JOURNAL OF HEALTH CARE FINANCE

Winter 2023

Galvanized By COVID, "Telemedicine" Grew Exponentially as Did "Remote Care" Medical Services: A Study of Remote Care Services Costing for Oxygen Monitoring Illustrates Challenges, Benefits and Future Potentials of Comprehensive "Remote Care"

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Abstract:

Remote and at-home medical services continue to increase in popularity in the United States due to workflow and cost advantages. Remote care is often promoted by providers and policymakers but the actual costs of delivering care are largely unknown. The recent COVID-19 pandemic gives an opportunity to determine costing of an at-home remote service. Utilizing time-driven activity-based costing (TDABC), this article examines the costs required for delivering an at-home oxygen monitoring system for recently discharged COVID-19 patients. Our study sheds light on some of the key cost considerations for delivering this type of care, such as the use of physicians increasing costs relative to using advanced practice providers (APP). Another important cost consideration is whether the patient needed interpreting services, as it increased costs for the provider. These results provide both management and reimbursement implications, particularly with regard to the use of interpreting services. As remote care services continue to grow as a mode of healthcare delivery, it is important for healthcare managers to be aware of the leveraging of APPs when appropriate, as well as what patients may require interpreting services. Payers, particularly government payers, benefit from knowing the cost implications that exist for providers delivering care to patients requiring interpreting services. Moreover, such information could impact future reimbursement policies.

INTRODUCTION

Due to technological advances and higher patient demand, remote care services have increased in the United States.[1-5] Remote healthcare services are a subset of telehealth services that allow patients to receive preventative care or control measures outside of a medical facility.[6] Additionally, healthcare providers have demonstrated various health conditions can be successfully managed using remote care services[7-11] resulting in favorable health outcomes.[8, 11-13] For organizations, remote care services may improve the overall service delivery workflow suggesting decreases in costs.[14-19] Furthermore, given the potential for remote care services to increase patient access and increase efficiencies, policymakers tend to favor its wider adoption.[20-23]

However, remote care services represent a substantial change from traditional office-based care: the remote approach changes the workflows, reimbursement, and costs for health providers. All of these factors influence a provider's financial performance.[24-25] Despite the pervasiveness, success, and interest in remote care services, the actual determination of the costs of delivering care represents a challenge from the provider's perspective.[17] Understanding the financial and reimbursement impacts are vital to offering remote and telehealth services to patients, as these considerations are not readily known.[26] The dramatic increase in remote care services in response to the recent COVID-19 pandemic provides an opportunity to assess the costs of this form of care delivery. Previous studies show the importance of remote care monitoring during the COVID-19 pandemic as a legitimate tool to monitor patients' health remotely to avoid an overburden of on-site resources.[27-28]

Time-driven activity-based costing (TDABC) is a proven technique used in healthcare to estimate service costs.[29-32] TDABC's usage focuses on gathering data in two key areas: the cost of applicable resources, and the time required for using those resources towards the delivery of a health service.[33] This study's purpose is to utilize TDABC to quantify the costs of providing an at-home oxygen monitoring intervention for COVID-19 patients. The findings inform healthcare providers of remote oxygen monitoring care costs and their related cost drivers. Thus, healthcare providers and policymakers become aware of the cost management, and potential reimbursement implications for these types of services.

METHODS

We used key informant interviews with healthcare providers to describe an at-home remote oxygen monitoring program and to obtain inputs for TDABC analyses. TDABC is a simplified version of traditional activity-based costing (ABC), as it takes less time and data to implement as a costing model. Additionally, TDABC applies well to calculating costs for specific medical services.[34-36]

Setting & Virtual Care at Home Program Description

In response to the increased demands for inpatient services during the COVID-19 pandemic, the Indiana Primary Health Care Association (IPHCA) in collaboration with the Indiana Family and Social Services Administration (FSSA) introduced remote patient monitoring. Referred to as *The*

Virtual Care at Home Program, the objective was to provide care to patients who could be effectively managed outside the inpatient setting – thus freeing the state's limited inpatient capacity. Patients included those discharged early from an inpatient admission, or those referred after an emergency department visit. Across the state, 8 community health centers participated in the program and at the time of this evaluation, over 200 COVID-19-diagnosed patients received remote monitoring services.

The Virtual Care at Home Program focused on patients who needed subsequent oxygen care and monitoring. It provided continued patient assessment and condition management for COVID-19-positive patients, and their use of oxygen. The primary means of patient evaluation focused on daily phone calls to the patient's home. The program typically lasted 14 days and consisted of continuous monitoring by a nurse via daily phone calls. The FSSA reimbursed providers at an in-person rate for remote care.

Subjects

In cooperation with Eskenazi Health, an Indianapolis area public hospital system, and Federally Qualified Health Center (FQHC), we interviewed 12 physicians, applicants, and other support staff that worked directly in the Virtual Care at Home Program. We also reviewed protocols, guidelines, and instruction documents prepared by IPHCA to support program delivery. The Indiana University Institutional Review Board approved this study.

