ORIGINAL RESEARCH

Trends in Outpatient Specialty Referrals During the COVID-19 Pandemic

[1]Daisuke Furukawa, MD, MS, [2]Chidinma Chima-Melton, MD, MBA and [2]Maria Han, MD, MS

[1]Division of Infectious Disease, Department of Medicine, University of California, Los Angeles, California, USA
[2]Division of General Internal Medicine, Department of Medicine, University of California, Los Angeles, California, USA

Introduction

The COVID-19 pandemic has fundamentally changed healthcare delivery and how patients seek medical care in the United States. Possibly due to concerns related to social distancing and fear of contracting the virus, studies have demonstrated decreased utilization of medical services including preventative care, elective procedures, and emergency room visits.[1-3] These decreases in healthcare utilization were seen while healthcare systems were rapidly implementing telehealth and remote visits.[4-6] While the proportion of telehealth visits has overall decreased and stabilized in recent months compared to its peak earlier in the pandemic, telehealth utilization remains significantly higher compared to pre-pandemic levels.[7]

The negative impact on patient utilization of healthcare services as well as the increased uptake of telehealth services during the pandemic are well-characterized. However, there is limited data on the impact of the pandemic on outpatient referral patterns to specialists and how referral patterns differ between in-person and telehealth visits. We describe changes in total number and rates of outpatient referrals to specialists during the pandemic compared to before. Additionally, we describe the differences in referral rates among in-person, televisit, and telephone encounters during the pandemic.

Materials and Methods

This cross-sectional study was conducted at a large academic center-based healthcare network which included over 200 ambulatory practices throughout Southern California. All outpatient consultation referrals placed 3/1/2020-8/31/2020 were abstracted from the electronic medical record. To account for seasonal variations, referrals from 3/1/2019-8/31/2019 were also abstracted as the comparator group. We collected, the type of encounter originating the referral in person, office visit, tele video visits, or telephone encounter and the consulting specialty to which the referral was placed. Televisit was defined as encounters conducted through remote video visit portal.

Total number of outpatient encounters was retrieved from our Telehealth dashboard maintained by our institution's Office of Health Informatics and Analytics. The dashboard records the total number of outpatient encounters by encounter type (in-person, televisit, telephone). Rates of outpatient referral was calculated monthly and reported as number of referrals per 1000 outpatient encounters for our analysis.

Rates of outpatient referrals were compared between 2019 and 2020 and amongst the three encounter types in 2020. For these analyses, data from March to May from both years were excluded and only data from June to August, when the number of outpatient encounters relatively stabilized during the pandemic, were included. When comparing rates of referrals for the three encounter types, in-person encounter was used as the control group and individually compared to televisit and telephone encounters. Chi-square test or Fisher's exact test was used for statistical analysis. Fisher's exact test was used for cases with small samples sizes when the expected cell count was less than 5. STATA, version 16 (StataCorp LLC) was used for the analysis. Internal Review Board review was not required as this project was conducted as a quality improvement initiative and patient level protected health information (PHI) was not accessed.

Results

<u>Decline in Outpatient Referrals</u>

A decrease in the total number of outpatient referrals was observed from the onset of the pandemic (Figure 1). The total number of referrals declined to a nadir of 5967 referrals in April 2020, a 66.8% decrease compared to April 2019, and steadily increased to 16552 referrals in August 2020, though still not reaching pre-pandemic levels.

Number of referrals generated from in-person encounters followed a similar trajectory, nadiring in April 2020, followed by gradual increase in number of referrals through August 2020. Conversely, referrals generated from televisits and telephone encounters increased in 2020 compared to 2019. The number of referrals generated from televisits was highest in May 2020, accounting for 42.0% of total referrals. The number of referrals generated from telephone encounters was highest in April 2020, accounting for 15.3% of total referrals.

