

# Maternal-Fetal Care and Telehealth in the Context of COVID-19 Pandemic: A Narrative Review

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## ABSTRACT

*The COVID-19 pandemic has led to widespread fears and strains on healthcare systems. Healthcare personnel and the global community are continuously struggling to evolve through the ongoing pandemic and its challenges. The unexpected surge of infectious COVID-19 cases has led to the cancellations of non-essential hospital appointments and delays in various procedures in many healthcare settings. Nevertheless, the healthcare sector has recognized the importance of providing integrated patient care through telemedicine-based health delivery systems. The practical approach to restructuring the clinical practices for the functional telehealth-based healthcare systems is much-needed in the current times. This narrative literature review sheds some light on the substantial clinical impacts of COVID-19 on women with pregnancy, lactation, and infertility. The study also reflects research about telehealth-based obstetrics- and gynecology-related health delivery services in the COVID-19 crisis. Meanwhile, robust, well-constructed scientific research may help identify short- and long-term telehealth practice outcomes on health and healthcare systems.*

## Introduction

COVID-19 has severely affected health delivery services, particularly in under-resourced healthcare settings<sup>1,2</sup>. Rapid transmission of the disease has significantly raised concerns in communities across the globe<sup>3</sup>. It has tested almost all healthcare systems, including those in resourceful countries<sup>4</sup>. The impact of the ongoing pandemic has led to the importance of more resilient health systems with the capability of accelerated provision of health services and access to patients, along with psychological support and counseling<sup>5</sup>. At this time, COVID-19 induced effects on pregnant women and infants are not entirely yet known. The medical community is still learning about the characteristics of a novel coronavirus, its new variants, and its impact on pregnant and breastfeeding women<sup>2,6</sup>. Various updated clinical guidelines and health information have become available by multiple national health authorities amidst the ongoing crisis<sup>5,7-11</sup>.

Technology-enhanced health services have quickly become valuable tools in delivering health care as the COVID-19 has evolved since its origin<sup>9,12,13</sup>. Telehealth requires the application of telecommunications-based technologies for providing clinical care and health education services to the long-distance patient population apart from public health administration<sup>14</sup>. Telemedicine-based virtual care is an important mode of enhancing patient's access to the current standard of care<sup>13,15,16</sup>. These modalities can be utilized to deliver acute, chronic, primary, and specialty care during COVID-19 era<sup>17,18</sup>.

WHO recommends strategies to optimize PPE (Personal Protective Equipment) availability in light of its surging demand during the ongoing pandemic globally. One such approach involves using telemedicine for evaluating suspected COVID-19 cases as an intervention to keep the need for PPE to a minimum in healthcare settings while preventing exposure of healthcare workers and other individuals to COVID-19<sup>9,19</sup>. Furthermore, besides improving healthcare governance, it is important to prioritize proper healthcare personnel training relating to infection prevention strategies to ensure adequate safety of health professionals.

Various health systems in developed countries, including the United States, offer telehealth options to the masses for COVID-19 screening via telehealth and telemedicine drive-thru option for testing COVID-19<sup>20</sup>. Health agencies in the United States, such as CDC, have recommended healthcare providers take advantage and expand the use of existing telehealth tools and their applications for directing patients to the right healthcare level for the required management during the COVID-19 pandemic<sup>5,21</sup>. The American Academy of Family Physicians (AAFP) encourages healthcare professionals to apply telehealth-based clinical practices during the COVID-19 pandemic<sup>22</sup>. In addition, the American College of Obstetrics and Gynecology (ACOG) has structured guidance to assist healthcare professionals in implementing telehealth

practice strategies<sup>23</sup>. Similarly, the American Academy of Pediatrics (AAP) also recommends establishing such health delivery services<sup>24,25</sup>. This approach enables clinicians to implement the infection-control measures and stratifying patients into well-defined risk groups for subsequent evaluation and management<sup>24</sup>. Moreover, pediatricians are encouraged to perform well-visits for children using Telehealth<sup>26</sup>.

Dedicated telehealth services can reduce the transmission of COVID-19 by keeping patients out of crowded waiting rooms<sup>27,28</sup>. These services can be rendered to raise awareness among the patients related to COVID-19 transmission in high-risk groups of people within the community<sup>13</sup>. Telehealth is an excellent technology-based tool to access patients in a safe and cost-effective manner<sup>4,28-32</sup>. For example, Korea has adopted "drive-through" dedicated COVID-19 testing sites considering the disease prevention and control measures<sup>33</sup>.

Amidst the pandemic crisis, patients requiring fertility treatment may feel stressed while facing difficult circumstances due to possible delays in appointments<sup>34</sup>. Counseling of these patients is imperative to address their concerns. Telehealth virtual care providers can utilize the telehealth system to provide preconception counseling and strategic treatment planning. In addition, behavioral health clinics can apply the concept of telemedicine for providing consultations and enhancing access to care while overcoming any impending workforce shortages and avoiding risk to COVID-19 exposure<sup>35</sup>.

In pregnancy and lactation, standard treatment protocols and management of COVID-19 should be designed in the light of current COVID-19 related scientific data rather than those driven from the past coronavirus outbreaks<sup>36</sup>. This literature review allows its readers to become aware of the implications of COVID-19 on maternal and fetal health and the role of digital technologies to enhance access to maternal-fetal care in current challenging times of ongoing pandemic. This narrative review is organized to discuss the topic of interest in two sections. The first section summarizes the impact of COVID-19 on pregnant women and lactating mothers and women with infertility. The second section outlines telehealth application and its integration in the healthcare sector for providing obstetrics- and gynecology-related care during the COVID-19 pandemic.

