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John R. Craig

Roderick W. Tataryn

Haley C. Sibley

William D. Mason

Joshua A. Deuel

See next page for additional authors

Authors
John R. Craig, Roderick W. Tataryn, Haley C. Sibley, William D. Mason, Joshua A. Deuel, Gary E. Loyd, David R. Nerenz, and Parul Goyal

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Expected Costs of Primary Dental Treatments and Endoscopic Sinus Surgery for Odontogenic Sinusitis

John R. Craig, MD; Roderick W. Tataryn, DDS; Haley C. Sibley, MD; William D. Mason, MD; Joshua A. Deuel, DDS; Gary E. Loyd, MD, MMM; David R. Nerenz, PhD; Parul Goyal, MD

Objectives: Treatment of odontogenic sinusitis (ODS) due to apical periodontitis (AP) is highly successful when both dental treatment and endoscopic sinus surgery (ESS) are performed. Variation exists in the literature with regard to types and timing of dental treatments and ESS when managing ODS. This study modeled expected costs of different primary dental and sinus surgical treatment pathways for ODS due to AP.

Study Design: Decision-tree economic model.

Methods: Decision-tree models were created based on cost and treatment success probabilities. Using Medicare and consumer online databases, cost data were obtained for the following dental and sinus surgical treatments across the United States: root canal therapy (RCTx), revision RCTx, apicoectomy, extraction, dental implant, bone graft, and ESS (maxillary, ± anterior ethmoid, ± frontal). A literature review was performed to determine probabilities of dental and sinus disease resolution after different dental treatments. Expected costs were determined for primary dental extraction, RCTx, and ESS pathways, and sensitivity analyses were performed.

Results: Expected costs for the three different primary treatment pathways when dental care was in-network and all diseased sinuses opened during ESS were as follows: dental extraction ($4,753.83), RCTx ($4,677.34), and ESS ($7,319.85).

Conclusions: ODS due to AP can be successfully treated with primary dental treatments, but ESS is still frequently required. Expected costs of primary dental extraction and RCTx were roughly equal. Primary ESS had a higher expected cost, but may still be preferred in patients with prominent sinonasal symptoms. Patients' insurance coverage may also impact decision-making.

Key Words: Odontogenic sinusitis, endoscopic sinus surgery, root canal therapy, dental extraction, dental implant, cost analysis.

Level of Evidence: N/A

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INTRODUCTION

Successful odontogenic sinusitis (ODS) management approaches 95% to 100% when appropriate dental treatment and endoscopic sinus surgery (ESS) are performed.[1] Treatment options vary based on the dental pathology causing ODS. Apical periodontitis (AP) is one of the most common causes of ODS[2,3] and refers to inflammation and infection of the apical periodontium caused by pulpal infection spreading through root apices. Periapical infection may progress to form a periapical lesion (PAL) radiographically, which can represent a cyst, granuloma, or abscess.[2] Different combinations of dental and sinus interventions are often necessary to treat ODS due to AP. Clinicians and patients work together through shared decision-making to decide whether dental treatment or ESS is performed primarily.[1]

Dental treatments are often pursued primarily for ODS due to untreated AP and include RCTx or dental extraction. If previously treated with RCTx, options include revision RCTx, apicoectomy, or extraction.[4–7] If ODS does not resolve after dental treatment, patients must consider revision dental procedures, ESS, or both. Additionally, if patients select extraction, they must decide on dental reconstructive options: none, partial denture, bridge, or dental implant with or without maxillary sinus bone grafting (MSG).[8]

In some ODS cases, patients may undergo ESS primarily. Although some studies suggest ESS only after dental treatment failures,[9–12] others have shown primary ESS to be an option for faster symptom resolution, followed by appropriate dental management.[13–15] Extent of ESS should also be considered. While most studies to date have reported addressing all diseased sinuses during ESS,[13,16–19] recent series have demonstrated maxillary

From the Department of Otolaryngology—Head and Neck Surgery (J.R.C., H.C.S.), Henry Ford Health System, Detroit, Michigan, U.S.A.; Tataryn Endodontics (R.W.T.), Spokane, Washington, U.S.A.; Department of Endodontics, School of Dentistry (R.W.T.), Loma Linda University, Loma Linda, California, U.S.A.; Wayne State School of Medicine (W.D.M.), Detroit, Michigan, U.S.A.; Department of Oral Maxillofacial Surgery (J.A.D.), Henry Ford Health System, Detroit, Michigan, U.S.A.; Department of Anesthesiology (G.E.L.), Henry Ford Health System, Detroit, Michigan, U.S.A.; Henry Ford Health System, Department of Neurosurgery (D.R.N.), Center for Health Policy and Health Services Research, Detroit, Michigan, U.S.A.; and the Syracuse Otolaryngology (P.G.), Syracuse, New York, U.S.A.

