Cost Identification Analysis of Telehealth versus In-Person Appointments with Orofacial Pain Patients at the University of Washington

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science

University of Washington

2023

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Program Authorized to Offer Degree:

Oral Medicine

University of Washington

Abstract

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Background: Oral medicine is a broad discipline within dentistry that focuses on diagnosing and managing complex oral and orofacial disorders in the craniofacial region. The specialty fills an important niche between medicine and dentistry, and specialists in the field are generally concentrated within metropolitan areas at hospitals and academic centers. Localization of providers in metropolitan areas may limit access to in-person specialty care related to geographic, socio-economic, and other barriers. In the early stages of the COVID-19 pandemic, healthcare developed creative solutions to ensure continuity of access to care, including increased use of telehealth. Oral Medicine Clinical Services (OMCS) at the University of Washington School of Dentistry implemented telehealth in April of 2020, after declaration of a public health emergency, to ensure continuity of care after gubernatorial mandates limited the provision of traditional in-person care in Washington state.

Aim: This study aimed to quantify and compare patient-related costs of telehealth versus traditional in-person care. The secondary aim was to evaluate potential operational resources that could be made available if clinical appointments could be shifted to telehealth.

Methods: A retrospective chart review was conducted for two cohorts of patients treated in OMCS between April 2020 (at the onset of telehealth) and June 2022. The telehealth cohort consisted of patients completing at least one telehealth visit during the study period, while the in-person cohort consisted of patients completing only in-person follow-ups. Individuals were included in either cohort if they were greater than or equal to 18 years of age at the time of the initial follow-up appointment and were being treated for a chronic orofacial pain condition confirmed by the primary ICD-10 diagnoses. Various patient-related outcomes were calculated based on the data gathered such as distance and time traveled, fuel consumption, lost productivity, and total patient cost per appointment. Potential clinical resources generated through telehealth were estimated by converting telehealth to in-person appointments and multiplying by average appointment revenue. A two-sample t-test, unequal variance was used to evaluate differences in patient costs for statistical analysis.

Results: The mean total direct patient cost per appointment in the telehealth cohort ($60.09) was significantly less than the in-person cohort ($97.89) with a p-value<0.0001. There was no significant difference between the two cohorts' mean total burden of patient cost, $174.54 in the in-person cohort and $228.04 in the telehealth cohort with a p-value of 0.20. Theoretical cost comparisons were calculated for members of the telehealth and in-person visits to evaluate the financial impacts of completing all appointments via one modality or the other. Subjects in the telehealth cohort experienced statistically significant cost savings when all in-person

appointments ($208.94) were converted to telehealth ($146.02) with a p-value of 0.02. Conversely, switching telehealth appointments ($144.64) to in-person appointments ($218.05) resulted in increased costs with a p-value of 0.03.

Discussion: Telehealth was associated with lower patient-related costs when compared to purely in-person care and has the potential to free up clinical resources and increase gross clinical revenue. It is anticipated that telehealth will continue to be utilized effectively, even after pandemic-era restrictions are lifted, due to economic viability, increased access to care, and ease of use for patients and providers.

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ACKNOWLEDGEMENTS

I wanted to thank everyone who has helped guide me on this journey towards the completion of my master’s thesis, my committee first and foremost along with Dr. Brian Leroux who helped me immensely with statistical analysis.

Chapter 1. BACKGROUND

Geographical, economic, and social barriers prevent patients from accessing healthcare. According to The Commonwealth Fund, the United States spends twice as much on health care compared to the average Organization for Economic Cooperation and Development (OECD) country yet has the worst health outcomes overall compared to other OECD countries.[1] The United States has the lowest life expectancy, the highest chronic disease burden, the highest number of hospitalizations for preventable causes, and the highest level of avoidable deaths of surveyed countries.[1] Per capita spending in the United States in 2019 exceeded 10,000 dollars, which is double the health-care-related spending compared to Australia, France, Canada, New Zealand, and the United Kingdom.[1] Each American on average pays 1122 dollars per year in out-of-pocket healthcare costs.[1] Americans are already burdened by medical spending, and adding dental care may prove to be beyond their patient means.

The US Surgeon General's Report in 2000 titled "Oral Health in America" was the first report to include oral health. It emphasized that oral health is essential to the general health and well-being and can be achieved by all Americans.[2] Not all Americans are receiving the same degree of care. Underrepresented groups, including the uninsured and underinsured, experience limited access to dental resources and suffer from relatively high levels of orofacial disease.[2] Accessing dental/oral care services remains low and has not significantly improved in the United States over the past 20 years.[3] The 2021 National Healthcare Quality and Disparities Report reported no statistically significant change in the percentage of adults under 65 years of age with any private dental insurance from 2006 to 2018.[3] Patients who have public insurance are provided limited coverage. Public insurance reimbursement is so low that many providers do not accept these plans. Even affluent individuals, including adults aged 35-44 years in the highest income brackets, demonstrated a significant increase in the number of decayed teeth when comparing statistics from 1999-2004, and 2013-2016.[7] Notably, adults receiving preventative dental care remained unchanged between 2002 and 2018.[3]