## Methodology

This narrative review was performed through a literature search of Cochrane library and digital libraries, including Medline, PubMed, and Google Scholar, using the search terms (keywords) to the articles published between the years 2000 to 2020. References of retrieved scientific publications and websites of various health agencies and professional bodies such as the United States CDC, WHO, and ACOG, were also searched for this narrative review. Strategic search for the following search terms was conducted by using the aforementioned electronic databases of online resources through the Google search engine: 'COVID-19', 'Pandemic', 'Preparedness',

'Pregnancy', 'Breastfeeding', 'Infertility', 'Telehealth', 'Telemedicine', 'Telecommunication', 'Online Consultation'. Also, the following sets of keywords were used through Boolean search strategy: 'COVID-19' AND 'pregnancy'; 'COVID-19' AND 'breastfeeding'; 'COVID-19' AND 'infertility'; 'Telemedicine' AND 'COVID-19'; 'Telehealth' AND 'COVID-19'; 'Telehealth' AND 'Obstetrics'; 'Telehealth' AND 'Gynecology'. The reviewers performed article selection based on a search of the relevant articles from the literature review restricted between the years 2000 and 2020 after tracing and removing the duplicate and irrelevant articles from the databases mentioned above. A total of 105 relevant articles were selected, reviewed, and included in this narrative literature review.

## Discussion

### Effects of COVID-19 on Maternal-Fetal Health

#### COVID-19 and Pregnancy

Certain pregnancy-related immunologic and physiologic changes make pregnant women more susceptible to viral respiratory infections<sup>37</sup>. For example, COVID-19 may cause a high risk of severe illness and lead to adverse sequelae affecting pregnant women<sup>38</sup>. Similarly, the morbidity and mortality associated with other viral infections, including SARS-CoV, MERS-CoV, and influenza in pregnant women, are noticeable compared with the general population<sup>39-42</sup>.

Initial information about the susceptibility of pregnant women to COVID-19 in pregnant women was limited, as it mainly was available from published scientific reports and small case series<sup>39,43-45</sup>. However, recent research studies have indicated the potential adverse impact of COVID-19 on pregnant women and their newborns, particularly pregnant women with pre-existing conditions such as diabetes, chronic hypertension, or those who are older or overweight<sup>46</sup>. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) cautiously recommends considering pregnant women vulnerable during the current pandemic<sup>47</sup>. Data suggest an increased risk of adverse outcomes in pregnant women with COVID-19, such as preterm birth<sup>6,48</sup>. In addition, comorbidities including chronic lung disease, cardiovascular disease, asthma, or diabetes may cause severe symptoms in pregnancy<sup>39</sup>. The American College of Obstetricians and Gynecologists (ACOG) updated its Practice advisory "Novel Coronavirus 2019 (COVID-19)" (*July 1, 2020*) while considering data analysis from United States CDC COVID-19 surveillance<sup>2,27</sup>. United States CDC published the Morbidity and Mortality Weekly Report (MMWR) that suggested pregnant women with COVID-19 (n = 8,207) being more likely to develop certain manifestations of severe COVID-19-associated illness compared to non-pregnant women with COVID-19 (n = 83,205)<sup>49</sup>. Data findings showed an increased risk of hospitalization, ICU admissions, and mechanical ventilation in pregnant women compared to non-pregnant women infected with COVID-19<sup>49</sup>. However, the rate of mortality did

not differ among pregnant infected women versus non-pregnant infected women. Due to the increased risk of severe outcomes in pregnant women with SARS-CoV-2 infection, it is essential to highlight the prevention strategies, particularly in pregnant women, as indicated in this CDC's report<sup>49</sup>.

Vertical transmission is possible but uncommon. Reports have raised concerns regarding in utero, intrapartum, and peripartum routes of transmission; however, vertical transmission's extent and clinical significance are not yet noticeably clear<sup>6,50</sup>. A systematic literature review (*published on April 20<sup>th</sup>, 2020*) suggested increasing reports of possible vertical transmission of COVID-19<sup>51</sup>. In addition, Alexandre et al. presented a case report (*published on July 14<sup>th</sup>, 2020*) demonstrating transplacental transmission of SARS-CoV-2 in a neonate of an infected mother<sup>52</sup>. This case study also described the neurological manifestations of COVID-19 in the neonate born to an infected mother<sup>52</sup>.

Pregnant patients with confirmed COVID-19 or suspected of COVID-19 are advised to inform the obstetric unit before arrival at their hospitals so that appropriate infection control measures are in place<sup>44</sup>. Currently, available data suggest that neonates with underlying conditions and preterm infants are more at risk of developing severe COVID-19<sup>50</sup>. COVID-19 testing is recommended for all neonates born to mothers with confirmed or suspected COVID-19<sup>50</sup>. Mothers with suspected or confirmed COVID-19, and their infants suspected with COVID-19, should be taken to isolation units to separate them from other healthy mothers<sup>50</sup>. Maternal autonomy should be respected while considering the medical decision-making process for deciding infant's isolation from mothers with suspected or confirmed SARS-CoV-2 infection<sup>50</sup>. Many factors that may influence this decision include the clinical condition of the mother and newborn, mother's wish for "rooming-in" to allow mother-infant bonding, COVID-19 test results of a mother and newborn, healthcare facility, and institution's capacity with a suitable environment for the isolated neonate, and other factors<sup>50</sup>. The United States CDC website's guidance mentions the criteria for considering isolation and discontinuing isolation about the care for newborn<sup>50</sup>. Health professionals should keep themselves abreast of updated practice guidelines and any subsequent changes in standard management protocols for obstetric care in patients with COVID-19.

### COVID-19 and Lactation

Limited data is available to ascertain the transmission of COVID-19 through breast milk<sup>48</sup>. According to the United States CDC, the chances of COVID-19 transmission from mother to fetus through breast milk are low. Various organizations such as WHO, RANZCOG, Royal College of Obstetricians and Gynecologists (RCOG), and Society of Obstetricians and Gynecologists of Canada (SOGC) encourage infected mothers to remain close contact with their infants while practicing enhanced measures for prevention and infection control<sup>27,53</sup>. However, the United States CDC's recommendations for initiating or discontinuing temporary isolation of



newborn from a mother with confirmed or suspected COVID-19 are based on certain criteria mentioned in its guidance which is continuously updated on its website<sup>48</sup>. However, such a decision requires the mother's consent after counseling and shared decision-making with the assistance of the clinical team<sup>54</sup>.

### Impact of COVID-19 on Infertility Treatment

Robust research studies are required to guide health professionals about the short-and long-term impact of COVID-19 on reproductive health and its influence on those intending to seek fertility treatments amid the COVID-19 pandemic<sup>55</sup>. Patients with infertility are more vulnerable to take an emotional toll due to multiple COVID-19 related factors. Mental health rehabilitation services play an important role in patient care with the mental health crisis in response to COVID-19<sup>56</sup>.