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Send correspondence to John Craig, MD, Henry Ford Health System, 2799 W Grand Blvd, Detroit, MI 48202. E-mail: jcraig1@hfhs.org

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antrostomy alone to be successful regardless of sinusitis extent.[20,21]

Choosing the optimal ODS treatment is difficult due to low publication volume and quality[22] and logistical challenges of coordinating multidisciplinary care between otolaryngologists and dental specialists. In the absence of high-quality evidence to guide management, it would be helpful to understand the potential costs of different treatment options. The purposes of this study were to outline treatment pathways for ODS due to AP, and to model expected costs of these dental and sinus surgical treatments.

MATERIALS AND METHODS

Economic Model

Decision-tree economic models were created to analyze dental treatment and ESS costs for uncomplicated ODS due to AP in US dollars in 2021. Different dental treatments were simulated if they had published success rates for treating AP or ODS. After review by an endodontist (R.W.T.), oral-maxillofacial surgeon (J.D.), anesthesiologist (G.E.L.), and rhinologists (J.R.C., P.G.), three different primary treatment pathways were modeled: dental extraction, RCTx, and ESS. Figures 1 to 3 are representative decision-tree diagrams illustrating the treatment pathways when patients had in-network dental care, and all diseased sinuses opened during ESS.

Figure 1 shows the primary dental extraction pathway. After extraction, patients could have complete ODS resolution, then consider reconstructive options (none, partial denture, bridge, or dental implant). Alternatively, they could require ESS to resolve persistent sinusitis, followed by dental reconstructive options.

Figure 2 shows the primary RCTx pathway. After RCTx, patients could have five initial outcomes. First, they could have AP and ODS resolution. They could also have AP resolution but persistent ODS, and require only subsequent ESS. They could also have no resolution of both AP and ODS, and require secondary dental treatments (revision RCTx, apicoectomy, or extraction), followed by subsequent dental or sinus surgical treatments until AP and ODS resolution.

Figure 3 shows the primary ESS pathway. After ESS, patients would undergo either RCTx or dental extraction. Treatment options thereafter mirrored the possible dental treatments from extraction or RCTx pathways.

Probabilities

PubMed literature searches were performed to determine success probabilities of different dental treatments for ODS due to AP. Note that for dental treatment of ODS due to AP, there is a success probability for resolving AP and a separate probability

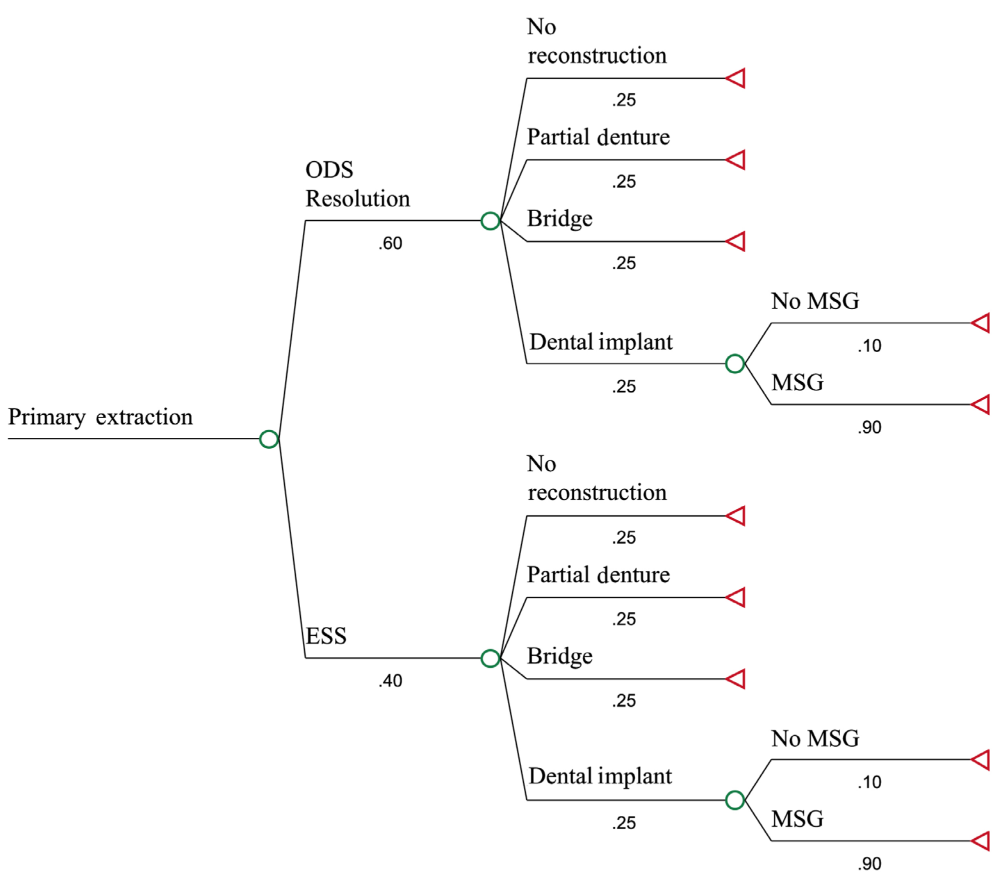

Fig. 1. Primary dental extraction decision-tree diagram. Probabilities are shown below respective treatments or outcomes, and each represents the probability of the treatment or outcome occurring after the previous intervention to the left of it in the diagram. ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; ODS = odontogenic sinusitis. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