A silent epidemic of oral diseases is especially prevalent in the most vulnerable; the elderly, racial/ethnic minorities, special needs patients, and people in lower socioeconomic levels. Between 2013-2016, the prevalence of untreated dental decay in adults age 25-44 was 42.6% in Mexican Americans, 39.6% in African Americans, and 24.3% in white Americans.[4]

Limited access to care is a major factor in emergency room (ER) utilization for treating oral and dental conditions with ER visits estimated to be 290.2 visits per 100,000 population in 2018.[5] Patients without insurance or had Medicaid were the bulk of those presenting to the ER. 70% of patients were those residing in low household income areas.[5] The financial impact is significant as over the span of three years, 2.7 billion dollars in hospital charges were associated with dental ER visits.[5] Common conditions include periodontitis, abscesses, and infections.[5] Significant hospital resources are allocated towards acute dental treatment in an emergency setting due to a lack of adequate insurance coverage for preventive dental care through community dental offices. The average American spends only 5% of their total personal healthcare expenditures on dental needs compared to 37% for hospital care, 24% for physician and clinical services, an 10% for prescription drugs.[3] Out of pocket costs account for only 13% of personal healthcare expenditure, yet dental care accounts for the largest share of that cost, at approximately 42%.[3]

Specialty resources to address the most complex oral healthcare needs are also limited. This is true in oral medicine (OM) and other areas of specialty care where qualified providers may not be available in certain geographic regions. OM specialists care for patients with complex medical and diagnostic needs, primarily through the nonsurgical management of conditions affecting the oral and maxillofacial complex.[6] Postdoctoral OM training programs have existed for decades yet OM was not recognized as a formal dental specialty by the American Dental Association until March of 2020 limiting public awareness of the field. The ADA Health Policy Institute reports the total number of general dentists in private practice within the US in 2021 was 159,246. The same report indicated only 6 OM and 25 Orofacial Pain specialists in practice.[7] While these numbers are underestimations, the statistics show an alarming lack of specialists in the United States to care for certain complex oral and orofacial conditions. The American Board of Oral Medicine has 181 board certified practitioners listed in comparison. Miller and Peterson estimates that 5% of the US population suffer from oral mucosal disorders (conditions regularly treated by OM that other dental and medical specialties rarely treat).[8] If 50% of patients were symptomatic this would equate to roughly 192,200 patients seeking care.[8] This would require a minimum of 125 OM specialists, working full-time, with practices dedicated solely to management of mucosal conditions to provide adequate access to this vulnerable population.[8] Estimations expanded to encompass the full scope of OM practice, including orofacial pain and TMD would equate to an additional 55 million patients requiring care.[8] These estimates are conservative, and the actual numbers are likely significantly higher. Patient needs in the US population do not correspond with an adequate number of OM specialists to meet the demand.

Patients treated in OM often suffer from diseases that "fall between medicine and dentistry" leading to challenges navigating the healthcare system.[6] Patients on average see 2.2 practitioners before consulting an OM specialist, correlating with a diagnostic delay of 16.8 months.[6] Patients typically present to the initial OM visit with no provisional diagnosis provided by the referring doctor and had already seen at least one previous provider. Oral medicine helps to fill this gap and plays a valuable role in the healthcare system. This is highlighted by physician referrals, particularly referrals from otolaryngology, constitute a large proportion when compared to other dental specialties.[6] Brigham and Women's Hospital reported 42.4% percent of patient referral to their OM clinic came from general dentists, while 37.1% from primary care providers.[9] Patients travel 3 to 4 times farther to see an OM specialist than the distance travelled to primary medical and dental providers.[9] This demonstrates a lack of awareness of OM and/or the scope of the specialty as well as a shortage accessible OM providers in the US healthcare system.[9] OM providers are often concentrated in metropolitan areas and academic centers, which can be especially limiting to patients in rural areas seeking specialized care. The use of technology, including telehealth, helps to improve access to specialty care.

Telehealth is a tool that may increase access in a variety of dental and medical settings. Telehealth employs telecommunication technology to render treatment. Early references, dating as early as 1879, focused on the use of the telephone to reduce the number of required office visits.[10] Telehealth expanded significantly during the COVID-19 pandemic. Expansion during this time was multifactorial and provided an alternative to traditional in-person care in response to gubernatorial mandates and patient and provider concerns regarding potential COVID exposures. For reference, Oregon Health and Science University (OHSU) hospital performed

1100 digital visits in February 2020, 1 month prior to the declaration of public health emergency.[11] Telehealth appointment increased to 13,000 in March 2020.[11] Increased integration of telehealth during the pandemic also led to increased training and credentialing of providers with an increase from 230 to 2500 trained providers at University of Washington (UW).[12] UW reported a 70-fold increase in telemedicine visits during the same time period with average visits increasing to 14,000 per month.[12] Telehealth claims in the United States increased by 8336 percent between April 2019 to April 2020.[13] Use of telehealth is still significantly higher than pre-pandemic levels even with a gradual decline from peak usage in April of 2020 to October 2021. Patient and provider acceptance, convenience of use, and economic considerations have helped to maintain high levels of utilization even as acute limitations to in person care have resolved. The American Hospital Association (AHA) reports that 76 percent of US hospitals still connect with patients and consulting physicians at a distance through telehealth.[14] The AHA supports continued expansion of patient access to telehealth through increased Medicare coverage and reimbursement, additional federal research funding, and improved access to broadband technology in rural areas.[14] Driving factors include convenience for patients, reduced number of patient transfers, and economical savings.[14] The Oral Medicine service at the University of Washington School of Dentistry has used telehealth extensively over the past 2 years in the continued management of established patients being treated for chronic orofacial pain conditions, but the economic impact of this practice has yet to be formally evaluated.