American Society of Reproductive medicine (ASRM) Coronavirus/COVID-19 Task Force has provided clinical recommendations and guidance for patient management during the COVID-19 pandemic through its periodic updates<sup>55</sup>. In its initial Updates (Update #1 and Update #2), ASRM recommended suspending the new treatment cycle and certain procedures for addressing infertility, elective surgeries, and non-urgent diagnostic procedures. At that time, it strongly considered canceling fresh/frozen embryo transfers; however, it recommended continuing to provide care to most urgent cases, including those who were "in-cycle" or who required urgent stimulation and cryopreservation<sup>55</sup>. Its guidance specifically recommended keeping the physical interactions to a minimum while encouraging telehealth. In later updates (Update #3 to Update #10), the ASRM task force issued recommendations for a gradual resumption of delivering reproductive care safely and judiciously with PPE recommendations and guidance for risk assessment and mitigation for reproductive care and activities<sup>55</sup>. ASRM task force recommends COVID-19 vaccination to women contemplating pregnancy (Update#11 to Update#15). This guidance is revisited and updated periodically as the pandemic evolves. Various health organizations have played a vital role in medical education and reproductive health awareness throughout crisis<sup>56-59</sup>.

### The Concept of Telehealth in Obstetrics and Gynecology

Telemedicine allows the exchange of medical information from one place to another using electronic communications and can be utilized as a clinical health tool to improve patient outcomes<sup>60</sup>. Telehealth-based technology works by using the internet, digital image technologies, telecommunications, and health information<sup>61</sup>. Moreover, such techniques can ease the training sessions relating to medical education activities and meetings for administrative purposes remotely<sup>61,62</sup>. The technology makes effective use of real-time "synchronous" secure audio and video services and store-and-forward secure "asynchronous" telemedicine services in the remote monitoring health status of patients<sup>61</sup>.

The term ‘Telehealth’ can be differentiated from ‘Telemedicine’<sup>60</sup>. ‘Telehealth’ encompasses a broad range of technology-based applications in the clinical contexts, such as teleconsultation and tele-practice, and non-clinical contexts such as Tele-education and Tele-research<sup>60</sup>. In comparison, ‘Telemedicine’ uses telecommunications-based technology explicitly to provide remote healthcare services to patients<sup>63</sup>. Nevertheless, both terminologies ‘Telehealth’ and ‘Telemedicine’ are generally used interchangeably.

Telehealth complements standard practice<sup>60</sup>. It involves providing clinical services through telecommunications, information, and virtual technology remotely<sup>64,65</sup>. An important example is “eHealth,” which integrates health-related data through information and communication technologies (ICTs)<sup>66</sup>. Digital technologies can be used to deliver healthcare services and health promotion and education by linking people at the same time present in different locations<sup>60,62</sup>. These modalities can be applied to facilitate patient assessment and surveillance and develop awareness programs for disease prevention and control using telecommunications technologies such as video conferencing<sup>62,67</sup>.

### Telehealth's Requirements

Fundamental components for telehealth delivery services include secured networking, internet availability, appropriate equipment, electronic health database, encrypted systems to protect data, physical and administrative safeguards. Health professionals must be aware of structured guidance and legal requirements such as telehealth licensing. Digital health systems require certain policies to be in place regarding credentialing and privileging, reimbursement issues, insurance coverage policy, network encryption requirements, billing and coding, and malpractice insurance, as applicable<sup>68-72</sup>.

### Potential Benefits of Telehealth

Telehealth can serve as an effective and resilient tool in healthcare settings burdened with an overwhelming number of patients, particularly vulnerable and aging population<sup>73</sup>. However, telemedicine's evolving practice necessitates fulfilling certain requirements for implementing such programs<sup>64,67</sup>.

Health mitigation strategies can be implemented through telehealth services during the current pandemic by increasing social distancing and reducing infectious exposure risk<sup>63,67,74</sup>. In addition, it can minimize the strain on healthcare systems while preserving the patient-provider relationship in remote areas<sup>67,75-77</sup>. Furthermore, it offers the benefits of prompt access with high patient satisfaction and can address the clinical workforce shortages<sup>78,79</sup>.

Telemedicine applications can be incorporated into the healthcare system of developing countries with limited medical infrastructure and an insufficient number of specialists and consultants, particularly in underserved rural communities<sup>80-82</sup>. Telehealth services can be applied to triage patients into low- and high-risk groups for subsequent care and management, as described in the United States CDC's guidance (shown in tabulated form in **Table 1**)<sup>64</sup>.

