Modeling the Impact of COVID-19 on Dental Insurance Coverage and Utilization

Appendix

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Text A1. Dental-related Emergency Department (ED) visit characteristics

Payer distribution for dental-related ED visits in 2019 was predicted by fitting trendline to the existing data points obtained from a prior analysis of Nationwide Emergency Department Sample (NEDS) by American Dental Association (ADA).

![Dental-related ED visits by payer graph]

Year 1 corresponds to 2014, first stable year after the ACA. Year 6 corresponds to 2019.

**Trendline equations**

Uninsured = 0.328*(year)^-0.154  
Medicaid = 0.394*(year)^0.0521  
Private = 0.0275*ln(year) + 0.1703

By using these equations, the payer distribution for the ED visits were expected to be 43.2% for Medicaid, 24.9% for uninsured, 21.9% for private.
### Table A1. Effect of unemployment rate on employer-sponsored insurance coverage rates

| Data source                                      | Data years | Population  | Parameter estimate |
|--------------------------------------------------|------------|-------------|--------------------|
| **Base-case**                                    |            |             |                    |
| American Community Survey (Base case)            | 2008–2018  | Adult       | -0.61              |
|                                                  |            | Children    | -0.52              |
| **Sensitivity analyses**                         |            |             |                    |
| Current Population Survey²                       | 1990–2003  | Adult       | -0.92              |
|                                                  |            | Children    | -0.95              |
| National Health Interview Survey (NHIS)          | 1998–2018  | All nonelderly | -0.99         |

### Table A2. Input model parameters

| Parameters                                                                 | Value             | Source                                      |
|---------------------------------------------------------------------------|-------------------|---------------------------------------------|
| Unemployment claims                                                       | Tables 1 and 2    | Bureau of Labor Statistics³                 |
| Population demographics at state level                                     |                   | American Community Survey⁴                  |
| Dental insurance payer distribution of overall population, 2019           |                   | NADP⁵                                        |
| Private                                                                   | 0.55              |                                             |
| Public                                                                    | 0.22              |                                             |
| Uninsured                                                                 | 0.23              |                                             |
| Dental insurance payer distribution at state level                        |                   | NADP⁵                                        |
| ED visits payer distribution                                              | Appendix Text A1  | Analysis of NEDS⁶                            |
| Effect of unemployment rate on employer-sponsored insurance coverage rates | Appendix Table A1 | Urban Insititute¹                           |
| Dental utilization rates                                                  | Appendix Table A3 | MEPS⁷                                        |
| Practice/patient characteristics                                          |                   |                                             |
| Number of patients visits per dentist (including hygienist appointment)   | 3,415 (347)       | ADA HPI ⁸                                   |
| Number of patients visits per dentist (excluding hygienist appointment)  | 1,831 (127)       | ADA HPI ⁸                                   |
| Number of patient visits per hour                                         | 2.3               | ADA HPI ⁸                                   |
| Number of hours spent on patient visits per day                           | 6.1               | ADA HPI ⁸                                   |

MEPS: Medical Expenditure Panel Survey, NADP: National Associations of Dental Plans, ED: Emergency department; NEDS: Nationwide Emergency Department Sample
Table A3. Utilization rates by dental procedure type and by insurance

Privately insured population

| Type      | Mean    | Lower   | Upper   |
|-----------|---------|---------|---------|
| d_exam    | 0.62181 | 0.00598 | 0.01173 |
| d_clean   | 0.63195 | 0.00598 | 0.01173 |
| d_xray    | 0.27872 | 0.00460 | 0.00901 |
| d_fluor   | 0.16102 | 0.00353 | 0.00693 |
| d_seal    | 0.08659 | 0.00090 | 0.00177 |
| d_filling | 0.06889 | 0.00178 | 0.00350 |
| d_crown   | 0.03078 | 0.00139 | 0.00272 |
| d_root    | 0.01287 | 0.00191 | 0.00374 |
| d_gumsurg| 0.08588 | 0.00077 | 0.00152 |
| d_perio_recall | 0.08663 | 0.00067 | 0.00133 |
| d_extract | 0.05833 | 0.00104 | 0.00205 |
| d_oralsurg| 0.00117 | 0.00039 | 0.00076 |
| d_denture | 0.00157 | 0.00065 | 0.00129 |
| d_repair  | 0.00079 | 0.00037 | 0.00073 |
| d_other   | 0.01726 | 0.00077 | 0.00151 |