Decline in Outpatient Encounters

Total number of outpatient encounters also dipped significantly with the pandemic, with nadir of 129952 encounters in April, a 35.5% decrease compared to the year prior (Figure 2a). Total encounters then gradually increased to a peak that exceeded pre-pandemic levels in June 2020, followed by a slight decline in the following months. A similar trajectory was observed when stratified to in-person encounters only where the number of total encounters reached a nadir of 49199 in April (75.6% decrease from the year prior) and peaked in June 2020 (Figure 2b). Conversely, sharp increases were observed for televisit and telephone encounters with the onset of the pandemic, peaking in April at 66686 (27570.5% increase) and 14067 (7342.9% increase) for televist and telephone encounters, respectively. (Figure 2c, 2d). Following April, total number of encounters decreased for both encounter types but remained above pre-pandemic levels.

Decline in Rates of Outpatient Referrals

The rates of referrals sharply declined at the onset of the pandemic, with a nadir April 2020 at 48.18 referrals/1000 encounters, followed by a steady recovery up to 83.98 referrals/1000 encounters by August 2020. A similar trend was observed with in-person visits with a nadir of 37.01 referrals/1000 encounters in April 2020 followed by gradual recovery. Rates of referrals sharply increased at the onset of the pandemic for televisit and telephone encounters, peaking in May 2020 at 68.35 referrals/1000 encounters for televisit encounters and in August 2020 at 116.1 referrals/1000 visits for telephone encounters.

Rates of Outpatient Referrals 2020 vs 2019

Overall, rate of referrals was lower in 2020 compared 2019 (74.95 vs 86.70 referrals/1000 encounters; $p<0.001$) (Table 1). Referrals to 9 out of 15 specialties saw a statistically significant decrease in rates of referrals in 2020 compared to 2019, with surgery experiencing the largest absolute decrease at minus 3.99 referrals/1000 visits. Referrals to behavioral health (6.52 vs 6.20 referrals/1000 encounters; $p<0.001$) was the only specialty that saw a statistically significant increase in rates of referrals in 2020 compared 2019.

Rates of Outpatient Referrals Amongst Encounter Types

Compared to in-person encounters, the rates of referrals were lower for televisits (79.74 vs 57.77 referrals/1000 encounters; $p<0.001$) and higher for telephone encounters (79.74 vs 112.08 referrals/1000 encounters; $p<0.01$) (Table 2). Referrals to 8 out of 15 specialties were lower with televisits compared to in-person encounters with surgery having the largest absolute difference in rates of referrals at minus 8.30 referrals/1000 encounters. Referrals to behavioral medicine was the only specialty with a higher rate of referrals with televisit encounters compared to in-person encounters (7.60 vs 6.04 referrals/1000 encounters; $p<0.001$). Rates of referrals to 7 out of 15 specialties were higher with telephone visits compared to in-person, with medicine seeing the largest absolute difference of plus 16.45 referrals/1000 encounters. Rates of referrals to 2 out of 15 specialties were lower with telephone visits compared to in-person, with dermatology having the largest absolute decrease of minus 3.53 referrals/1000 encounters.

Discussion

Our study found the total number and rates of outpatient referrals abruptly decreased with the onset of the pandemic followed by a steady recovery but not to pre-pandemic levels by the end of our study period 6 months into the pandemic. This is notable, because with increased uptake of televisit and telephone encounters, total number of outpatient encounters recovered to pre-pandemic levels by June 2020 in our cohort, suggesting that the persistently low number of referrals is not simply due to a decrease in the denominator. Studies have demonstrated that routine patient care has been compromised or delayed due to the pandemic,[8-10] and our study suggests that referrals to specialty care has similarly been negatively affected by the pandemic.

Our analysis showed referrals to almost all specialties decreased post-pandemic compared to the pre-pandemic period. Notably, referrals to surgery saw the biggest decline in rates of referrals. This finding is not surprising, as many elective surgical cases were cancelled or postponed during the study period, and decreases in surgical consults and cases during the pandemic are well documented in the literature.[11-13] Other studies have also shown decreased number of patients seen in specialty clinics including neurology and dermatology.[14-16] These studies are however limited due to their short study period and focus on a single specialty. Our study demonstrated that the negative effects of the pandemic were still seen 4 to 6 months into the pandemic across a wide spectrum of specialties.