Application of TDABC

As a costing method, TDABC granularly determines a healthcare service's costs throughout the cycle of care for a patient.[33] In summary, TDABC begins with an identification of a medical service with defined start and end points. Within this bounded service, TDABC requires the identification of the included activities. Process maps aid in the identification of resources needed for each activity. The time, and the associated costs, are then recorded for each activity. Following this, the computation of a cost capacity rate (CCR) for each activity is determined and applied towards each activity to calculate total service costs.[33] For our study, we applied the traditional TDABC 7-step process to estimate the cost of the Virtual Care at Home Program as follows.

1. Identify the medical service of interest: This analysis was limited to the services directly offered as part of the Virtual Care at Home Program. The program was an outpatient-only service offered through the community health centers, so our analyses excluded inpatient costs associated with COVID-19 admission but included costs from the Emergency Department (ED) and inpatient (IP) discharges. When a patient met clinical guidelines for the Virtual Care at Home Program at discharge, they were referred to ensure remote monitoring services could begin.

2. Define the care delivery chain: Through semi-structured phone interviews with program administrators and staff, we outlined each activity and decision in the administration of the Virtual Care at Home Program. Prior to interviews, the team reviewed program documents to determine the high-level workflow. The key informants then recounted each activity by describing a patient from

enrollment to program end. Activities included those necessary for service delivery and administrative activities. The final list of activities was sent to the organization's primary point of contact as a member check. We described the care delivery chain as a diagram.

3. Identified resources needed: We created data collection sheets that gathered data for each of the direct and indirect cost categories. We identified the direct costs for the two main phases of the program, which were associated with the administration of and actual delivery of the Virtual Care at Home Program. We also captured direct personnel costs needed to oversee the program, and applicable indirect shared services costs.

4. Estimate time requirements: After mapping the delivery chain activities, we created a standardized data collection sheet that captured the time required for each activity along with the relevant salary data. We interviewed personnel to obtain estimates of each activity's time and effort requirements.

5. Calculate cost of resources: The required resources encompassed the actual home oxygen monitor itself, and the needed personnel costs. The personnel costs included the provider, nursing, and other support personnel costs (e.g. interpreting services). We used salary and wage data provided by Eskenazi Health and assumed a 40-hour work week for all the clinicians and support personnel. When Eskenazi was unable to provide certain salary data, published averages were used.

6. The sixth step entailed calculating a cost capacity rate (CCR) for each activity in the care delivery chain. The cost capacity rate is the total costs needed for an activity divided by the time duration for that activity. We computed a CCR in dollars per minute for each activity. For most activities, this meant determining a cost-per-minute rate for a physician or advanced practice provider (APP).

