several practitioner/practice, patient, and lesion characteristics significantly associated with use of amalgam and RBC: region, years since graduation, dental insurance, tooth location and surface, and pre-and post-operative depth.

**Clinical implications**—Amalgam remains a material commonly used by United States dentists to restore posterior caries lesions.

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## Keywords

direct resin-based composite; amalgam; practice-based research; multi-center studies; clinical research

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## Introduction

Restorative dentistry, which includes the placement and replacement of restorations, constitutes the majority of the workload in daily clinical practice.<sup>1-3</sup> With the increasing availability of new dental materials, choice of material is an important part of a dentist's decision-making process. At one point, amalgam was the material of choice for posterior tooth restorations<sup>4-5</sup>, but over time materials have changed such that amalgams are being phased out in favor of more-esthetic choices.<sup>6-11</sup> This change is a result of various patient and dentist factors.<sup>10-12</sup>

Patients may choose to have direct resin-based composites (RBC) placed instead of amalgams due to esthetics.<sup>6-9,15</sup> Patients may also opt for RBC because of the public perception of mercury toxicity from amalgams<sup>7-9-11</sup>, although numerous studies have shown no adverse health effects.<sup>16-18</sup> Alternatively, patients may instead request amalgams because they are less expensive than RBC, especially patients who are not covered by dental insurance.<sup>19-20</sup>

Dentists may choose to place amalgam because they consider it an effective low-cost restorative treatment with a long clinical life.<sup>15-21-25</sup> In the early 1990s, one study showed that the typical life-span of posterior RBC was three to 10 years, with large fillings lasting fewer than five years.<sup>26</sup> However, the quality of RBC material has since improved<sup>27</sup>, and a longitudinal study on RBC demonstrated a success rate of 76% after 17 years, with success being defined as color matching, no marginal discoloration, marginal integrity, and no loss of surface texture or anatomic form.<sup>28</sup> On one hand, amalgams are not as technique sensitive,<sup>29-30</sup> have less post-operative sensitivity<sup>5</sup>, and a longitudinal study found a higher survival time for complex amalgam restorations compared to complex RBC restorations.<sup>31</sup> On the other hand, with RBC restorations, greater retention may be achieved with a smaller cavity preparation which might lead to greater conservation of tooth structure.<sup>6</sup> Therefore, it is likely that certain characteristics of practitioners, practices, patients, and caries lesions influence whether or not a caries lesion is restored with amalgam or RBC.

The Dental Practice-Based Research Network (DPBRN) conducted a study on the placement of restorations on previously un-restored tooth surfaces in daily clinical practice.<sup>32-33</sup> Dentists in this study recorded information about certain patient and caries lesion characteristics during this study. DPBRN is a consortium of dental practices whose purpose is to answer questions raised by dental practitioners in everyday clinical practice and to evaluate the effectiveness of current strategies to prevent, manage, and treat oral diseases and conditions.<sup>31-34</sup> The DPBRN includes dental practitioner-investigators (dentists and hygienists) from the United States (US) and Scandinavia mainly from five regions: Alabama/Mississippi (AL/MS); Florida/Georgia (FL/GA); Minnesota (MN); Permanente Dental Associates (PDA); and the Scandinavian countries of Norway, Denmark, and Sweden (SK). DPBRN represents substantial diversity of both dentists and patients with regard to practice types (large group, small group, public), treatment philosophies, race, ethnicity, workload, age, and gender. Although DPBRN dentists have substantial diversity, previous analyses have demonstrated that DPBRN dentists have much in common with dentists at large.<sup>35</sup>

The purpose of this study was to test the hypothesis that certain factors (practitioner/practice, patient, and caries lesion characteristics) are associated with use of restorative material types (amalgam and RBC) that DPBRN practitioners from the US used to restore posterior carious teeth.