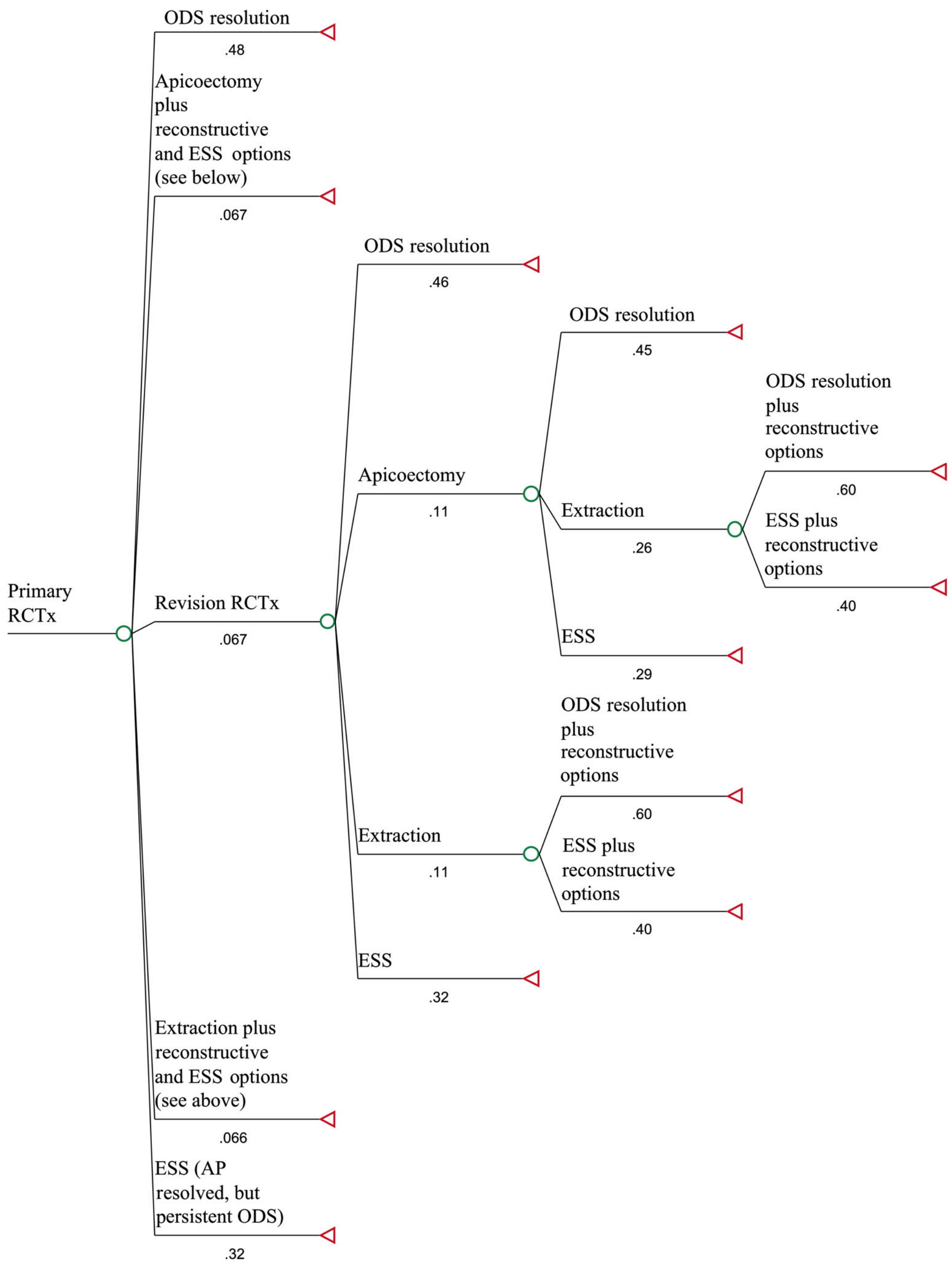

Fig. 2. Primary root canal therapy (RCTx) decision-tree diagram. Probabilities are shown below respective treatments or outcomes, and each represents the probability of the treatment or outcome occurring after the previous intervention to the left of it in the diagram. The "plus Reconstructive Options" shorthand refers to the reconstructive options (none, partial denture, bridge, dental implant) depicted in primary dental extraction pathway from Figure 1. AP = apical periodontitis; ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; ODS = odontogenic sinusitis. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

for resolving ODS. Dental extraction was the only primary dental treatment for which success rates were published for resolving ODS.