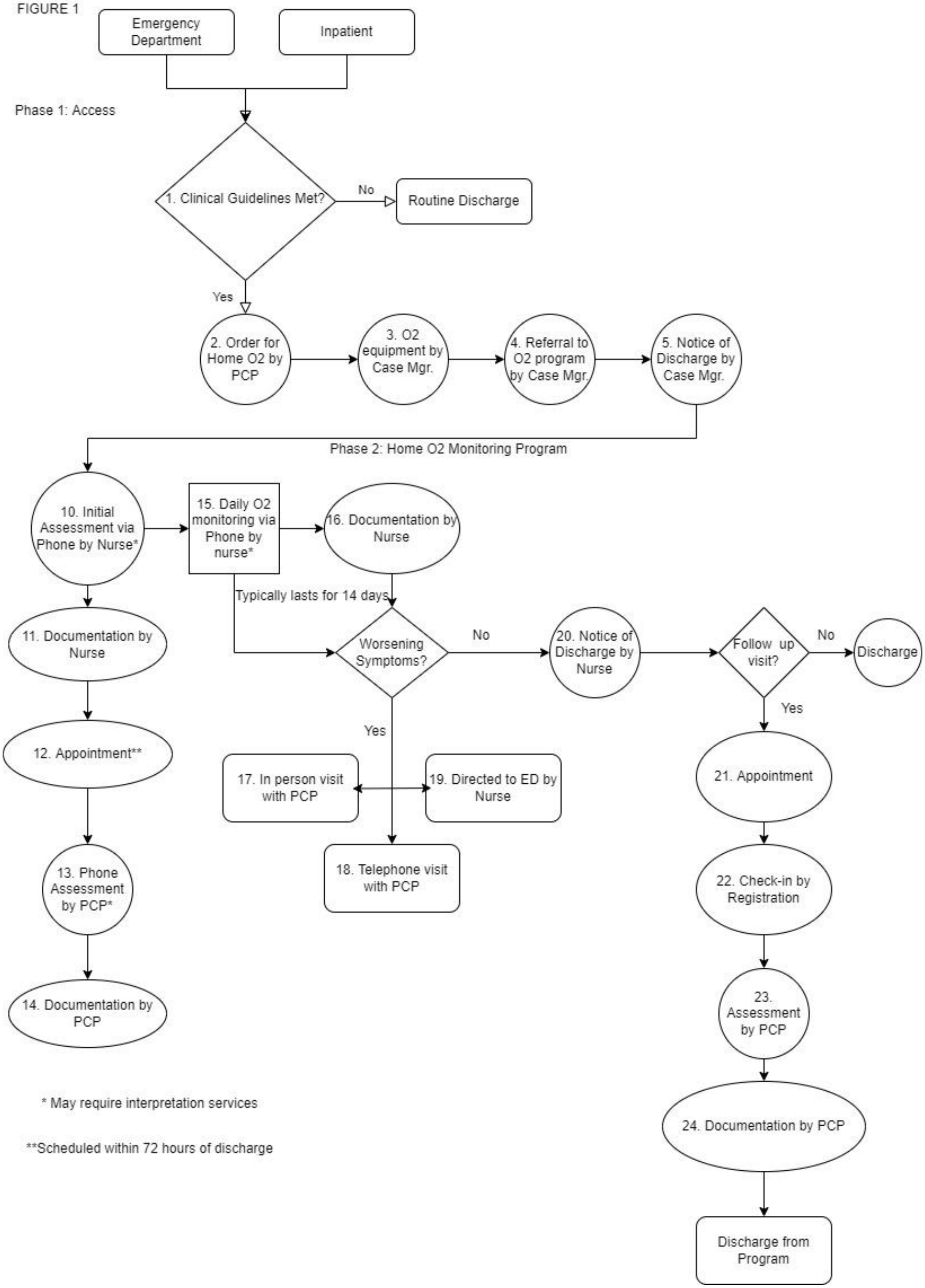
7. Finally, in step seven, we calculated the total costs for implementing the Virtual Care at Home Program. To do this, we calculated the cost of each activity as the time spent in each activity multiplied by the activity's CCR. After computing each activity's cost, we summed the costs of all the activities in the care delivery chain. This final total represented the cost of providing the Virtual Care at Home Program. We reviewed all activities, costs, and time estimates with program staff for verification.

RESULTS

The Virtual Care at Home Program consisted of two phases: An access to care phase, and the actual administration and delivery of the home O_2 monitoring (Figure 1). The access to care phase started after a patient is discharged from the ED or IP setting. The provider then determined if clinical guidelines were met for provision of the Virtual Care at Home Program. When a patient did not meet clinical guidelines, they were classified as a routine discharge and were not referred to the Virtual Care at Home Program.

The administration of the Virtual Care at Home Program began with a nurse's initial patient assessment via phone (figure 1). If the patient did not warrant an in-person appointment, then daily monitoring via phone calls occurred between the nurse and patient. Continued O_2 monitoring typically lasted for 14 days. If during the 14 days, a patient's symptoms worsened, the patient returned for an in-person visit with a primary care provider, and if necessary, sent back to the ER. If conditions did not worsen, the nurse provided a notice of discharge, whereby the patient was either discharged outright or underwent a follow-up in-person appointment with a primary care provider. When the follow-up visit met clinical guidelines for discharge, patients were released from the program.

FIGURE 1



* May require interpretation services

**Scheduled within 72 hours of discharge

Table 1 presents the cost information by activity for the access phase using TDABC. Of note, the first activity, *Provider assessment if guidelines are met*, was considered a part of the discharged inpatient cost center and therefore not attributable to the cost calculation for phase one.

Table 1

PHASE OF CARE: ACCESS	Total Cost
1. Provider assessment if guidelines are met	**$**
2. Order for Home O2 by provider	$18.44
3. Case manager obtains oxygen, cylinder	$33.68
4. Referral to O2 monitoring program	$7.48
5. Notice of discharge by case manager	$7.48
Total Costs (PHASE OF CARE: ACCESS)	$67.09

The second phase of care was the actual delivery and management of the Virtual Care at Home Program – that of oxygen monitoring. Table 2 reports the total cost information for both phases. For the monitoring program, three distinct areas make up the bulk of total costs: (1) the provider assessments, (2) the RN/support staff patient monitoring, and (3) other direct costs. Other direct costs consisted of time allocated to provider and/or executive leadership meetings, revenue cycle costs, food pantry box deliveries, EMR template building, on-call physician services, and the oxygen monitoring system itself.

Finally, interpreting services report the costs associated with using the language line when a patient needed an interpreter while communicating with providers, RNs, and other support staff. Based on our study, the cost of delivering the Virtual Care at Home Program for 14 days to 1 patient ranged from $703-$1298. Costs varied by two key factors: (1) the type of provider used (either a physician or advanced practice provider) and (2) the need for interpreter services. We stratified costs depending on the type of provider at $131.12 per patient. Interpreting services cost $462 per patient for the entire 2-week time period. Approximately 60% of the patients in Eskenazi Health's program required interpreting services.