## Material and Methods

### Selection and recruitment process

To become a member of DPBRN, practitioners must first complete a 101-item DPBRN Enrollment Questionnaire. This questionnaire, which is publicly available at <http://www.dpbrn.org/users/publications/supplement.aspx>, queries information on practitioner, practice, and patient characteristics. DPBRN practitioners were recruited to become members of the network through continuing dental education courses as well as letters sent to licensed dentists from the participating regions. To be eligible for the DPBRN study “Reasons for placing the first restoration on previously unrestored permanent tooth surfaces”, practitioners had to complete the enrollment questionnaire, a questionnaire regarding how they diagnose and treat dental caries (also available at <http://www.dpbrn.org/users/publications/supplement.aspx>), attend a DPBRN orientation session or watch a video of it, and complete their training in human subjects protection.

### Study Design

Details of the DPBRN study “Reasons for placement of the first restoration on previously un-restored permanent tooth surfaces” have been described elsewhere.<sup>33</sup> Briefly, this study was a cross-sectional study conducted by DPBRN practitioner-investigators in their offices. The respective institutional review boards of all participating regions approved the study and all patients who took part in this investigation provided informed consent after dentists or their staff provided them with a full explanation of the nature of the procedures.

The practitioners recorded data on consented consecutive patients who had a restoration placed on a previously un-restored permanent tooth surface. The practitioner could enroll up to 4 restorations per patient and continued to collect data until information on 50 restorations had been collected. The number of lesions/patient was restricted in order to limit the size of clustering at the patient-level, thus increasing the precision and generalizability of the study. Primary caries were defined as the first caries lesion on a surface, not related to a current restoration. Practitioners also recorded the technique used to diagnose the lesion: clinical assessment, radiograph, and transillumination or optical technique (such as DiagnoDENT®). A consecutive patient log was maintained to record information on each eligible restoration regardless of whether the lesion was enrolled. A total of 95% of eligible patients were enrolled in the study. Copies of all data collection forms are available at <http://www.dpbrn.org/users/publications/supplement.aspx>.

Factors tested for their association with dental material use are shown in Table 1. These factors were grouped into three categories: (1) practitioner/practice characteristics; (2) patient characteristics; and (3) caries lesion characteristics.

### Practitioner and/or practice characteristics

Practitioner-level variables were collected from the DPBRN Enrollment Questionnaire. In addition to DPBRN region, this form also included questions related to their gender, year of graduation, type of practice, and practice workload. Graduation year was re-categorized to depict years since graduation and consisted of the following categories: 5 years or less, 6-15 years, 16-19 years, and 20 or more years. Type of practice was characterized as: (1) large group practice (LGP); (2) solo or small group practice (SGP); and (3) public health practice

(PHP). LGP was defined as those participating in a practice consisting of 4 or more practitioners, SGP consisted of practices with 3 or fewer practitioners, and PHP was defined as those practices receiving the majority of their funding from public sources. For the AL/MS region, 98% (62/63) of the practitioners worked in a SGP and 2% (1/63) were in PHP. In the FL/GA region, 97% of the practitioners were in a SGP (36/37) and 3% (1/37) were in PHP. In the MN region, 90% of practitioners were in LGP (28/31) and 10% were in SGP (3/31). All practitioners in the PDA region were in LGP. Responses are found in Table 1.

### Patient-level characteristics

If the patient consented, a data collection form was completed on the tooth (teeth) being restored. This included information regarding the patient's race, ethnicity, age, gender, and whether the patient had dental insurance. Responses to this information are found in Table 1.

### Caries lesion characteristics

The practitioner also completed information about the caries lesion itself. This included: (1) tooth number (only premolars and molars were used for the analyses in the current report); (2) which surface(s) were restored; (3) the main reason for placing the restoration: carious or non-carious (we confined analyses in the current report to restorations done mainly due to primary caries); (4) depth estimated pre-operatively; and (5) depth determined post-operatively. For the purposes of these analyses, tooth surface was categorized as multi-surface or one-surface (occlusal, mesial or distal, and buccal or lingual). For pre- and post-operative depth, the categories were: E1 (outer 1/2 of enamel), E2 (inner 1/2 of enamel), D1 (outer 1/3 of dentin), D2 (middle 1/3 of dentin), and D3 (inner 1/3 of dentin). Because restorations done with other materials were relatively uncommon (4%; 247/5,846), analyses were limited to amalgam and RBC restorations. Responses to this information are found in Table 1.