1.1 Aim: The aim of this study was to compare the patient related costs involving established chronic orofacial pain patients in our service when treated via telehealth versus traditional in-person care.

1.2 Hypotheses: Our primary hypothesis is that telehealth will reduce patient related costs by decreasing travel-related expenses and lost earning potential. Our secondary hypothesis is that the use of telehealth can simultaneously increase operational resources for provision of traditional clinically based care by increasing available person-hours and chair-time available for in-person appointments.

Chapter 2. METHODS

2.1 Study Design: A retrospective chart review was conducted of established patients being treated for chronic orofacial pain conditions in Oral Medicine Clinical Services (OMCS) at the University of Washington between April of 2020 (the date that telehealth was initiated) and June 2022.

2.2 Eligibility Requirements/Study Population: All established patients completing at least 1 in-person or telehealth follow-up appointment through OMCS at the University of Washington within the study period were reviewed for potential inclusion. Individuals were included in the cohort if they were greater than or equal to 18 years of age at time of initial follow-up appointment and were being treated for an orofacial pain condition, confirmed by primary ICD-10 diagnosis. (**Figure 1**) Potential subjects were excluded if they had notified OMCS that they were no longer seeking care in a UW clinic or if they had not returned for a follow-up appointment within 6 months of their initial OMCS appointment.

ICD-10 billing codes were used to generate a list of eligible patients via the University's Electronic Medical Record system (AxiUm, Exan Enterprises/Henry Schein, Las Vegas, NV). ICD-10 diagnosis codes were cross referenced with schedules in OMCS to identify potential subjects. Subjects were divided into 2 groups: the in-person cohort (consisting of patients completing only in-person appointments) and the telehealth cohort (consisting of patients completing at least 1 telehealth appointment during the study period). The telehealth cohort was further subdivided into patients who have only had telehealth follow-up visits, and patients who have had both telehealth and in-person follow-up visits.

2.3 Demographic Information: Age, sex, primary diagnosis, and total appointments (in-person and telehealth) were collected for both cohorts.

2.4 Outcome Variables of Interest: Patient-related outcomes of interest included variables related to distance, time, and cost of care. Distance travelled to OMCS was estimated by measuring the distance from the zip code of the patient's primary residence and OMCS (98195) using Google Maps. Fuel efficiency was estimated based EPA automotive trend reports for a typical light duty sedan (25.7 miles per gallon for model year 2020 and 31.7 miles per gallon for 2021[15]). Average fuel economy was utilized to calculate estimated gallons of consumption during travel which was multiplied by the average cost for unleaded fuel in WA state between April 2020 to June 2022[16] to calculate estimated fuel cost ($/gallon). Accommodation cost was calculated for patients living a round trip distance greater than one hundred and fifty miles from the OMCS clinic. This cost was determined by averaging the per night cost of the 5 hotels closest to OMCS using Google Maps.[17] Finally, parking cost was calculated at a rate of $3/hour (the cost to part in the triangle garage at University of Washington Medical Center, an estimated 5 minute walk to the OMCS clinic).

Travel time was estimated using Google Maps during the day within the clinic's hours from 8:30am to 4:00pm. Current Procedural Terminology (CPT©) codes were utilized to estimate length of patient appointments as codes were generated using time-based billing (**Figure 2,** e.g., 99213: Established patient office visit, 20-29 minutes). Total time lost was calculated by adding travel time and appointment length. Travel time, appointment length, and time walking to and from the triangle garage (5 minutes each way) were added together to determine in-person visit time. Productivity loss was calculated by multiplying the total appointment time by minimum wage in Washington state ($13.89). All applicable costs for an individual patient were summed to determine the total direct patient cost per appointment, as well as the total burden of patient cost.[18]

Clinically relevant outcome measures included total number of patient visits, mean appointment complexity (**Figure 2**), mean production per appointment (defined as the gross dollar amount generated in each visit prior to financial or insurance adjustments), mean out of pocket costs (defined as the bill patients are responsible for), and total revenue per appointment (defined as United States Dollars USD received by OMCS after adjustments and insurance) evaluated for each cohort. Potential clinic days saved by converting in-person to telehealth appointments were calculated assuming 30 minutes to complete a telehealth appointment and a daily operational chair time of 7 hours.[17] Potential gross increase in this scenario was also calculated by multiplying average appointment revenue by an additional 14 telehealth appointments that could be performed in the 7 hour timeframe (assuming adequate clinic staffing was available).

