Table 1. Characteristics of included studies

| <!--Col Count:4-->First Author (Date)  Study Purpose | Design, Intervention, Comparison | Setting, Sample, Study Period | Measures, Outcomes, Results |
| --- | --- | --- | --- |
| Davis, C (2019).  Purpose: Compare antibiotic prescribing patterns for acute sinusitis when patients are treated with virtual urgent care versus in-person urgent care services | Design: Retrospective cohort study with matching  Intervention: Virtual urgent care using live interactive video (n = 35, 61%) and telephone (n = 22; 39%); providers have access to UCHealth's Epic health records; board-certified or board-eligible emergency physicians  Comparison: In-person urgent care services, primarily delivered by nurse practitioners and physician assistants | Setting: UCHealth System, USA, Colorado  Sample:   Intervention group: 57 patients older than 18 years, diagnosed with acute sinusitis treated in virtual urgent care   Comparison group: 100 patients older than 18 years treated for acute sinusitis at an in-person urgent care center  Study period: September 1, 2016—September 11, 2017 | Measures and outcomes: Antibiotic prescribing for acute sinusitis visits (%)  Results:   Antibiotic prescribed:    Virtual urgent care: 67% of visits (n = 39)    Traditional urgent care visits: 92% (n = 92) (*p* < .001) |
| Johnson, K (2019)  Purpose: Compare guideline-concordant diagnosis, antibiotic prescribing, and unplanned revisits for sinusitis between virtual visits and in-office visits for patients treated for acute sinusitis | Design: Retrospective cohort study  Intervention: Virtual visit conducted within a PCP network; text-based format using Zipnosis platform with patient symptom questionnaire, patient summary, and display of diagnostic criteria–based national guidelines and drop-down menu of treatment options; delivered by physician and advanced practice PCPs  Comparison: In-person office visits within same primary care network; delivered by physician and advanced practice PCPs | Setting: Primary care provider network in Grand Rapids, Michigan, USA  Sample:   Intervention group: 175 patients ≥ 18 years, diagnosed with acute sinusitis by virtual visits   Comparison group: 175 patients ≥ 18 years, diagnosed with acute sinusitis by in-person office-visit  Study period: January 1, 2018–July 30, 2018 | Measures and outcomes:  Antibiotic prescribing (%), guideline-concordant antibiotic prescribing (%), guideline-concordant duration of antibiotic therapy (%), guideline-concordant sinusitis diagnosis (%), unplanned revisit rates within 24 hours and within 30 days of initial visit (%)  Results:   Antibiotic prescribed:    Virtual visit: 68.6%    Office visit: 94.3% (*p* < .001)   Guideline-concordant antibiotic prescribing:    Virtual visit: 67.5%    Office visit: 64.8% (*p* = .641)   Guideline-concordant diagnosis:    Virtual visit: 69.1%    Office visit: 45.7% (*p* < .001)   Unplanned revisits within 24 hours:    Virtual visit: 8%    Office visit: 1.7% (*p* = .006)   Unplanned revisits within 30 days:    Virtual visit: 14.9%    Office visit: 7.4% (*p* = .027) |
| Shi, Z (2018)  Purpose: Compare the quality of care provided during direct-to-consumer telemedicine visits with primary care visits and urgent care visits, based on antibiotic management among patients with acute respiratory infections | Design: Retrospective cohort study with matching  Intervention: Virtual visits with commercial DTC telemedicine companies; conducted with real-time audio and audiovisual  Comparison: In-person visits with primary care physicians and advanced practice providers in clinics and urgent care centers | Setting: Large national commercial insurer; USA  Sample: Adults, ages 18–64 years, with ARI symptoms and pharmaceutical coverage at the time of visit   Matched weighted sample:    DTC telemedicine visits: 38,839    PCP visits: 942,613    Urgent care visits: 186,016  Study period: 2015-2016 | Measures and outcomes: Antibiotic prescribing based on pharmaceutical claims (%), broad-spectrum antibiotic