### Statistical Methods

We analyzed data by using SAS statistical software version 9.2 (SAS Institute, Cary, NC). We considered  $p < 0.05$  to be statistically significant. Descriptive statistics were calculated as counts and percentages of restorations that utilized amalgam rather than RBC. Counts and percentages are presented for each level of the predictor variables. Statistical significance was evaluated using generalized estimating equation (GEE) modeling to implement logistic regression analysis, in order to account for correlated observations due to multiple restorations conducted by the same dentist and up to four restorations within the same patient. Associations between each of the potential predictor variables and each of the materials were evaluated in Table 2.

Multivariable models to predict use of amalgam versus RBC were developed using three blocks of potential predictors, representing practitioner/practice characteristics, patient characteristics and caries lesion characteristics, which are found in Table 3. Separate analyses were conducted for each block. Variables showing significant association at  $p < 0.10$  were then included in a multiple logistic regression model. Variables which were significant in models were included in a final predictive model in order to avoid excluding variables which might become more significant in the multivariable model.

### Results

The overall frequency results are shown in Table 1. A total of 229 practitioner-investigators participated in the study, but because amalgam is being phased out or already banned in Denmark, Norway, and Sweden,<sup>4,7</sup> the DPBRN practitioners in Scandinavia were not included in these analyses. Therefore, the final number of practitioners, for the purpose of

this analysis, was 182. Although a total of 9,980 lesions were enrolled in the study, restorations placed on non-carious lesions (n=1,539), those placed on anterior teeth (n=2,087), or lesions where a material other than amalgam or RBC was used (n=930), and restorations placed in non-US regions (n=1,312) were excluded from the current report, resulting in 5,599 restorations enrolled in 3,421 patients. Note that the exclusion categories are not mutually exclusive.

### Regional Participation

The highest percentage of practitioner-investigators were from the AL/MS region, followed by PDA, FL/GA, and MN (Table 1). One-third of the restorations were from the AL/MS region, followed by PDA, with the MN and FL/GA region representing 19% (1,076/5,599 and 1,068/5,599, respectively) of the restorations (Table 1).

### Practitioner and Practice Characteristics

With regard to practitioner characteristics (Table 1), 81% (147/182) of the practitioner-investigators who participated in this study were male, 49% (86/175) had graduated 20 or more years ago, and a majority of the practitioner-investigators worked in a SGP (56%; 101/182). When asked about practice workload, 58% (101/175) of the practitioners responded that they were able to provide care to all but were not overburdened, and only 10% (17/175) said they were too busy to treat all their patients.

### Patient Characteristics

Fifty-four percent (1,850/3,414) of the patients enrolled in the study were female and 82% (2,561/3,414) were White or Caucasian (Table 1). The mean age of patients was 31.1 (SD 16.4) and 6% (205/3,188) were of Hispanic or Latino origin. With regard to dental insurance, 84% (2,859/3,412) of the patients reported having some type of dental insurance.

### Caries Lesion Characteristics

As shown in Table 1, a majority of the restorations placed were located on the molars (69%; 3,886/5,599), and were one-surface restorations (66%; 3,672/5,599). Of the one-surface restorations, more than half (51%; 1,866/3,672) were on the occlusal surface. Prior to preparing the tooth, practitioners assessed the depth of the lesion to be restored. The most common estimated pre-operative depth was in D3 (54%; 2,997/5,534), which coincided with the post-operative (actual) depth (44%; 2,468/5,565).

Table 2 describes the associations of individual potential predictor variables with amalgam (n=3,028) and RBC (n=2,571) restorations. A majority of the PDA region's restorations placed were amalgam (78%; 1,268/1,621), followed by MN (76%; 814/1,076), AL/MS (36%; 663/1,834), with the smallest percent in FL/GA (27%; 283/1,068).