2.5 Statistical Analysis: Descriptive statistics (mean, median, range) were determined for all outcome variables of interest. Additional calculations were performed in the subgroup of telehealth patients who were being treated with both telehealth and in-person visits to investigate the effects of converting all appointments to 1 of the 2 modalities (i.e., all appointments telehealth vs. all appointments in-person). A scenario was also examined after removal of outliers. Patients living a round trip distance of greater than 2 standard deviations above the mean were excluded as "outliers". Patients living this distance from the clinic are very unlikely to travel by car to attend in-person follow-up appointments.

Two-sample t-tests for unequal variance were employed to compare the mean total patient cost per appointment and the mean total burden of cost between the two cohorts. In addition, the telehealth subgroup consisting of patients who have had both modalities of treatment were also analyzed, comparing the mean total burden of patient cost of all in-person visits were converted to telehealth and vice versa. Significance was set at p less than 0.05 for all four scenarios.

ICD-10 Diagnoses

- M79.10 Myalgia, unspecified site
- M79.11 Myalgia of mastication muscle
- M79.12 Myalgia of auxiliary muscles, head, and neck
- M79.18 Myalgia, another site
- M26.6 Temporomandibular joint disorder, unspecified
- M26.601 Right temporomandibular joint disorder, unspecified
- M26.601 Left temporomandibular joint disorder, unspecified
- M26.603 Bilateral temporomandibular joint disorder, unspecified
- M26.609 Unspecified temporomandibular joint disorder, unspecified
- M26.631 Articular disc disorder of right temporomandibular joint
- M26.632 Articular disc disorder of left temporomandibular joint
- M26.633 Articular disc disorder of bilateral temporomandibular joint
- M26.602 Left temporomandibular joint disorder, unspecified
- M26.611 Adhesions and ankylosis of right temporomandibular joint
- M26.612 Adhesions and ankylosis of left temporomandibular joint
- M26.613 Adhesions and ankylosis of bilateral temporomandibular joint
- M26.619 Adhesions and ankylosis of temporomandibular joint, unspecified side
- M26.621 Arthralgia of right temporomandibular joint
- M26.622 Arthralgia of left temporomandibular joint
- M26.623 Arthralgia of bilateral temporomandibular joint
- M26.629 Arthralgia of temporomandibular joint, unspecified side
- M26.639 Articular disc disorder of temporomandibular joint, unspecified side
- M26.641 Arthritis of right temporomandibular joint
- M26.642 Arthritis of left temporomandibular joint
- M26.643 Arthritis of bilateral temporomandibular joint
- M26.649 Arthritis of unspecified temporomandibular joint
- M26.651 Arthropathy of right temporomandibular joint
- M26.652 Arthropathy of left temporomandibular joint
- M26.653 Arthropathy of bilateral temporomandibular joint
- M26.659 Arthropathy of unspecified temporomandibular joint
- M26.69 Other specified disorders of temporomandibular joint
- G44.0 Cluster headaches and other trigeminal autonomic cephalalgias
- G44.2 Tension-type headache
- G44.3 Post-traumatic headache
- G44.05 Short lasting unilateral neuralgiform headache with conjunctival injection and tearing
- G44.51 Hemicrania Continua
- G50.1 Atypical facial pain
- G50.8 Other disorders of trigeminal nerve
- G50.0 Trigeminal Neuralgia
- G51.9 Disorder of the facial nerve, unspecified
- R68.84 Jaw pain
- K14.6 Glossodynia
- F50.1 Atypical facial pain

Figure 1 – ICD-10 Diagnoses: Orofacial Pain Conditions

Chapter 3. RESULTS

Application of inclusion and exclusion criteria yielded 309 patients in the in-person cohort, and 245 patients in the telehealth cohort (**Figure 3**). In the in-person cohort there were 257 female and 52 males with a mean age of 49.0 years compared to 191 females and 55 males with a mean age of 54.0 years in the telehealth cohort (**Table 1**). The most common primary ICD-10 diagnoses were TMD myalgia/myofascial pain (32.5%) and TMD articular diagnoses (31.1%). A summary of ICD-10 appointment type and frequency by ICD-10 diagnosis is included in **Table 2**. The mean visit complexity (in-person = 3.94; telehealth = 3.71) and mean appointment time (in-person = 34.41 minutes; telehealth = 32.13 minutes) were similar between groups (**Table 3**). The mean ratio of telehealth to in-person follow-up visits within the telehealth group was 3:2.