For mean success of RCTx, revision RCTx, and apicoectomy at resolving AP, systematic reviews and large prospective studies were included. For mean success of dental extraction at resolving ODS, all published case series and cohort studies were included.

There were also points in decision trees where likelihoods of performing different revision dental treatments, or reconstructive options after extraction, were determined by expert opinion due to data absence in the literature.

For ESS simulation, surgery extent was modeled with either all diseased sinuses being opened or maxillary alone. When all diseased sinuses were opened, probabilities of opening maxillary (30%), maxillary plus anterior ethmoid (30%), or maxillary plus anterior ethmoid and frontal sinuses (40%) were estimated based on a recent ODS literature review.[2]

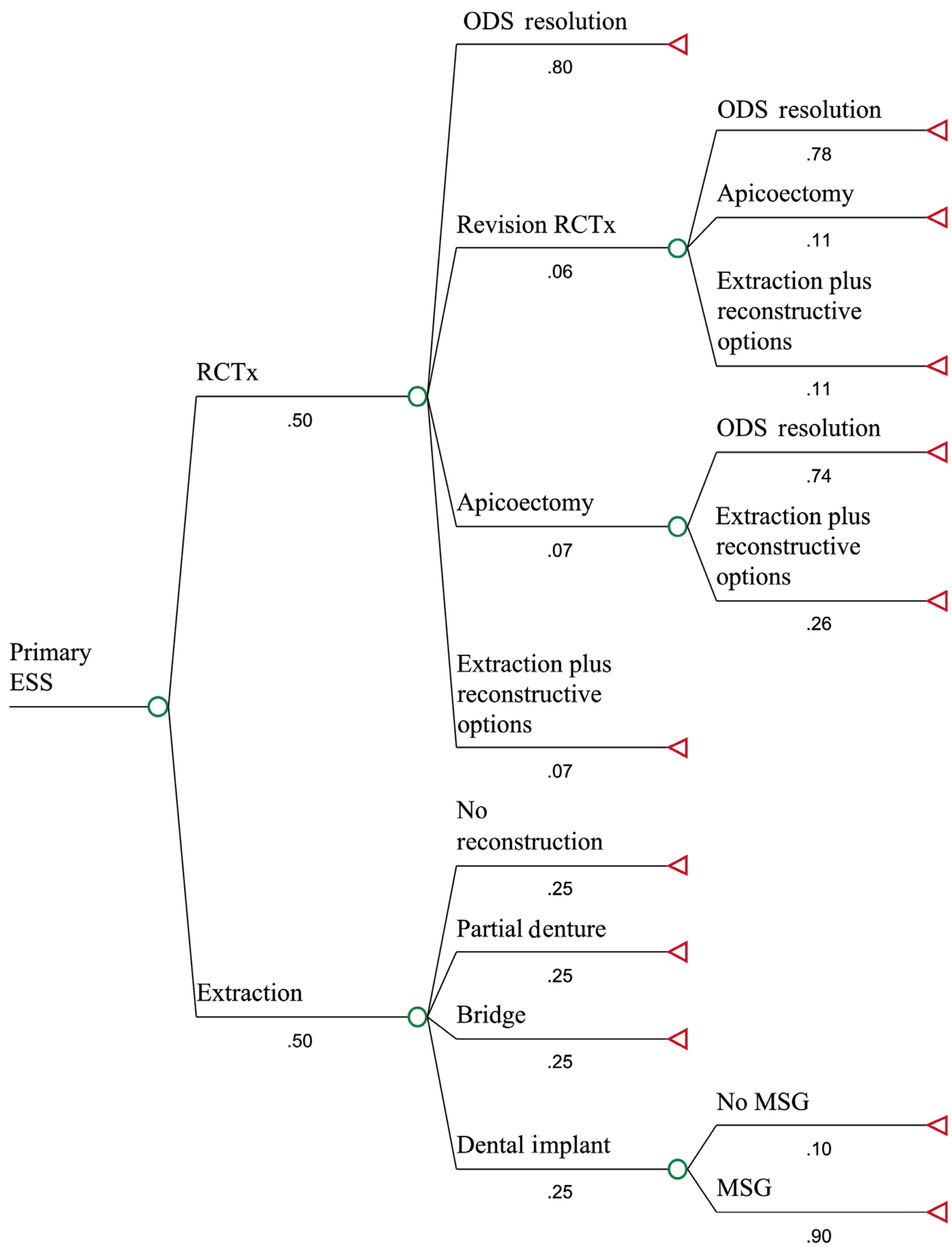

Fig. 3. Primary endoscopic sinus surgery decision-tree diagram. Probabilities are shown below respective treatments or outcomes, and each represents the probability of the treatment or outcome occurring after the previous intervention to the left of it in the diagram. The "plus Reconstructive Options" shorthand refers to the reconstructive options depicted after extraction following primary ESS in the lowest portion of this diagram. ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; ODS = odontogenic sinusitis. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

Table I shows assumptions made when structuring the treatment models. Table II shows the mean probabilities utilized in different treatment models, with supporting references.

