Systematic Review

The Impact of COVID-19 on Telemedicine Utilization Across Multiple Service Lines

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Abstract:

Background – The profound impact of COVID-19 on the U.S. healthcare industry cannot be overstated. Telemedicine utilization exploded virtually overnight as healthcare systems, hospitals, and clinical practices rushed to implement this delivery model to ensure accessibility and continuity of patient care access across myriad service lines and dimensions.

Objective – The purpose of this systematic literature review is to examine the measures that were implemented to accommodate community and individual patient needs not only to afford access to critical services, but to also maintain safety standards for affected parties.

Methods – Boolean operators were crafted with the expressed intent of identifying articles within multiple database domains germane to our chosen topic.

Results – 52,206 articles were captured from a general search query and subsequently distilled to 44 through group consensus based on pertinence to our basic research question. The four health service lines identified encountered similar, surmountable obstacles in their care delivery models, but adapted accordingly to the respective needs of their patient populations.

Conclusion – This review showcased the healthcare industry's ability to rapidly acclimate and change due to the pervasive spread of COVID-19 throughout the U.S. Although imperfect, unique responses were developed within telemedicine platforms to broadly and effectively mitigate disruptions in care and treatment modalities.

Keywords: telemedicine; COVID-19; telehealth; health service lines; pandemic

1. Introduction

Telemedicine is not a recent phenomenon. Origins of its utilization can be traced as far back as 500 B.C.E., when ancient Greeks and Romans transmitted messages through the application of crude mediums such as smoke signals and light reflection to announce plague outbreaks and health events such as births and deaths [1]. In April 1924, *Radio News* magazine foreshadowed the idea of modern telemedicine through the depiction of a "radio doctor" linked to a patient via sound and a live picture [2]. In 1948, the first known transfer of records through telephone lines occurred in Pennsylvania, when radiologic images were sent across a 24-mile stretch between West Chester and Philadelphia [3]. A decade later, in 1959, medical uses of video communications were initiated at the University of Nebraska, when they used two-way interactive television to transmit information across campus and, in 1964, further established a telemedicine link with the Norfolk State Hospital 112 miles away for group consultations through a closed-circuit, two-television link [2]. A breakthrough in urban emergency medicine was initiated in 1967, between the University of Miami School of Medicine, and local fire departments to transmit electrocardiographic rhythms in rescue situations over the radio to

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Jackson Memorial Hospital [4]. In 1968, a foundational telemedicine project was established involving Boston's Logan Airport, and nearby Massachusetts General Hospital (MGH), in which a medical station at the airport was linked via microwave relay to the hospital as a vehicle for providing primary and emergency services to airport staff and travelers. MGH parlayed the success of this effort two years later with a tele-psychiatry link to the Veteran's Administration Hospital in Bedford, MA, that continued operations into the 1980s [5]. One of the earliest joint ventures involving a federal agency was the Space Technology Applied to Rural Papago Advanced Health Care Project (STARPAHC), which was a major initiative begun in 1973, between what was then known as the U.S. Department of Health, Education, and Welfare (now DHHS), and involved NASA, Lockheed Company, and the U.S. Indian Health Service, in which they began sharing complex medical data, including neurological examinations, videos, stethoscope sounds, and radiological images to promulgate healthcare services to individuals in distant locales [6].

With the advent of the Internet in the 1990s, telemedicine capabilities proliferated as networks began integrating on a global scale and rendered an easier and cheaper method of building software applications specifically geared towards the asynchronous exchange and storage of clinically-relevant data through mediums such as e-mails, text messaging, and patient portals, and the subsequent synchronous interfacing between provider and patient in real time with live video feeds. Electronic medical records, with the assistance of government incentives, are now ubiquitous and can be engineered to include clinical metrics and user-friendly interfaces to optimize patient care, telemedicine capabilities, and interoperability with vendors, such as laboratory and imaging organizations, for workflow proficiency.

Definition of Key Terms

The Kaiser Family Foundation (2020) considers telehealth and telemedicine to be interchangeable terms and collectively defines them as the "remote provision of health care services using technology to exchange information for the diagnosis, treatment, and prevention of disease." [7] Ludwig and Zarbock (2020) delineate Severe Acute Respiratory Syndrome-Associated Coronavirus 2 (SARS-CoV-2) as the novel strain of coronavirus and is defined as the causal agent of Coronavirus Disease 2019 (COVID-19); these terms may also be interchangeable when referencing the current, ongoing pandemic [8]. DHHS is an acronym for the Department of Health and Human Services, which is the executive branch department of the U.S. Federal Government responsible for providing essential human services to advance the health and well-being of the American people. CMS stands for the Center for Medicare and Medicaid Services, which is an agency embedded within DHHS that administers the major health programs in the U.S.

Rationale

Prior to COVID-19's incursion on U.S. soil, approximately 9.6% of the population used telemedicine for clinical encounters, but 74.3% noted they either did not have access or were unaware of telemedicine options [9]. Further, only 18% of physicians provided such a platform for their patients in 2018 [10]. A significant change occurred in 2020 when physician practice deployment of telemedicine usage mushroomed to 48% as healthcare providers scrambled to minimize gaps in care provision amid the SARS-CoV-2 global pandemic [11]. A recent study by the Commonwealth Fund showcased the surge in telehealth visits beginning in mid-March 2020 by a showing of an increase from around zero to a high of nearly 14% of baseline visits being telehealth visits [12].

Accommodations in federal, state, and local jurisdictions have facilitated the advancement of telemedicine capabilities through the relaxation of state licensure requirements; DHHS enforcement discretion and penalty waivers of HIPAA regulations; dissemination of reimbursement allowances for current procedural terminology (CPT) codes, modifiers, and appropriate clinical encounter documentation; and general acceptance and provision of telemedicine utilization to enable the preservation of clinical service delivery [13].

Significance

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The swift rise of COVID-19 infection rates upended traditional care delivery models, which overwhelmingly centered around in-person visitations within inpatient and ambulatory care settings. Restrictive measures enacted by state and local officials, such as stay-at-home orders, necessitated the expansion of a nascent platform to accommodate routine and emergent needs for patient populations. While telemedicine can never fully replace face-to-face physical clinical encounters due to its unconventional and remote nature, particularly as it relates to hands-on care provision in the form of provider-assisted procedures (e.g., biopsies, surgeries, colonoscopies), physical exams, vaccinations, lab work, imaging, rehabilitative therapies, etc., its widespread acceptance and consumption in the wake of COVID-19 spread renders it a meaningful and valuable model of care for current and future practice [14].