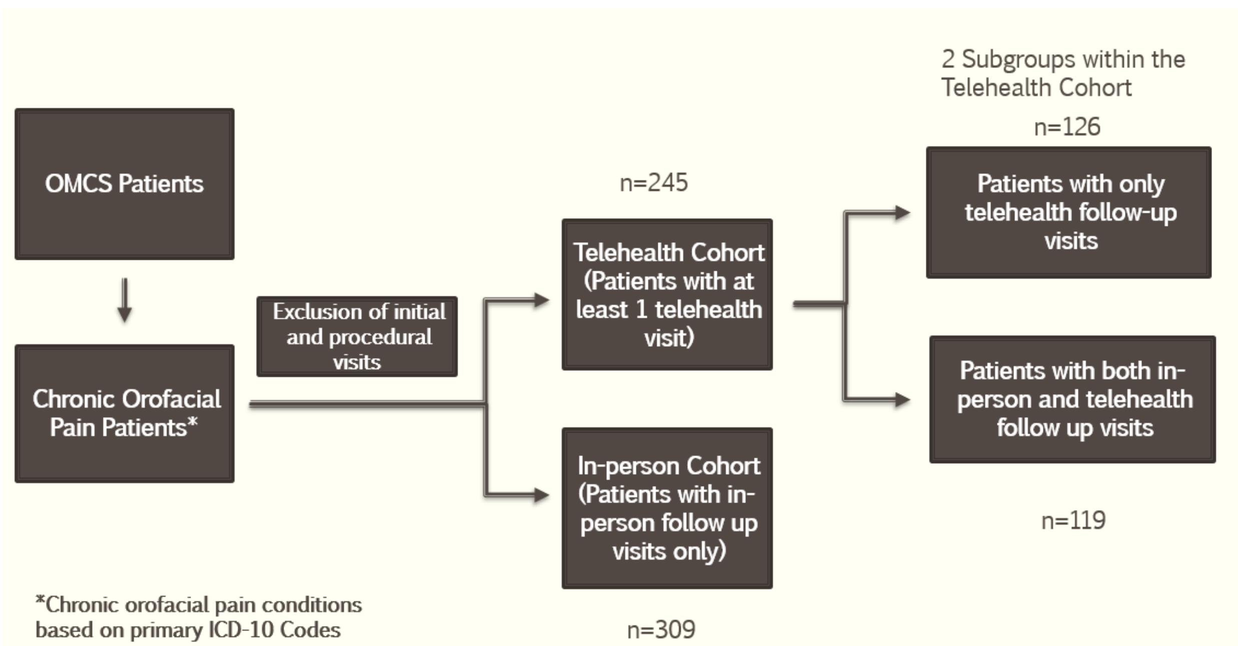

Figure 2: Flow Diagram for Inclusion and Exclusion

Table 1: Cohort Demographics

Cohort	N	Female	Male	Age (mean)	Age (median)
Total	**554**	**448**	**106**	**51.5**	**53.5**
In-Person	309	257	52	49.0	50.0
Telehealth	245	191	54	54.0	57.0

Table 2: Appointment Type by Orofacial Pain Diagnosis

Cohort	AFP	Glossodynia	HA	TMD-Myalgia/TMD-Myofascial Pain	TMD (Articular Diagnoses)	TN	Total
Total	**2**	**215**	**1**	**462**	**441**	**298**	**1419**
In-Person	0	58	0	242	251	56	607
Telehealth	2	157	1	220	190	242	812

AFP: Atypical Facial Pain; HA: Headache; TMD: Temporomandibular Disorder TN = Disorders; of the trigeminal nerve

Table 3: Appointment Details

Cohort	Appointments (total)	Appointments per Patient (mean)	Range of Appointments per Patient	Appointment Complexity (mean)	Appointment Duration (mean)	Appointment Duration (median)
Total	**1419**	**2.64**	**(1,20)**	**3.82**	**33.76 min**	**35.00 min**
In-Person	607	1.96	(1,13)	3.94	34.41 min	35.00 min
Telehealth	812	3.31	(1,20)	3.71	32.13 min	35.00 min

The mean out of pocket costs per appointment after insurance reimbursement was equal to \$50.62 and \$53.98 in the in-person and telehealth cohorts respectively (**Table 4**). The mean total direct cost per appointment in the in-person cohort was \$128.12 compared to \$59.85 with the telehealth cohort **(Table 4)**. Direct cost per appointment was statistically lower in the telehealth group (p-value = 0.0000008).

Mean time dedicated to in-person appointments was equal to 181.5 minutes compared to 32 minutes for telehealth appointments resulting in an opportunity cost due to lost productivity of \$42.10 per appointment in the in-person cohort vs. \$7.41 in the telehealth group (**Table 4**).

When considering all appointments across the study period, the total cost of care was similar in both the in-person and telehealth groups (\$71,924.09 vs. \$72,614.01) with the mean total burden of patient cost equal to \$234.28 in the in-person cohort and \$298.95 in the telehealth cohort though differences in total cost were not statistically significant (p = 0.13) (**Table 5**). Higher costs in the telehealth cohort appeared to be driven by the higher number of total appointments (812 vs. 607) (**Table 3**).