prescribing (%), guideline-concordant antibiotic prescribing (%), strep testing with a strep pharyngitis diagnosis (%)  Results:   Antibiotic prescribed, matched sample:    DTC virtual visit: 52%    PCP visit: 53% (*p* < .01)    Urgent care visit: 56% (*p* < .001)   Antibiotic prescribed, unmatched sample:    DTC virtual visit: 52%    PCP visit: 50% (*p* < .001)    Urgent care visit: 53% (*p* < .001)   Broad-spectrum antibiotic use, matched sample:    DTC virtual visit: 27%    PCP visit: 29% (*p* < .001)    Urgent care visit: 28% (*p* < .001)   Guideline-concordant antibiotic prescribing, matched sample:    DTC virtual visit: 62%    PCP visit: 60% (*p* < .001)    Urgent care visit: 59% (*p* < .001)   Strep testing:    DTC virtual visit: 1%    PCP visit: 67% (*p* < .001)    Urgent care visit: 78% (*p* < .001) |
| Tan, L (2017)  Purpose: Compare outcomes between virtual visits and in-person urgent care visits for viral URI, specifically the frequency of follow-up visits and antibiotic prescribing | Design: Retrospective cohort study  Intervention: Virtual visits conducted using American Well platform; mostly audiovisual visits; delivered by salaried physicians and advanced practice providers (APPs) with access to electronic medical record  Comparison: In-person urgent care visits; staffed by physicians and APPs | Setting: Southwest Medical multispecialty group in Las Vegas, NV, USA  Sample:   Intervention group: 382 adults, ages 18–64 years, diagnosed with upper respiratory tract infection by virtual visit   Comparison group: 6,373 adults, ages 18–64 years, diagnosed with URI by in-person urgent care visit  Study period: January 2014—September 2014 | Measures and outcomes: Follow-up within 14 days of the initial visit for worsening condition, development of a complication, or initial misdiagnosis (%), antibiotic prescribing (%)  Results:   Antibiotic prescription:    Virtual visits: 25%    Urgent care visits: 21%   Follow-up within 14 days of initial visit:    Virtual visits: 4%    Urgent care visits: 26% (*p* < .0002) |
| Uscher-Pines, L (2015)  Purpose: Compare antibiotic prescribing rates for acute respiratory infections between treatment by DTC telemedicine visits and in-person physician office visits | Design: Retrospective cohort study  Intervention: Teladoc DTC telemedicine virtual visits; mostly occurred via telephone; private for-profit company  Comparison: In-person physician office visits | Setting: CalPERS, USA  Sample:   Intervention group: 1,219 Teladoc visits for acute respiratory infection by CalPERS members, aged 18–64 years   Comparison group: 85,149 ARTI in-person visits by CalPERS members, aged 18–64 years  Study period: April 2012—October 2013 | Measures and outcomes: Antibiotic prescribing (%), broad-spectrum antibiotic prescription (%)  Results:   Antibiotic prescribed, adjusted:    Teladoc visits: 58%    In-person visits: 55% (*p* = .07)   Antibiotic prescribed for all acute respiratory infections, unadjusted:    Teladoc visits: 55.7%    In-person visits: 55.3% (*p* = .79)   Broad-spectrum antibiotic use, adjusted:    Teladoc visits: 86%    In-person visits: 56% (*p* < .01)   Broad-spectrum antibiotic use, unadjusted:    Teladoc visits: 86.5%    In-person visits: 56.3% (*p* < .01) |
| Uscher-Pines, L (2016)  Purpose: Compare quality of care provided during DTC telemedicine visits versus in-person office visits, using Healthcare Effectiveness Data and Information Set measures | Design: Retrospective cohort study  Intervention: Teladoc DTC telemedicine virtual visits; mostly occur via telephone; private for-profit company  Comparison: In-person physician office visits | Setting: CalPERS, California, USA  Sample:   Intervention group: 1,219 Teladoc visits for acute respiratory infection by CalPERS members, aged 18–64 years   Comparison group: 85,149 in-person visits for acute respiratory infection by CalPERS members, aged 18–64 years  Study period: April 2012—October 2013 | Measures and outcomes: Avoidance of antibiotics in adults with acute bronchitis (%), appropriate testing for pharyngitis (%)<!--Para Run-on-->  Results:   Avoidance of antibiotics for acute bronchitis based, HEDIS measure:    Teladoc visits: 16.7%    In-person visits: 27.9% (*p* < .01)   Appropriate testing for pharyngitis:    Teladoc visits: 3.4%    In-person visits: 49.5% (*p* < .01) |
