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Antibiotic prescribing for acute infections in synchronous telehealth consultations: a systematic review and meta-analysis

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Abstract

Background

Antibiotic prescribing is a major concern that contributes to the problem of antibiotic resistance.

Aim

To assess the effect on antibiotic prescribing in primary care of telehealth (TH) consultations compared to face-to-face (F2F).

Design and setting

Systematic review and meta-analysis of adult or paediatric patients with a history of a community acquired acute infection (respiratory, urinary, or skin and soft tissue). We included studies that compared synchronous TH consultations (phone or video based) to F2F consultations in primary care.

Methods

We searched PubMed, Embase, Cochrane CENTRAL (inception-2021), clinical trial registries and citing-cited references of included studies. Two review authors independently screened the studies and extracted the data.

Results

We identified 13 studies. The one small randomized controlled trial found a non-significant 25% relative increase in antibiotic prescribing in the TH group. The remaining 10 were observational studies but did not control well for confounding, and therefore at high risk of bias. When pooled by specific infections, there was no consistent pattern. The six studies of sinusitis – including one before-after study - showed significantly less prescribing for acute rhinosinusitis in TH consultations, whereas the two studies of acute otitis media showed a significant increase. Pharyngitis, conjunctivitis, and urinary tract infections showed not-significant higher prescribing in the TH group. Bronchitis showed no change.

Conclusions

The impact of telehealth on prescribing appears to vary between conditions with more increases than reductions. However, there is insufficient evidence to draw strong conclusions, and higher quality research is urgently needed.

Keywords: Anti-Bacterial Agents, Respiratory Tract Infections, Urinary Tract Infections, Telemedicine, primary health care

How this fits in

Acute infections are commonly treated with antibiotics adding to the problem of antibiotic resistance. Due to the coronavirus pandemic (COVID-19), there was a shift towards remote consultations to decrease the risk of infection and transmission. However, it is not clear if telehealth consultations are contributing to antibiotic overuse or not. This study assessed the effect on antibiotic prescribing in primary care of telehealth (TH) consultations compared to face-to-face (F2F) for acute infections. The impact of telehealth on prescribing appears to vary between conditions with more increases than reductions. However, there is insufficient evidence to draw strong conclusions, and higher quality research is urgently needed.

Introduction

Antibiotic prescribing is a major concern that contributes to the problem of antibiotic resistance.[1] In Australia, more than 41% of the population received at least one antibiotic in 2017,[2] and 80% of antibiotic prescriptions occurred in primary care.[3]
In primary care antibiotics are frequently prescribed for self-limiting acute respiratory infections (ARIs) such as; middle ear infections, acute bronchitis, and sore throat,[4] where antibiotics have little benefits[5-8] and may cause harms (such as vomiting, diarrhoea and rash).
Before the coronavirus pandemic in 2019 (COVID-19), several strategies (such as delayed prescribing) and campaigns (such as the Choosing Wisely campaigns) aimed to reduce antibiotic prescribing. In Australia antibiotics are usually prescribed in a face-to-face consultation with general practitioners. However, in the era of COVID-19, remuneration for telehealth was introduced and many clinicians have shifted to deliver patient care remotely to decrease the risk of transmission. This change in mode of delivery may influence prescribing.
A recent systematic review concluded that there is insufficient evidence for an impact of telehealth consultations on antibiotic prescribing.[9] This review has several limitations, mainly related to the search strategy, including studies for both synchronous and asynchronous telehealth consultations, and the method of analysis of the included studies, hindering the interpretation of the impact of telehealth on antibiotic prescribing. Our systematic review focuses only on synchronous telehealth consultations- better comparable to face-to-face consultations, our search strategy included broader keywords and mesh terms to find any relevant studies, and with a more detailed analysis sub-grouped by the different conditions.
In this systematic review we aimed to identify and synthesize studies that have assessed the effect of synchronous telehealth consultations on antibiotic prescribing compared to face-to-face clinical encounters.