Table 4: Summary of Patient Costs per Appointment (USD)

	In-Person		Telehealth	
	Mean	Median	Mean	Median
Direct Cost (Total)	**128.12**	**58.83**	**59.85**	**28.10**
Appointment Charge (Out of Pocket Cost)	50.62	25.00	53.98	15.00
Accommodation	285.50	285.50	NA	NA
Gas	9.71 [3.19 gallons]	2.11 [0.70 gallons]	NA	NA
Distance Travelled (miles) (Round trip)	*85.13*	*20*	*NA*	*NA*
Parking	3.68	4.00	NA	NA
Opportunity Cost (Productivity loss)	**42.10**	**20.60**	**7.41**	**8.11**
Appointment Duration (min)	*34*	*35*	*32*	*35*
Travel Time (min) (Round trip)	*161.9*	*54*	*NA*	*NA*

Table 5: Total Burden of Patient Cost (USD)

	In-Person	Telehealth
Overall (cohort)	**71,924.09**	**72,614.01**
Mean (per patient)	234.28	298.95
Median (per patient)	98.21	82.19

Subgroup analysis in the telehealth group of patients who had both telehealth, and in-person visits (N = 119) was simulated to further characterize patient-related costs.

- *Scenario 1: All in-person appointments converted to telehealth appointments:* Mean decrease in patient-related costs by $198.97 per patient (**Table 7**).
- *Scenario 2: All telehealth appointments converted to in-person appointments:* Mean increase in patient related costs by $261.52 per patient (**Table 8**).

Table 6: Subgroup analysis: Telehealth Cohort: All In-Person Appointments Converted to Telehealth (USD)

	Burden of Cost for In-Person Appointments within Telehealth Cohort	**Burden of Cost if In-Person Appointments Converted to Telehealth**	**Patient Cost**
Total (cohort)	40,784.33	17,250.37	-23,533.96
Mean (per patient)	342.72	143.75	-198.97
Median (per patient)	95.82	52.38	-43.44

Note that a (-) sign indicates cost saved.

Table 7: Subgroup analysis: Telehealth Cohort: All Telehealth Appointments Converted to In-Person (USD)

	Burden of Cost for Telehealth Appointments within Telehealth Cohort	**Burden of Cost if Telehealth Appointments Converted to In-Person**	**Patient Cost**
Total (cohort)	17,426.13	48,547.28	31,121.15
Mean (per patient)	146.44	407.96	261.52
Median (per patient)	58.10	87.20	29.10

In the subgroup analysis, converting all in-person appointments in the telehealth subgroup cohort to telehealth appointments resulted in statistically significant savings from $342.72 to $143.75 (if all follow-up appointments were converted to telehealth) (p = 0.029). Conversely, converting all telehealth appointments to in-person appointments within the telehealth subgroup resulted in a statistically significant increase in cost from $146.44 to $407.96 per patient ($p = 0.016$).

Calculations were also performed with removal of outliers to avoid potential bias produced by patients living an excessive distance (two standard deviations) from the clinic. In the in-person cohort, the mean round trip distance travelled was 85.14 miles, and the standard deviation was 439.59 miles, resulting in the upper limit of 964.33 miles. With the telehealth cohort, the mean round trip distance was 106.9 with a standard deviation of 303.56 miles, resulting in an upper limit of 714.10 miles. Patients living beyond the upper limits for both cohorts were removed from calculation. Removal of outliers results in 302 patients in the in-person cohort and 236 patients in the telehealth cohort. After removal of outliers, the mean total direct cost per patient was $97.89 and $60.09 in the in-person and telehealth cohorts respectively (**Table 9**). The mean direct total cost per appointment continued to be statistically lower in the telehealth group ($p = 0.0000008$). After removal of outliers, the mean total burden of patient cost was $174.54 in the in-person cohort, and $228.04 in the telehealth cohort (**Table 10**). The difference between groups remained statistically insignificant ($p = 0.19$).

Table 8: Removal of Outliers, Patient Related Costs per Appointment (USD)

	In-Person		Telehealth	
	Mean	Median	Mean	Median
Total Patient Cost	**97.89**	**56.73**	**60.09**	**28.10**
Appointment Charge (Out of Pocket Cost)	50.62	25.00	53.98	15.00
Accommodation	285.50	285.50	NA	NA
Gas	3.60 [1.18 gallons]	2.11 [0.70 gallons]	NA	NA
Distance Travelled (miles) (Round trip)	*32.09*	*20*	*NA*	*NA*
Parking	3.68	4.00	NA	NA
Opportunity Cost (Productivity loss)	**24.32**	**20.60**	**7.56**	**8.11**
Appointment Duration (min)	*34*	*35*	*32*	*35*
Travel Time (min) (Round trip)	*72.88*	*54*	*NA*	*NA*

Table 9: Removal of Outliers, Total Burden of Patient Cost (USD)

	In-Person	**Telehealth**
Total (cohort)	52,709.97	53,788.23
Mean (per patient)	174.54	228.04
Median (per patient)	92.32	81.29

Subgroup analysis after removal of outliers (N = 109) in the subgroup of telehealth patients who were treated with both modalities of care.

- *Scenario 1: All in-person appointments converted to telehealth appointments (Outliers excluded):* Mean decrease in patient-related costs by $62.92 per patient (**Table 11**).
- *Scenario 2: All telehealth appointments converted to in-person appointments (Outliers excluded):* Mean increase in patient related costs by $73.41 per patient (**Table 12**).