| Yao, P (2020)  Purpose: Compare antibiotic prescribing for acute respiratory infections between patients treated with telemedicine and in-person ED care | Design: Retrospective cohort study with matching  Intervention: Telemedicine visits in two urban EDs with audiovisual conferencing; staffed by ED physicians  Comparison: In-person visits at the same two EDs as the telemedicine service | Setting: NY Presbyterian hospitals, one community hospital and one tertiary care center, New York, NY, USA  Sample:   Intervention group: 260 patients, aged 18 years and older, treated for ARTI by telemedicine   Comparison group: 260 patients, aged 18 years and older, treated for ARTI at in-person ED;  Matched by diagnosis, treatment hospital, and ESI triage level  Study period: July 2016—September 2017 | Measures and outcomes: Antibiotic prescribing (%)  Results:   Antibiotics prescribed:    Telemedicine visits: 29%    In-person ED visits: 28% *(p* = .846) |

NOTE: ARTI = acute respiratory tract infection; ARI = acute respiratory infection; CalPERS, California Public Employees' Retirement System; DTC = direct to consumer; ED = emergency department; ESI = Emergency Severity Index; PCP, primary care provider.

Table 2. Excluded studies

| <!--Col Count:3-->Author and Date | Reference | Reason for Exclusion |
| --- | --- | --- |
| Brunett (2015) | Brunett, P. H., DiPiero, A., Flores, C., Choi, D., Kum, H., & Girard, D. E. (2015). Use of a voice and video internet technology as an alternative to in-person urgent care clinic visits. *Journal of Telemedicine and Telecare,* 21(4), 219–226. doi: 10.1177/1357633X15571649 | Ineligible comparison: Analyzed antibiotic prescriptions for virtual visits compared with virtual visits that were completed at an in-person visit; included ARTIs and other diagnoses; however, did not stratify results by diagnosis |
| Chaiyachati (2019) | Chaiyachati, K. H., Snider, C. K., Mitra, N., Huffenberger, A. M., Hanson, B., Kruse, G., Mahraj, K., Mehta, S., & Asch, D. A. (2019). Cost and utilization outcomes for a telemedicine-based urgent care clinic offered to employees at a large academic medical center. *Journal of General Internal Medicine,* 34(2), S177. doi: 10.1007/11606.1525-1497 | Ineligible outcome measure: Analyzed the cost of virtual urgent care compared with conventional in-person treatment |
| Clark (2019) | Clark, S., Greenwald, P. W., Gogia, K., Hafeez, B., & Hsu, H. (2019). Differences in antibiotics prescriptions for telehealth in the emergency department vs direct-to-consumer encounters. *Academic Emergency Medicine,* 26(S1), page S70. doi: 10.1111/acem.13756 | Ineligible comparison: Compared antibiotic prescriptions for ARTIs for adults treated by telemedicine while physically in the ED and those treated by DTC telemedicine |
| Dvorin (2020) | Dvorin, E. L., Rothberg, M. B., Rood, M. N., & Martinez, K. A. (2020). Corticosteroid use for acute respiratory tract infections in direct-to-consumer telemedicine. *The American Journal of Medicine,* 133(8), e399-e405. doi: 10.1016/j.amjmed.2020.02.014 | Ineligible treatment: Examined corticosteroid prescriptions for ARTIs in DTC telemedicine; does not examine antibiotic prescriptions |
| Foster (2019) | Foster, C. B., Martinez, K. A., Sabella, C., Weaver, G. P., & Rothberg, M. B. (2019). Patient satisfaction and antibiotic prescribing for respiratory infections by telemedicine. *Pediatrics,* 144(3), e20190844. doi: 10.1542/peds.2019-0844 | Ineligible population and no comparison: Analyzed antibiotic prescriptions, visit length, and patient satisfaction at pediatric ARTI visits during DTC telemedicine visits |