The most complex model was primary RCTx (Fig. 3). RCTx was approximated to have a 48% success rate for treating both AP and ODS, leaving 52% probability to be divided between the other four possible treatment paths. As RCTx had an 80% success probability for resolving AP, a 2×2 probability table yielded a 32% probability of RCTx successfully resolving AP but not ODS. If RCTx failed to resolve both AP and ODS, equal probabilities were assumed for revision RCTx, apicoectomy, and extraction. Subsequent branches in the model followed the same methodology until resolution of both AP and ODS.

Costs

Different dental procedure costs were obtained by searching for in-network and out-of-network costs of Current Dental Terminology (CDT) codes on an online consumer database.[23] Different ESS costs were obtained by searching Current Procedural Terminology (CPT) codes in Medicare databases.[24,25] ESS costs were

TABLE I.
Assumptions to Structure Decision-Tree Models.

Assumptions
1. All treatment pathways would eventually lead to 100% ODS resolution.
2. Dental extraction would resolve AP with 100% success.
3. After primary dental extraction, equal probabilities were assigned to the likelihoods of patients choosing no reconstruction, partial dentures, bridges, and dental implants.
4. For maxillary dental implants, 90% of patients would require MSG.
5. Maxillary dental implants and MSG would be performed with 100% success.
6. Probabilities of success of RCTx, revision RCTx, and apicoectomy at resolving ODS would equal the probability of each of their successes at resolving AP, multiplied by the probability of success of dental extraction at resolving ODS.
7. Unsuccessful dental treatment would never resolve ODS.
8. Primary ESS alone would never resolve ODS due to AP completely, and therefore would always be followed with either RCTx or dental extraction.
9. Dental treatments after primary ESS would be as successful as primary dental treatments at resolving ODS.
10. Secondary ESS after appropriate primary dental treatment would resolve ODS with 100% success, both for maxillary antrostomy alone and for all diseased sinuses being opened.
11. For each set of branches in the decision trees, probabilities of given treatments being performed must sum to 100%.

AP = apical periodontitis; ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; ODS = odontogenic sinusitis; RCTx = root canal therapy.

TABLE II.
Model Reference Data for Treatment Success Probabilities.

Parameters in Tree Diagrams	Probabilities	Sources
Extraction-related probabilities		
Probability of ODS resolution after extraction	0.60	Mattos et al.,[36] Tomomatsu et al.,[37] Tsuzuki et al.,[38] Yoo et al.,[9] Simuntis et al.[10]
Probability of no reconstruction after extraction	0.25	Expert opinion
Probability of each reconstructive option after extraction	0.25	Expert opinion
Probability of dental implant with no MSG	0.10	Expert opinion
Probability of MSG for dental implant	0.90	Expert opinion
RCTx-related probabilities		
Probability of AP resolution after RCTx	0.80	Friedman et al.,[45] Torbinejad et al.,[4] Ricucci et al.[46]
Probability of ODS resolution after RCTx	0.48	0.60× (probability of RCTx success for AP)
Probability of each dental treatment after RCTx	0.067	2 × 2 probability table
Probability of AP resolution, but persistent ODS after RCTx (requiring ESS)	0.32	2 × 2 probability table
Probability of AP resolution after revision RCTx	0.78	Ng et al.,[47] Torabinejad et al.,[5] Chercoles-Ruiz et al.[6]
Probability of ODS resolution after revision RCTx	0.46	0.60× (probability of revision RCTx success for AP)
Probability of each dental treatment after revision RCTx	0.11	2 × 2 probability table
Probability of AP resolution, but persistent ODS after revision RCTx (requiring ESS)	0.32	2 × 2 probability table
Probability of AP resolution after apicoectomy	0.74	Torabinejad et al.,[5] Chercoles-Ruiz et al.[6]
Probability of ODS resolution after apicoectomy	0.45	0.60× (probability of Apicoectomy success for AP)
Probability of after extraction after apicoectomy	0.26	2 × 2 probability table
Probability of AP resolution, but persistent ODS after apicoectomy (requiring ESS)	0.29	2 × 2 probability table
ESS-related probabilities		
Probability of extraction after ESS	0.50	Expert opinion
Probability of RCTx after ESS	0.50	Expert opinion

AP = apical periodontitis; ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; ODS = odontogenic sinusitis; RCTx = root canal therapy.

determined by adding facility[24] and ambulatory surgery center fees.[25] CDT and CPT code searches were performed between January and April 2021. Codes were searched across nine metropolitan zip codes in the nine US regions according to the census.[26] Mean costs with 95% confidence intervals (CIs) were calculated for all CDT and CPT codes across all zip codes.