Behavioral health was one exception which saw an increase in the number and rate of referrals in 2020 compared to 2019. This observation is consistent with reports of increased mental health burden experienced by the population during the pandemic. A study by Cseisler *et al.* reported 40.9% of adults reported at least one adverse mental health or behavioral health condition, including 10.7% of them who seriously considered suicide.[17] Additionally, a study by Ettman *et al* reported prevalence of depression symptoms was 3-fold higher during the pandemic compared to prior to the pandemic.[18] As the pandemic unfolds, the need for increased access to mental health services is expected and ongoing efforts are needed to ensure that our patients' mental health needs are adequately met.

Our study also showed that compared to in-person visits, rates of referrals were significantly lower with televisit encounters but significantly higher with telephone encounters. For tele-visits, the lower rates of referrals may be explained by selection bias as patients with more serious conditions that would require

specialty referrals may have been more likely to have their appointments scheduled as an in-person visit. A possible explanation for the high rates of referrals with telephone encounters is that patients scheduled for telephone visits may have been biased towards elderly patients with greater comorbidities needing specialty referrals but were unable to navigate a televisit encounter due to difficulty with technology. Additionally, patients with greater provider continuity may have been preferentially scheduled as a telephone visit rather than televisit or in-person, and physicians may have felt more comfortable making clinical decisions without visualizing the patient. Further studies evaluating patient-level and provider-level factors are needed to better understand referral patterns amongst the three encounter types.

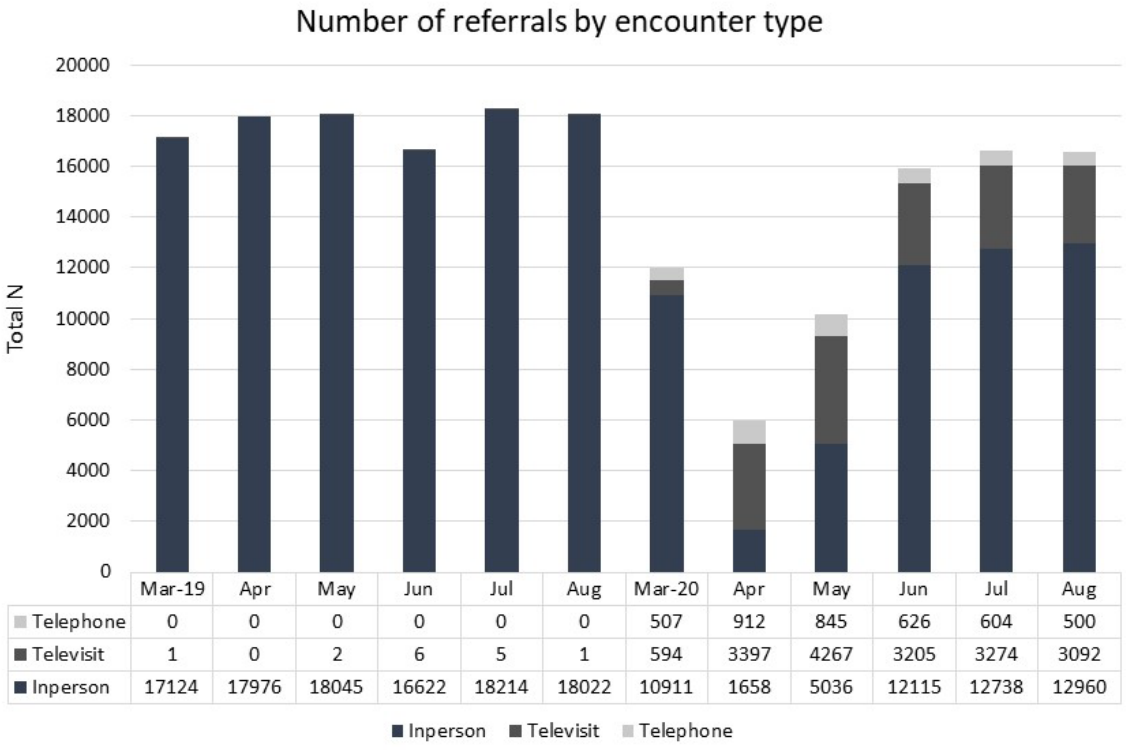
Inequities in access to telephone and televisit care based on racial and socioeconomic factors have been previously reported with minorities and low-income patient population experiencing decreased in utilization of remote visits.[1,19-20] It is unclear if these factors influence rates of referrals and if these same factors apply to our cohort of patients. Nonetheless, the differences in total number and rates of referrals seen in our study do raise the question if racial and socioeconomic factors contributed to the differences observed amongst the three encounter types. As we anticipate telehealth to continue to play a major role in our healthcare system even after the resolution of the pandemic,[21] better understanding referral patterns of the different encounter types will be essential to ensure equitable access to specialty care.