| Gordon (2017) | Gordon, A. S., Adamson, W. C., & DeVries, A. R. (2017). Virtual visits for acute, nonurgent care: A claims analysis of episode-level utilization. *Journal of Medical Internet Research, 19*(2), e35. doi: 10.2196/jmir.6783 | Ineligible population: Included all patients younger than 65 years, including children, and did not stratify results by age; could not identify adult-specific results |
| Halpren-Ruder (2019) | Halpren-Ruder, D., Chang, A. M., Hollander, J. E., & Shah, A. (2019). Quality assurance in telehealth: Adherence to evidence-based indicators. *Telemedicine Journal and E-Health,* 25(7), 599–603. doi: 10.1089/tmj.2018.0149 | Ineligible population: Included pediatric and adult patients; results were not stratified by age |
| Hertzog (2019) | Hertzog, R., Johnson, J., Smith, J., McStay, F. W., Graca, B., Haneke, T., Heavener, T., & Couchman, G. R. (2019). Diagnostic accuracy in primary care e-visits: Evaluation of a large integrated health care delivery system's experience. *Mayo Clinical Proceedings,* 94(6), 976–984. doi: 10.1016.j.mayocp.2019.02.011 | Ineligible outcomes and population: Studied diagnostic accuracy; included pediatric and adult participants and did not stratify results by age |
| Llor (2019) | Llor, C., Boel, M., Cordoba, G., & Bjerrum, L. (2019). Antibiotic prescribing for respiratory tract infections and encounter length. *Annals of Internal Medicine,* 171(2), 149–150. doi: 10.7326/L19-0263 | Not a study; Letter to the editor regarding a published manuscript |
| Lovell (2019) | Lovell, T., Albritton, J., Dalto, J., Ledward, C., & Daines, W. (2019). Virtual vs traditional care settings for low-acuity urgent conditions: An economic analysis of cost and utilization using claims data. *Journal of Telemedicine and Telecare,* 27(1), 59–65. doi: 10.1177/1357633X19861232 | Population eligibility is unclear: Compared antibiotic prescription and follow-up visits for virtual visits and in-person visits, but did not stratify results by age or diagnosis |
| Martinez (2018a) | Martinez, K. A., Rood, M., Jhangiani, N., Kou, L., Rose, S., Boissy, A., & Rothberg, M. B. (2018a). Patterns of use and correlates of patient satisfaction with a large nationwide direct to consumer telemedicine service. *Journal of General Internal Medicine,* 33(10), 1768–1773. doi: 10.1007/s11606-018-4621-5 | Cross-sectional study; ineligible outcome; no comparison; assessed factors associated with patient satisfaction who received care through a large DTC telemedicine service |
| Martinez (2018b) | Martinez, K. A., Rood, M., Jhangiani, N., Kou, L., Boissy, A., & Rothberg, M. B. (2018b). Association between antibiotic prescribing for respiratory tract infections and patient satisfaction in direct-to-consumer telemedicine. *JAMA Internal Medicine,* 178(11), 1558–1560. doi: 10.1001/jamainternalmed.2018.4318 | Ineligible comparison: Examined patterns of use antibiotic prescribing rates within a large DTC telemedicine service but did not compare outcomes to in-person visits |
| Martinez (2019) | Martinez, K. A., Rood, M., Jhangiani, N., Boissy, A., & Rothberg, M. B. (2019). Antibiotic prescribing for respiratory tract infections and encounter length: An observational study of telemedicine. *Annals of Internal Medicine,* 170(4), 275–277. doi: 10.7326/M18-2042 | No comparison: Reported antibiotic prescribing in telemedicine, visits; however, did not include comparison group or data; the focus was associations between visit length and antibiotic prescribing |
| Mehrotra (2013) | Mehrotra, A., Paone, S., Martich, G. D., Albert, S. M., & Shevchik, G. J. (2013). A comparison of care at e-visits and physician office visits for sinusitis and urinary tract infection. *JAMA Internal Medicine,* 173(1), 72–74. doi: 10.1001/2013.jamainternmed.305 | Population eligibility is unclear: Did not specify age population in this study; unsure whether pediatric patients were included |
| Patel (2016) | Patel, Y. M. (2016). Variation in quality of care among virtual urgent care providers. *Find Brief,* 42(8), 1–3 | Ineligible comparison: Compared outcomes between different virtual urgent care providers but not in-person visits |