**Table 1: Benefits and Potential Uses of Telehealth**<sup>64</sup>

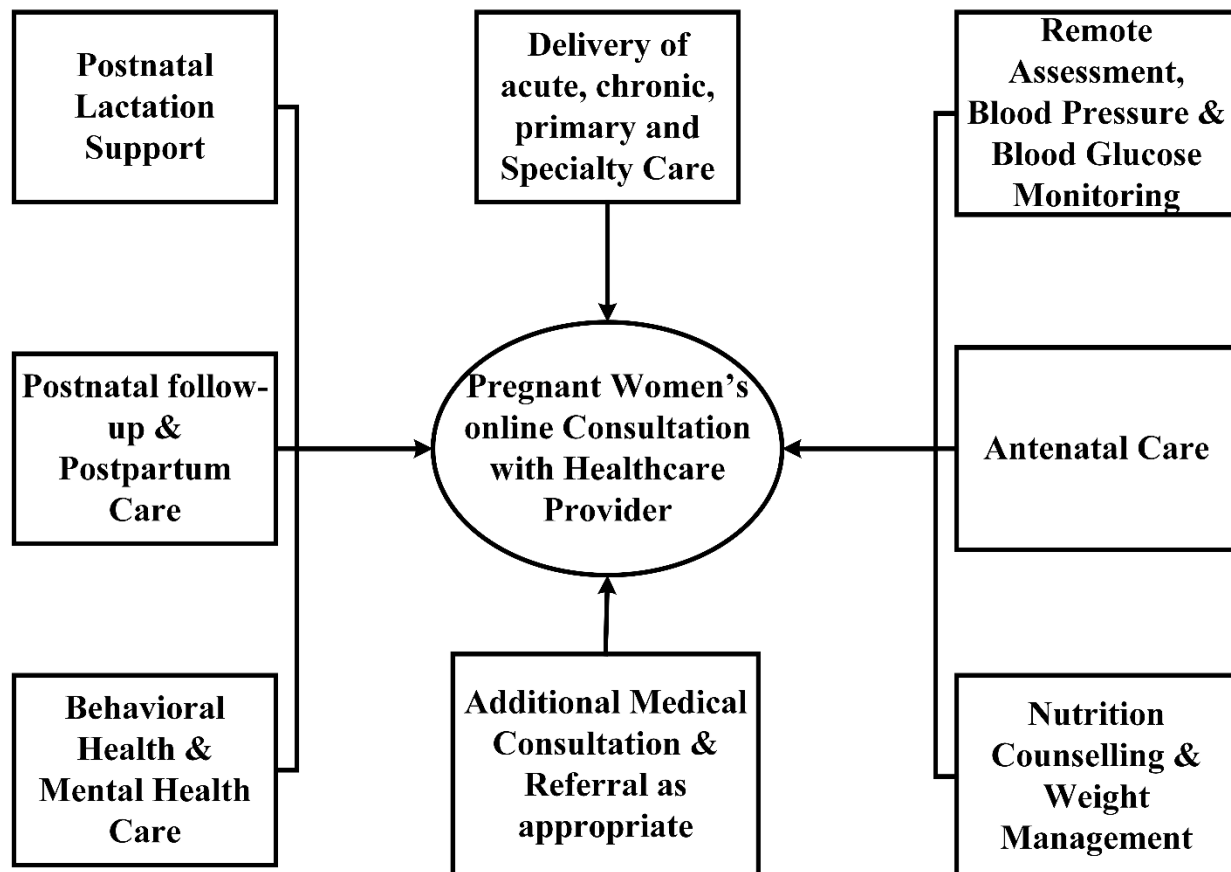
1.	Provide low-risk urgent care for non-COVID-19 conditions, identify those persons who may need additional medical consultation or assessment, and refer as appropriate
2.	Access primary care providers and specialists, including mental and behavioral health, for chronic health conditions and medication management
3.	Provide coaching and support for patients managing chronic health conditions, including weight management and nutrition counseling
4.	Participate in physical therapy, occupational therapy, and other modalities as a hybrid approach to in-person care for optimal health
5.	Monitor clinical signs of certain chronic medical conditions (e.g., blood pressure, blood glucose, other remote assessments)
6.	Engage in case management for patients who have difficulty accessing care (e.g., those who live in very rural settings, older adults, those with limited mobility)
7.	Follow up with patients after hospitalization
8.	Deliver advance care planning and counseling to patients and caregivers to document preferences if a life-threatening event or medical crisis occurs
9.	Provide non-emergent care to residents in long-term care facilities
10.	Provide education and training for H.C.P. through peer-to-peer professional medical consultations (inpatient or outpatient) that are not locally available, particularly in rural areas

Healthcare delivery services, supplemented by technology advancements, enhance the current standard of practice in Obstetrics and Gynecology. The digital clinical tools for implementing telehealth in practice are becoming popular amongst health professionals<sup>79,83,84</sup>. Medical software applications related to Obstetrics and Gynaecology include fertility tracking and prenatal care Apps<sup>85</sup>. In addition, many user-friendly medical applications can track ovulation, menstrual cycle, and record bladder diary. Wi-Fi smart blood pressure monitoring is another helpful



application installed through portable electronic devices<sup>86</sup>. Furthermore, the mobile app can deliver follow-up care following an ambulatory surgery such as breast reconstruction<sup>77,87</sup>. Pregnancy and childbirth are the milestones requiring emotional support<sup>88</sup>. Maternal telemedicine may play an important role in providing high-quality patient care while preventing the spread of COVID-19<sup>88-90</sup>. Remote antenatal<sup>91,92</sup> and postnatal care can be delivered through online consultations during the COVID-19 pandemic (**Figure 1**).

Telehealth can improve access to care in patients with infertility living in a remote area through virtual online consultations and ultrasound recording assessments by gynecologists and fertility specialists. Online support communities, including webinars and virtual meetings, are beneficial in this regard. Furthermore, a patient's referral to a trained mental health provider can aid in stress management in patients with infertility requiring counseling. Many healthcare providers may offer telehealth consultation options, particularly if an individual's insurance carrier permits using such services. Virtual care is an effective modality for designing emerging telehealth-based service delivery models and programs with integrated health care<sup>93,94</sup>.



**Figure 1: Telemedicine services in pregnancy**

Science and technology-based recent advances such as nanotechnology, virtual reality, artificial intelligence, and robotics have enabled telemedicine to come up more than just a connectivity tool<sup>90</sup>. It is an innovative tool that can be integrated within an optimally effective and precise healthcare system, with an effective outreach<sup>64,67,70,91,92</sup>. The rising trend and growing demand for telehealth-based technology have encouraged its providers and policymakers to evolve and advance through the recent medical field<sup>63,65,95</sup>. Appropriate studies must be executed to provide

a clearer vision of outcome-based telemedicine strategies and tele-triage methods during the current pandemic and post-crisis period.

### Potential Limitations to Telehealth

The potential limitations to telehealth include availability of certain prerequisites such as technology requirements; telehealth-eligibility and standardized training programs for the patients, practitioners, and providers, including systematic education and training, telehealth-related academic or vocational educational courses, simulation-based education (S.B.E.) for both formative and summative learning for familiarity with the concept and understanding of telehealth-based modalities; effective communication skills and verbal feedback; licensure and regulatory issues; insurance coverage requirements, economic support, and reimbursement policies; situations requiring an in-person consultation; concerns about patient's comfort and satisfaction; issues related to ethical conduct; limited availability and access to telehealth modalities; pediatric considerations and cultural acceptance of its practice within communities, as applicable<sup>64,69,79,96-98</sup>. Telemedicine is a means of complementing and enhancing access to healthcare; however, it may not replace the current standard of care in certain conditions. One major challenge is the healthcare professional's inability to perform a patient's physical examination as one would do in face-to-face visits<sup>99-101</sup>. Moreover, the telehealth program requires ensuring the proper guardrails for protecting personal health information and addressing patient's privacy concerns by establishing comprehensive privacy and security safeguards for safekeeping of electronic record<sup>81,102</sup>. Before implementing such a program, it is important to ensure the provider's ability to bear the cost required for implementation, maintenance, and continuation of the program and cost linked with security and reimbursement issues for optimal results<sup>95,102</sup>. Barriers to such services include limited access to technology in regions lacking ICTs services, intricate systems, lack of organizational support, resistance, and poor communication on the patient's part, particularly in developing countries<sup>66,69,80,96</sup>. Such projects can be challenging due to the constantly innovative and evolving concepts and technical contingencies related to the evaluation framework and its various components, including health technologies, communication infrastructure, environmental settings, socioeconomic analysis, health domains, and relatable services<sup>103-105</sup>.