Our study has number of limitations. First, the study was conducted at a single healthcare network in Southern California and thus generalizability may be limited, particularly with healthcare organizations with different payment models or organizations from other regions in the nation that were differentially affected by the COVID-19 pandemic. Second, patient level data was not included in the study thus we were not able to assess factors such as comorbidities or chief complaints that may have influenced the rates of referrals amongst the different encounter types. Third, our analysis of referral rates from May through August 2020 may not be reflective of the referral patterns that we are seeing presently. A study by Commonwealth Fund reported rates of outpatient visits to many specialties have recovered or exceeded pre-pandemic levels by October 2020.[7] A similar trajectory may have been observed in our cohort of patients. Fourth, we do not have data on whether patients completed the referral or not, so our data do not necessarily reflect whether the patient received specialty care.

Conclusion

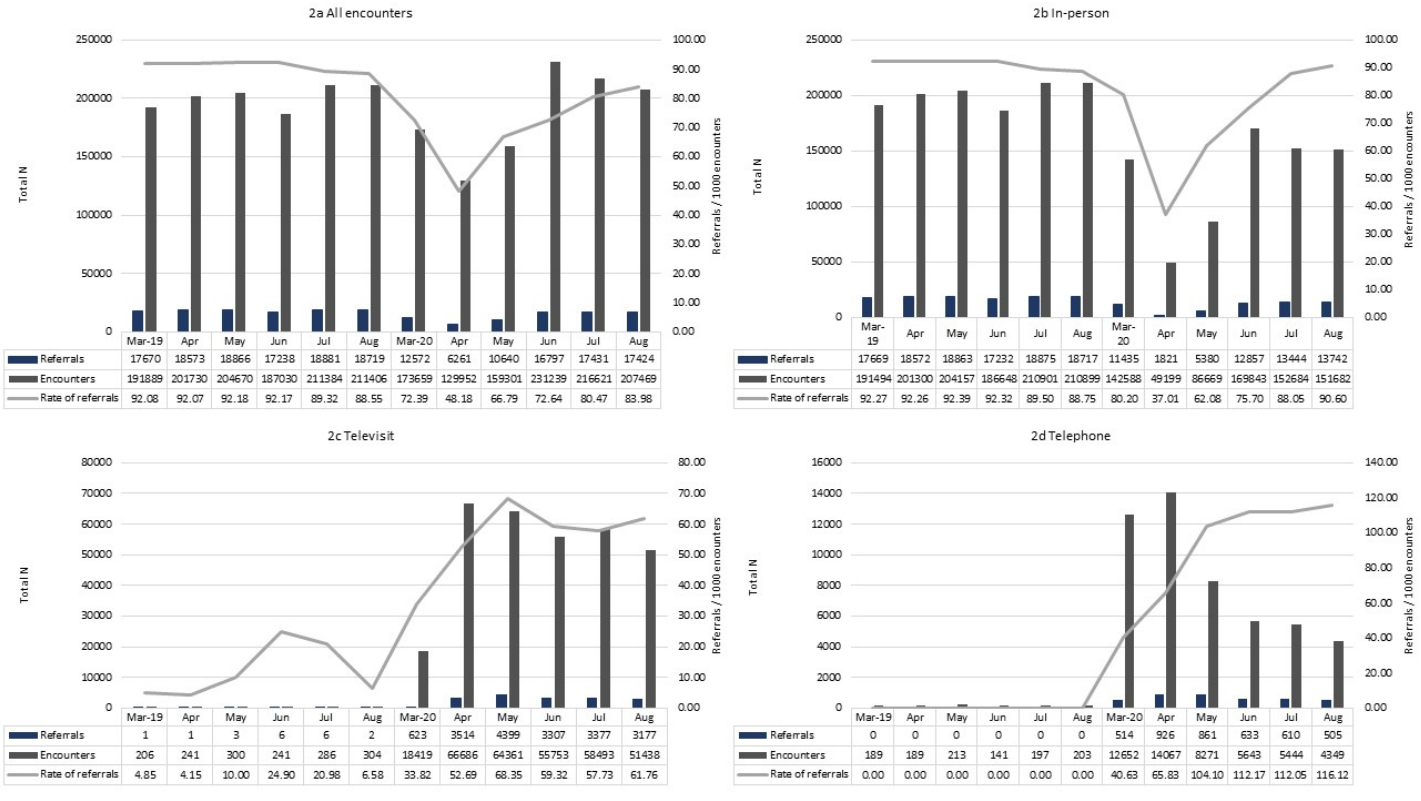
Our study demonstrated that both total number and rate of referrals significantly decreased with the onset of the pandemic with differential rates of referrals observed by different specialty and encounter types. We notably identified an increased rate of referral to behavioral health despite referrals to most other specialties decreasing significantly since the start of the pandemic. We additionally identified that referral rates were significantly lower with televisit encounters while higher with telephone encounters compared to in-person visits. Additional studies are needed to better characterize referral patterns of remote visits so that health administrators and policy makers could appropriately make decisions and allocate resources to ensure that patients continue to receive appropriate access to specialty care as we navigate through the pandemic.