### Practitioner and Practice Characteristics

The association between restorative material and gender was significant and RBC (51%; 2,250/4,430) was placed as often as amalgam by male practitioners, but a majority of the restorations placed by female practitioners were amalgam (Table 2, 67%; 778/1,169) in their patients. The number of years since graduation was associated with the type of restorative material used with a tendency to increased use of RBC among older dentists (p=0.02). For practitioners who graduated 5 years ago or less, 61% (536/882) of the restorations were amalgam and 45% (1,175/2,561) of the amalgam restorations were from those who graduated 20 or more years ago. The type of practice was also associated with the type of material used. A large percent of amalgams placed were from a LGP (79%; 2,064/2,612). Alternatively, RBC restorations were placed from practitioners who were in a SGP or PHP

(68%; 1,993/2,940 and 64%; 30/47, respectively). Practice workload was not statistically significant. A little more than half of the amalgam restorations (58%; 346/594) were from practitioners who were too busy to treat all their patients.

### Patient Characteristics

Regarding patient characteristics, gender was associated with type of material (Table 2). Male patients were more likely to receive amalgam restorations (59%; 1516/2580). Amalgam and RBC restorations were approximately equally distributed among female patients. Race of the patient was also significantly associated with material use. Amalgam restorations placed in White or Caucasian and Black or African-American patients were almost equally distributed (51%; 2,123/4,160 and 53%; 381/713, respectively); however, 72.9% (205/281) of the restorations placed in patients of "Other" race (American Indian/Alaska Native/Asian/Pacific Islander) were amalgam. Ethnicity was not associated with material use, with amalgam and RBC placement approximately equally distributed among Hispanics and non-Hispanics. With regard to dental insurance, amalgam restorations (56%; 2,657/4,712) were more often placed on patients who did have insurance compared to RBC. A larger percent of patients who did not have dental insurance had RBC restorations (58%; 508/875) placed compared to amalgam.

### Caries Lesion Characteristics

All variables regarding lesion characteristics were significantly related to which type of material was used (Table 2). More than half of the restorations placed in either molars or premolars received an amalgam (54%; 2,108/3,886). In addition to tooth location, more than half of the restorations placed on multiple surfaces or one surface were also amalgam (57%; 1,104/1,927 and 52%; 1,924/3,672, respectively). Of those restorations placed in one surface, only 41% (765/1,866) of those placed in the occlusal were amalgam, 78% (796/1,016) placed in the mesial or distal were amalgam, and 46% (363/790) placed in the buccal or lingual were amalgam. Regarding pre-operative depth, as restorations became deeper, the more likely amalgam was used. For lesions perceived pre-operatively to be limited to E1, amalgam was used in one-fourth of the restorations (53/211) and for D3, amalgam was used 61% (214/351). For post-operative depth (actual depth), a similar pattern was noted. On average, RBCs were placed in younger people compared to amalgam. The average age of the person receiving RBC was 27.5 (SD 15.3) compared to 30.5 (SD 15.2) for amalgam.

### Patients with both an amalgam and RBC restorations

There was only a small percent of patients who had both an amalgam and RBC restorations (3%; 107/3,421) placed at the same visit on different teeth. A majority of these patients were enrolled from the PDA region (57%; 61/107), followed by AL/MS (19%; 20/107), FL/GA (15%; 16/107) and MN (9%; 10/107). More than half of these patients were female (54%; 58/107), were White or Caucasian (84%; 88/105) and non-Hispanic (91%; 96/105). Most of these patients had dental insurance (89%; 95/107).

### Block model for practitioner/patient characteristics

The block model for practitioner/patient characteristics is found in Table 3. Practitioner/practice characteristics included gender, years since graduation and type of practice. Only type of practice was significant ( $p < 0.0001$ ) in the block model. The patient characteristics model included gender, race, Hispanic/Latino ethnicity, age and dental insurance. All of these except Hispanic/Latino ethnicity remained significant in the block model. Tooth location, tooth surface, pre-operative depth and post-operative depth were included in the lesion characteristics model, and all were significant in the block model. The block models indicated a final model including type of practice, patient gender, race, age and dental



insurance, tooth location, tooth surface, pre-operative depth and post-operative depth. Due to strong association between tooth location and tooth surface (contingency coefficient = 0.3078,  $p < 0.0001$ ) and between pre-operative and post-operative depth (contingency coefficient = 0.7681,  $p < 0.0001$ ), tooth surface and post-operative depth were excluded from the final model. Thus, the final model included type of practice, patient gender, race, age and dental insurance, tooth type, and pre-operative depth, with all variables significant ( $p < 0.05$ ).