Methods

This systematic review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[10]. The protocol was developed prospectively and registered on the International prospective register of systematic reviews (PROSPERO) Registration number CRD42021239164. We followed the “2-week systematic review” (2weekSR) processes.[11]

Eligibility criteria

Participants

We included studies of adult or paediatric patients with a history of a community acquired acute infection (respiratory, urinary, or skin and soft tissue). We excluded studies of patients with chronic infections, or hospitalized patients.

Interventions

We included studies of any type of synchronous telehealth consultations (phone or video-based). Studies that reported the use of asynchronous telehealth consultations (text-based or web-based with automated feedback) were excluded. Studies with telehealth consultations combined with an education component were excluded unless it was given to both groups.

Comparators

We included studies that compared telehealth consultations to the usual face-to-face consultations.

Outcomes (primary, secondary)

The primary outcome was the number of antibiotic prescriptions in each type of consultation. The secondary outcomes were follow-up visit rates, testing rates or number of samples sent to the laboratory, any reported adverse events, hospitalization, and associated costs.

Study design

We included randomized controlled trials of any design (e.g., parallel, cluster, crossover), and any type of observational studies. Reviews of primary studies (e.g., systematic reviews, literature reviews, etc.) were excluded.

Search strategies

Database search

We searched PubMed, Embase, Cochrane CENTRAL from inception until 23 February 2021. We designed the search string in PubMed, then translated it for use in the other databases using the Polyglot Search Translator.[12] The complete search strings for all databases are provided in **Supplementary Box 1**.

Clinical trial registries were searched on 2 March 2021 via Cochrane CENTRAL, which includes the WHO International Clinical Trials Registry Platform (ICTRP) and clinicaltrials.gov. We also searched for preprint articles through the Europe PMC database.
On 1 March 2021, we conducted a backwards (cited) and forwards (citing) citation analysis in Scopus on the included studies identified by the database searches. These were screened against the inclusion criteria.

No restrictions by language or publication date were imposed. We included publications that were published in full. Publications available as abstract only (e.g., conference abstract) were included if they had a clinical trial registry record, or other public report, with the additional information required for inclusion. We excluded publications available as abstract only (e.g., conference abstract) unless additional information available.

Study selection and screening

Two review authors (MB and EB or NK) independently screened the titles and abstracts for inclusion against the inclusion criteria. One author (JC) retrieved full-text, and two authors (EB and NK) screened the full-texts for inclusion. Any disagreements were resolved by discussion, or reference to a third author (MB, MVD, CDM). The selection process was recorded in sufficient detail to complete a PRISMA flow diagram (see Figure 1) and a list of excluded (full text) studies with reasons for exclusions (**Supplementary Table 1**).

Data extraction

We used a data extraction form for study characteristics and outcome data, which was piloted on 2 studies in the review. Two authors extracted the following data from included studies:

- **Methods:** study authors, location, study design, duration of follow-up
- **Participants:** N, age (mean/median, range/SD), conditions, recent antibiotic use.
- **Interventions:** Type of telehealth consultation (video, phone, mixed, online), duration, who provided it, training, previous experience.
- **Primary and secondary outcomes:** indication for antibiotics, antibiotic prescribing rate, adverse events, number of follow-up visits, number of tests requested, or samples sent to the laboratory, hospitalization, antibiotic resistance (if measured in a follow-up visit).

Assessment of risk of bias

Two authors (MB and EB or NK) independently assessed the risk of bias for RCTs using the Cochrane Risk of Bias Tool [13] and for observational studies using ROBINS-I.[14] We did not use the Newcastle-Ottawa Scale as initially reported in our protocol, due to the lack of comprehensive manuals, which meant that the tool instructions could be interpreted differently by different assessors. All disagreements were resolved by discussion.

Measurement of effect and data synthesis

Review Manager 5.4 was used to calculate the treatment effect[15]. We used odds ratios for dichotomous outcomes reporting the number of patients with an event (e.g., antibiotic prescribing). We undertook meta-analyses only when meaningful (when ≥2 studies or comparisons reported the same outcome); anticipating considerable heterogeneity, we used a random effects model.