In the subgroup analysis after removal of outliers, converting all in-person appointments in the telehealth subgroup cohort to telehealth visits resulted in a statistically significant difference in mean total burden per patient cost from $208.94 to $146.02 (when all follow-up appointments were converted to telehealth) (p = 0.029). Conversely, converting all telehealth appointments to in-person appointments within the telehealth subgroup resulted in a statistically significant increase in cost from $144.64 to $218.05 per patient (p = 0.033).

Table 10: Removal of Outliers, Sub analysis: Telehealth Patients if All In-Person Visits were Converted to Telehealth (USD)

	Burden of Cost for In-Person Appointments within Telehealth Cohort	Burden of Cost if In-Person Appointments Converted to Telehealth	Patient Cost
Total (cohort)	22,759.55	15,915.77	-6,843.78
Mean (per patient)	208.94	146.02	-62.92
Median (per patient)	76.67	50.79	-25.88

Note that a (-) sign indicates amount saved.

Table 11: Removal of Outliers, Sub analysis: Telehealth Patients if all Telehealth Visits were Converted to In-Person (USD)

	Burden of Cost for Telehealth Appointments within Telehealth Cohort	Burden of Cost if Telehealth Appointments Converted to In-Person	Patient Cost
Total (cohort)	15,750.60	23,767.10	8,016.50
Mean (per patient)	144.64	218.05	73.41
Median (per patient)	57.97	78.84	20.87

Clinical financial metrics were also assessed in both cohorts. Mean clinical production per visit in the in-person cohort was $195.79 versus $184.32 in the telehealth cohort with mean revenue per visit equal to $99.93 and $103.83 respectfully (**Table 13**). Projected clinic days saved by converting all in-person appointments (N = 607) to telehealth would result in 43.35 extra clinic days result in increased gross revenue of $168,718.20.

Table 12: Clinical Production and Revenue (USD)

Cohort	Production (gross)	Production per Visit (mean)	Revenue (gross)	Revenue per visit (mean)
Total (cohort)	268,707.00	190.06	145,065.58	101.88
In-Person	119,039.00	195.79	60,758.14	99.93
Telehealth	149,668.00	184.32	84,307.44	103.83

Chapter 4. DISCUSSION

Increased operation of telehealth during the COVID-19 pandemic has led to wider use of the technology in both medicine and dentistry. Generally, telehealth provides a convenient way for patients to access specialty care. This study is consistent with others to suggest that there are economic advantages for both the individual patient and the healthcare system. Estai et al, demonstrated that the use of telehealth in screening low risk children could potentially free up 40 million dollars per year in Australia.[19] This could allow resources to be reallocated to at risk populations who are underrepresented in current resource utilization.[19] A second Australian study at the Royal Children's Hospital suggested a decrease in the per visit cost of 431.29 AUS to 294.35 AUS by utilizing telehealth in traditional orthodontic and pediatric dental visits which also freed up 36.7 days of clinic time.[20] These results are similar to the findings in this study where potentially up to 43.35 extra clinic days could be made available if in-person visits were converted to telehealth, with a potential increase in clinical revenue of $168 000 if applied solely within the clinic.

During the COVID-19 pandemic, the American Dental Association (ADA) collected biweekly surveys from dentists across the United States to assess the impact of the pandemic on dental practices. By October of 2020, 99% of dental offices were open, but patient volume had plateaued at approximately 80% of pre-pandemic levels.[21] Patient volume has remained roughly the same up to December 2021 which is when the ADA halted collecting surveys, suggesting that this may represent a new normal in dental resource consumption.[21] The use of telehealth could potentially increase revenue in a private practice setting as teledentistry is covered with many insurances including Medicaid. The increased number of telehealth visits conducted, along with ease of use, convenience, and economic considerations have continued to bolster and maintain high levels of application in the years to come.

This study demonstrated that telehealth reduced patient related costs after implementation in April 2020 while potentially increasing operational resources within OMCS. In this study, telehealth resulted in a lower mean patient cost per appointment while subgroup analysis suggested that converting in-person appointments in the telehealth cohort would result in statistically significant savings for patients treated with both telehealth and in-person care. The study is strengthened by its large sample size and its application of real-world data (in contrast to many economic studies in literature which have been limited to statistical modelling). This study is one of the few that analyzes an existing population being treated with telehealth to quantify outcomes. Some weaknesses with this study are the fact that this is a retrospective chart review limited to information collected during clinical care. Its retrospective nature raises the possibility of selection bias as study operations, data collection, entry, and quality assurance were not completed in advance. Furthermore, confounding variables may exist such as the presence or absence of health insurance which could affect results. Lack of patient reported outcomes (PROs) and validated clinical outcome measures limits the ability to directly compare the clinical outcomes of telehealth versus in-person care in this study design. Future prospective studies can apply PROs to further characterize patient acceptance of telehealth, ease of use, and impressions regarding its effectiveness. Clinical outcome measures could also be applied in these studies to characterize clinical effectiveness through measurement of pain intensity and pain-related interference (e.g., PEG scale, chronic graded pain scale) over time.