Clinic visits were also modeled. For each dental treatment or reconstructive option, models included one pretreatment

Table III.
Model Reference Data for Costs of Dental and Sinus Surgical Treatments.

Dental Treatment Options (Plus Clinic Visit Cost)	CDT or CPT Codes	Costs	
		Dental In-Network	Dental Out-of-Network
Extraction	D7210	$328.55	$528.00
RCTx	D3330 + D2740	$2,399.33	$3,072.12
Revision RCTx	D3348 + D2391	$1,643.89	$2,129.12
Apicoectomy	D3425 + D3426 + D3430 (x2)	$2,018.78	$2,756.34
Reconstructive options after extraction (plus clinic visit cost)			
Dental Implant	D6010 + D6066 + D6011	$4,276.69	$5,769.59
MSG	D7951	$2,128.33	$2,771.89
Maxillary bridge	D6242 + D6750 (x2)	$3,065.56	$4,513.44
Partial maxillary denture	D5213	$1.496.11	$2,238.89
Sinus Surgery Options (Plus Clinic Visit Costs)			ESS Costs
ESS (all diseased sinuses)	31276 (×0.4) + 31267 (×0.5 ×0.3) + 31254 (×0.5 ×0.3)		$4,342.04
ESS (maxillary only)	31267		$3,052.37

CDT = Current Dental Terminology; CPT = current Procedural Terminology; ESS = endoscopic sinus surgery; MSG = maxillary sinus bone grafting; RCTx = root canal therapy.

TABLE IV.
Overall Expected Costs of Primary Dental and Sinus Surgical Treatment Pathways for Odontogenic Sinusitis Due to Apical Periodontitis.

Primary Treatment Pathways	In-Network Dental Costs		Out-of-Network Dental Costs	
	Cost With All Diseased Sinuses Opened During ESS	Cost With Maxillary Antrostomy Alone During ESS	Cost With All Diseased Sinuses Opened During ESS	Cost With Maxillary Antrostomy Alone During ESS
Primary extraction	$4,753.83	$4,237.96	$6,018.97	$5,503.10
Primary RCTx	$4,677.34	$4,160.53	$5,553.95	$5,037.96
Primary ESS	$7,319.85	$6,030.18	$8,391.59	$7,101.92

ESS = endoscopic sinus surgery; RCTx = root canal therapy.

consultation. No posttreatment clinic costs were modeled as these are included in dental treatment costs. For ESS, models included one preoperative consultation plus nasal endoscopy, and two postoperative visits (first with endoscopic debridement, second with routine endoscopy).

Cost of the following variables were excluded: dental and sinus imaging, oral antibiotics, oral or topical corticosteroids, over-the-counter medications, CT image navigation (CPT 61782), anesthesia, and treatment-related complications.

Supporting Table SI shows individual CDT codes and descriptions that comprised different dental treatment options, with their average in-network and out-of-network costs and 95% CIs. Supporting Table SII shows CPT codes, costs, and 95% CIs for ESS options used in models.

Table III shows CDT and CPT code combinations used to model each treatment and their costs. For dental treatments, costs are highlighted as in-network or out-of-network. For ESS, costs are reported as maxillary only or all diseased sinuses being opened.

Analytic Approach

Cost and sensitivity analyses were performed using TreeAge Pro Healthcare Module 2021 (TreeAge Software, Inc., Williamstown, MA, USA). For initial cost estimates of the three treatment models, average costs for ESS addressing all diseased sinuses and in-network dental care were used.

Sensitivity analysis was conducted in two ways. First, three alternative scenarios were modeled that involved changing one or more cost parameters: ESS with maxillary antrostomy alone, out-of-network dental costs, or both. The second sensitivity analysis examined the effects of 20% increases or decreases in all cost values, and 10% increases or decreases in all probabilities. This was done for the primary ESS pathway since it was likely the most expensive, and whether alternative inputs could change that conclusion was of interest. This was also done for the primary extraction pathway since the initial treatment cost was small relative to subsequent treatment costs (as opposed to the RCTx or ESS decision trees). Therefore, the relative importance of variation in initial treatment costs versus subsequent treatment costs could be examined. For RCTx analysis, only the effects of 20% variation in RCTx cost was assessed as this represented the strongest possible effect on the model.

RESULTS

Table IV shows expected costs of the three primary treatment pathways for ODS due to AP in four different scenarios: in-network and out-of-network dental costs, and ESS with all diseased sinuses or only maxillary sinus being opened. The first scenario modeling ESS for all sinuses and in-network dental costs represented the "base" scenario; the other 3 represented the first form of sensitivity analyses. Although changing input costs had some influence on relative costs, expected costs of primary RCTx and extraction pathways were always lower than primary ESS, regardless of dental care being in-network or out-of-network, or ESS extent.