We separated analysis for RCTs, and observational studies (e.g., cross-sectional studies). We split our analysis by reported conditions (e.g., sinusitis, bronchitis). No studies reported the severity of the condition and thus we did not perform this subgroup analysis.

The individual was used as the unit of analysis, where possible. However, the data on the number of individuals with primary and secondary outcomes of interest was not available. We extracted the information as it was presented, e.g., the number of antibiotic prescriptions for all encounters/visits in each group.

We contacted the authors of all included cross-sectional studies to obtain data of antibiotic prescribing in previous years to control for any trend of change in antibiotic prescribing. However, the responding authors stated they were unable to provide this for a variety of reasons.

We used the I^2 statistic to measure heterogeneity. As we only included one trial, we did not create a funnel plot.

Results

Search results

The searches across 3 databases yielded 650 records. A backwards (cited) and forwards (citing) citation analysis yielded an additional 433 records. The clinical registry search returned 19 records, and the preprint search via Europe PMC returned an additional 150, resulting in a total of 1067 records to screen after deduplication. We excluded 1011 records after title and abstract screening and obtained 56 records for full-text screening. We included 13 studies in the qualitative synthesis and the meta-analysis (**Figure 1**). See **Supplementary Table 1** for a full list of excluded Studies with reasons for exclusion.

[Figure 1]

Study characteristics

Of the 13 included studies (**Supplementary Table 2**[16-28]), all except two, were conducted in the United States of America (USA); they comprised 11 cross-sectional studies,[16-18 21-28] one retrospective before-after study[20] and just one RCT.[19] Nine studies reported antibiotic prescribing for a respiratory infection only, two studies provided data for all acute infections (respiratory, urinary, and skin and soft tissue infections), one for both urinary and respiratory infections, and one for urinary infections only. We did not find any studies that reported on antibiotic prescribing in telehealth versus face-to-face consultations for skin and soft tissue infections. The type of telehealth consultations varied; five studies reported the use of mixed phone and video consultation, four phone-only consultations, two video consultations, and the mode was not clearly reported in two studies.

Risk of bias assessment

For the only RCT identified, we used the Cochrane risk of bias tool-1 to assess the risk of bias.[19] The overall risk of bias was generally unclear. Blinding of the patients and health care providers was not possible. Random sequence generation, allocation concealment, blinding of outcome assessment and the conflict-of-interest statement were all unclear due to inadequate reporting in the trial. We found no evidence of incomplete outcome data or selective reporting of outcomes. The study funding was reported.

For the remaining 12 studies, using the ROBINS-I tool to assess the risk of bias,[16-18 20-28] found the studies were mostly of moderate or serious risk of bias (**Table 1)**. Due to the study designs, most studies were considered at serious risk of confounding, unless the study authors reported an appropriate analysis method used to adjust for important baseline confounding factors such as: age, severity of infection, and any reported co-morbidities. Most studies had serious bias for the selection of participants, as patients with less severe infections may differentially choose a mode of consultations (telehealth rather than face-to-face). No information was available for the reporting of missing data or selection of the reported results (no available protocols). The included studies had moderate or serious risk of bias in classification of interventions and reported deviations from intended interventions. Measurement of outcomes was rated ‘moderate’ for all studies.

[Table 1]

Primary outcome: Antibiotic prescribing

Randomized controlled trials (n=1)

Only one small trial investigated the difference of antibiotic prescribing between patients requesting same-day appointments managed by face-to-face consultation (n=187) compared with telephone consultation (n=180).[19] There was more, but not significant, antibiotic prescribing in the telehealth group compared to F2F consultations (Odds ratio (OR) 1.25, 95% CI 0.73 to 2.15) **(Figure 2)**.

Before-After study (n=1)

One study examined antibiotic prescribing patterns after the transition to telehealth visits, due to COVID-19 pandemic, and compared it to the previous F2F visits for acute rhinosinusitis.[20] There was significantly less antibiotic prescribing in telehealth consultations (OR 0.78, 95% CI 0.69 to 0.89) **(Figure 2)**.