Objective

Telemedicine utilization erupted on an unprecedented scale as healthcare providers across the U.S. endeavored to stem the deleterious effects of COVID-19. Although the healthcare industry in general was significantly impacted on various levels, we strived to answer this specific question: "What impact has the current COVID-19 pandemic had on the provision of care through telemedicine across unique health service lines that include dermatology, oncology, obstetrics/gynecology, and mental health?"

2. Materials and Methods

Protocol

Researchers utilized the evidence-based Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology to guarantee a transparent and comprehensive reporting of results. The database searches for the systematic literature review were completed in June 2020, amidst the SARS-CoV-2 pandemic. Articles were deemed out of scope if there was either no reference to COVID-19 or they were only tangentially related to COVID-19 impacts.

Eligibility Criteria

A set of limiters were applied to streamline our eligibility requirements to collect articles, which included (1) publication occurring between the years 2016 – 2020, (2) written in English, and (3) full text availability. For a historical perspective on the evolution of telemedicine unrelated to COVID-19, multiple articles were incorporated with publication dates prior to 2016 and did not contain any limiters in the search parameters outside basic key terms, which included telemedicine, telehealth, history, and evolution.

Information Sources, Search, and Study Selection

In conjunction with the utilization of PRISMA guidelines, the preliminary search deployed tailored Boolean operators to identify articles germane to our basic research question within the search databases PubMed (MEDLINE) and the Cumulative Index of Nursing and Allied Health Literature (CINAHL). Identical Boolean search strategies were implemented in each database, including key terms. The search for this systematic literature review transpired in June 2020. Each member of the research team reviewed abstracts of articles to determine relevance of the literature and overarching themes.

Data Collection Process

Filtered results were entered in an Excel spreadsheet and were designed to parse out applicable data into a comprehensive repository of key information. Researchers met weekly to refine search terms, discuss findings, assign workload, and troubleshoot barriers. Within several of these collaborative sessions, consensus meetings were held to reconcile loose ends to establish final agreement on articles germane to our research that would comprise the foundation of our systematic literature review.

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Risk of Bias

Due to the novel presentation of SARS-CoV-2, source material was generally in short supply as there was a dearth of peer-reviewed studies to inform our search results. SARS-CoV-2 is an evolving global concern and data continues to be collected for literature that is yet to be written and, subsequently, circulated. Resulting from this limited resource availability, what we identified in this review included editorials and other published articles based on best practice recommendations not necessarily applicable to all health service line domains. This may lead to an inherent bias within an article's thesis if it is argued through a lens that is not tested in a practical or real world setting and only speaks to a narrowly defined specialty or primary care arena.

The research group incorporated strategies to minimize the effects of the articles' inherent bias. This included the assignment of article reviews on a randomized basis to which each member had a nearly identical volume of articles to evaluate. Independent analysis was conducted and insights were subsequently shared through a data repository accessible to each member. A Cohen's kappa coefficient was then calculated to measure inter-rater reliability to determine an acceptable level of congruence. The kappa was 0.78, which indicates a substantial level of agreement among raters.

Summary Measures and Synthesis of Results

The final assortment of articles from our dedicated search focused on the relationship between telemedicine/telehealth through a COVID-19 prism and how this impacted the provision of care across specifically chosen service lines. General facilitators and barriers were extracted from each reviewed article and consolidated in an Excel file. This data set was further condensed into an affinity matrix that organized mutual similarities to identify common themes running through the research and were subsequently sorted by frequency of occurrence. We also identified implementation successes unique to each service line to highlight positive outcomes in their respective approaches to care provision resulting from the strategies they deployed to overcome barriers.

Study Selection and Data Collection Process

Figure 1 illustrates the PRISMA roadmap that comprised our search and selection process. In June 2020, the researchers created a collection of search strings to gather the necessary amount of quality source material and narrow the scope of the search, which led to a sizable return of results. The initial search yielded 267 articles in CINAHL and 51,939 in PubMed, for a cumulative count of 52,206. After applying our limiters, we pared down the finally tally to 15 for CINAHL and 29 for PubMed.

To be included in the study, articles must have explored the effects of COVID-19 on telemedicine utilization to specific service lines in healthcare as chosen by the student researchers, which included dermatology, oncology, obstetrics/gynecology, and mental health. The rationale for selecting these services was twofold: (1) they yielded the largest volume of applicable literature to the basic question we posed, and (2) although these services lines share similar facilitators and barriers in a virtual domain, each is unique in their treatment modalities, which we felt would render differing approaches to patient care in a telemedicine environment that would emphasize the kinds of adaptations that were necessary to obtain desired outcomes from a patient and provider perspective. Qualifying articles must have been deemed relevant by at least two of the three authors during an abstract screening process.

The final grouping of articles, after using both inclusion and exclusion criteria, were analyzed by all researchers. Multiple consensus meetings were convened in which source material was discussed at length until a definitive pool of literature was deemed worthy of the study.

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199 **Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of**
200 **the literature search and selection process.**