Table 2: Complete Cost Summary of the Virtual Care at Home Program

PHASE OF CARE	Cost if primary care assessment by MD	Cost if primary care assessment by APP
Access to program from hospital[1] (Case manager orders, referrals)	$67.09	$67.09
Monitoring program – Provider portion (Provider assessments (3x) & additional calls for worsening symptoms)	$262.78	$131.66
Monitoring program (14 days of phone calls, scheduling, discharge visit, documentation, and weekend effort)	$424.30	$424.30
Other direct costs (meetings, executive leadership, community health workers, revenue cycle, equipment)[2]	$82.47	$82.47
Total costs	$836.64	$705.52
Additional costs if interpreter services required[3]	$462.00	$462.00
Total costs including interpreting services	$1,298.64	$1,167.52

1. **MD assessment of patient eligibility for referrals excluded (considered part of inpatient stay costs).**
2. **All costs distributed across all patients in the program.**
3. **Estimated at $2.20 per minute for interpreter phone[37]. Eskenazi estimates that up to 60% of patients require interpreter services via the language line.**

DISCUSSION

Using TDABC methods, this study estimated the cost of delivery for a remote home monitoring service in response to the COVID-19 pandemic to range from $700 to $1300 per patient. Cost estimation is important for healthcare organizations offering remote services, *whether COVID-related or not*, to understand the financial value of these services,[37] particularly in wake of the COVID-19 pandemic.[38]

The TDABC methodology highlighted the two critical cost drivers for this remote service: (a) provider type and (b) the use of interpretation services. It should be stressed that these two factors are *both* relevant for numerous types of remote services. Prior research indicates that the use of "advanced practice" providers instead of physician providers results in lower cost of care delivery in both office-based settings[39-42] and for remote care.[43-44] In our study, using APPs lowered costs and is congruent with industry data. Therefore, health systems will benefit from understanding how to leverage APPs towards relevant services to achieve cost savings.

Additionally, the continued growth in language needs in the United States demands that healthcare organizations meet the linguistic needs of their patients. In this study, interpretation services were both a provider expense and frequently needed. In the US, those that did not have English as their primary language were associated with an increased risk of COVID-19.[45] For organizations considering remote services, a key preliminary step to understanding potential costs will be an adequate assessment of the linguistic needs of their patient populations. The presence of interpreting services for medical providers is known to improve health disparities, access to care,[46,] and the quality of treatment decisions.[47] Moreover, the use of interpreting services decreases long-term care costs for patients with chronic conditions.[48] These findings highlight the importance of considering the cost implications of interpreting services in contracting with payer organizations. For example, only under certain Medicaid plans can providers get reimbursed for interpreting services.[49] Consequently, further study is needed around reimbursement issues regarding the use of interpreting services in order for providers to realistically provide healthcare to non-English speaking patients.

In this study, the use of remote care was driven, at least in part, by threats to health system capacity (i.e. the availability of hospital beds) and public health considerations (i.e. limiting patients' exposure to COVID-positive individuals during treatment, as well as during travel to/from office visits). Nevertheless, apart from worldwide emergencies, remote care delivery is increasing. For example, the recent COVID-19 pandemic spurred telehealth usage. Since April 2020, telehealth for outpatient care grew by 17%, and patient preferences and attitudes towards telehealth improved markedly compared to the pre-pandemic era.[50]

This growth in remote care is also reflected in reimbursement policy. The Centers for Medicare & Medicaid Services expanded the 2021 physician fee schedule for reimbursable telehealth codes.[51] Providers can now better prepare for the financial planning of remote care services. Transparent cost identification and reimbursement all lend themselves to maintaining high-quality financial management of remote care services and, ultimately, the financial viability of the organization.

Multiple methodologies exist to estimate the costs of care. TDABC provides significant benefits as a costing technique. Utilizing TDABC is useful because it enables the calculation of costs for a service at a very granular level without the cumbersome efforts of other costing methods.[33-34] The information needed includes the resources required and the time needed with each component resource that combine to produce the service.[33-34.]

In healthcare, TDABC is relevant as a costing methodology. Its use is pervasive and has been applied for various services, ranging from surgical services[52-57] to outpatient care.[58-61] TDABC is known for being a more efficient method to determine costs than with traditional ABC[54, 57, 62-63] yet provides accurate costing information to manage service delivery[52-53,57] and inform reimbursement policy.[60-61, 64]

Furthermore, this study underscores the importance of understanding the overall workflow and what supportive infrastructure is needed to care for patients in a remote environment. Irrespective of the type of remote care monitoring, creating a seamless infrastructure involves a relevant and detailed workflow, coordination among the care team, and effective communication with the patient. Our study highlighted identifying patient needs, such as interpreting services, as a means to solidify such an infrastructure. The maintenance of hospital and ED capacity is vital, perhaps moreso in a pandemic environment, but critical as well in non-pandemic times. Remote monitoring helps inpatient providers avoid diverting patients elsewhere and facilitates providing post-discharge care. To that end, determining the workflow and costs for providing remote care supports its successful implementation.