Cross-sectional studies (n=11)

Comparison of telehealth consultations with face-to-face in cross-sectional studies was sub-grouped into the type of reported condition, to reduce confounding of type of consultation by condition **(Figure 2).**

Acute sinusitis (n=6)

There was higher, but not significant, antibiotic prescribing in the F2F group (OR 0.83, 95% CI 0.68 to 1.0). Heterogeneity was high (78%).

Pharyngitis (n=4)

There was higher, but not significant, antibiotic prescribing in the telehealth group (OR 1.4, 95% CI 0.95 to 2.1). Heterogeneity was high (81%)

Bronchitis (n=3)

There was no significant difference in antibiotic prescribing for patients with bronchitis (OR 0.98, 95% CI 0.6 to 1.6). Heterogeneity was high (90%)

Acute otitis media (n=2)

There was significantly more antibiotic prescribing for patients with acute otitis media in telehealth consultations (OR 1.3, 95% CI 1.11 to 1.5), with no heterogeneity.

Conjunctivitis (n=2)

There was higher, but not significant, antibiotic prescribing in the telehealth group (OR 1.8, 95% CI 0.7 to 4.5). Heterogeneity was high (91%).

Urinary tract infections (n=2)

There was higher, but not significant, antibiotic prescribing in the telehealth group (OR 1.4, 95% CI 0.7 to 2.9). Heterogeneity was high (79%).

[Figure 2]

Secondary outcomes

Diagnostic tests performed

Table 2 shows the reported diagnostic tests performed after each type of consultation from six studies. Generally, there are fewer diagnostic tests performed with telehealth consultations compared to F2F.

[Table 2]

One study reported the percentage of adults who were diagnosed with pharyngitis and received an appropriate Group A Streptococcus (strep) test to confirm the diagnosis.[28] The F2F group (n=2297, 49.5%) performed better than the telehealth group (n=4, 3.4%) on appropriate testing for pharyngitis.

Follow-up visits

Seven studies provided results of follow-up visits (See **Table 3**). In general, patients who were initially evaluated through phone contact were more likely to receive follow-up. The studies show different follow-up time points.

[Table 3]

Adverse events (AE)

One study reported no statistically significant difference in the reported adverse events as evaluated by diagnosis of pyelonephritis within 30-day follow-up duration for patients with urinary tract infections.[21] The study reported no hospitalization or sepsis in any patients for both F2F and telehealth encounters (**Supplementary Table 3**).

Discussion

Summary of findings

Our review identified only one RCT that assessed the impact of telehealth compared with face-to-face consultations on antibiotic prescribing: finding a non-significant 25% relative increase. Most studies were observational, did not control well for confounding, and therefore were prone to bias. Pooling observational studies does not show a consistent pattern when analysed for specific infections. For instance, antibiotic prescribing for acute sinusitis may be higher in a F2F consultation and for pharyngitis higher in telehealth. However, many effect estimates do not reach statistical significance and with significant heterogeneity suggesting, other than clinical differences, methodological issues within the included studies.

Comparison with existing literature

Our general finding is broadly consistent with the systematic review by Han et al[9] who concluded there was insufficient evidence that telehealth consulting has a significant impact on antibiotic prescribing in primary care. However, in our review we pooled the observational studies and explored the impact in consultations concerning specific infections. These results show a more diverse picture that can make clinical sense. The two cross-sectional studies that assessed prescribing for acute otitis media[25 26] consistently find that antibiotics are more likely to be prescribed in TH consultations. Perhaps the inability to examine the ear allows clinicians to be more lenient with prescribing, especially under parental pressure.[29]

Strengths and weaknesses

This review's main strength is its rigor of methods and analysis: the extensive search is unlikely to missed important studies; and the detailed synthesis of the results by study design and by condition has made best use of the available published research. However, there are also several weaknesses: the paucity of studies with adequate control of confounding; the wide heterogeneity (both of clinical conditions and results); and imprecision of the results, means that there is no single reliable message to take away from this research.