Acknowledgements
This work was in part funded by Health Resources and Services Administration Ruth L. Kirschstein-National Research Service Award [T32HPI19001].



	Mar-19	Apr	May	Jun	Jul	Aug	Mar-20	Apr	May	Jun	Jul	Aug
Telephone	0	0	0	0	0	0	507	912	845	626	604	500
Televisit	1	0	2	6	5	1	594	3397	4267	3205	3274	3092
Inperson	17124	17976	18045	16622	18214	18022	10911	1658	5036	12115	12738	12960

Figure 1: Total number of monthly referrals by encounter type



2a All encounters	Mar-19	Apr	May	Jun	Jul	Aug	Mar-20	Apr	May	Jun	Jul	Aug
Referrals	17670	18573	18866	17238	18881	18719	12572	6261	10640	16797	17431	17424
Encounters	191889	201730	204670	187030	211384	211406	173659	129952	159301	231239	216621	207469
Rate of referrals	92.08	92.07	92.18	92.17	89.32	88.55	72.39	48.18	66.79	72.64	80.47	83.98

2b In-person	Mar-19	Apr	May	Jun	Jul	Aug	Mar-20	Apr	May	Jun	Jul	Aug
Referrals	17669	18572	18863	17232	18875	18717	11435	1821	5380	12857	13444	13742
Encounters	191494	201300	204157	186648	210901	210899	142588	49199	86669	169843	152684	151682
Rate of referrals	92.27	92.26	92.39	92.32	89.50	88.75	80.20	37.01	62.08	75.70	88.05	90.60

2c Televisit	Mar-19	Apr	May	Jun	Jul	Aug	Mar-20	Apr	May	Jun	Jul	Aug
Referrals	1	1	3	6	6	2	623	3514	4399	3307	3377	3177
Encounters	206	241	300	241	286	304	18419	66686	64361	55753	58493	51438
Rate of referrals	4.85	4.15	10.00	24.90	20.98	6.58	33.82	52.69	68.35	59.32	57.73	61.76

2d Telephone	Mar-19	Apr	May	Jun	Jul	Aug	Mar-20	Apr	May	Jun	Jul	Aug
Referrals	0	0	0	0	0	0	514	926	861	633	610	505
Encounters	189	189	213	141	197	203	12652	14067	8271	5643	5444	4349
Rate of referrals	0.00	0.00	0.00	0.00	0.00	0.00	40.63	65.83	104.10	112.17	112.05	116.12