Limitations

This study's findings may lack generalizability to other settings and services. The estimated costs were specific to a defined service. Other instances of remote monitoring for COVID-19[39-42] may have resulted in different applied cost methodologies, and cost results. Likewise, salaries and indirect costs may be variable in different institutions or regions. Also, this study did not assess patient experience in contrast to other modes of care delivery or experiences within different provider types. Future work could directly collect and contrast patient experiences under different arrangements while incorporating costs.

CONCLUSION

The continued growth of remote care services proves their importance in the United States healthcare system, with such services significantly galvanized by the recent COVID-19 pandemic. The driving factors of remote care costs for patients with COVID-19 were (a) the type of provider and (b) whether the patient required interpretation services. The TDABC approach provides a granular yet accessible method to determine costing and identifies key cost drivers of a particular health service. Health systems should consider the application of TDABC for *any* relevant analysis of service costing.

REFERENCES

1. Jaffe DH, Lee L, Huynh S, Haskell TP. Health Inequalities in the Use of Telehealth in the United States in the Lens of COVID-19. Population Health Management. 2020 Oct;23(5):368-377. doi: 10.1089/pop.2020.0186. Epub 2020 Aug 18. PMID: 32816644.
2. Hong YR, Lawrence J, Williams D Jr, Mainous III A. Population-Level Interest and Telehealth Capacity of US Hospitals in Response to COVID-19: Cross-Sectional Analysis of Google Search and National Hospital Survey Data. JMIR Public Health Surveill. 2020 Apr 7;6(2):e18961. doi: 10.2196/18961. PMID: 32250963; PMCID: PMC7141249.
3. Omboni S, Padwal RS, Alessa T, Benczúr B, Green BB, Hubbard I, Kario K, Khan NA, Konradi A, Logan AG, Lu Y, Mars M, McManus RJ, Melville S, Neumann CL, Parati G, Renna NF, Ryvlin P, Saner H, Schutte AE, Wang J. The worldwide impact of telemedicine during COVID-19: current evidence and recommendations for the future. Connect Health. 2022 Jan 4;1:7-35. doi: 10.20517/ch.2021.03. PMID: 35233563; PMCID: PMC7612439.
4. Goodridge D, Marciniuk D. Rural and remote care: Overcoming the challenges of distance. Chron Respir Dis. 2016 May;13(2):192-203. doi: 10.1177/1479972316633414. Epub 2016 Feb 21. PMID: 26902542; PMCID: PMC5734598.
5. Donelan K, Barreto EA, Sossong S, Michael C, Estrada JJ, Cohen AB, Wozniak J, Schwamm LH. Patient and clinician experiences with telehealth for patient follow-up care. Am J Manag Care. 2019 Jan;25(1):40-44. PMID: 30667610.
6. Telehealth and Remote Patient Monitoring. (2022, April 22). https://telehealth.hhs.gov/providers/preparing-patients-for-telehealth/telehealth-and-remote-patient-monitoring/
7. Bolton L. Remote Wound Care. Wounds. 2020 Dec;32(12):350-352. PMID: 33472161.
8. Bolton L. Telemedicine Improves Chronic Ulcer Outcomes. Wounds. 2019 Apr;31(4):114-116. PMID: 30924792.
9. Téot L, Geri C, Lano J, Cabrol M, Linet C, Mercier G. Complex Wound Healing Outcomes for Outpatients Receiving Care via Telemedicine, Home Health, or Wound Clinic: A Randomized Controlled Trial. Int J Low Extrem Wounds. 2020 Jun;19(2):197-204. doi: 10.1177/1534734619894485. Epub 2019 Dec 18. PMID: 31852312.
10. Kong LY, Ramirez-GarciaLuna JL, Fraser RDJ, Wang SC. A 57-Year-Old Man with Type 1 Diabetes Mellitus and a Chronic Foot Ulcer Successfully Managed with a Remote Patient-Facing Wound Care Smartphone Application. Am J Case Rep. 2021 Dec 15;22:e933879. doi: 10.12659/AJCR.933879. PMID: 34910717; PMCID: PMC8689370.
11. Qian W, Lam TT, Lam HHW, Li CK, Cheung YT. Telehealth Interventions for Improving Self-Management in Patients With Hemophilia: Scoping Review of Clinical Studies. J Med Internet Res. 2019 Jul 10;21(7):e12340. doi: 10.2196/12340. PMID: 31293241; PMCID: PMC6652120.
12. DeNicola N, Grossman D, Marko K, Sonalkar S, Butler Tobah YS, Ganju N, Witkop CT, Henderson JT, Butler JL, Lowery C. Telehealth Interventions to Improve Obstetric and Gynecologic Health Outcomes: A Systematic Review. Obstet Gynecol. 2020 Feb;135(2):371-382. doi: 10.1097/AOG.0000000000003646. PMID: 31977782; PMCID: PMC7012339.
13. Greiwe, J. (2020). Telemedicine in a post-COVID world: How eConsults can be used to augment an allergy practice. *The Journal of Allergy and Clinical Immunology. in Practice*.
14. Sommer AC, Blumenthal EZ. Telemedicine in ophthalmology in view of the emerging COVID-19 outbreak. Graefes Arch Clin Exp Ophthalmol. 2020 Nov;258(11):2341-2352. doi: 10.1007/s00417-020-04879-2. Epub 2020 Aug 19. PMID: 32813110; PMCID: PMC7436071.