Implications for research and clinical practice

It is important to note there are different modalities of telehealth, with or without visual that may impact the inclination to prescribe. Also, the link with clinical outcomes and patient satisfaction deserves further exploration.[30] In situations like the current COVID-19 pandemic, synchronous telehealth consultations have ensured patients' access to primary care services and have changed the landscape of service delivery for good.[31] Therefore, better understanding how prescribing adapts is critical for antimicrobial stewardship.

While there is insufficient evidence about the rate of antibiotic prescribing in teleconferences compared to the usual face-to-face ones to draw strong conclusions, there are some concerns. The impact appears to vary between conditions, but more suggest increases in antibiotic than reductions. For example, if patients with acute respiratory infections all chose to consult via telehealth, then the antibiotic prescriptions for telehealth would be greater than face-to-face (and the reverse of those patients selectively chose face-to-face consultation). Furthermore, telehealth may change the diagnostic process because of the limitations on physical examination. Given the importance of any increased antibiotic use to the development of antibiotic resistance,[32] this clearly this suggests more studies need to be undertaken with better design — either as randomized trials, or at least controlled before-after studies. To study prescribing change at population level, the ideal study process would be to compare the change in antibiotics when a blend of telehealth and face-to-face consultations are introduced with the change of face-to-face is retained. In the situation when randomisation of practices is not possible, then we might adjust for confounding by using the pre-change level of antibiotic prescribing, and ideally for any trends using a series of times prior to the change. If the suggestions that in some diagnoses more antibiotics are prescribed in F2F consultations, then further research to understand ameliorate will become urgent.

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Ethical approval: None required

Competing interests: None

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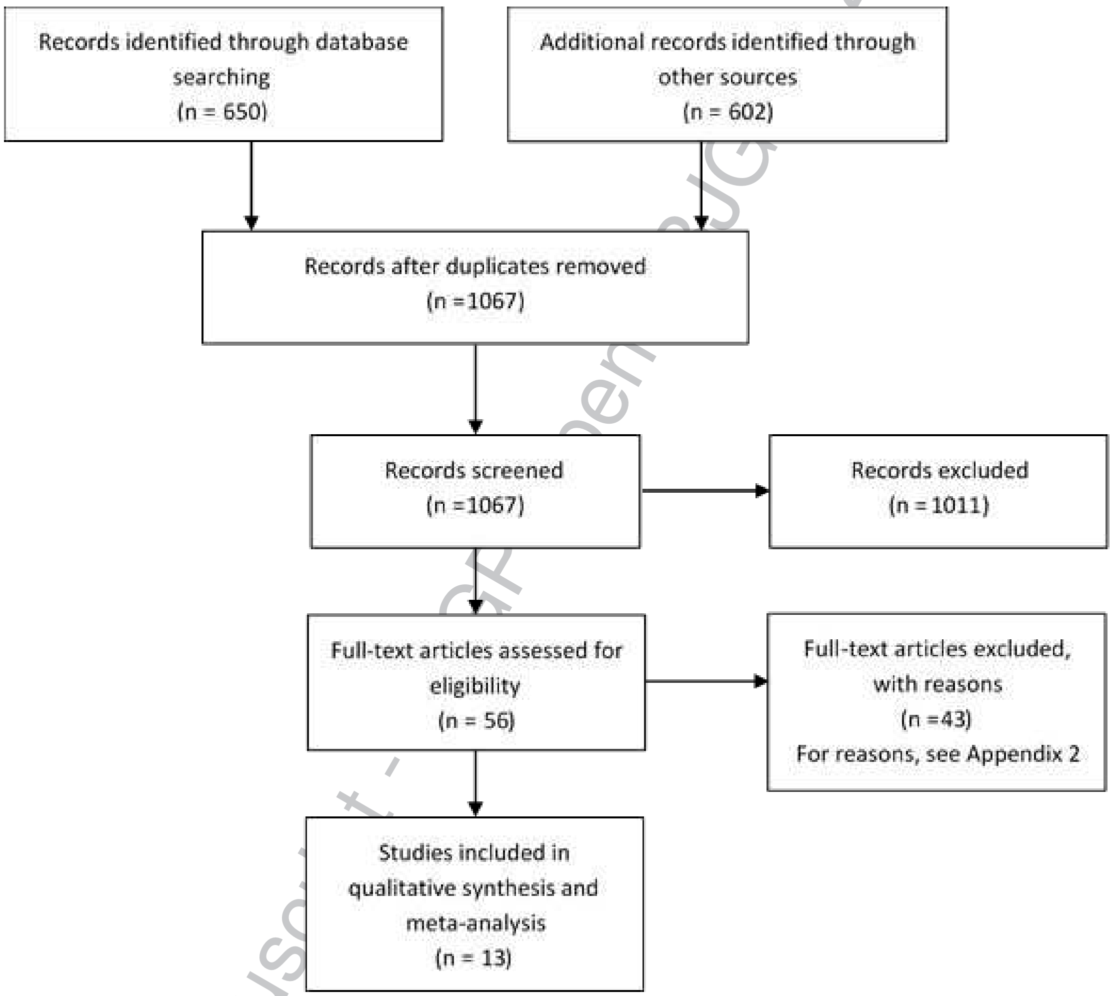