## Discussion

These results suggest that there are many factors associated with material use when placing the first restoration on a tooth surface. Although there are many materials available, amalgam and RBC are the materials used for the vast majority of first-time restorations of caries lesions in posterior teeth. This is interesting to note because although there is an increasing trend in the use of esthetic materials<sup>6-11</sup>, amalgam is still being used in the US for many restorations, specifically on dentists themselves. A web survey<sup>9</sup> of more than 700 dentists found that of the 5,908 molar restorations present in their own mouth, 36% (2,104/5,908) were amalgam, compared to just 7% (400/5,908) composite.

Selection of restoration material differed significantly among regions. For the AL/MS region, in which 98% (62/63) of dentists were in SGP, 64% (1,171/1,834) of the restorations placed were RBC. In the FL/GA region, in which 97% (36/37) of dentists were in SGP, 74% (785/1,068) of the restorations placed were RBC. In the MN region, in which 90% (28/31) of dentists were in LGP, only 24% (262/1,076) of the restorations placed were RBC. In the PDA region, in which all dentists were in LGP, only 22% (353/1,621) of the restorations placed were RBC. LGPs (the PDA and HealthPartners (in MN) practices) tend to place amalgams over RBC. For PDA and HP practitioners this may be due to the fact that practitioners in LGPs are not compensated solely by production, but rather a mix of fixed-based salary and pay-for-performance measures. A study on Norwegian clinicians found that RBC was used less often by salaried dentists<sup>9</sup>, which is consistent with our findings that salaried dentists are less likely to use RBC than amalgam compared to those in a private practice setting. Another study done on the selection of dental materials in Public Health Clinics in Sweden found that 93% of all the restorations placed due to primary caries used RBC and less than 1% used amalgam.<sup>6</sup> Although these are in contrast to the Norwegian study done in 1999 and our findings, this particular study was more recent (2009) and may reflect the fact that amalgam is being phased out or already banned in Denmark, Norway, and Sweden.<sup>4,7</sup>

It is interesting to note that the most-recent graduates (five years or less) placed amalgams in 61% (536/882) of their restorations. This is in contrast to reports that numerous schools do not teach students how to use amalgam, and older dentists are not as experienced in placing RBC.<sup>36-37</sup> One possible reason for the high amalgam proportion is that recent graduates may work in a LGP rather than an SGP. Past literature found that PDA had the youngest practitioner-investigators compared to the other DPBRN regions, with many of them having graduated less than 5 years ago.<sup>38</sup> Alternatively, older clinicians may work in a SGP, with private insurance or cash services, and receive higher compensation for placing RBCs.

For patient-level characteristics, gender, race, and dental insurance were significantly associated with material use. One study on Norwegian clinicians also found a gender difference in the selection of materials. Female patients were more likely to receive RBC than amalgam (73% vs. 65%, respectively).<sup>9</sup> For the restoration-level characteristics, all variables were significant: tooth location, tooth surface, pre-operative depth, and post-operative depth, and age of the patient. Our findings that younger patients were more likely

to have received RBC is consistent with another study which found that older patients received amalgams, which they noted could be related to the size of the restoration placed.<sup>9</sup>

There were some limitations with this study. The sample size for individual predictors did vary due to non-responses. Also, the data collection form did not record other reasons why certain materials were placed, such as patient request. This study investigated treatment as delivered in everyday, “real world” clinical practice and therefore made no attempt to standardize or calibrate that treatment. However, dentists were chosen from each of the regions and recent literature suggests that although DPBRN dentists have substantial diversity, they have much in common with dentists at large.<sup>35</sup>

Previous studies have focused on material choice of younger patients<sup>10</sup> or were conducted in Scandinavian countries, where a ban on amalgam has been placed or in the process of being banned.<sup>4,5,7,9,39,40</sup> For example, a 2004 Finnish study<sup>41</sup> looked at perceptions of the longevity composites and amalgams. A survey was sent out to public and private practice dentists asking their estimation for the mean age of a restoration in permanent teeth in Class II MOD composites and amalgams and Class II composites. The results concluded that the mean estimate for all composites was 9 years and 18.7 years for amalgam. The male dentists gave longer estimates for composites and the female dentists gave longer estimates for amalgam. These results do coincide with our findings that female dentists tend to use amalgam more than RBC.