Telehealth technology can provide a solid foundation for clinicians to deliver the right care to the right patient at the right time<sup>63</sup>. In-depth analysis measuring the cause and effect relationship may help design an optimal telehealth system that could help make an errorless clinical decision during the current pandemic crisis<sup>67</sup>. However, there is a limitation to predict outcomes because of scarce pre-intervention data's availability for comparing pre- and post-measures in telemedicine. Future healthcare systems must have the ability to triage patients to guide them about the potential benefits and identify the possible abuse associated with this system<sup>67</sup>. Further research is needed to test hypotheses about telemedicine-based outcomes within specific clinical applications and comparing them with contextual effects and other telehealth regimens<sup>67</sup>.

## Conclusion

Potential telehealth-based health services delivery programs can serve remote patient populations while minimizing the COVID-19 transmission risk. Telehealth-enhanced health care services and technology-based well-designed schemes may help achieve cost-savings to the healthcare system and improve healthcare access in patients with COVID-19 and other low-risk non-COVID-19 conditions. Healthcare providers, regulatory authorities, policymakers, payers, telemedicine advocates, researchers, and society need to collaborate and find a clear path to utilize telehealth as an effective healthcare tool for rural and urban communities during and in the post-pandemic period.

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## References

1. Hazafa A, ur-Rahman K, Haq I ul, et al. The broad-spectrum antiviral recommendations for drug discovery against COVID-19. *Drug Metab Rev.* 2020. doi:10.1080/03602532.2020.1770782
2. Data on COVID-19 during Pregnancy | CDC. <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/special-populations/pregnancy-data-on-covid-19.html>. Accessed August 4, 2020.
3. Ghafoor S. Analysis of Covid-19 Pandemic Through Narrative Literature Review. *Int J Obstet Gynaecol Res.* 2020;X(X):100-115. <http://www.ijogr.com/2020/analysis-of-covid-19-pandemic-through-narrative-literature-review/>.
4. Dashraath P, Wong JLJ, Lim MXK, et al. Coronavirus disease 2019 (COVID-19) pandemic and pregnancy. *Am J Obstet Gynecol.* 2020;222(6). doi:10.1016/j.ajog.2020.03.021
5. Machhi J, Herskovitz J, Senan AM, et al. The Natural History, Pathobiology, and Clinical Manifestations of SARS-CoV-2 Infections. *J Neuroimmune Pharmacol.* 2020;15(3):359-386. doi:10.1007/s11481-020-09944-5
6. Di Mascio D, Khalil A, Saccone G, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *Am J Obstet Gynecol MFM.* 2020;2(2):100107. doi:10.1016/j.ajogmf.2020.100107
7. Public Health Emergency COVID-19 Initiative.

- <https://www.ncbi.nlm.nih.gov/pmc/about/covid-19/>. Accessed August 4, 2020.
8. Considerations for Inpatient Obstetric Healthcare Settings | CDC. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/inpatient-obstetric-healthcare-guidance.html>. Accessed August 4, 2020.
  9. Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages. [https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-\(covid-19\)-and-considerations-during-severe-shortages](https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages). Accessed August 4, 2020.
  10. COVID-19 FAQs for Obstetrician-Gynecologists, Obstetrics | ACOG. <https://www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics>. Accessed August 4, 2020.
  11. Di Mascio D, Khalil A, Saccone G, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *Am J Obstet Gynecol MFM*. 2020;2(2):100107. doi:10.1016/j.ajogmf.2020.100107
  12. Portnoy J, Waller M, Elliott T. Telemedicine in the Era of COVID-19. *J Allergy Clin Immunol Pract*. 2020;8(5). doi:10.1016/j.jaip.2020.03.008
  13. Mann DM, Chen J, Chunara R, Testa PA, Nov O. COVID-19 transforms health care through telemedicine: evidence from the field. *J Am Med Inform Assoc*. 2020. doi:10.1093/jamia/ocaa072
  14. What is telehealth? How is telehealth different from telemedicine? HEALTHIT.gov. <https://www.healthit.gov/faq/what-telehealth-how-telehealth-different-telemedicine>. Published 2020. Accessed April 21, 2020.
  15. Tuckson RV, Edmunds M, Hodgkins ML. Telehealth. *N Engl J Med*. 2017;377(16):1585-1592. doi:10.1056/NEJMSr1503323
  16. Samiotakis Y, Anagnostopoulou S, Alexakis A. A regulated telemedicine system for day to day application in remote areas. In: *Studies in Health Technology and Informatics*. Vol 57. ; 2000. doi:10.3233/978-1-60750-901-1-91
  17. O'Connor M, Asdornwised U, Dempsey ML, et al. Using telehealth to reduce all-cause 30-day hospital readmissions among heart failure patients receiving skilled home health services. *Appl Clin Inform*. 2016;7(2). doi:10.4338/ACI-2015-11-SOA-0157
  18. Groves RH, Holcomb BW, Smith ML. Intensive care telemedicine: evaluating a model for proactive remote monitoring and intervention in the critical care setting. *Stud Health Technol Inform*. 2008;131.
  19. Aziz A, Zork N, Aubey JJ, et al. Telehealth for High-Risk Pregnancies in the Setting of the COVID-19 Pandemic. *Am J Perinatol*. 2020;37(8):800-808. doi:10.1055/s-0040-1712121
  20. Telehealth Virtual Care Providers (COVID-19) | SCDHEC. <https://scdhec.gov/infectious-diseases/viruses/coronavirus-disease-2019-covid-19/telehealth-virtual-care-providers-covid-19>. Accessed August 4, 2020.
  21. Telemedicine | Medicaid.