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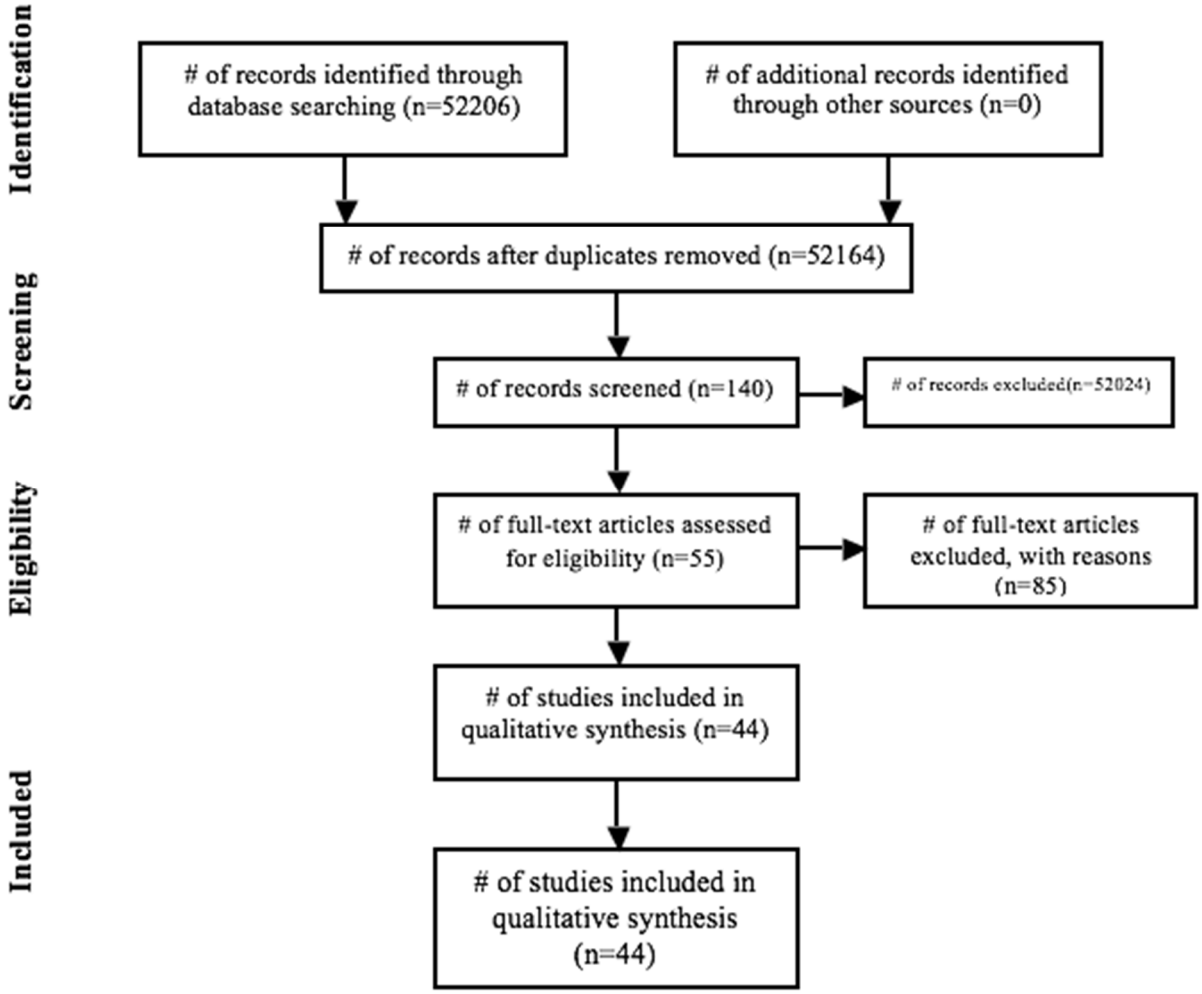

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204 **3. Results**

205 **Results of Individual Studies and Synthesis of Results**

206 The impact of the COVID-19 pandemic has created a rapid expansion in telemedicine
207 administration. To reduce the spread of the virus, healthcare providers have engaged social
208 distancing and heightened infection control measures with their patients [15-20, 22-28].
209 Telemedicine has been effective through risk mitigation, improved access, convenience, lower
210 cost, and patient satisfaction, of which improved access and risk mitigation were the leading
211 themes [1, 13, 15-17, 20-25, 27-31, 33-44]. The results have also shown a relaxation of licensure
212 requirements, thereby allowing providers to practice across state lines, as well as with HIPAA
213 regulations so devices including smartphones and tablets can be utilized for video conferencing
214 within applications such as Zoom, FaceTime, and Google Hangouts Meet [13, 21, 27, 32, 34, 39, 41,
215 45-46]. From the four selected service lines of dermatology, mental health, OB/GYN, and oncology,
216 mental health has had the most documented outcomes with the use of telemedicine; this is due in
217 large part because mental health is conversational in nature and the provision of care does not

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hinge upon in-person interactions. Each service line has found effective uses of telemedicine during the COVID-19 pandemic and, although there are still areas that will require in-person visits for testing, ultrasounds, physical exams, etc., telemedicine is demonstrating that many visits do not require physical attendance and has significantly reduced the total number of patients being seen at a healthcare facility.

Table 1 summarizes the main observations in the articles used and common themes expressed in the investigation that pertained to the search query. The "Outcomes" section did not apply to most of the articles since they are mainly based on opinion pieces; however, articles 15 and 13 were based on studies and the results can be seen in the column. Articles 1-2, 4-5, 8-10, and 16 were used for historical evidence and did not impact the results.

Table 1. Summary of Results.

Date	Title	Authors	Publication	Observations	Themes	Outcomes
20-Jun	Telehealth for High-Risk Pregnancies in the Setting of the COVID-19 Pandemic	Aziz, Aleha; Zork, Noelia; Aubey, Janice J.; Baptiste, Caitlin D.; D'Alton, Mary E.; Emeruwa, Ukachi N.; Fuchs, Karin M.; Goffman, Dena; Gyamfi-Bannerman, Cynthia; Haythe, Jennifer H.; LaSala, Anita P.; Madden, Nigel; Miller, Eliza C.; Miller, Russell S.; Monk, Catherine; Moroz, Leslie; Ona, Samsiya; Ring, Laurence E.; Sheen, Jean-Ju; Spiegel, Erica S.; et al	American Journal of Perinatology	Telehealth for pre-natal care is feasible; Tailored regimens for increased surveillance and counseling are permissible; Certain high-risk pregnancies may require increased frequency of in-person encounters.	Mitigate risk for COVID-19 exposure; minimize patient travel	
4/16/20	The Role of Telehealth in Reducing the Mental Health Burden from COVID-19	Xiaoyun Zhou, Centaine L. Snoswell, Louise E. Harding, Matthew Bambling, Sisira Edirippulige, Xuejun Bai, Anthony C. Smith	Telemedicine Journal and e-health	Tele-mental health services are feasible, appropriate, and perfectly suited to current pandemic environment; Simple communication methods (e.g., e-mails, texts, etc.) should be used more extensively.	Increased access; infection risk mitigation	
20-Jun	Telehealth in Pregnancy	Reynolds, Rebecca M.	Lancet Diabetes & Endocrinology	In the rapid implementation of delivery of remote antenatal care in response to COVID-19 there remain many uncertainties. There is limited knowledge about women's views of use of telehealth for monitoring pregnancy complications although available data suggests that women find this to be a positive experience.9 There is concern that most of the trials of telehealth technologies have been done in highly selected groups and so the findings	Social distancing; Self-Isolation; Risk mitigation	The GLOW trial reports a robust approach of delivering a telehealth weight management intervention in pregnancy with success at reducing GWG