## Conclusion

To our knowledge, this is the first study in recent years to test whether certain factors are associated with type of material used in the United States to restore carious posterior teeth. The results suggest that several practitioner/practice, patient, and caries lesion-level characteristics are associated with use of amalgam and RBC.

## Acknowledgments

This investigation was supported by NIH grants DE-16746 and DE-16747. Opinions and assertions contained herein are those of the authors and are not to be construed as necessarily representing the views of the respective organizations or the National Institutes of Health. The informed consent of all human subjects who participated in this investigation was obtained after the nature of the procedures had been explained fully.

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**Table 1**

Frequency distributions of potential predictors of type of material used\*

Variable		Number	Percent
<b>Regional Participation</b>			
<b>Practitioner-Investigators, by DPBRN region</b>			
AL/MS		63	35
FL/GA		37	20
MN		31	17
PDA		51	28
	Total	182	
<b>Restorations, by DPBRN Region</b>			
AL/MS		1834	33
FL/GA		1068	19
MN		1076	19
PDA		1621	29
	Total	5599	
<b>Patients, by DPBRN Region</b>			
AL/MS		1077	31
FL/GA		693	20
MN		712	21
PDA		939	27
	Total	3421	
<b>Practitioner and Practice Characteristics</b>			
<b>Gender</b>			
Male		147	81
Female		35	19
	Total	182	
<b>Years Since Graduation</b>			
≤ 5		25	14
6-15		35	20
16-19		29	17
20 or more		86	49
Missing		7	--
	Total	182	
<b>Type of Practice</b>			
Large group practice (4 or more practitioners)		79	43
Small group practice (3 or fewer practitioners)		101	56
Public health practice		2	1
	Total	182	
<b>Practice Workload</b>			

Variable		Number	Percent
Too busy to treat all		17	10
Provided care to all, but overburdened		31	18
Provided care to all, but not overburdened		101	58
Not busy enough		26	15
Missing		7	--
	Total	182	
<b>Patient Characteristics</b>			
<b>Gender</b>			
Male		1564	46
Female		1850	54
Missing		7	--
	Total	3421	
<b>Race</b>			
White or Caucasian		2561	82
Black or African-American		398	13
Other (American Indian/Alaska Native/ Asian/ Pacific Islander)		179	6
Missing		283	--
	Total	3421	
<b>Hispanic or Latino Ethnicity</b>			
Hispanic or Latino		205	6
Not Hispanic or Latino		2983	94
Missing		233	
	Total	3421	
<b>Mean (SD) Age in years (n = 3407)</b>		31.1 (16.4)	
<b>Dental Insurance</b>			
Yes		2859	84
No		553	16
Missing		9	--
	Total	3421	
<b>Caries Lesion Characteristics</b>			
<b>Tooth Location</b>			
Molar		3886	69
Premolar		1713	31
	Total	5599	
<b>Tooth Surface</b>			
Posterior multi-surface		1927	34
Posterior one surface		3672	66
<i>occlusal</i>		1866	51 <sup>†</sup>

Variable		Number	Percent
<i>mesial or distal</i>		1016	28 <sup>†</sup>
<i>buccal or lingual</i>		790	22 <sup>†</sup>
<b>Depth estimated pre-operatively</b>			
E1, outer ½ enamel		211	4
E2, inner ½ enamel		629	11
D1, outer ⅓ dentin		2997	54
D2, middle ⅓ dentin		1314	24
D3, inner ⅓ dentin		351	6
Uncertain		32	1
Missing		65	--
	Total	5599	
<b>Depth as determined post-operatively</b>			
E1, outer ½ enamel		127	2
E2, inner ½ enamel		442	8
D1, outer ⅓ dentin		2468	44
D2, middle ⅓ dentin		1823	33
D3, inner ⅓ dentin		705	13
Missing		34	--
	Total	5599	