Figure 1. PRISMA Flow Diagram[10]

Study or Subgroup	Telehealth Events	Telehealth Total	F2F Events	F2F Total	Weight	Odds Ratio M-H, Random, 95% CI
1. Randomised controlled trial						
1.1. All conditions						
McKinstry (UK, 2002)	35	181	30	187	100%	1.25 [0.73, 2.15]
2. Before-after						
2.1. Acute sinusitis						
Miller (USA, 2020)	1496	2075	2804	3654	100%	0.78 [0.69, 0.89]
3. Cross-sectional						
3.1. Acute sinusitis						
Gordon (USA, 2017)	971	1157	2327	2807	23.2%	1.08 [0.89, 1.30]
Shi (USA, 2018)	9932	16168	252871	392393	29.4%	0.88 [0.85, 0.91]
Ray (USA, 2019)	410	646	43219	68080	24.5%	1.00 [0.85, 1.17]
Halpren-Ruder (USA, 2019)	56	121	62	101	8.9%	0.54 [0.32, 0.93]
Davis (USA, 2019)	39	57	92	100	3.8%	0.19 [0.08, 0.47]
Penza (USA, 2020 A)	92	150	108	150	10.2%	0.62 [0.38, 1.00]
Subtotal (95% CI)		**18299**		**463631**	**100%**	**0.83 [0.68, 1.00]**
Total events	11500		298679			
Heterogeneity: Tau² = 0.03; Chi² = 23.04, df = 5 (P = 0.0003); I² = 78%						
3.2. Pharyngitis						
Gordon (USA, 2017)	130	175	249	464	26%	2.49 [1.70, 3.67]
Shi (USA, 2018)	461	669	10937	16236	32.9%	1.07 [0.91, 1.27]
Ray (USA, 2019)	178	250	17315	26347	29.8%	1.29 [0.98, 1.70]
Norden (USA, 2020)	8	40	17	82	11.3%	0.96 [0.37, 2.45]
Subtotal (95% CI)		**1134**		**43129**	**100%**	**1.39 [0.95, 2.05]**
Total events	777		28518			
Heterogeneity: Tau² = 0.11; Chi² = 15.89, df = 3 (P = 0.001); I² = 81 %						
3.3. Bronchitis						
Uscher-Pines (USA, 2016)	140	168	5294	7342	29.4%	1.93 [1.29, 2.91]
Gordon (USA, 2017)	191	279	545	698	32.6%	0.61 [0.45, 0.83]
Shi (USA, 2018)	3161	5547	81360	134624	38%	0.87 [0.82, 0.92]
Subtotal (95% CI)		**5994**		**142664**	**100%**	**0.98 [0.62, 1.56]**
Total events	3492		87199			
Heterogeneity: Tau² = 0.15; Chi² = 19. 77, df = 2 (P < 0.0001); I² = 90%						
3.4. Acute otitis media						
Shi (USA, 2018)	420	603	9449	14635	60%	1.26 [1.06, 1.50]
Ray (USA, 2019)	244	369	23380	38888	40%	1.29 [1.04, 1.61 l
Subtotal (95% CI)		**972**		**53523**	**100%**	**1.27 [1.11, 1.46]**
Total events	664		32829			
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.85); I² = 0%						
3.5. Conjunctivitis						
Gordon (USA, 2017)	157	246	373	610	51.5%	1.12 [0.82, 1.52]
Penza (USA, 2020 B)	84	202	40	202	48.5%	2.88 [1.85, 4.50]
Subtotal (95% CI)		**448**		**812**	**100%**	**1.77 [0.70, 4.47]**
Total events	241		413			
Heterogeneity: Tau² = 0.41; Chi² = 11. 74, df = 1 (P = 0.0006); I² = 91 %						
3.6. Urinary Tract Infections						
Gordon (USA, 2017)	217	284	415	663	55.7%	1.94 [1.41, 2.65]
Murray (USA, 2020)	122	150	124	150	44.3%	0.91 [0.51, 1.65]
Subtotal (95% CI)		**434**		**813**	**100%**	**1.39 [0.67, 2.88]**
Total events	339		539			
Heterogeneity: Tau² = 0.22; Chi² = 4.84, df = 1 (P = 0.03); I² = 79%						