15. Braune K, Boss K, Schmidt-Herzel J, Gajewska KA, Thieffry A, Schulze L, Posern B, Raile K. Shaping Workflows in Digital and Remote Diabetes Care During the COVID-19 Pandemic via Service Design: Prospective, Longitudinal, Open-label Feasibility Trial. JMIR Mhealth Uhealth. 2021 Apr 5;9(4):e24374. doi: 10.2196/24374. PMID: 33571104; PMCID: PMC8023381.
16. Garg S, Williams NL, Ip A, Dicker AP. Clinical Integration of Digital Solutions in Health Care: An Overview of the Current Landscape of Digital Technologies in Cancer Care. JCO Clin Cancer Inform. 2018 Dec;2:1-9. doi: 10.1200/CCI.17.00159. PMID: 30652580.
17. Kichloo A, Albosta M, Dettloff K, Wani F, El-Amir Z, Singh J, Aljadah M, Chakinala RC, Kanugula AK, Solanki S, Chugh S. Telemedicine, the current COVID-19 pandemic and the future: a narrative review and perspectives moving forward in the USA. Fam Med Community Health. 2020 Aug;8(3):e000530. doi: 10.1136/fmch-2020-000530. PMID: 32816942; PMCID: PMC7437610.
18. Kadir, M. A. (2020). Role of telemedicine in healthcare during COVID-19 pandemic in developing countries. *Telehealth and Medicine Today*.
19. Hur J, Chang (2020). Usefulness of an Online Preliminary Questionnaire under the COVID-19 Pandemic. *MC J Med Syst. 2020 May 19; 44(7):116.*
20. Gaziel-Yablowitz M, Bates DW, Levine DM. Telehealth in US hospitals: State-level reimbursement policies no longer influence adoption rates. Int J Med Inform. 2021 Sep;153:104540. doi: 10.1016/j.ijmedinf.2021.104540. Epub 2021 Jul 22. PMID: 34332467.
21. Huilgol YS, Miron-Shatz T, Joshi AU, Hollander JE. Hospital Telehealth Adoption Increased in 2014 and 2015 and Was Influenced by Population, Hospital, and Policy Characteristics. Telemed J E Health. 2020 Apr;26(4):455-461. doi: 10.1089/tmj.2019.0029. Epub 2019 May 23. PMID: 31120388.
22. Hong YR, Lawrence J, Williams D Jr, Mainous III A. Population-Level Interest and Telehealth Capacity of US Hospitals in Response to COVID-19: Cross-Sectional Analysis of Google Search and National Hospital Survey Data. JMIR Public Health Surveill. 2020 Apr 7;6(2):e18961. doi: 10.2196/18961. PMID: 32250963; PMCID: PMC7141249.
23. Chen J, Amaize A, Barath D. Evaluating Telehealth Adoption and Related Barriers Among Hospitals Located in Rural and Urban Areas. J Rural Health. 2021 Sep;37(4):801-811. doi: 10.1111/jrh.12534. Epub 2020 Nov 12. PMID: 33180363; PMCID: PMC8202816.
24. Assessing Organizational Readiness: Is Your Organization Ready for Telemedicine? Sacramento, CA, California Telemedicine and eHealth Center, 2009. http://www.caltrc.org/wp-content/uploads/ 2013/10/08-1129-final_ctec_discovery_series.pdf 15.
25. Ross J, Stevenson F, Lau R, et al: Factors that influence the implementation of e-health: a systematic review of systematic reviews (an update). Implement Sci 2016; 11:146.
26. Haque, S. N. (2021). Telehealth beyond COVID-19. *Psychiatric Services*, *72*(1), 100-103.
27. Sherlaw-Johnson, C., Georghiou, T., Morris, S., Crellin, N. E., Litchfield, I., Massou, E., ... & Fulop, N. J. (2022). The impact of remote home monitoring of people with COVID-19 using pulse oximetry: A national population and observational study. *EClinicalMedicine*, *45*, 101318.
28. Alboksmaty, A., Beaney, T., Elkin, S., Clarke, J. M., Darzi, A., Aylin, P., & Neves, A. L. (2022). Effectiveness and safety of pulse oximetry in remote patient monitoring of patients with COVID-19: a systematic review. *The Lancet Digital Health*, *4*(4), e279-e289. .