Economic calculations in the study also required assumptions regarding mode of transportation and lost productivity. Costs were calculated conservatively based on the average fuel economy of a light model sedan and the minimum wage in Washington state. Patients treated in clinic were assumed to use their own personal transportation and does not account for variations in make or model of the vehicle, or whether patients took public transportation. The use of minimum wage to calculate opportunity cost is likely an underestimate of lost income based on the demographics of the patient population in OMCS. This study first and foremost is a cost identification analysis demonstrating that telehealth offers an economical advantage compared to in-person visits. Results suggest that telehealth offers convenience and economic savings for chronic orofacial pain patients and economic viability for use in OM practice. Future studies can expand on this work through use of patient reported outcomes and validated clinical measures, ideally in a prospective randomized controlled trial in which patients are randomly assigned to either telehealth or in-person treatment modalities to directly measure effectiveness while reassessing economic variables.

Conclusions: Integration of telehealth in a specialty OM clinic reduced patient-related costs by decreasing travel-related expenses and lost earning potential. The use of telehealth demonstrated that it could also increase operational resources for provision of traditional in-person clinically based care by increasing the available person hours and chair time, resulting in increased potential gross revenue. Overall, the results demonstrate that telehealth is a cost-effective alternative to exclusive in-person care in the treatment of patients with orofacial pain.

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APPENDIX A

CPT – Level of Complexity Criteria

Code	Level of MDM (Based on 2 out of 3 Elements of MDM)	Elements of Medical Decision Making		
		Number and Complexity of Problems Addressed	Amount and/or Complexity of Data to be Reviewed and Analyzed **Each unique test, order, or document contributes to the combination of 2 or combination of 3 in Category 1 below.*	Risk of Complications and/or Morbidity or Mortality of Patient Management
99211	N/A	N/A	N/A	N/A
99202 99212	**Straightforward**	**Minimal** • 1 self-limited or minor problem	**Minimal or none**	**Minimal risk of morbidity from additional diagnostic testing or treatment**

99203
99213
	Low	**Low**
		• 2 or more self-limited or minor problems;
		or
		• 1 stable chronic illness;
		or
		• 1 acute, uncomplicated illness or injury
			Limited
			(Must meet the requirements of at least 1 of the 2 categories)
			Category 1: Tests and documents
			• **Any combination of 2 from the following:**
			  • Review of prior external note(s) from each unique source*;
			  • review of the result(s) of each unique test*;
			  • ordering of each unique test*
			or
			Category 2: Assessment requiring an independent historian(s)
			(For the categories of independent interpretation of tests and discussion of management or test interpretation, see moderate or high)
				Low risk of morbidity from additional diagnostic testing or treatment

99204
99214
	Moderate	**Moderate**
		• 1 or more chronic illnesses with exacerbation, progression, or side effects of treatment;
		or
		• 2 or more stable chronic illnesses;
		or
		• 1 undiagnosed new problem with uncertain prognosis;
		or
		• 1 acute illness with systemic symptoms;
		or
		• 1 acute complicated injury
			Moderate
			(Must meet the requirements of at least 1 out of 3 categories)
			Category 1: Tests, documents, or independent historian(s)
			• **Any combination of 3 from the following:**
			  • Review of prior external note(s) from each unique source*;
			  • Review of the result(s) of each unique test*;
			  • Ordering of each unique test*;
			  • Assessment requiring an independent historian(s)
			or
			Category 2: Independent interpretation of tests
			• Independent interpretation of a test performed by another physician/other qualified health care professional (not separately reported);
			or
			Category 3: Discussion of management or test interpretation
			• Discussion of management or test interpretation with external physician/other qualified health care professional\appropriate source (not separately reported)
				Moderate risk of morbidity from additional diagnostic testing or treatment
				Examples only:
				• Prescription drug management
				• Decision regarding minor surgery with identified patient or procedure risk factors
				• Decision regarding elective major surgery without identified patient or procedure risk factors
				• Diagnosis or treatment significantly limited by social determinants of health

99205
99215
	High	**High**
		• 1 or more chronic illnesses with severe exacerbation, progression, or side effects of treatment;
		or
		• 1 acute or chronic illness or injury that poses a threat to life or bodily function
			Extensive
			(Must meet the requirements of at least 2 out of 3 categories)
			Category 1: Tests, documents, or independent historian(s)
			• **Any combination of 3 from the following:**
			  • Review of prior external note(s) from each unique source*;
			  • Review of the result(s) of each unique test*;
			  • Ordering of each unique test*;
			  • Assessment requiring an independent historian(s)
			or
			Category 2: Independent interpretation of tests
			• **Independent interpretation of a test performed by another physician/other qualified health care professional (not separately reported);**
			or
			Category 3: Discussion of management or test interpretation
			• Discussion of management or test interpretation with external physician/other qualified health care professional/appropriate source (not separately reported)
				High risk of morbidity from additional diagnostic testing or treatment
				Examples only:
				• Drug therapy requiring intensive monitoring for toxicity
				• Decision regarding elective major surgery with identified patient or procedure risk factors
				• Decision regarding emergency major surgery
				• Decision regarding hospitalization
				• Decision not to resuscitate or to de-escalate care because of poor prognosis