Figure 2a-d: Rates of referrals by encounter type

Table 1: Rates of referrals to different specialties by year

	2019 (Total # encounters=609820)		2020 (Total # of encounters = 655329)		
	Total referrals (N)	Rate (referrals/1000 encounters)	Total referrals (N)	Rate (referrals/1000 encounters)	p-value
Surgery	13719	22.50	12129	18.51	<0.001
Medicine	11905	19.52	11669	17.81	<0.001
Rehab and therapy	6827	11.20	4884	7.45	<0.001
Dermatology	5275	8.65	4753	7.25	<0.001
Behavioral health	3778	6.20	4274	6.52	0.021
Procedures	3596	5.90	3384	5.16	<0.001
Other	2762	4.53	3045	4.65	0.329
Obstetrics gynecology	2569	4.21	2648	4.04	0.131
Neurology	1724	2.83	1727	2.64	0.039
Pain	509	0.83	445	0.68	0.001
Optometry	99	0.16	74	0.11	0.018
Interventional radiology	96	0.16	60	0.09	0.001
Radiation oncology	7	0.01	17	0.03	0.062
Anesthesia	4	0.01	2	0.00	0.365
Imaging	0	0.00	3	0.00	0.095
Any specialty	52870	86.70	49114	74.95	<0.001

Table 2: Rates of referrals to different specialties by encounter type

	In person (Total # encounters = 474209)		Televisit (Total # encounters = 165684)			Telephone (Total # encounters = 15436)		
	Total referrals (N)	Rate (referrals/1000 encounters)	Total referrals (N)	Rate (referrals/1000 encounters)	p-value	Total referrals (N)	Rate (referrals/1000 encounters)	p-value
Surgery	9722	20.50	2021	12.20	<0.001	386	25.01	<0.001
Medicine	8600	18.14	2535	15.30	<0.001	534	34.59	<0.001
Dermatology	3886	8.19	795	4.80	<0.001	72	4.66	<0.001
Rehab and therapy	3855	8.13	916	5.53	<0.001	113	7.32	0.27
Procedures	2939	6.20	393	2.37	<0.001	52	3.37	<0.001
Behavioral medicine	2864	6.04	1260	7.60	<0.001	150	9.72	<0.001
Others	2235	4.71	593	3.58	<0.001	217	14.06	<0.001
Obstetrics gynecology	2080	4.39	492	2.97	<0.001	76	4.92	0.321
Neurology	1193	2.52	438	2.64	0.374	96	6.22	<0.001
Pain	312	0.66	103	0.62	0.618	30	1.94	<0.001
Optometry	61	0.13	13	0.08	0.102	0	0.00	0.268
Interventional radiology	51	0.11	7	0.04	0.016	2	0.13	0.684
Radiation oncology	13	0.03	2	0.01	0.382	2	0.13	0.08
Anesthesia	1	0.00	1	0.01	0.451	0	0.00	1
Imaging	1	0.00	2	0.01	0.166	0	0.00	1
Any specialty	37813	79.74	9571	57.77	<0.001	1730	112.08	<0.001