29. Au J, Rudmik L. Cost of outpatient endoscopic sinus surgery from the perspective of the Canadian government: a time-driven activity-based costing approach. International Forum of Allergy & Rhinology 2013;3:748–54.
30. Balakrishnan K, Goico B, Arjmand EM. Applying cost accounting to operating room staffing in otolaryngology: time-driven activity-based costing and outpatient adenotonsillectomy. Otolaryngology-Head and Neck Surgery 2015;152:684–90.
31. Box AC, Park J, Semerad CL, Konnesky J, Haug JS. Cost accounting method for cytometry facilities. Cytometry A 2012;81:439–44.
32. Campanale C, Cinquini L, Tenucci A. Time-driven activity-based costing to improve transparency and decision making in healthcare. Management 2014; 11:165-186.
33. Kaplan RS, Porter ME. How to solve the cost crisis in health care. Harv Bus Rev. 2011;89:46-52.
34. Sharan, A. D. , Schroeder, G. D. , West, M. E. & Vaccaro, A. R. (2016). Understanding Time-driven Activity-based Costing. *Clinical Spine Surgery, 29* (2), 62-65. doi: 10.1097/BSD.0000000000000360.
35. Keel G, Savage C, Rafiq M, Mazzocato P. Time-driven activity-based costing in health care: A systematic review of the literature. Health Policy. 2017 Jul;121(7):755-763. doi: 10.1016/j.healthpol.2017.04.013. Epub 2017 May 10. PMID: 28535996.
36. Niñerola A, Hernández-Lara AB, Sánchez-Rebull MV. Improving healthcare performance through Activity-Based Costing and Time-Driven Activity-Based Costing. Int J Health Plann Manage. 2021 Nov;36(6):2079-2093. doi: 10.1002/hpm.3304. Epub 2021 Aug 24. PMID: 34428325.
37. Bergmo T. S. (2015). How to Measure Costs and Benefits of eHealth Interventions: An Overview of Methods and Frameworks. *Journal of medical Internet research*, *17*(11), e254. https://doi.org/10.2196/jmir.4521
38. Medicare Cost Trend: Behind the Numbers- Pwc 2022. Available: https://www.pwc.com/us/en/industries/health-industries/library/assets/pwc-hri-behind-the-numbers-2022.pdf
39. Middleton A, Simpson KN, Bettger JP, Bowden MG. COVID-19 Pandemic and Beyond: Considerations and Costs of Telehealth Exercise Programs for Older Adults With Functional Impairments Living at Home-Lessons Learned From a Pilot Case Study. Phys Ther. 2020 Aug 12;100(8):1278-1288. doi: 10.1093/ptj/pzaa089. PMID: 32372072; PMCID: PMC7239185.
40. Tenforde AS, Borgstrom H, Polich G, Steere H, Davis IS, Cotton K, O'Donnell M, Silver JK. Outpatient Physical, Occupational, and Speech Therapy Synchronous Telemedicine: A Survey Study of Patient Satisfaction with Virtual Visits During the COVID-19 Pandemic. Am J Phys Med Rehabil. 2020 Nov;99(11):977-981. doi: 10.1097/PHM.0000000000001571. PMID: 32804713; PMCID: PMC7526401.
41. Weiner JP, Bandeian S, Hatef E, Lans D, Liu A, Lemke KW. In-Person and Telehealth Ambulatory Contacts and Costs in a Large US Insured Cohort Before and During the COVID-19 Pandemic. JAMA Netw Open. 2021 Mar 1;4(3):e212618. doi: 10.1001/jamanetworkopen.2021.2618. PMID: 33755167; PMCID: PMC7988360.
42. Yen YF, Tsai YF, Su VY, Chan SY, Yu WR, Ho H, Hou CM, Chen CC, Woung LC, Huang SJ. Use and Cost-Effectiveness of a Telehealth Service at a Centralized COVID-19 Quarantine Center in Taiwan: Cohort Study. J Med Internet Res. 2020 Dec 11;22(12):e22703. doi: 10.2196/22703. PMID: 33259324; PMCID: PMC7735809.