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				might not be applicable to the wider population. GLOW was a randomized trial of a weight management intervention delivered by telephone during a pregnancy with an aim of reducing gestational weight gain in women with overweight or obesity.		
3/31/20	COVID-19 From a Psychiatry Perspective: Meeting the Challenges	Freeman, Marlene P.	The Journal of Clinical Psychiatry	We've seen telemedicine set up at record speed to meet the needs of patients. Regulatory barriers to reach many patients were brought down almost overnight	Regulatory barrier removal, rapid expansion, improved access	
20-Jun	Optimizing Your Telemedicine Visit During the COVID-19 Pandemic: Practice Guidelines for Patients With Head and Neck Cancer	Prasad, Aman; Brewster, Ryan; Newman, Jason; Rajasekaran, Karthik	Head & Neck	Guidelines are necessary to set patient expectations and to also ensure both providers and patients are appropriately educated on telemedicine platform functionality.	Patient/Provider Telemedicine Education	
20-Jun	Social Media and Telemedicine for Oral Diagnosis and Counselling in the COVID-19 Era	Machado, Renato Assis; Lins de Souza, Natalia; Oliveira, Rayane Maria; Martelli, Jr.,Hercillio; Rogerio Ferreti Bonan, Paulo	Oral Oncology	"Forward triaging" is possible to screen for SARS-COV2-2 symptoms and mitigate community spread; Alternative forms of telemedicine usage (e.g., text messaging, e-mailing, social media messaging) are encouraged to avoid long lines, rule out oral lesions, and obtain early diagnoses.	Social distancing; Self-Isolation; Risk mitigation	
20-Jun	Shift to Telehealth Could Remain Trend After COVID-19: Reproductive health remains priority.	AHC Media	Relias Media	Clinics have quickly shifted to phone screenings and videoconferences; no penalties for HIPAA noncompliance; positive experience from patients and providers; Medicare waiving copays and deductibles.	HIPAA compliance; lower costs; patient satisfaction	
1-May-20	COVID-19 Shuts Down Nation; Family Planning	AHC Media	Relias Media	Clinics can phone triage patients before a scheduled	"Improved access; increased	

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	Need Not Stop: Clinics resort to remote care.			visit to determine whether the visit can be done by telephone visit, or synchronous or asynchronous telemedicine," Policar said. Telehealth is especially important in this time of distancing. Medicaid and other payers could cover telehealth services. "In California, we successfully advocated for the Medi-Cal [state Medicaid program] and the Family PACT programs to cover and reimburse services delivered through telehealth platforms," Rabinovitz says.	reimbursements; social distancing; risk mitigation; telemedicine education"	
4/14/20	Telepsychiatry Coming Into Its Own With COVID-19	Knopf, Alison	Brown University Child & Adolescent Pharmacology Update	Children find tele-psychiatry easy to use since they are used to technology; children with anxiety or trauma feel more comfortable with tele-psychiatry; increase in patient and provider satisfaction rate; reimbursement likely to increase.	"Patient satisfaction; reimbursement; improved access"	
4/22/20	"Cardio-Oncology Care In the Time of COVID-19 and the Role of Telehealth"	Parikh, Amar; Kumar, Anupam A.; Jahangir, Eiman	JACC CardioOncology	Many cardio-oncology visits cannot be safely deferred; Officials have approved interstate licensing; patients can be monitored remotely; telehealth obviates inconvenience of brief in-person visits	"Improved access; risk mitigation; convenience"	
20-Jun	Lessons from the coronavirus disease 2019 pandemic: Will virtual patient management reshape uro-oncology in Germany?	Rodler, Severin; Apfelbeck, Maria; Stief, Christian; Heinemann, Volker; Casuscelli, Jozefina	European Journal of Cancer	Patients with exposure to COVID follow up via phone or e-mail and asked to write a symptom diary; virtual management and reductions in frequency of visits are feasible; a strategy has been developed to ensure patient safety, reduce clinic visits, and implement virtual patient management	Risk mitigation	

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3/23/20	COVID-19 outbreak represents a new way of mental health service delivery.	Canady, Valerie A.	Mental Health Weekly	Staff are equipped with iPads and other equipment necessary to work from home; staff is provided training; medications can be left at patient's door	"Telemedicine education; Social distancing promotion; improved access"	
6/19/20	Telehealth Triage and Oncology Nursing Practice	Steingass, Sharon K.; Maloney-Newton, Susie	Seminars in Oncology Nursing	Oncology nurses need to understand various methods of telehealth and how to establish and work in the new environment; The organization needs to make sure that the telehealth program is focused on meeting the clinical needs of the defined patient population; Identifying ways to improve gaps in care coordination or management will help determine what types of telehealth encounters must be deployed within the organization.	Telemedicine education	
4/1/20	"Telemedicine in the time of COVID-19 Pandemic"	Gondal, Khalid Masud; Shaukat, Shehla	Journal of the College of Physicians and Surgeons	The disadvantage of telemedicine is that physical examination, laboratory or radiological tests cannot be performed virtually; Lack of education, communication network availability and awareness also hinders its acceptance by the people at large; telemedicine may be used for medical education and distant learning/teaching. New techniques and procedures can be learnt through this. It is the way forward to make healthcare accessible and cost-effective.	"Telemedicine education; risk mitigation; convenience; lower cost; social distancing promotion; improved access"	
18-Aug	Telehealth: A new frontier in ob/gyn	Lowery, Curtis	Contemporary OB/GYN	In utilizing telehealth, the overall healthcare system benefits from lower costs, less travel, improved health	"Social distancing; convenience;	