\* Includes restorations using amalgam or RBC only

<sup>†</sup> Percentages of 3672 posterior one-surface restorations

**Table 2**

Associations of individual potential predictor variables with use of amalgam or resin-based composite (RBC)

\*†

Variable	Amalgam Number (%)	RBC Number (%)	p-value
	n=3028	n=2571	
<b>Regional Participation</b>			
<b>Restorations, by DPBRN Region</b>			
AL/MS	663 (36.2)	1171 (63.8)	<b>&lt; 0.0001</b>
FL/GA	283 (26.5)	785 (73.5)	
MN	814 (75.7)	262 (24.3)	
PDA	1268 (78.2)	353 (21.8)	
<b>Practitioner and Practice Characteristics</b>			
<b>Gender</b>			
Male	2250 (50.8)	2180 (49.2)	<b>0.0077</b>
Female	778 (66.6)	391 (33.4)	
<b>Years Since Graduation</b>			
≤ 5	536 (60.8)	346 (39.2)	<b>0.0216</b>
6-15	747 (68.9)	337 (31.1)	
16-19	495 (56.1)	387 (43.9)	
20 or more	1175 (45.9)	1386 (54.1)	
<b>Type of Practice</b>			
Large group practice (4 or more practitioners)	2064 (79.0)	548 (21.0)	<b>&lt; 0.0001</b>
Small group practice (3 or fewer practitioners)	947 (32.2)	1993 (67.8)	
Public health practice	17 (36.2)	30 (63.8)	
<b>Practice Workload</b>			
Too busy to treat all	346 (58.3)	248 (41.8)	<b>0.4021</b>
Provided care to all, but overburdened	497 (52.7)	447 (47.3)	
Provided care to all, but not overburdened	1727 (55.9)	1362 (44.1)	
Not busy enough	357 (44.9)	439 (55.1)	
<b>Patient Characteristics</b>			
<b>Gender</b>			
Male	1516 (58.8)	1064 (41.2)	<b>&lt; 0.0001</b>
Female	1500 (49.9)	1506 (50.1)	
<b>Race</b>			
White or Caucasian	2123 (51.0)	2037 (49.0)	<b>0.0261</b>
Black or African-American	381 (53.4)	332 (46.6)	
Other (American Indian/Alaska Native/Asian/ Pacific Islander)	205 (72.9)	76 (27.1)	
<b>Hispanic or Latino Ethnicity</b>			
Hispanic or Latino	172 (49.0)	179 (51.0)	<b>0.7834</b>



Variable	Amalgam Number (%)	RBC Number (%)	p-value
	<b>n=3028</b>	<b>n=2571</b>	
Not Hispanic or Latino	2581 (52.8)	2304 (47.2)	
<b>Dental Insurance</b>			
Yes	2657 (56.4)	2055 (43.6)	<b>0.0398</b>
No	367 (41.9)	508 (58.1)	
<b>Mean (SD) Age in years</b>	30.5 (15.2)	27.5 (15.3)	<b>&lt;0.0001</b>
<b>Caries Lesion Characteristics</b>			
<b>Tooth Location</b>			
Molar	2108 (54.3)	1778 (45.8)	<b>0.0003<sup>‡</sup></b>
Premolar	920 (53.7)	793 (46.3)	
<b>Tooth Surface</b>			
Posterior multi-surface	1104 (57.3)	823 (42.7)	<b>&lt; 0.0001</b>
Posterior one surface	1924 (52.4)	1748 (47.6)	
<i>occlusal</i>	765 (41.0)	1101 (59.0)	<b>&lt; 0.0001</b>
<i>mesial or distal</i>	796 (78.3)	220 (21.7)	
<i>buccal or lingual</i>	363 (45.9)	427 (54.1)	
<b>Depth estimated pre-operatively</b>			
E1, outer ½ enamel	53 (25.1)	158 (74.9)	<b>&lt; 0.0001</b>
E2, inner ½ enamel	212 (33.7)	417 (66.3)	
D1, outer ⅓ dentin	1697 (56.6)	1300 (43.4)	
D2, middle ⅓ dentin	783 (59.6)	531 (40.4)	
D3, inner ⅓ dentin	214 (61.0)	137 (39.0)	
Uncertain	13 (40.6)	19 (59.4)	
<b>Depth as determined post-operatively</b>			
E1, outer ½ enamel	40 (31.5)	87 (68.5)	<b>&lt; 0.0001</b>
E2, inner ½ enamel	143 (32.4)	299 (67.7)	
D1, outer ⅓ dentin	1399 (56.7)	1069 (43.3)	
D2, middle ⅓ dentin	1007 (55.2)	816 (44.8)	
D3, inner ⅓ dentin	425 (60.3)	280 (29.7)	