Publicly insured population

| Type      | Mean    | Lower   | Upper   |
|-----------|---------|---------|---------|
| d_exam    | 0.57584 | 0.01001 | 0.01961 |
| d_clean   | 0.56547 | 0.00986 | 0.01932 |
| d_xray    | 0.26643 | 0.00722 | 0.01415 |
| d_fluor   | 0.17452 | 0.00467 | 0.00916 |
| d_seal    | 0.16702 | 0.00197 | 0.00385 |
| d_filling | 0.08635 | 0.00297 | 0.00583 |
| d_crown   | 0.02386 | 0.00202 | 0.00396 |
| d_root    | 0.00796 | 0.00199 | 0.00390 |
| d_gumsurg| 0.06332 | 0.00104 | 0.00205 |
| d_perio_recall | 0.04687 | 0.00049 | 0.00096 |
| d_extract | 0.14417 | 0.00290 | 0.00569 |
| d_oralsurg| 0.00114 | 0.00072 | 0.00142 |
| d_denture | 0.00552 | 0.0024  | 0.00470 |
| d_repair  | 0.00157 | 0.00090 | 0.00177 |
| d_other   | 0.01356 | 0.00111 | 0.00217 |

Uninsured population

| Type      | Mean    | Lower   | Upper   |
|-----------|---------|---------|---------|
| d_exam    | 0.62181 | 0.00598 | 0.01172 |
| d_clean   | 0.63195 | 0.00598 | 0.01173 |
| d_xray    | 0.27872 | 0.00460 | 0.00901 |
| d_fluor   | 0.16102 | 0.00353 | 0.00693 |
| d_seal    | 0.08659 | 0.00090 | 0.00177 |
| d_filling | 0.06889 | 0.00178 | 0.00350 |
| d_crown   | 0.03078 | 0.00139 | 0.00272 |
| d_root    | 0.01287 | 0.00191 | 0.00374 |
| d_gumsurg| 0.08588 | 0.00077 | 0.00152 |
| d_perio_recall | 0.08663 | 0.00067 | 0.00133 |
| d_extract | 0.05833 | 0.00104 | 0.00205 |
| d_oralsurg| 0.00117 | 0.00039 | 0.00076 |
| d_denture | 0.00157 | 0.00065 | 0.00129 |
| d_repair  | 0.00079 | 0.00037 | 0.00073 |
| d_other   | 0.01726 | 0.00077 | 0.00151 |
| d          |         |         |         |
|------------|---------|---------|---------|
| d_exam     | 0.53257 | 0.02567 | 0.050314 |
| d_clean    | 0.521235| 0.024712| 0.048435 |
| d_xray     | 0.265914| 0.019289| 0.037806 |
| d_fluor    | 0.09359 | 0.009214| 0.018059 |
| d_seal     | 0.11003 | 0.003058| 0.005993 |
| d_filling  | 0.108129| 0.011444| 0.02243 |
| d_crown    | 0.03655 | 0.006812| 0.013351 |
| d_root     | 0.032449| 0.008703| 0.017058 |
| d_gumsurg  | 0.066516| 0.003261| 0.006392 |
| d_perio_recall | 0.062916| 0.001218| 0.002387 |
| d_extract  | 0.216713| 0.010164| 0.019922 |
| d_oralsurg | 0.001682| 0.002438| 0.004778 |
| d_denture  | 0.003531| 0.003559| 0.006975 |
| d_repair   | 0.001614| 0.00213 | 0.004174 |
| d_other    | 0.02172 | 0.004563| 0.008943 |
Table A4. Final set of procedures offered by general dentists

Dental procedures that could be offered by general dentists by matching dental procedures classified in the Medical Expenditure Panel Survey (MEPS) data with the Code on Dental Procedures and Nomenclature (CDT Code) \(^9,10\). The final set of procedures offered by general dentists was determined based on the list of dental procedures covered by adult Medicaid dental benefits in Massachusetts, and by expert opinions from more than two general dentists \(^11\). The final set of procedures does not include procedures that involve cost-prohibitive dental equipment for a small general dental practice, such as a Panorex machine, or are primarily billed by dentist specialists, such as orthodontic services which would most commonly be referred

Matching between dental procedure codes offered by general dentist and MEPS dental practice categories