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				outcomes, and reduced emergency room utilization. A typical virtual visit includes the pregnant woman utilizing home monitoring supplies to track measures such as fetal heart rate, maternal blood pressure, and fundal height; Barriers include: Licensing and credentialing, malpractice insurer, and reimbursement and billing.	lower costs; risk mitigation"	
20-May	COVID-19 Devastates At-Risk Populations: Telemedicine could be new normal	AHC Media	Relias Media	Case managers should focus more on remote case management, taking the pandemic into account as they contact and monitor patients. A major shift to telemedicine is one of the likely long term outcomes.	Risk mitigation; social distancing	
20-May	Hospitals Use Telemedicine to Limit Exposures, Preserve PPE, Guide Patients to Right Setting	AHC Media	Relias Media	New Bridge Medical Center in Paramus began using telemedicine to check in with patients who are discharged from the emergency department (ED) and ensure appropriate follow-up appointments are in place. CMS pledges penalties will not be imposed on providers who use telehealth in ways that are not compliant with HIPAA requirements. Clinicians can bill for telemedicine visits with reimbursement rates on par with in-person visits.	"Improved access; HIPAA compliance; increased reimbursement; rapid expansion"	
5/30/20	Use of Telemedicine and Virtual Care for Remote Treatment in Response to COVID-19 Pandemic	Bokolo Anthony, Jr.	Journal of Medical Systems	This article provides practical guide based on how to use telemedicine and virtual care during the COVID-19 pandemic. To better mitigate and manage the spread of coronavirus hospitals can	Rapid expansion; risk mitigation	

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				improve the efficiency of the medical system by replacing a proportion of physical treatments with digital technologies; CMS now allow medical-care providers to utilize devices such as smartphones and electronic devices to treat patients. The US drug enforcement administration is also allowing medical practitioners to prescribe of medication after patient diagnosis and assessment conducted via telemedicine.		
6/1/20	Telemedicine - Maintaining Quality During Times of Transition	Romanick-Schmied, Sue; Raghu, Ganesh	Nature Reviews Disease Primers	The COVID-19 crisis has accelerated the adoption of telemedicine; Clinics and hospitals have the obligation to communicate to patients that all possible means are being taken to prevent transmission of infection while maintaining quality in the delivery of care. Ultimately, the advantage of convenience from conducting a telemedicine visit must be balanced and weighed against the benefits of direct human interactions.	"Improved access; rapid expansion; social distancing; convenience; risk mitigation"	
4/17/20	Telemedicine in the Face of the COVID-19 Pandemic	Josep Vidal-Alaball, Ruthy Acosta-Roja, Nuria Pastor Hernandez, Unai Sanchez Luque, Danielle Morrison, Silvia Narejos Perez, Jesus Perez-Llano, Angels Salvador Verges, & Francesc Lopez Segui	Atencion Primaria	Telemedicine connects the convenience, low cost, and ready accessibility of health-related information and communication using the Internet and associate technologies; Telemedicine during the coronavirus epidemic has been the doctors' first line of defense to slow the spread of the coronavirus, keeping social distancing and	"Improved access; rapid expansion; social distancing; lower cost; convenience"	

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				providing services by phone or videoconferencing.		
5/17/20	Telehealth transformation: COVID-19 and the rise of virtual care	Jedrek Wosik, Marat Fudim, Blake Cameron, Ziad F. Gellad, Alex Cho, Donna Phinney, Simon Curtis, Matthew Roman, Eric G. Poon, Jeffrey Ferranti, Jason N. Katz, & James Tcheng	Journal of the American Medical Informatics Association	The pandemic has catalyzed rapid adoption of telehealth, or the entire spectrum of activities used to deliver care at a distance; The target is to dramatically decrease the proportion of in-person care, offering in-person clinic visits only for patients who cannot access telehealth technology or who have urgent (but not emergency-level) clinical concerns that require detailed physical examination. Healthcare enterprises may already have in place technologies that can be employed to accomplish telehealth.	Rapid expansion; social distancing	
4/26/20	Incorporating Telemedicine as part of COVID-19 Outbreak Response Systems	Lovett Rockwell, Kimberly; Gilroy, Alexis S.	The American Journal of Managed Care	Telemedicine platforms are ideal for managing several challenges facing healthcare systems in response to global infectious disease outbreaks. Implementing telemedicine systems focuses on addressing the needs of low-acuity patients with disease exposure concern; State and federal laws and regulations have evolved in recent years, months, and days to facilitate greater reimbursement for and adoption of various telemedicine models; state, federal, and international laws and regulations have been significantly relaxed to promote greater adoption and use of telemedicine and other	"Improved access; increased reimbursement; rapid expansion; risk mitigation, relaxed regulations"	

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				digital health technologies to deliver clinical services.		
5/6/20	Telemedicine and the COVID-19 Pandemic, Lessons for the Future	Bashshur, Rashid; Doarn, Charles R., Frenk, Julio M.; Kvedar, Joseph C, Woolliscroft, James O.	Telemedicine Journal and e-health	Conversion to telemedicine demonstrates its utility as an effective tool for social distancing; A sizeable proportion of outpatient visits can be clinically managed effectively from a distance; The requisite infrastructure for connectivity is widely available at both ends of the clinical encounter; Government has relaxed all restrictive regulations for telemedicine deployment; The necessary logistics can be developed promptly.	"Improved access; increased reimbursement; rapid expansion; social distancing; convenience; lower cost; risk mitigation; telemedicine education; relaxed regulations"	
Jun/July 2020	Telemedicine Options: The COVID-19 pandemic underscores the role of remote patient management	Lehrman, Jeffrey	Podiatry Management	Certain telemedicine services can be provided year-round; A new survey of healthcare consumers from Vivify Health underscores the rapid acceleration of telehealth since the advent of COVID-19, enforcement discretion and penalty waivers were issued for HIPAA violations while providing these services.	HIPAA compliance; rapid expansion	"A full 70% of respondents say at least one of their providers now offers telehealth; 66% said virtual visits can address at least some of their medical concerns, with an additional 27% stating that most of their medical needs can be met using telemedicine. 73% are not planning to put off major surgery, elective or non-elective, due to COVID. Nearly eight in ten reported they are very or somewhat interested in switching to providers who can accommodate virtual visits."
20-Jun	COVID-19 Pandemic: Perspectives on an Unfolding Crisis	Spinelli, A.; Pellino, G.	British Journal of Surgery	Telemedicine may reduce the need for physical attendance in outpatient clinics, minimizing contact exposure; surgical staff and the available units have been modified to balance service provision, reducing infection risk, and specialist care.	Risk mitigation; social distancing	