| Penza (2018) | Penza, K. S., Murray, M. A., Pecina, J. L., Myers, J. F., & Furst, J. W. (2018). Electronic visits for minor acute illnesses: Analysis of patient demographics, prescription rates, and follow-up care within an asynchronous text-based online visit. *Telemedicine and e-health,* 24(3), 210–215. doi: 10.1089/tmj.2017.0091 | Ineligible comparison: Examined antibiotic prescription rates and follow-up care within virtual visits but did not compare to in-person visits |
| Player (2018) | Player, M., O'Bryan, E., Sederstrom, E., Pinckney, J., & Diaz, V. (2018). Electronic visits for common acute conditions: Evaluation of a recently established program. *Health Affairs,* 37(12), 2024–2030. doi: 10.1377/hlthaff.2018.05122 | Ineligible comparison: Evaluated virtual visits, but did not compare to in-person visits |
| Rood (2017) | Rood, M. N., Martinez, K. A., Jhangiani, N., Boissy, A., & Rothberg, M. B. (2017). Prescription of antibiotics in a primary care telemedicine service: Association with patient satisfaction and visit length. *Journal of General Internal Medicine,* 32(2), S285 | Ineligible comparison: Examined antibiotic prescription rates during virtual visits but did not compare rates to in-person visits |
| Rothberg (2020) | Rothberg, M. B. & Martinez, K. A. (2020). Influenza management via direct to consumer telemedicine: An observational study. *Journal of General Internal Medicine,* 35(10), 3111–3113. doi: 10.1007/s11606-020-05640-5 | Ineligible treatment: Examined influenza management in telemedicine visits with antivirals and did not mention the use of antibiotics in this setting |
| Schmidt (2017) | Schmidt, M., Spencer, M. D., & Davidson, L. E. (2017). Antimicrobial prescribing rates comparing on-site visits with two types of virtual care visits across a large integrated health care system. *Open Forum Infectious Diseases,* 4(Suppl 1), S506-S507. doi: 10.1093/ofid/ofx163.1312 | Unclear population: Did not specify age range of population studied; abstract from poster presentation |
| Schoenfeld (2016) | Schoenfeld, A. J., Davies, J. M., Marafino, B. J., Dean, M., DeJong, C., Bardach, N. S., Kazi, D. S., Boscardin, J., Lin, G. A., Duseja, R., Mei, J., Mehrotra, A., & Dudley, R. A. (2016). Variation in quality of urgent health care provided during commercial virtual visits. *JAMA Internal Medicine, 176*(5), 635–642. doi: 10.1001/jamainternmed.2015.8248 | Ineligible comparison: Compared quality of care between different telemedicine companies but did not compare to in-person settings |
| Shah (2017) | Shah, A., Chang, A. M., Hollander, J. E., & Halpren-Ruder, D. (2017). Quality assurance in telehealth: Adherence to evidence-based indicators. *Annals of Emergency Medicine, 70*(4), s131-s132. doi: 10.1016/j.annemergmed.2017.07.403 | Population eligibility is unclear: Study did not include all of the information to determine whether inclusion and exclusion criteria were met |
| Smith (2016) | Smith, K. L. (2016, May 15). Sinusitis treatment guideline adherence in the e-visit setting: A performance improvement project. Abstracts from The American Telemedicine Association 2016 Annual Meeting and Trade Show. *Telemedicine and e-Health, Session 1,* A3. doi: 10.1089/tmj.2016.29004-A.abstracts | Ineligible study design and study aim: pretest posttest quality improvement project; evaluated a multimodal clinician intervention aimed at improving improving adherence to practice guidelines in an e-visit setting |
| Stenehjem (2019) | Stenehjem, E., Wallin, A., Fleming-Dutra, K. E., Buckel, W. R., Stanfield, V., Brunisholz, K. D., Sorensen, J., Samore, M. H., Srivastava, R., Hicks, L. A., & Hersh, A. L. (2019). Antibiotic prescribing variability in a large urgent care network: A new target for outpatient stewardship. *Health care Epidemiology,* 70, 1781–1787. doi: 10.1093/cid/ciz910 | Ineligible setting: Study was conducted in in-person urgent care settings rather than telehealth |

Note: ARTI = acute respiratory tract infection; DTC = direct to consumer; ED = emergency department.