\* p-values from individual regression models accounting for clustering within practitioner

<sup>†</sup> all counts are at the restoration level

<sup>‡</sup> The association between tooth location and material was confounded by clustering in the data set, due to unequal numbers of restorations and varying proportions of material usage for different dentists. Appropriately accounting for clustering in the analysis demonstrated a significant association that was not apparent from the raw percentages.

**Table 3**

Multivariable predictive models of use of amalgam vs. RBC\*

Variable	Univariate model	Block model	Final model
	p-value	p-value	p-value
<b>Regional Participation</b>			
<b>Restorations, by DPBRN Region</b>			
AL/MS	<b>&lt; 0.0001</b>	--	--
FL/GA			
MN			
PDA			
<b>Practitioner and Practice Characteristics</b>			
<b>Gender</b>			
Male	<b>0.0077</b>	0.6687	--
Female			
<b>Years Since Graduation</b>			
≤ 5	<b>0.0216</b>	0.8563	--
6-15			
16-19			
20 or more			
<b>Type of Practice</b>			
Large group practice (4 or more practitioners)	<b>&lt; 0.0001</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
Small group practice (3 or fewer practitioners)			
Public health practice			
<b>Practice Workload</b>			
Too busy to treat all	0.4021	--	--
Provided care to all, but overburdened			
Provided care to all, but not overburdened			
Not busy enough			
<b>Patient Characteristics</b>			
<b>Gender</b>			
Male	<b>&lt; 0.0001</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
Female			
<b>Race</b>			
White or Caucasian	<b>0.0261</b>	<b>0.0096</b>	<b>0.0131</b>
Black or African-American			
Other (American Indian/Alaska Native/Asian/ Pacific Islander)			
<b>Hispanic or Latino Ethnicity</b>			
Hispanic or Latino	0.7834	--	--
Not Hispanic or Latino			

Variable	Univariate model	Block model	Final model
	p-value	p-value	p-value
<b>Dental Insurance</b>			
Yes	<b>0.0398</b>	<b>0.0060</b>	<b>0.0096</b>
No			
<b>Mean (SD) Age in years</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
<b>Caries Lesion Characteristics</b>			
<b>Tooth Location</b>			
Molar	<b>0.0003</b>	<0.0001	<0.0001
Premolar			
<b>Tooth Surface</b> †			
Posterior multi-surface	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>	--
Posterior one surface			
<i>occlusal</i>			
<i>mesial or distal</i>			
<i>buccal or lingual</i>			
<b>Depth estimated pre-operatively</b>			
E1, outer ½ enamel	<b>&lt; 0.0001</b>	<b>0.0026</b>	<b>&lt;0.0001</b>
E2, inner ½ enamel			
D1, outer ⅓ dentin			
D2, middle ⅓ dentin			
D3, inner ⅓ dentin			
Uncertain			
<b>Depth as determined post-operatively</b> ‡			
E1, outer ½ enamel	<b>&lt; 0.0001</b>	<b>0.0374</b>	--
E2, inner ½ enamel			
D1, outer ⅓ dentin			
D2, middle ⅓ dentin			
D3, inner ⅓ dentin			

\* Variables showing significant association at  $p < 0.10$  in the univariate model were included in the block model

† Due to high correlation with tooth location, this variable was excluded from the final model

‡ Due to high correlation with post-operative depth, this variable was excluded from the final model