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4/23/20	COVID-19 Transforms Health Care Through Telemedicine: Evidence From the Field	Mann, Devin M.; Chen, Ji; Chunara, Rumi; Testa, Paul A.; Nov, Oded	Journal of the American Medical Informatics Association	U.S. insurers have quickly expanded coverage to include all telemedicine visit types; HHS waived enforcement of HIPAA regulations to allow the use of consumer audio and video communication for telemedicine visits; In the non-urgent care setting, the forced transition to video visits has demonstrated its feasibility, satisfaction, and value in promoting social distancing.	"HIPAA compliance; increased reimbursement; rapid expansion; social distancing; patient satisfaction; risk mitigation; telemedicine education"	
2/4/20	Global Telemedicine Implementation and Integration Within Health Systems to Fight the COVID-19 Pandemic: A Call to Action	Ohannessian, Robin; Anh Duong, Tu; Odone, Anna	JMIR Public Health and Surveillance	Telemedicine was shown to be helpful in previous outbreaks; Two possibilities are currently available for patients: (1) direct-to-consumer telemedicine with private providers mostly relying on out-of-pocket or private insurance payment and (2) free solutions, mainly from US-based companies (for example, WhatsApp, Skype, or Facetime), that may not respect national health data privacy and security requirements; A scientific evaluation framework and dedicated research funds to describe and assess the impact of telemedicine during outbreaks.	"Improved access; telemedicine education"	
3/24/20	Telemedicine in the Era of COVID-19	Portnoy, Jay; Waller, Morgan; Elliott, Tania	The Journal of Allergy and Clinical Immunology	Telemedicine (TM) has the potential to help by permitting mildly ill patients to get the supportive care they need while minimizing their exposure to other acutely ill patients. Nearly all health plans and large employers offer some form of coverage for TM services; patients may be	"Risk mitigation; improved access; increased reimbursement; HIPAA compliance"	

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				unaware that they have TM as an option and do not know how to access it; For routine telemedicine video visits, many of the requirements have been waived during this time.		
5/8/20	Telemedicine: Patient-Provider Clinical Engagement During the COVID-19 Pandemic and Beyond	Contreras, Carlo M.; Metzger, Gregory A.; Beane, Joan D.; Dedhia, Priya H; Ejaz, Aslam; Pawlik, Timothy M.	Journal of Gastrointestinal Surgery	In response to the COVID-19 pandemic, federal agencies have promoted telehealth both through regulatory relaxation and increased funding; telemedicine can facilitate an international reach to patients across the world. In addition, a telemedicine platform can expand clinical services even when local physical structures are constrained. the number of telemedicine visits dramatically increased within days following the institution of novel coronavirus pandemic restrictions on in-person clinical encounters. Prior to the pandemic, telemedicine utilization was weak throughout surgical specialties due to regulatory and reimbursement barriers.	Increased reimbursement; relaxed regulations; improved access;	
5/13/19	Advantages and utilization of telemedicine	Boxer, Richard J.; Ellimoottil, Chad	mHealth	In this issue, several research groups outline the advantages of telemedicine for multiple specialties. The authors explore the various reasons for telemedicine utilization and offer suggestions to increase the delivery of high-quality telemedicine services; telemedicine is, at present, a primary means of expanding care to those with limited access to physicians; some states have introduced cross-	Improved access; relaxed regulations; increased reimbursement	

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				state licensing. Economics is another barrier to the expansion of telemedicine. Congressional Telehealth Caucus reintroduced several bills aimed at addressing Medicare barriers impeding telemedicine efforts these include an expansion of the scope of reimbursed services along with redefining rural qualifications		
20-Apr	"Utilizing Telemedicine for Managing COVID-19"	Hamidreza Badeli, Azita Tangestani Nejad, Afagh Hassanzadeh Rad	Journal of Pediatric Nephrology	The integration of eHealth for patients with COVID-19 is indicated as a global emergency to reduce virus transmission; Telemedicine provides a promising solution to provide quality care while recuing risk of transmissions to both other patients and healthcare providers; previous investigations on the effect of this method on outpatients with chronic stable diseases showed its cost effectiveness, high satisfaction among patients and caregivers, and no significant difference in service use or disease progression, it is not an appropriate method for all clinical situations. not appropriate for patients with severe diseases; As Nephrology consultation needs commonly laboratory assessments, video consultation can help patients to receive disease education and explanation of treatment choices	"Improved access; social distancing; lower cost; patient satisfaction; "	
20-Jun	"The COVID-19 pandemic and treating suicidal risk: The	Jobes, David A.; Crumlish, Jennifer A.; Evans, Andrew D.	Journal of Psychotherapy	The pandemic has thus sparked a sudden interest in providing mental health services via tele-psychotherapy. The	Telemedicine education	

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	telepsychotherapy use of CAMS"			coronavirus pandemic now poses all new ethical concerns about the routine practice of having an acutely suicidal patient go to an emergency department and/or admitting such patients to an inpatient psychiatric unit. this article describes a pandemic-driven effort to rapidly provide support, guidance, and resources to providers around the world to use a suicide-focused and evidence-based intervention called the Collaborative Assessment and Management of Suicidality.		
20-May	Tele-dermatology and HIPAA compliance in the era of COVID-19.	Goldberg, David J.	Dermatology Times	The article discusses the liability issues under the HIPAA that physicians and dermatologists will be facing when using telemedicine or tele-dermatology to communicate with patients amidst the coronavirus pandemic. It includes being subjected to disciplinary action if they exceed the license granted by his/her state, and negligence liability for doctors providing the telemedicine service in a state different from where the patient lives. E-health and Telemedicine are great tools that can be utilized within the healthcare industry especially during the COVID pandemic. However, there is also an assortment of regulation and guidelines organizations must abide to avoid repercussions and penalties.	HIPAA compliance	

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Spring 2020	Impact of Human Disasters and COVID-19 Pandemic on Mental Health: Potential of Digital Psychiatry	Kresimir Cosic, Sinisa Popovic, Marko Salija, & Ivan Kesedzic	Psychiatria Danubina	This article looks at Comprehensive approach based on digital psychiatry is proposed to address the lack of access to psychiatric services, which includes artificial intelligence, tele-psychiatry and an array of new technologies, like internet-based computer-aided mental health tools and services. Increasing the sup- ply side of mental health services to match the demand can be facilitated by broader use of state-of-the-art tools and means of digital psychiatry, particularly for high- risk groups like: confirmed coronavirus patients, health workers directly caring for these patients, as well as quarantined people and those exhibiting vulnerable psychological traits.	"Improved access; telemedicine education"	
20-Apr	Telemedicine for cancer patients during COVID-19 pandemic: between threats and opportunities	Elkaddoum, Ronaldo; Haddad, Fady; Eid, Roland; Kourie, Hampig Raphael	Future Oncology	It was clearly recommended to switch to telemedicine as much as possible for patients who present new symptoms or side effects, despite being considered high-to-medium priority patients; This approach minimizes the need for individuals to visit healthcare facilities, leading to a lesser consumption of PPE by the patients and the doctors; They will not have to go through the long hours of waiting in clinics and above all will not be exposed to other patients who could be carriers of pathogens, from COVID-19 to the most common infectious agents.	Improved access; risk mitigation	