- <https://www.medicaid.gov/medicaid/benefits/telemedicine/index.html>. Accessed August 4, 2020.
22. Using Telehealth to Care for Patients During the COVID-19 Pandemic. <https://www.aafp.org/patient-care/emergency/2019-coronavirus/telehealth.html>. Accessed August 3, 2020.
  23. Implementing Telehealth in Practice: ACOG Committee Opinion Summary, Number 798. *Obstet Gynecol.* 2020;135(2). doi:10.1097/AOG.0000000000003672
  24. Guidance on the Necessary Use of Telehealth During the COVID-19 Pandemic. <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/guidance-on-the-necessary-use-of-telehealth-during-the-covid-19-pandemic/>. Accessed August 3, 2020.
  25. Rimsza ME, Hotaling AJ, Keown ME, et al. The use of telemedicine to address access and physician workforce shortages. *Pediatrics.* 2015;136(1). doi:10.1542/peds.2015-1253
  26. Guidance on Providing Pediatric Ambulatory Services via Telehealth During COVID-19. <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections2/guidance-on-providing-pediatric-ambulatory-services-via-telehealth-during-covid-19/>. Accessed August 4, 2020.
  27. Novel Coronavirus 2019 (COVID-19) | ACOG. <https://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2020/03/novel-coronavirus-2019>. Accessed August 4, 2020.
  28. Fryer K, Delgado A, Foti T, Reid CN, Marshall J. Implementation of Obstetric Telehealth During COVID-19 and Beyond. *Matern Child Health J.* 2020. doi:10.1007/s10995-020-02967-7
  29. Wood CL, Clements SA, McFann K, Slover R, Thomas JF, Wadwa RP. Use of Telemedicine to Improve Adherence to American Diabetes Association Standards in Pediatric Type 1 Diabetes. *Diabetes Technol Ther.* 2016;18(1). doi:10.1089/dia.2015.0123
  30. Gagnon MP, Duplantie J, Fortin JP, Landry R. Implementing telehealth to support medical practice in rural/remote regions: What are the conditions for success? *Implement Sci.* 2006;1(1). doi:10.1186/1748-5908-1-18
  31. Jennett PA, Affleck Hall L, Hailey D, et al. The socio-economic impact of telehealth: A systematic review. *J Telemed Telecare.* 2003;9(6). doi:10.1258/135763303771005207
  32. Williams AM, Bhatti UF, Alam HB, Nikolian VC. The role of telemedicine in postoperative care. *mHealth.* 2018;4. doi:10.21037/mhealth.2018.04.03
  33. Kwon KT, Ko JH, Shin H, Sung M, Kim JY. Drive-through screening center for covid-19: A safe and efficient screening system against massive community outbreak. *J Korean Med Sci.* 2020;35(11). doi:10.3346/jkms.2020.35.e123
  34. Turocy J, Robles A, Hercz D, D'Alton M, Forman E, Williams Z. The Emotional Impact of the ASRM Guidelines on Fertility Patients During the Covid-19 Pandemic. *medRxiv.* 2020. doi:10.1101/2020.03.29.20046631
  35. CCBHCs Using Telehealth or Telemedicine | SAMHSA.



- <https://www.samhsa.gov/section-223/care-coordination/telehealth-telemedicine>. Accessed August 3, 2020.
36. Syeda S, Baptiste C, Breslin N, Gyamfi-Bannerman C, Miller R. The Clinical Course of COVID in Pregnancy. *Semin Perinatol.* July 2020;151284. doi:10.1016/j.semperi.2020.151284
  37. Chen H, Guo J, Wang C, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *Lancet.* 2020;395(10226). doi:10.1016/S0140-6736(20)30360-3
  38. Liang Huan AG. Novel corona virus disease (COVID-19) in pregnancy: What clinical recommendations to follow? *Acta Obstet Gynecol Scand.* 2020;99(4):439-442. doi:10.1111/aogs.13836
  39. Publications and Clinical Guidance. Society of Maternal and Fetal Medicine. <https://www.smfm.org/covidclinical>. Accessed April 16, 2020.
  40. [The Spanish flu in Iceland 1918. Lessons in medicine and history] - PubMed. <https://pubmed.ncbi.nlm.nih.gov/18974435/>. Accessed August 13, 2020.
  41. Jamieson DJ, Honein MA, Rasmussen SA, et al. H1N1 2009 influenza virus infection during pregnancy in the USA. *Lancet.* 2009;374(9688). doi:10.1016/S0140-6736(09)61304-0
  42. Wong SF, Chow KM, Leung TN, et al. Pregnancy and perinatal outcomes of women with severe acute respiratory syndrome. *Am J Obstet Gynecol.* 2004;191(1). doi:10.1016/j.ajog.2003.11.019
  43. Clinical Questions about COVID-19: Questions and Answers. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/faq.html#Obstetrical-Care>. Accessed July 30, 2020.
  44. Khoiwal K, Kapur D, Gaurav A, Chaturvedi J. Management of Pregnant Women in Times of Covid-19: A Review of Current Literature. *J Obstet Gynecol India.* 2020. doi:10.1007/s13224-020-01342-4
  45. RANZCOG - National Registry for Australian women infected with SARS-COV2 in pregnancy. <https://ranzcof.edu.au/news/national-registry-for-australian-women-infected-wi>. Accessed August 3, 2020.
  46. Allotey J, Stallings E, Bonet M, et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: Living systematic review and meta-analysis. *BMJ.* 2020;370. doi:10.1136/bmj.m3320
  47. A message for pregnant women and their families. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists. <https://ranzcof.edu.au/statements-guidelines/covid-19-statement/information-for-pregnant-women>. Accessed July 31, 2020.
  48. If You Are Pregnant, Breastfeeding, or Caring for Young Children | COVID-19 | CDC. <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/pregnancy-breastfeeding.html>. Accessed August 4, 2020.