REFERENCES

1. **Whaley CM, Pera MF, Cantor J, Chang J, Velasco J, Hagg HK, Sood N, Bravata DM**. Changes in Health Services Use Among Commercially Insured US Populations During the COVID-19 Pandemic. *JAMA Netw Open*. 2020 Nov 2;3(11):e2024984. doi: 10.1001/jamanetworkopen.2020.24984. PMID: 33151319; PMCID: PMC7645698.
2. **Alexander GC, Tajanlangit M, Heyward J, Mansour O, Qato DM, Stafford RS**. Use and Content of Primary Care Office-Based vs Telemedicine Care Visits During the COVID-19 Pandemic in the US. *JAMA Netw Open*. 2020 Oct 1;3(10):e2021476. doi: 10.1001/jamanetworkopen.2020.21476. PMID: 33006622; PMCID: PMC7532385.
3. **Hartnett KP, Kite-Powell A, DeVies J, Coletta MA, Boehmer TK, Adjemian J, Gundlapalli AV; National Syndromic Surveillance Program Community of Practice**. Impact of the COVID-19 Pandemic on Emergency Department Visits - United States, January 1, 2019-May 30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Jun 12;69(23):699-704. doi: 10.15585/mmwr.mm6923e1. PMID: 32525856; PMCID: PMC7315789.
4. **Demeke HB, Pao LZ, Clark H, Romero L, Neri A, Shah R, McDow KB, Tindall E, Iqbal NJ, Hatfield-Timajchy K, Bolton J, Le X, Hair B, Campbell S, Bui C, Sandhu P, Nwaise I, Armstrong PA, Rose MA**. Telehealth Practice Among Health Centers During the COVID-19 Pandemic - United States, July 11-17, 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Dec 18;69(50):1902-1905. doi: 10.15585/mmwr.mm6950a4. PMID: 33332297; PMCID: PMC7745961.
5. **Patel SY, Mehrotra A, Huskamp HA, Uscher-Pines L, Ganguli I, Barnett ML**. Trends in Outpatient Care Delivery and Telemedicine During the COVID-19 Pandemic in the US. *JAMA Intern Med*. 2021 Mar 1;181(3):388-391. doi: 10.1001/jamainternmed.2020.5928. PMID: 33196765; PMCID: PMC7670397.
6. **Koonin LM, Hoots B, Tsang CA, Leroy Z, Farris K, Jolly T, Antall P, McCabe B, Zelis CBR, Tong I, Harris AM**. Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic - United States, January-March 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Oct 30;69(43):1595-1599. doi: 10.15585/mmwr.mm6943a3. PMID: 33119561; PMCID: PMC7641006.
7. **Mehrotra A, Chernew ME, Linetsky D, Hatch H, Cutler DM**. The Impact of the COVID-19 Pandemic on Outpatient Care: Visits Return to Prepandemic Levels, but Not for All Providers and Patients. Published Oct 15 2020; Available at: https://www.commonwealthfund.org/publications/2020/oct/impact-covid-19-pandemicoutpatient-care-visits-return-prepandemic-levels. Accessed Nov 30, 2020
8. The corona-virus disease 2019 pandemic compromised routine care for hypertension: a survey conducted among excellence centers of the European Society of Hypertension. *J Hypertens.* 2021 Jan;39(1):190-195. doi: 10.1097/HJH.0000000000002703. PMID: 33273364.
9. **Bramer CA, Kimmins LM, Swanson R, Kuo J, Vranesich P, Jacques-Carroll LA, Shen AK.** Decline in Child Vaccination Coverage During the COVID-19 Pandemic - Michigan Care Improvement Registry, May 2016-May 2020. *MMWR Morb Mortal Wkly Rep*. 2020 May 22;69(20):630-631. doi: 10.15585/mmwr.mm6920e1. PMID: 32437340.
10. **Czeisler MÉ, Marynak K, Clarke KEN, Salah Z, Shakya I, Thierry JM, Ali N, McMillan H, Wiley JF, Weaver MD, Czeisler CA, Rajaratnam SMW, Howard ME**. Delay or Avoidance of Medical Care Because of COVID-19-Related Concerns – United States, June 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Sep 11;69(36):1250-1257. doi: 10.15585/mmwr.mm6936a4. PMID: 32915166; PMCID: PMC7499838.
11. **Hübner M, Zingg T, Martin D, Eckert P, Demartines N**. Surgery for non-Covid-19 patients during the pandemic. *PLoS One*. 2020 Oct 23;15(10):e0241331. doi: 10.1371/journal.pone.0241331. PMID: 33095834; PMCID: PMC7584248.
12. **Borrelli E, Grosso D, Vella G, Sacconi R, Querques L, Zucchiatti I, Prascina F, Bandello F, Querques G**. Impact of COVID-19 on outpatient visits and intravitreal treatments in a referral retina unit: let's be ready for a plausible "rebound effect". *Graefes Arch Clin Exp Ophthalmol.* 2020 Dec;258(12):2655-2660. doi: 10.1007/s00417-020-04858-7. Epub 2020 Sep 22. PMID: 32960319; PMCID: PMC7505937.
13. **Gallo O, Locatello LG, Orlando P, Martelli F, Bruno C, Cilona M, Fancello G, Mani R, Vitali D, Bianco G, Trovati M, Tomaiuolo M, Maggiore G**. The clinical consequences of the COVID-19 lockdown: A report from an Italian referral ENT department. *Laryngoscope Investig Otolaryngol*. 2020 Aug 26;5(5):824–31. doi: 10.1002/lio2.446. Epub ahead of print. PMID: 32904910; PMCID: PMC7461474.
14. **D'Anna L, Sheikh A, Bathula R, Elmamoun S, Oppong A, Singh R, Redwood R, Janssen J, Banerjee S, Vasileiadis E**. Decreasing referrals to transient ischaemic attack clinics during the COVID-19 outbreak: results from a multicentre cross-sectional survey. *BMJ Open*. 2020 Oct 23;10(10):e041514. doi: 10.1136/bmjopen-2020-041514. PMID: 33099501; PMCID: PMC7590351.
15. **Wang R, Helf C, Tizek L, Neuhauser R, Eyerich K, Zink A, Eberlein B, Biedermann T, Brockow K, Boehner A**. The Impact and Consequences of SARS-CoV-2 Pandemic on a Single University Dermatology Outpatient Clinic in Germany. *Int J Environ Res Public Health.* 2020 Aug 26;17(17):6182. doi: 10.3390/ijerph17176182. PMID: 32858870; PMCID: PMC7504311.
16. **Zhao J, Wang Y, Fisher M, Liu R**. Slower recovery of outpatient clinics than inpatient services for stroke and other neurological diseases after COVID-19 Pandemic.