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20-Jul	Telemedicine for inpatient dermatology consultations in response to the COVID-19 pandemic	Trinidad, John; Kroshinsky, Daniela; Kaffenberger, Benjamin H.; Rojek, Nathan W.	Journal of the American Academy of Dermatology	Dermatologists are poised to use tele-dermatology to increase access to dermatologic care for hospitalized patients, reduce the risk of infection of patients, trainees, and staff, and reduce the use of precious resources such as personal protective equipment and medical supplies.	Improved access; risk mitigation	
15-Sep	History of Telemedicine	http://mdportal.com/education/history-of-telemedicine/	mdPortal	We'll start the times of ancient Greece and Rome, around 500 BCE. Several widely-used communication mediums included: Fires, smoke signals, light reflection beacons, drums, horns. Around the same historical time, we have evidence that some of these communication mediums, specifically smoke signals and light reflection, were used to communicate medical information. Specifically, long distance communication methods were used to signal the outbreaks of plagues and to notify about health events such as births or deaths.		
1-Jan	The STARPAHC collection: part of an archive of the history of telemedicine	Freiburger, Gary; Holcomb, Mary; Piper, Dave	Journal of Telemedicine	The project employed advanced technology to deliver medical services on the Papago Indian reservation; extensive evaluation criteria were used.1The STARPAHC system included a control center located in the Indian Health Service hospital on the Papago reservation which was staffed by physicians and a system operator. There was a remote clinic in the village of Santa Rosa located 50 km away		

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				which was staffed by a physician assistant. There was also a mobile health unit staffed by a physician assistant and a laboratory technician. Finally, there was a referral center at the Indian Health Service hospital in Phoenix with access to medical specialists. Two-way video, audio and data commu-nications linked these units, which were used primarily for remote diagnosis.		
16-Dec	The Roots of Telemedicine	Castro, Freida	Athene TeleHealth	1967: The University of Miami School of Medicine partnered with the local fire department to transmit electrocardiographic rhythms over radio to Jackson Memorial Hospital in rescue situations, a breakthrough in urban emergency medicine.		
2018	History of Telemedicine	Nesbitt, Thomas; Katz-Bell, Jane	Understanding Telehealth	In 1968, a seminal telemedicine project was established involving Massachusetts General Hospital (MGH) and Logan Airport. Staffed by nurses, the “medical station” at the airport was linked via microwave relay to MGH as a means of providing primary and emergency services to travelers and airport staff. 41 The telemedicine efforts at the MGH continued two years later with a tele-psychiatry link with the Veterans Administration Hospital in Bedford, Massachusetts, that remained in service into the 1980s.		

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4/23/20	Nearly half of physicians using telehealth, up from just 18% in 2018	Eddy, Nathan	Healthcare IT News	Physicians are changing the patterns of their practice because of the COVID-19 pandemic, with nearly half of them using telehealth to treat patients, up from just 18% in 2018.		
7/31/19	One in 10 Americans Use Telehealth, But Nearly 75% Lack Awareness or Access, J.D. Power Finds	J.D. Power	PR Newswire	While 9.6% of Americans have used telehealth services, nearly three-fourths (74.3%) say they either don't have access or are unaware of telehealth options, according to a J.D. Power pulse survey tracing telehealth user experience, hurdles to adoption and real-world patient concerns.		
3/31/20	Coronaviruses and SARS-CoV-2: A Brief Overview	Ludwig, Stephan; Zarbock, Alexander	Anesthesia and Analgesia	In late December 2019, several cases of pneumonia of unknown origin were reported from China, which in early January 2020 were announced to be caused by a novel coronavirus. The virus was later denominated severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and defined as the causal agent of Coronavirus Disease 2019 (COVID-19).		
Jan-96	Evolution and Current Applications of Telemedicine	https://www.ncbi.nlm.nih.gov/books/NBK45445/	Institute of Medicine	In April 1924, an imaginative cover for the magazine Radio News foreshadowed telemedicine in its depiction of a "radio doctor" linked to a patient not only by sound but also by a live picture		

Additional Analysis

Table 2 is an affinity matrix that displays the effectiveness themes extracted from our research and the specific articles in which they were found. The total number of occurrences were summed and divided by the total volume of articles (n) to create the probability of occurrence. It should be noted these themes are meant to demonstrate a measure of mutual similarity and do not equate to a hierarchy of importance.

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235 **Table 2 – Affinity Matrix.**

Effectiveness Themes	Article Citation Number	Incidence of Occurrence (n=43)	Probability of Occurrence
Improved Access	1, 13,17, 20, 23, 24, 25, 28, 30, 31, 32, 33, 34, 36, 38, 39, 40, 41, 42, 43, 44	21	48%
Risk Mitigation	1, 13, 15, 16, 17, 20, 21, 22, 23, 25, 27, 29, 30, 34, 35, 37, 38, 40, 44	19	43%
Social Distancing Promotion	13, 15, 16, 17, 20, 21, 23, 24, 27, 36, 37, 38, 42, 45	14	32%
Rapid Telemedicine Expansion	13, 22, 23, 24, 25, 26, 31, 33, 34, 36, 38, 45	12	27%
HIPAA Compliance/Relaxed Regulations	13, 25, 26, 28, 31, 32, 38, 39, 40, 41, 48	11	25%
Telemedicine Education	13, 17,19, 20, 36, 38, 39, 43, 46, 47	10	23%
Increased or Similar Reimbursements	13, 17, 25, 28, 38, 39 40, 41	8	18%
Convenience	13, 20, 21, 23, 24, 32, 34	7	16%
Lower Cost	13, 20, 21, 24, 39, 42	6	14%
Patient Satisfaction	32, 33, 38, 42	4	9%

236 Table 3 is a chart that outlines some of the implementation successes of telemedicine utilization
237 on the health service lines we selected for this systematic literature review in the wake of COVID-19
238 proliferation. Each service line experiences diverse workflow requirements and care provision
239 criteria, which translated to varying levels of positive outcomes resulting from the accelerated
240 transition to virtual medicine.