49. Ellington S, Strid P, Tong VT, et al. Characteristics of Women of Reproductive Age with Laboratory-Confirmed SARS-CoV-2 Infection by Pregnancy Status — United States, January 22–June 7, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69(25). doi:10.15585/mmwr.mm6925a1
50. Caring for Newborns | COVID-19 | CDC. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/caring-for-newborns.html>. Accessed August 4, 2020.
51. Fornari Federico. Vertical Transmission of Covid-19-A Systematic Review. *J Pediatr Perinatol Child Heal* . 2020;4(2):007-013. doi:10.26502/jppch.7405034
52. Vivanti AJ, Vauloup-Fellous C, Prevot S et al. Transplacental transmission of SARS-CoV-2 infection. *Nat Commun.* 2020;11. doi:10.1038/s41467-020-17436-6
53. Committee Opinion No. 400 – COVID-19 in Pregnancy (updated May 14, 2020). <https://www.sogc.org/en/content/featured-news/Committee-Opinion-No-400-COVID-19-in-Pregnancy-updated-May-14-2020.aspx>. Accessed August 4, 2020.
54. Hu YJ, Wake M, Saffery R. Clarifying the Sweeping Consequences of COVID-19 in Pregnant Women, Newborns, and Children With Existing Cohorts. *JAMA Pediatr.* August 2020. doi:10.1001/jamapediatrics.2020.2395
55. Patient Management and Clinical Recommendations During The Coronavirus (COVID-19) Pandemic | ASRM. <https://www.asrm.org/news-and-publications/covid-19/statements/patient-management-and-clinical-recommendations-during-the-coronavirus-covid-19-pandemic/>. Accessed August 3, 2020.
56. Society for Assisted Reproductive Technology. A Message for Patients from The Society for Assisted Reproductive Technology. Society for Assisted Reproductive Technology. <https://www.sart.org/patients/covid-19-alert-for-patients/>. Accessed April 16, 2020.
57. COVID-19: Questions Your Patients May Have | ASRM. <https://www.asrm.org/news-and-publications/news-and-research/announcements/covid-19-questions-your-patients-may-have/>. Accessed August 3, 2020.
58. Read RESOLVE’s Statement on COVID-19. <https://resolve.org/about-us/news-and-press-releases/resolve-statement-on-covid-19/>. Accessed August 3, 2020.
59. Coronavirus (COVID-19) infection in pregnancy and newborn : Guidelines, reviews, statements, recommendations, standards. [https://www.gfmer.ch/Guidelines/Maternal\\_neonatal\\_infections/Coronavirus.htm](https://www.gfmer.ch/Guidelines/Maternal_neonatal_infections/Coronavirus.htm). Accessed August 4, 2020.
60. What is Telehealth. <https://www.aap.org/en-us/professional-resources/practice-transformation/telehealth/Pages/What-is-Telehealth.aspx>. Accessed August 4, 2020.
61. Lurie N, Carr BG. The role of telehealth in the medical response to disasters. *JAMA Intern Med.* 2018;178(6):745-746. doi:10.1001/jamainternmed.2018.1314
62. Källander K, Tibenderana JK, Akpogheneta OJ, et al. Mobile health (mhealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: A review. *J Med Internet Res.* 2013;15(1). doi:10.2196/jmir.2130

63. COVID-19: AMA's recent and ongoing advocacy efforts | American Medical Association. <https://www.ama-assn.org/delivering-care/public-health/covid-19-amas-recent-and-ongoing-advocacy-efforts>. Accessed August 4, 2020.
64. Using Telehealth to Expand Access to Essential Health Services during the COVID-19 Pandemic | CDC. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/telehealth.html>. Accessed August 4, 2020.
65. Ray Dorsey E, Topol EJ. State of telehealth. *N Engl J Med*. 2016;375(2). doi:10.1056/NEJMra1601705
66. Almathami HKY, Win KT, Vlahu-Gjorgievska E. Barriers and Facilitators That Influence Telemedicine-Based, Real-Time, Online Consultation at Patients' Homes: Systematic Literature Review. *J Med Internet Res*. 2020;22(2). doi:10.2196/16407
67. Bashshur R, Doarn CR, Frenk JM, Kvedar JC, Woolliscroft JO. Telemedicine and the COVID-19 pandemic, lessons for the future. *Telemed e-Health*. 2020;26(5). doi:10.1089/tmj.2020.29040.rb
68. Harvey JB, Valenta S, Simpson K, Lyles M, McElligott J. Utilization of Outpatient Telehealth Services in Parity and Nonparity States 2010-2015. *Telemed e-Health*. 2019;25(2). doi:10.1089/tmj.2017.0265
69. Smith WR, Atala AJ, Terlecki RP, Kelly EE, Matthews CA. Implementation Guide for Rapid Integration of an Outpatient Telemedicine Program During the COVID-19 Pandemic. *J Am Coll Surg*. 2020. doi:10.1016/j.jamcollsurg.2020.04.030
70. Voran D. Telemedicine and beyond. *Mo Med*. 2015;112(2).
71. Jacobson PD, Selvin E. Licensing telemedicine: The need for a national system. *Telemed J e-Health*. 2000;6(4). doi:10.1089/15305620050503915
72. Managing Patients Remotely: Billing for Digital and Telehealth Services | ACOG. <https://www.acog.org/practice-management/coding/coding-library/managing-patients-remotely-billing-for-digital-and-telehealth-services>. Accessed August 3, 2020.
73. WHO | Telehealth. <https://www.who.int/gho/goe/telehealth/en/>. Accessed August 4, 2020.
74. Jones MS, Goley AL, Alexander BE, Keller SB, Caldwell MM, Buse JB. Inpatient Transition to Virtual Care During COVID-19 Pandemic. *Diabetes Technol Ther*. 2020;22(6). doi:10.1089/dia.2020.0206
75. Orlando JF, Beard M, Kumar S. Systematic review of patient and caregivers' satisfaction with telehealth videoconferencing as a mode of service delivery in managing patients' health. *PLoS One*. 2019;14(8). doi:10.1371/journal.pone.0221848
76. Odibo IN, Wendel PJ, Magann EF. Telemedicine in obstetrics. *Clin Obstet Gynecol*. 2013;56(3). doi:10.1097/GRF.0b013e318290fef0
77. Armstrong KA, Coyte PC, Bhatia RS, Semple JL. The Effect of Mobile App Home Monitoring on Number of In-Person Visits Following Ambulatory Surgery: Protocol for a Randomized Controlled Trial. *JMIR Res Protoc*. 2015;4(2). doi:10.2196/resprot.4352
78. Martinez KA, Rood M, Jhangiani N, et al. Patterns of Use and Correlates of Patient Satisfaction with a Large Nationwide Direct to Consumer Telemedicine Service. *J Gen*