Expected costs of primary RCTx and extraction were similar, ranging from $4,161 to $4,754 for in-network care and $5,038 to $6,019 for out-of-network care. For in-network care, primary extraction cost only about $80 more than primary RCTx. For out-of-network care, primary extraction cost about $500 more than primary RCTx.

Expected primary ESS costs ranged from $6,030 to $7,320 if subsequent dental care was for in-network work and $7,102 to $8,392 for out-of-network dental care. For primary ESS, addressing all diseased sinuses cost approximately $1,300 more than maxillary antrostomy alone, regardless of dental care being in-network or out-of-network.

In the second set of sensitivity analyses, as expected, variation in higher-cost and higher-probability treatments had more influence on expected costs than less-expensive or lower-probability treatments. The expected cost of primary ESS ranged from $6,449 to $8,186, with a variation in ESS cost having the dominant effect on expected cost. Expected cost of primary extraction ranged from $4,365 to $5,101, with no single cost or probability being most impactful. Expected primary RCTx cost ranged from $4,197.34 to $5,157.34 when a 20% variation in initial RCTx cost was assessed. Primary ESS was therefore always the most expensive option.

DISCUSSION

ODS management success approaches 100% when diseased dentition and affected sinuses are appropriately treated.[1] Treatment costs are increasingly important in healthcare decision-making, but ODS treatment costs have not been discussed in the literature. The current study modeled different ODS treatment pathways and their expected costs.

Based on this study's models, primary ESS resulted in higher expected costs than primary dental treatment pathways. Two important assumptions drove the higher cost of primary ESS. First, all patients undergoing primary ESS were assumed to require subsequent dental treatments, whereas only about 50% of patients undergoing primary dental treatments would require subsequent ESS. Second, ESS was only modeled in surgical centers. Facility fees account for approximately 85% of total ESS costs, which increases ESS costs compared to dental treatments typically performed in the office setting.

Although primary ESS has a higher expected cost, it remains an important primary treatment option for some ODS patients. Important considerations when selecting between dental treatment and ESS options for ODS include symptom burdens and insurance coverage. Primary ESS is particularly useful when sinonasal symptoms are most prominent. Craig et al. demonstrated resolution of sinus-related symptoms in 7 to 12 days after primary ESS, compared to 35 to 56 days after primary dental treatment.[13] Primary dental treatment may be better for those with tolerable sinonasal symptoms or prominent dental symptoms. However, dental treatment alone resolves ODS in only 50% to 60% of cases. Should primary dental treatment fail, symptomatic patients may suffer unnecessarily until undergoing ESS.

Another important consideration is the effect of insurance coverage on costs incurred by ODS patients. The American Dental Association reported that about 30% of adults had no dental insurance coverage, 60% had private insurance, and 7% had Medicaid with dental benefits.[27] Comparatively, 92% of the US population had health insurance (68% private, 34% public).[28] Insurance benefits may have a significant impact on patients' expected out-of-pocket costs.

State-provided dental insurances vary substantially with regard to coverage for nonpreventative care, whereas private dental insurances generally cover 50% to 80% of costs up to the maximal annual coverage. For dental implants, state-provided insurance plans provide no coverage, whereas private insurance generally covers 50% to 80% up to maximal annual coverage. Maximum annual dental coverage may be as low as $1,000, varying by state and insurance plan.[29–32] ODS patients will likely exceed their annual coverage if they undergo anything other than dental extraction alone, especially if revision dental treatments are required. Patients' financial responsibilities for ESS vary substantially between different private,[33] Medicare,[34] and Medicaid[35] insurance plans. These factors could drive decision-making. For example, patients without dental insurance or minimal dental coverage may select primary ESS. Alternatively, patients who have medical insurance plans with high out-of-pocket costs may select primary dental treatments.

When pursuing dental treatment, ODS patients must decide on preserving or extracting their diseased dentition, but there are multiple factors to consider. One issue is that for ODS, efficacy data for dental treatment is limited. Dental extraction is the only primary dental treatment with published success rates.[9,10,36–38] While RCTx, revision RCTx, and apicoectomy are options for managing ODS, they have only been reported as standalone treatments in case reports[39,40] or small series.[13,39–41] Interestingly, costs of primary RCTx and dental extraction were comparable, so future studies assessing RCTx efficacy in managing ODS would be extremely valuable.

The purpose of RCTx in treating ODS due to AP is to disinfect and obliterate the tooth's infected pulp chambers, which may or may not resolve PALs and sinusitis. Importantly, RCTx for maxillary molars is more challenging than for non-molar teeth because maxillary molar roots have more complex configurations or extra roots that can be missed.[42–44] Additionally, PALs increase the risk of RCTx failure.[45–47] Due to these complexities, the American Association of Endodontists suggested endodontists perform endodontic therapies of maxillary molars.[48]

Considering the technical complexities and lack of published success of endodontic therapies for ODS, dental extraction may seem simpler and more effective, but there are important issues to consider. First, maxillary molar extractions can be challenging due to their root anatomy. Even with optimal techniques, these extractions can lead to oroantral communication, retained or displaced root fragments, and alveolar fractures.[49] Second, patients must decide if and how their lost dentition is replaced. Although least expensive to have no reconstruction, there are functional and cosmetic concerns with this option. Tooth loss will result in decreased masticatory efficiency, and cosmetic deficits depending on tooth location and smile line. Additionally after dental extraction, patients lose substantial alveolar bone volume over time,[50–53] which complicates future implant placement.