43. Wolff-Baker D, Ordona RB. The Expanding Role of Nurse Practitioners in Home-Based Primary Care: Opportunities and Challenges. J Gerontol Nurs. 2019 Jun 1;45(6):9-14. doi: 10.3928/00989134-20190422-01. PMID: 31135933.
44. Yao NA, Rose K, LeBaron V, Camacho F, Boling P. Increasing Role of Nurse Practitioners in House Call Programs. J Am Geriatr Soc. 2017 Apr;65(4):847-852. doi: 10.1111/jgs.14698. Epub 2016 Dec 28. PMID: 28029709.
45. Cohen-Cline, H., Li, HF., Gill, M. [44]*et al.* Major disparities in COVID-19 test positivity for patients with non-English preferred language even after accounting for race and social factors in the United States in 2020. *BMC Public Health* **21,** 2121 (2021).
46. Jacobs, E. A., Shepard, D. S., Suaya, J. A., & Stone, E. L. (2004). Overcoming language barriers in health care: costs and benefits of interpreter services. *American journal of public health*, *94*(5), 866-869.
47. Hampers, L. C., & McNulty, J. E. (2002). Professional interpreters and bilingual physicians in a pediatric emergency department: effect on resource utilization. *Archives of pediatrics & adolescent medicine*, *156*(11), 1108-1113.
48. Bischoff A, Denhaerynck K. What do language barriers cost? An exploratory study among asylum seekers in Switzerland. BMC Health Serv Res. 2010;10(1):248.
49. Shah, S. A., Velasquez, D. E., & Song, Z. (2020, October). Reconsidering reimbursement for medical interpreters in the era of COVID-19. In *JAMA Health Forum* (Vol. 1, No. 10, pp. e201240-e201240). American Medical Association.
50. Bestsennyy et al. (2021, July 9). Telehealth: A Quarter Trillion Dollar Post Covid-19 Reality? https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality
51. Center for Medicare & Medicaid Services. (2021, November 2). CMS Physician Payment Rule Promotes Greater Access to Telehealth Services, Diabetes Prevention Programs. Available: https://www.cms.gov/newsroom/press-releases/cms-physician-payment-rule-promotes-greater-access-telehealth-services-diabetes-prevention-programs
52. Au J, Rudmik L. Cost of outpatient endoscopic sinus surgery from the perspective of the Canadian government: a time-driven activity-based costing approach. International Forum of Allergy & Rhinology 2013;3:748–54.
53. Balakrishnan K, Goico B, Arjmand EM. Applying cost accounting to operating room staffing in otolaryngology: time-driven activity-based costing and outpatient adenotonsillectomy. Otolaryngology-Head and Neck Surgery 2015;152:684–90.
54. Chen A, Sabharwal S, Akhtar K, Makaram N, Gupte CM. Time-driven activity based costing of total knee replacement surgery at a London teaching hospital. The Knee 2015;22:640–5.
55. DiGioia 3rd AM, Greenhouse PK, Giarrusso ML, Kress JM. Determining the true cost to deliver total hip and knee arthroplasty over the full cycle of care: preparing for bundling and reference-based pricing. The Journal ofArthroplasty 2016;31:1–6.
56. Donovan CJ, Hopkins M, Kimmel BM, Koberna S, Montie CA. How cleveland clinic used TDABC to improve value. Health Finance Management 2014;68:84–8.
57. Erhun F, Mistry B, Platchek T, Milstein A, Narayanan VG, Kaplan RS. Time-driven activity-based costing of multivessel coronary artery bypass grafting across national boundaries to identify improvement opportunities: study protocol. British Medical Journal Open 2015;5:e008765.

58. Demeere N, Stouthuysen K, Roodhooft F. Time-driven activity-based costing in an outpatient clinic environment: development, relevance and managerial impact. Health Policy 2009;92:296–304.
59. French KE, Albright HW, Frenzel JC, Incalcaterra JR, Rubio AC, Jones JF, et al. Measuring the value of process improvement initiatives in a preoperative assessment center using time-driven activity-based costing. Healthcare 2013;1:136–42.
60. Inverso G, Lappi MD, Flath-Sporn SJ, Heald R, Kim DC, Meara JG. Increasing value in plagiocephaly care: a time-driven activity-based costing pilot study. Annals of Plastic Surgery 2015;74:672–6.
61. Kaplan RS, Witkowski ML, Hohman JA. Boston Children's Hospital: Measuring Patient Costs; 2013. Harv Bus Rev Boston, MA: Harv Bus Rev.
62. Gao NN, Liu ZX, Li YF. Estimating the hidden costs of operating room with time-driven activity-based costing. 19th International Conference on Industrial Engineering and Engineering Management 2013: 87-94.
63. Kaplan, A. L., Agarwal, N., Setlur, N. P., Tan, H. J., Niedzwiecki, D., McLaughlin, N., ... & Saigal, C. S. (2015, March). Measuring the cost of care in benign prostatic hyperplasia using time-driven activity-based costing (TDABC). In *Healthcare* (Vol. 3, No. 1, pp. 43-48).
64. Öker, F., & Özyapici, H. (2013). A new costing model in hospital management: time-driven activity-based costing system. *The health care manager, 32*(1), 23-36.