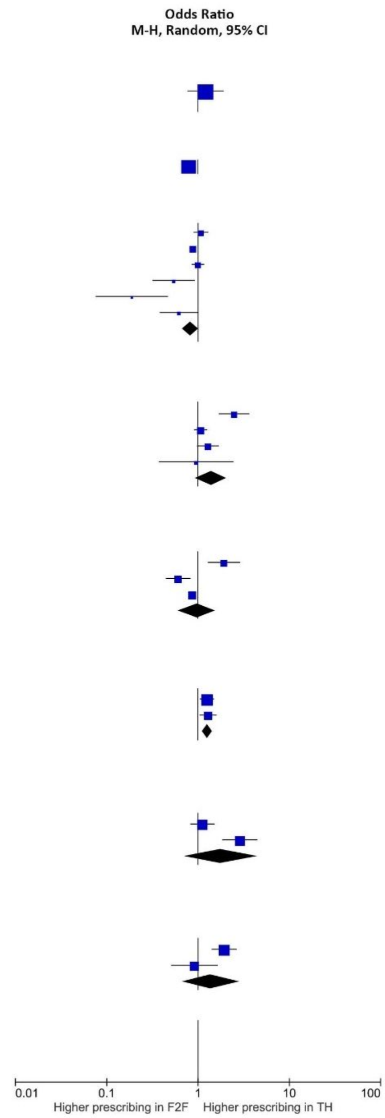

Figure 2. Antibiotic prescribing in synchronous telehealth compared to face-to-face (F2F) consultations

Table 1. Risk of bias of included observational studies using ROBINS-I

Reference	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported results	Overall risk of bias
Uscher-Pines (USA, 2016)[28]	Serious	Moderate	Moderate	Serious	No available information	Moderate	No available information	Moderate
Gordon (USA, 2017)[17]	Serious	Moderate	Moderate	Moderate	No available information	Moderate	No available information	Moderate
Shi (USA, 2018)[26]	Moderate	Serious	Moderate	Moderate	No available information	Moderate	No available information	Moderate
Davis (USA, 2019)[16]	Serious	Moderate	Moderate	Serious	No available information	Moderate	No available information	Serious
Halpren-Ruder (USA, 2019)[18]	Serious	Serious	Moderate	Moderate	No available information	Moderate	No available information	Moderate
Ray (USA, 2019)[25]	Moderate	Serious	Moderate	Moderate	No available information	Moderate	No available information	Moderate
Miller (USA, 2020)[20]	Serious	Moderate	Moderate	Serious	No available information	Moderate	No available information	Moderate
Murray (USA, 2020)[21]	Serious	Serious	Moderate	Serious	No available information	Moderate	No available information	Serious
Penza (USA, 2020 A)[23]	Serious	Serious	Serious	Serious	No available information	Moderate	No available information	Serious
Penza (USA, 2020 B)[24]	Serious	Serious	Serious	Serious	No available information	Moderate	No available information	Serious
Stenehjem (USA, 2020)[27]	Serious	Serious	Moderate	Serious	Moderate	Moderate	No available information	Moderate
Norden (USA, 2020)[22]	Serious	Serious	Serious	Serious	No available information	Moderate	No available information	Serious