If patients choose to undergo dental reconstruction, they must decide between partial dentures, bridges, and dental implants. Dental implants have become popular because in contrast to other options, they preserve adjacent tooth structure and bone, and enhance masticatory function and quality of life.[54] However, dental implants are expensive, especially when MSG is necessary. For implant success, ≥4 to 6 mm of maxillary alveolar bone height is necessary, below which MSG is recommended.[55–57] MSG is often necessary after maxillary molar extractions, and may be more likely in ODS due to frequent periapical bone erosion. The cost of implant plus MSG is two to three times more than other reconstructive options, and this cost must be weighed against implant functionality. Partial dentures are the least expensive reconstructive option, but they provide minimal masticatory support. Bridges fall between partial denture and implant costs, but they result in damage to healthy abutment teeth, placing them at risk for caries and endodontic disease.[58]

For patients undergoing ESS, the extent of surgery is another important consideration. Safadi et al. showed that maxillary antrostomy alone was sufficient for ODS with frontal sinus involvement,[21] shortening operative time and decreasing surgical risks. Based on the current study, expected cost of maxillary antrostomy alone was about $1,300 less than opening all diseased sinuses. More studies are necessary to assess whether the potential decreases in risks and costs with maxillary antrostomy alone compare favorably with clinical outcomes from opening all diseased sinuses.

Limitations

Costs of certain components of ODS management were not modeled. This was generally due to those components having inadequate published data, being impractical to model, or being nominal compared to other costs. For example, some out-of-pocket nominal costs were not modeled such as nasal saline sprays or irrigations, or over-the-counter analgesics like acetaminophen or nonsteroidal anti-inflammatory medications. Additionally, costs for imaging, CT image navigation, antibiotic use, and anesthesia were not modeled in this study.

Imaging studies needed may include periapical X-rays, orthopantograms, cone-beam CT, and sinus CT scans.[59] Costs of these imaging modalities range from $25 to $225.[23,24] CT image navigation was also not modeled, as image navigation use is variable across surgeons, and the cost would be approximately $175 to $195.[24] Although these variables do not represent a significant proportion of ODS management costs, patients should expect to incur these costs.

Antibiotic costs were not modeled because little evidence exists with regard to the utility of antibiotics for ODS.[14] Additionally, antibiotic use would be equivalent between all three treatment pathways.

Anesthesia costs were also not incorporated into models for two reasons. First, there is significant variability in dental practice patterns with respect to anesthesia types used. Secondly, the anticipated general anesthesia cost for ESS is $200 to $400,[60] and this cost was felt to be nominal for modeling. However, anesthesia costs would generally be lower for dental treatments as most extractions and endodontic therapies are done under local anesthesia.

Next, the assumption that all treatments were ultimately 100% effective does not capture the duration of time elapsed over the course of dental and otolaryngologic evaluations and treatments. Ly and Hellgren showed that ODS patients experienced an average 18 week delay from Otolaryngology referral to dental consultation, and an additional 22 week delay from time of dental diagnosis to treatment.[61] Delays in evaluation, treatment, and disease resolution could impact the effectiveness of different ODS treatment pathways and should be considered in future studies.

Another point to consider is that this study modeled direct healthcare costs, but did not measure indirect costs related to productivity loss or missed workdays. Since ESS can lead to more rapid symptom resolution in ODS, it is possible that it could lead to less productivity loss or missed workdays compared to primary dental treatments, and these indirect costs should be considered in future studies.

Another model limitation was that it was presumed that dental extraction would resolve AP in 100% of cases, and ESS would resolve the sinusitis in ODS patients in 100% of cases. Similarly, MSG and dental implants were presumed to be performed with 100% success. Each of these interventions can potentially fail, with substantial costs related to retreatments. Patients should be educated on the potential for such treatment failures.

Lastly, this study only modeled costs of managing uncomplicated ODS on an elective basis. While rare, ODS can lead to extrasinus infectious complications requiring hospitalization.[62] Expected costs of complicated ODS care would be substantially greater than uncomplicated ODS, and future studies could explore such costs.

CONCLUSION

ODS due to AP can be successfully treated with primary dental treatments, but ESS is still frequently required. This study showed that expected costs of primary dental extraction and RCTx were roughly equal. Primary ESS had a higher expected cost, but may still be preferred in patients with severe sinonasal symptoms.

Patients' insurance coverage may also impact decision-making.

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