CNS Neurosci Ther. 2020 Dec;26(12):1322-1326. doi: 10.1111/cns.13459. Epub 2020 Oct 15. PMID: 33058536; PMCID: PMC7675482.

17. **Czeisler MÉ, Lane RI, Petrosky E, Wiley JF, Christensen A, Njai R, Weaver MD, Robbins R, Facer-Childs ER, Barger LK, Czeisler CA, Howard ME, Rajaratnam SMW**. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic - United States, June 24-30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Aug 14;69(32):1049-1057. doi: 10.15585/mmwr.mm6932a1. PMID: 32790653; PMCID: PMC7440121.
18. **Ettman CK, Abdalla SM, Cohen GH, Sampson L, Vivier PM, Galea S**. Prevalence of Depression Symptoms in US Adults Before and During the COVID-19 Pandemic. *JAMA Netw Open*. 2020 Sep 1;3(9):e2019686. doi: 10.1001/jamanetworkopen.2020.19686. PMID: 32876685; PMCID: PMC7489837.
19. **Reed ME, Huang J, Graetz I, Lee C, Muelly E, Kennedy C, Kim E**. Patient Characteristics Associated With Choosing a Telemedicine Visit vs Office Visit With the Same Primary Care Clinicians. *JAMA Netw Open*. 2020 Jun 1;3(6):e205873. doi: 10.1001/jamanetworkopen. 2020.5873. PMID: 32585018; PMCID: PMC7301227.
20. **Eberly LA, Kallan MJ, Julien HM, Haynes N, Khatana SAM, Nathan AS, Snider C, Chokshi NP, Eneanya ND, Takvorian SU, Anastos-Wallen R, Chaiyachati K, Ambrose M, O'Quinn R, Seigerman M, Goldberg LR, Leri D, Choi K, Gitelman Y, Kolansky DM, Cappola TP, Ferrari VA, Hanson CW, Deleener ME, Adusumalli S**. Patient Characteristics Associated With Telemedicine Access for Primary and Specialty Ambulatory Care During the COVID-19 Pandemic. *JAMA Netw Open*. 2020 Dec 1;3(12):e2031640. doi: 10.1001/jamanetworkopen.2020.31640. Erratum in: *JAMA Netw Open*. 2021 Feb 1;4(2):e211913. PMID: 33372974; PMCID: PMC7772717.
21. **Wosik J, Fudim M, Cameron B, Gellad ZF, Cho A, Phinney D, Curtis S, Roman M, Poon EG, Ferranti J, Katz JN, Tcheng J**. Telehealth transformation: COVID-19 and the rise of virtual care. *J Am Med Inform Assoc*. 2020 Jun 1;27(6):957-962. doi: 10.1093/jamia/ocaa067. PMID: 32311034; PMCID: PMC7188147.