| MEPS Category | Procedure Code | Description of Service |
|---------------|----------------|------------------------|
| d_exam        | D0120          | Periodic oral evaluation — established patient |
| d_exam        | D0140          | Limited oral evaluation - problem focused |
| d_exam        | D0145          | Oral evaluation for a patient under three years of age and counseling with primary caregiver |
| d_exam        | D0150          | Comprehensive oral evaluation — new established patient |
| d_exam        | D0160          | Detailed and extensive oral evaluation — problem focused, by report |
| d_exam        | D0180          | Comprehensive periodontal evaluation — new or established patient |
| d_xray        | D0210          | Intraoral - complete series of radiographic images |
| d_xray        | D0220          | Intraoral - periapical first radiographic image |
| d_xray        | D0230          | Intraoral - periapical each additional radiographic image |
| d_xray        | D0272          | Bitewings - two radiographic images |
| d_xray        | D0273          | Bitewings - three radiographic images |
| d_xray        | D0274          | Bitewings - four radiographic images |
| d_xray        | D0277          | Vertical bitewings - 7 to 8 radiographic images |
| d_clean       | D1110          | Prophylaxis - adult |
| d_clean       | D1120          | Prophylaxis - child |
| d_fluor       | D1206          | Topical application of fluoride varnish |
| d_fluor       | D1208          | Topical application of fluoride – excluding varnish |
| d_seal        | D1351          | Sealant - per tooth |
| d_seal        | D1352          | Preventive resin restoration in a moderate to high caries risk patient — permanent tooth |
| d_filling     | D2140          | Amalgam - one surface, primary or permanent |
| d_filling     | D2150          | Amalgam - two surfaces, primary or permanent |
| d_filling     | D2160          | Amalgam - three surfaces, primary or permanent |
| d_filling     | D2161          | Amalgam - four or more surfaces, primary or permanent |
| d_filling     | D2330          | Resin-based composite - one surface, anterior |
| d_filling     | D2331          | Resin-based composite - two surfaces, anterior |
| d_filling     | D2332          | Resin-based composite - three surfaces, anterior |
| d_filling     | D2335          | Resin-based composite - four or more surfaces or involving incisal angle (anterior) |
| d_filling     | D2390          | Resin-based composite crown, anterior |
| d_filling     | D2391          | Resin-based composite - one surface, posterior |
| d_filling     | D2392          | Resin-based composite - two surfaces, unposterior |
| d_filling     | D2393          | Resin-based composite - three surfaces, posterior |
| Code   | Description                                               |
|--------|-----------------------------------------------------------|
| D2394  | Resin-based composite - four or more surfaces, posterior  |
| D2710  | Crown - resin-based composite                             |
| D2720  | Crown - resin with high noble metal                       |
| D2721  | Crown - resin with predominantly base metal               |
| D2722  | Crown - resin with noble metal                            |
| D2740  | Crown - porcelain/ceramic substrate                       |
| D2750  | Crown - porcelain fused to high noble metal               |
| D2751  | Crown - porcelain fused to predominantly                  |
| D2752  | Crown - porcelain fused to noble metal                    |
| D2780  | Crown - ¾ cast high noble metal                           |
| D2783  | Crown - ¾ porcelain/ceramic                               |
| D2790  | Crown - full cast high noble metal                        |
| D2794  | Crown - titanium                                          |
| D2910  | Re-cement inlay                                           |
| D2920  | Re-cement or re-bond crown                                |
| D2929  | Prefabricated porcelain/ceramic crown - primary tooth     |
| D2930  | Prefabricated stainless steel crown - primary tooth       |
| D2931  | Prefabricated stainless steel crown - permanent tooth     |
| D2940  | Protective restoration                                    |
| D2950  | Core buildup, including any pins when required            |
| D2951  | Pin retension - per tooth                                 |
| D2952  | Post and core in addition to crown, indirectly fabricated  |
| D2954  | Prefabricated post and core in addition to crown          |
| D2961  | Labial veneer (resin laminate) - laboratory               |
| D2962  | Labial veneer (porcelain laminate) - laboratory           |
| D2980  | Crown repair necessitated by restorative material failure |
| D3110  | Pulp cap - direct (excluding final restoration)           |
| D3120  | Pulp cap - indirect (excluding final restoration)         |
| D3220  | Therapeutic pulpotomy (excluding final restoration)       |
| D3221  | Pulpal debridement, primary and permanent teeth           |
| D3230  | Pulpal therapy (resorbable filling) - anterior, primary tooth (excluding final restoration) |
| D3240  | Pulpal therapy (resorbable filling) - posterior, primary tooth (excluding final restoration) |
| D3310  | Endodontic therapy, anterior tooth (excluding final restoration) |
| D3320  | Endodontic therapy, bicuspid tooth (excluding final restoration) |
| D3330  | Endodontic therapy, molar (excluding final restoration)   |
| D4320  | Provisional splinting - intra                            |
| D4321  | Provisional splinting - extracoronal                      |
| D4341  | Periodontal scaling and root planing - four or more teeth per quadrant |
| D4342  | Periodontal scaling and root planing - one to three teeth per quadrant |