- Intern Med.* 2018;33(10). doi:10.1007/s11606-018-4621-5
79. Waller M, Stotler C. Telemedicine: a Primer. *Curr Allergy Asthma Rep.* 2018;18(10). doi:10.1007/s11882-018-0808-4
  80. Combi C, Pozzani G, Pozzi G. Telemedicine for developing countries: A survey and some design issues. *Appl Clin Inform.* 2016;7(4). doi:10.4338/ACI-2016-06-R-0089
  81. Alajmi D, Almansour S, Househ MS. Recommendations for implementing telemedicine in the developing world. In: *Studies in Health Technology and Informatics.* Vol 190. ; 2013. doi:10.3233/978-1-61499-276-9-118
  82. Rao B, Lombardi A. Telemedicine: Current status in developed and developing countries. *J Drugs Dermatology.* 2009;8(4).
  83. Poenaru C, Poenaru E, Vinereanu D. Current Perception of Telemedicine in an EU Country. *Maedica (Buchar).* 2014;9(4).
  84. AMA digital health care 2016 & 2019 study findings | American Medical Association. <https://www.ama-assn.org/about/research/ama-digital-health-care-2016-2019-study-findings>. Accessed August 4, 2020.
  85. Marko KI, Ganju N, Krapf JM, et al. A mobile prenatal care app to reduce in-person visits: Prospective controlled trial. *JMIR mHealth uHealth.* 2019;7(5). doi:10.2196/10520
  86. Farag S, Chyjek K, Chen KT. Identification of iPhone and iPad applications for obstetrics and gynecology providers. *Obstet Gynecol.* 2014;124(5). doi:10.1097/AOG.0000000000000510
  87. Armstrong KA, Coyte PC, Brown M, Beber B, Semple JL. Effect of home monitoring via mobile app on the number of in-person visits following ambulatory surgery a randomized clinical trial. *JAMA Surg.* 2017;152(7). doi:10.1001/jamasurg.2017.0111
  88. Jago CA, Singh SS, Moretti F. Coronavirus Disease 2019 (COVID-19) and Pregnancy: Combating Isolation to Improve Outcomes. *Obstet Gynecol.* 2020;136(1). doi:10.1097/AOG.00000000000003946
  89. Nakagawa K, Umazume T, Mayama M, et al. Feasibility and safety of urgently initiated maternal telemedicine in response to the spread of COVID-19: A 1-month report. *J Obstet Gynaecol Res.* 2020. doi:10.1111/jog.14378
  90. Bokolo AJ. Exploring the adoption of telemedicine and virtual software for care of outpatients during and after COVID-19 pandemic. *Ir J Med Sci.* 2020;1. doi:10.1007/s11845-020-02299-z
  91. Butler Tobah YS, LeBlanc A, Branda ME, et al. Randomized comparison of a reduced-visit prenatal care model enhanced with remote monitoring. *Am J Obstet Gynecol.* 2019;221(6). doi:10.1016/j.ajog.2019.06.034
  92. Peahl AF, Novara A, Heisler M, Dalton VK, Moniz MH, Smith RD. Patient Preferences for Prenatal and Postpartum Care Delivery. *Obstet Gynecol.* 2020;135(5):1038-1046. doi:10.1097/aog.00000000000003731
  93. Resources - ATA. <https://www.americantelemed.org/covid-19/resources/>. Accessed August 3, 2020.

94. Clinical Documentation Integrity Education & Training | AHIMA. <https://www.ahima.org/education-events/education-by-topic/>. Accessed August 4, 2020.
95. Greiner AL. Telemedicine Applications in Obstetrics and Gynecology. *Clin Obstet Gynecol.* 2017;60(4). doi:10.1097/GRF.0000000000000328
96. Seto E, Smith D, Jacques M, Morita PP. Opportunities and challenges of telehealth in remote communities: Case study of the Yukon telehealth system. *J Med Internet Res.* 2019;21(11). doi:10.2196/11353
97. Chaet D, Clearfield R, Sabin JE, Skimming K. Ethical practice in Telehealth and Telemedicine. *J Gen Intern Med.* 2017;32(10). doi:10.1007/s11606-017-4082-2
98. Mandirola Brioux HF, Bhuiyan Masud JH, Kumar Meher S, et al. Challenges and Hurdles of eHealth Implementation in Developing Countries. In: *Studies in Health Technology and Informatics.* Vol 216. ; 2015. doi:10.3233/978-1-61499-564-7-434
99. Turrentine M, Ramirez M, Monga M, et al. Rapid Deployment of a Drive-Through Prenatal Care Model in Response to the Coronavirus Disease 2019 (COVID-19) Pandemic. *Obstet Gynecol.* 2020;136(1):29-32. doi:10.1097/AOG.00000000000003923
100. Grimes CL, Balk EM, Crisp CC, et al. A guide for urogynecologic patient care utilizing telemedicine during the COVID-19 pandemic: review of existing evidence. *Int Urogynecol J.* 2020;31(6). doi:10.1007/s00192-020-04314-4
101. Telehealth Systems - StatPearls - NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK459384/>. Accessed August 4, 2020.
102. da Luz PL. Telemedicine and the doctor/patient relationship. *Arq Bras Cardiol.* 2019;113(1). doi:10.5935/abc.20190117
103. Chang H. Evaluation framework for telemedicine using the logical framework approach and a fishbone diagram. *Healthc Inform Res.* 2015;21(4). doi:10.4258/hir.2015.21.4.230
104. May C, Harrison R, Finch T, MacFarlane A, Mair F, Wallace P. Understanding the Normalization of Telemedicine Services through Qualitative Evaluation. *J Am Med Informatics Assoc.* 2003;10(6). doi:10.1197/jamia.M1145
105. May C, Mort M, Williams T, Mair F, Gask L. Health technology assessment in its local contexts: Studies of telehealthcare. *Soc Sci Med.* 2003;57(4). doi:10.1016/S0277-9536(02)00419-7