241 **Table 3** – Service Line Successes Through Telemedicine Utilization During COVID-19 Pandemic.

Service Line	Implementation Successes
	Rapid diagnosis and treatment; increased access; reduced risk of infection; minimization of PPE and medical supply utilization;

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Dermatology	addressed health care disparities for underserved and rural populations.
OB/GYN	A typical virtual visit includes the pregnant woman utilizing home monitoring supplies to track measures such as fetal heart rate, maternal blood pressure, and fundal height; specialists are able to view ultrasounds and other examinations through available technology, often in real-time; home monitoring is also possible for certain high-risk conditions; clinics quickly shifted to phone screening and initial consultations, as well as videoconferences with patients; some clinics provided contraception renewals and new prescriptions through telemedicine; from a family planning perspective, telehealth visits have been a positive experience that both patients and providers favor; clinics can phone triage patients before a scheduled visit to determine whether the visit can be done by telephone visit, or synchronous or asynchronous telemedicine; GLOW was a randomized trial of a weight management intervention delivered by telephone during a pregnancy with an aim of reducing gestational weight gain in women with overweight or obesity – goals of implementation were to consolidate in-person prenatal screening, surveillance, and examinations into fewer in-person visits while maintaining patient access to ongoing antenatal care and subspecialty consultations via telehealth virtual visits.
Oncology	Less consumption of PPE; can ensure patients are adhering to given recommendations; patients can address new symptoms, fears, or questions with providers; cardio-oncology patients can be evaluated regularly, e.g., blood pressure readings, weight scales, or CardioMEMS; strict quarantine observation; reduced clinic visits; survivorship care planning; patient education
Mental Health	Supporting both physical and psychosocial needs irrespective of geographic locations; children with anxiety or significant trauma feel more comfortable than they would with in-person therapy; in response to the sudden need to provide tele-psychotherapy services, organizations quickly developed and offered free resources, clinical guidance, and synchronous and asynchronous access to online presentations to thousands of mental health providers around the world; prescriptions can now be made (but not for other controlled substances such as ADHD medications) after a thorough assessment through a live interactive video; Collaborative Assessment and Management of Suicidality (CAMS) protocols were created to provide support, guidance, and resources; increase in patient and provider satisfaction rates.

4. Discussion

Summary of Evidence

Telemedicine acts a bridge between patient and provider in separate locations in one of the safest manners possible. The sweeping prevalence of COVID-19 within the U.S. forced the

healthcare industry to reimagine their models of care and how they provisioned services to new and established patients that directly resulted in the explosion of telemedicine utilization. We narrowed our focus to address four specific service lines with unique requirements to examine how disruptions to continuity of care could be mitigated, which required sophisticated, timely course corrections to meet individual and community needs for urgent and non-urgent encounters.

A detailed analysis of our research resulted in the emergence of an array of themes that were commonplace within the selected service lines. The leading indicators for telemedicine utilization expansion were efforts to increase access to patients with transportation and physical limitations, as well as those engaged in social distancing measures who would not otherwise seek medical care and, by extension, a concerted attempt to mitigate risk by limiting exposure to parties within the confines of a clinical environment. Telemedicine provides a more convenient method of care provision as patients can obtain services inside the comforts of their own home, which reduces travel time and can also decrease opportunity and monetary costs. Two of the more notable barriers to widespread telemedicine adoption prior to COVID-19 dispersion were issues related to HIPAA compliance in the context of privacy concerns with secure communication lines and data sharing, burdensome regulations, interstate licensure requirements, and reimbursement disparities amongst U.S. insurers who rendered payouts not on-par with in-person visits; these obstacles were relaxed by CMS, DHHS, and public and commercial payers to accommodate a new care provision reality. Even though telemedicine was marginally utilized prior to the spread of COVID-19, additional training and education for patients and providers are necessary to adapt to changing protocols, assessment criteria, and basic understanding of telemedicine functionality [13, 17, 19, 20, 36, 38, 39, 43, 46, 47]. Lastly, patient satisfaction levels were not widely discussed in the literature, but there were indications they were generally satisfied with their telemedicine experience provided they could connect with their providers in the virtual domain and achieve desirable outcomes from the encounters [7, 9, 27, 32].

Limitations

We encountered a series of limitations during our research: (1) Recent phenomenon of COVID-19 dramatically restricts our research timeline and availability of pertinent articles due to novel, mercurial circumstances. In the two-month span of our study, additional articles were likely published after our initial capture that were not employed in our final analysis. (2) With protective measures ebbing and flowing in real time in response to the changing tides of COVID-19's effects, healthcare services may reinstitute in-person services (i.e., elective surgeries, minor procedures, physical exams, etc.) or scale them back as conditions on the ground dictate in any given locality; these fluctuations, in turn, will cause a see-saw effect of telemedicine utilization. (3) Selection bias – we attempted to control against this variable through a rigorous vetting process via group consensus. (4) Publication bias – our searches were narrowly conducted across only two databases and did not include any forms of grey literature; as a result, it is probable we did not secure supplementary articles that may have illuminated additional information germane to our research.

5. Conclusion

Telemedicine has had a transformative impact on the provision of care in the era of COVID-19. It is evident from the presented research the service lines covered are demonstrating nimble and effective responses to the COVID-19 outbreak through workflow adaptations via telemedicine within their respective care provisions. While general obstacles were encountered, which encompassed a lack of reimbursement parity, telemedicine infrastructure capabilities, regulatory and HIPAA compliance guidelines, lack of internet connectivity, and patient/provider discomfort with technology, each developed the capacity to accelerate telemedicine adoption to adjust to the needs of their patient populations by marshaling resources,

expertise, and access. Since the SARS-CoV2 pandemic thrust telemedicine into uncharted territory, its capabilities continue to be refined as best practices are codified and data sets are assembled for utilization in future peer-reviewed publication dissemination. It behooves legislative and industry leaders to re-examine the benefits of telemedicine to remove barriers to its application not just in times of public health crises, but also for normal and customary clinical practice.

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