Table 2. Diagnostic test performed

Study ID	Diagnostic tests requested	Condition	Telehealth group N (%)	Face-to-face group N (%)	Reported *P* value [a]
		Randomized controlled trial			
McKinstry (UK, 2002)[19]	Not specified blood test	All conditions	8 (4%)	10 (5%)	Not reported
	Not specified urine test		6 (3%)	8 (4%)	
	X-ray		1 (0.6%)	5 (3%)	
		Cross-sectional studies			
Gordon (USA, 2017)[17 b]	Not specified lab tests	UTI	85 (20.6%)	1095 (88.4%)	**<0.001**
		Pharyngitis	45 (15.8%)	627 (73.5%)	**<0.001**
		Sinusitis	185 (11%)	1302 (25.7%)	**<0.001**
		Bronchitis	40 (10.1%)	308 (25.8%)	**<0.001**
	Not specified Imaging	Cough	18 (11.4)	111 (23.5)	**0.001**
		Bronchitis	34 (8.6%)	212 (17.8%)	**<0.001**
		UTI	34 (8.2%)	227 (18.3%)	**<0.001**
		URI	69 (8.1%)	236 (9.3%)	0.31
		Sinusitis	90 (5.3%)	497 (9.8%)	**<0.001**
Murray (USA, 2020)[21 c]	Urinalysis/dip stick	UTI	8 (5%)	140 (93%)	**<0.0001**
	Urine culture		11 (7%)	31 (21%)	**<0.001**
Norden (USA, 2020)[22 d]	Not specified lab tests	Pharyngitis	0.125	0.207	0.55
		URI excluding pharyngitis	0.023	0.129	0.096
		Otitis media	0.250	0.107	0.60
Ray (USA, 2019)[25]	Strep test	Streptococcal Pharyngitis	**7 (1%)**	**10878 (67%)**	Not reported
Shi (USA, 2018)[26]	Strep test	Streptococcal Pharyngitis	**9 (4%)**	**17818 (68%)**	Not reported

UTI: Urinary tract infections, URI: Upper respiratory tract infections

[a] Chi-square test
[b] Tests were conducted within 21 days of index visit for all conditions
[c] Tests were conducted at initial encounter
[d] Average numbers of labs ordered

Table 3. Follow-up characteristics by initial encounter type

Study ID	Follow-up visits within	Condition	Telehealth group		Face-to-face	
			Number of follow-up visits	**%**	**Number of follow-up visits**	**%**
Ray (USA, 2019)[25]	**2 days**	ARI	226	5	5875	1
	21 days		525	11	45629	9
Shi (USA, 2018)[26]	**2 days**	ARI	1165	3	4713	0.5
	21 days		3884	10	56557	6
Gordon (USA, 2017)[17]	**21 days**	All conditions	1302	28	3900	28
Murray (USA, 2020)[21]	**Same day as initial encounter**	UTI	15	10	6	9
	30 days		47	31	39	26
Penza (USA, 2020 A)[23]	**Same day as initial encounter**	Sinusitis	26	49	1	5
	30 days		53	35	21	14
Penza (USA, 2020 B)[24]	**14 days**	Conjunctivitis	92	46	15	7
Norden (USA, 2020)[22]	**1-day**	Pharyngitis	Not reported	40	Not reported	21
		ARI		7		2
		Otitis media		13		7
	3-day	Pharyngitis	Not reported	53	Not reported	28
		ARI		14		9
		Otitis media		13		14