| D4355  | Full mouth debridement to enable comprehensive evaluation and diagnosis |
| D4910  | Periodontal maintenance                                   |
| D5110  | Complete denture - maxillary                             |
| D5120  | Complete denture - mandibular                             |
| D5130  | Immediate denture - maxillary                             |
| D5140  | Immediate denture - mandibular                             |
| Code       | Description                                                                 |
|------------|-----------------------------------------------------------------------------|
| d_dentures | Maxillary partial denture - resin base (including any conventional clasps, rests and teeth) |
| D5211      | Mandibular partial denture - resin base (including any conventional clasps, rests and teeth) |
| D5212      | Maxillary partial denture - cast metal framework with resin denture bases and teeth |
| D5213      | Mandibular partial denture - cast metal framework with resin denture bases (including any conventional clasps, rests, and teeth) |
| D5214      | Immediate maxillary partial denture - resin base (including any conventional clasps, rests and teeth) |
| D5221      | Immediate mandibular partial denture - resin base (including any conventional clasps, rests and teeth) |
| D5222      | Immediate maxillary partial denture - cast metal framework with resin denture bases (including any conventional clasps, rests and teeth) |
| D5223      | Immediate mandibular partial denture - cast metal framework with resin denture bases (including any conventional clasps, rests and teeth) |
| D5224      | Maxillary partial denture — flexible base (including any clasps, rests, and teeth) |
| D5225      | Mandibular partial denture - flexible base (including any clasps, rests, and teeth) |
| D5226      | Repair broken complete denture base |
| D5510      | Replace missing or broken teeth — complete denture (each tooth) |
| D5520      | Repair resin denture base |
| D5610      | Repair or replace broken clasp |
| D5630      | Replace broken teeth - per tooth |
| D5640      | Add tooth to existing partial denture |
| D5660      | Add clasp to existing partial denture - per tooth |
| D5710      | Rebase complete maxillary denture |
| D5711      | Rebase complete mandibular denture |
| D5720      | Rebase maxillary partial denture |
| D5721      | Rebase mandibular partial denture |
| D5730      | Reline complete maxillary denture (chairside) |
| D5731      | Reline complete mandibular denture (chairside) |
| D5740      | Reline maxillary partial |
| D5741      | Reline mandibular partial |
| D5750      | Reline complete maxillary denture (laboratory) |
| D5751      | Reline complete mandibular denture (laboratory) |
| D5760      | Reline maxillary partial |
| D5761      | Reline mandibular partial |
| D7111      | Extraction, coronal remnants -deciduous tooth |
| D7140      | Extraction, erupted tooth or exposed root (elevation and/or forceps removal) |
| D7210      | Surgical removal of erupted tooth requiring removal of bone and/or sectioning of tooth, and including elevation of mucoperiosteal flap if indicated |
| D7230      | Removal of impacted tooth -partially bony |
| D7240      | Removal of impacted tooth -completely bony |
| D7250      | Surgical removal of residual tooth roots (cutting procedure) |
| D7251      | Coronectomy - intentional partial tooth removal |
| D7260      | Incisional biopsy of oral tissue - soft |
| D7310      | Alveoloplasty in conjunction with extractions - four or more teeth or tooth spaces, per quadrant |
| D7970      | Excision of hyperplastic tissue - per arch |
| D9110      | Palliative (emergency) treatment of dental pain - minor procedure |
| Code   | Description                                                                 |
|--------|----------------------------------------------------------------------------|
| D9230  | Inhalation of nitrous oxide/analgesia, anxiolysis                           |
| D9310  | Consultation - diagnostic service provided by dentist or physician other than requesting dentist or physician |
| D9910  | Application of desensitizing medicament                                     |
| D9940  | Occlusal guard, by report                                                   |
| D9941  | Fabrication of athletic mouth guard                                         |
| D9951  | Occlusal adjustment - limited                                               |
| D9952  | Occlusal adjustment - complete                                              |
Figure A1. Study flow diagram [data sources]

ADA: American Dental Association; MEPS: Medical Expenditure Panel Survey, NADP: National Association of Dental Plans, NEDS: Nationwide Emergency Department Sample
Figure A2. Utilization rates by procedure and insurance types

exam: diagnostic; clean: prophylaxis; xray: radiographic image; fluor: fluoride; seal: sealant; root: root canal; gumsurg: periodontal scaling, root planning or gum; extract: extraction/ tooth pulled; repair: repair of bridges/dentures or relining
Figure A3. Sensitivity analysis: Increase in non-preventive procedures due to a lack of access to dental care during COVID-19

a) 5% increase in non-preventive procedures

b) 10% increase in non-preventive procedures
c) 20% increase in non-preventive procedures
Figure A4. Sensitivity analysis: Individuals who recently lost ESDI maintaining 50% of access behaviors (50% of the difference in utilization between ESDI and other insurance groups)

The rate of cleanings (prophylaxis) will decline by 0.17 percentage points (95%CI: -0.20, -0.15), and the rate of tooth extraction would increase by 0.25 percentage points (95%CI: 0.24, 0.27)
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