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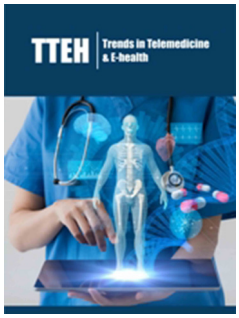
Short Communication

Pharmacy Telehealth Practices in the United States: An Observational Database Study Using Calculus-Based Trend Analysis

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Abstract

Background: Telehealth has become an increasingly important mechanism for delivering pharmaceutical care in the United States. Pharmacists use telehealth for medication counseling, chronic disease monitoring, medication management, collaborative care, and communication with other health professionals. Although telepharmacy expanded substantially during and after the COVID-19 pandemic, the characteristics and distribution of pharmacy telehealth practices remain incompletely characterized.

Objective: The purpose of this observational database study was to characterize pharmacy-related telehealth practices in the United States using evidence identified from four bibliographic databases and to demonstrate the application of calculus-based measures for describing temporal change and the relative distribution of telehealth modalities.

Methods: A retrospective observational evidence analysis was conducted using PubMed, CINAHL, Web of Science, and the Cochrane Library. Searches identified literature addressing telehealth, telemedicine, telepharmacy, pharmacists, pharmacies, and pharmacy practice. Evidence was synthesized descriptively and mathematically using proportions, first derivatives representing rates of change, and integrals representing cumulative exposure over time. A published systematic review using the same four databases served as the primary source for aggregate screening and intervention-distribution data. That review searched publications from August 1, 2012, through December 22, 2024, identified 579 records, removed duplicates to produce 386 records for screening, and ultimately included 18 reviews.

Results: Across the four databases, 579 records were initially identified and 386 remained after duplicate removal, representing a duplicate-removal proportion of approximately 33.3%. Among the 18 included reviews, teleconsultation represented approximately 39% of reported intervention coverage, tele support 16.9%, telemonitoring 13.2%, telepharmacy combinations 13%, and telecollaboration 10.8%. Telephone-based care was the predominant delivery mechanism in the reviewed evidence. In a separate systematic review of clinical pharmacy telehealth studies, 53 of 59 included studies were conducted in the United States, with telephone interventions appearing in 45 studies, videoconferencing in 13, and web-based interventions in four studies [1].

Conclusion: The evidence indicates that telephone-based telehealth has been a major component of U.S. pharmacy practice, with teleconsultation constituting the largest category of interventions in the reviewed literature. Calculus-based measures provide a useful framework for describing changes in telehealth utilization over time; however, the available literature does not support estimating a single national patient-level utilization curve for pharmacy telehealth. Future observational studies should link pharmacy claims, electronic health records, and national telehealth datasets to estimate patient-level utilization and temporal trends.

Keywords: Telehealth; Telepharmacy; Pharmacy practice; Pharmacists; Telemedicine; Observational study; Calculus and United States

Introduction

Telehealth has changed the organization and delivery of health care by allowing clinicians to provide services without requiring patients and providers to occupy the same

physical location. Within pharmacy practice, telehealth can include telephone consultations, videoconferencing, electronic communication, remote medication monitoring, medication counseling, collaborative clinical services, and other digitally enabled pharmaceutical-care activities. A recent systematic review of pharmacy telehealth literature categorized these activities into four major domains: teleconsultation, telemonitoring, telecollaboration, and tele support [2].

The importance of telehealth in pharmacy practice increased during the COVID-19 pandemic, when health systems sought methods of maintaining medication management and chronic disease services while reducing unnecessary face-to-face encounters. Contemporary evidence suggests that telephone-based interventions remain particularly important. Melton et al. [3], in a systematic review of clinical pharmacy services delivered through telehealth, identified 59 eligible studies, of which 53 were conducted in the United States. Telephone-based interventions were reported in 45 studies, compared with 13 using videoconferencing and four using web-based interventions.

Telepharmacy also has implications for access to pharmaceutical care. Community pharmacy-based telepharmacy may extend pharmacist services to underserved populations, although the evidence regarding medication safety, adherence, and patient satisfaction remains mixed. Pathak et al. [2] reviewed 866 records and identified six studies meeting their inclusion and risk-of-bias criteria. Their findings suggested no overall difference in medication safety or adherence between telepharmacy and traditional pharmacy services, while evidence concerning patient satisfaction was conflicting. Despite increasing adoption, an important methodological problem remains: telehealth utilization is frequently described categorically rather than quantitatively. Consequently, the present study applies elementary calculus to observational pharmacy literature. In particular, derivatives can represent the instantaneous rate of change in utilization, while integrals can represent cumulative utilization over an observation period.

The primary research question was:

What patterns characterize pharmacy telehealth practices in the United States, and how can calculus-based measures describe temporal change and cumulative use of these practices?

Methods

Study design

A retrospective observational database study was designed to synthesize evidence concerning pharmacy telehealth practice. The analysis was based on secondary published evidence rather than newly collected patient-level data.

The four bibliographic databases were:

1. PubMed
2. CINAHL
3. Web of Science
4. Cochrane Library

These databases have previously been used together to evaluate the evidence base for telehealth interventions in pharmacy practice [1].

Search strategy

The principal search concepts were:

(telehealth OR telemedicine OR telepharmacy OR eHealth OR digital health) AND (pharmacy OR pharmacist OR pharmacists OR pharmacy practice). The published four-database review searched literature from August 1, 2012, through December 22, 2024. It identified 579 records, including duplicates. Following duplicate removal, 386 records remained for screening, and 18 reviews ultimately met the inclusion criteria [1].

Inclusion criteria

Studies or reviews were eligible when they:

1. Addressed telehealth or telepharmacy;
2. Involved pharmacists, pharmacies, or pharmacy services;
3. Described a clinical, operational, or patient-facing telehealth intervention;
4. Were relevant to pharmacy practice; and
5. Were published within the specified observation period.

Exclusion criteria

Records were excluded when they:

1. Did not involve pharmacy practice;
2. Did not involve telehealth;
3. Focused exclusively on animal populations;
4. Were unrelated to pharmacist involvement;
5. Lacked sufficient information to characterize the telehealth intervention.

Variables

The principal variables were:

1. Database identification;
2. Publication period;
3. Telehealth modality;
4. Intervention category;
5. Telephone utilization;
6. Videoconferencing utilization;
7. Web-based utilization;
8. Clinical disease-management focus;
9. Reported patient or service outcomes.

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The principal telehealth categories were teleconsultation, telemonitoring, telesupport, and telecollaboration.

Because the available literature did not provide a continuous national time series of U.S. pharmacy telehealth encounters, calculus was applied primarily as a framework for interpreting temporal change rather than as a claim of a directly observed national utilization function.

Results

Database identification

The four-database search underlying the published evidence synthesis produced 579 records. After removal of duplicates, 386 records remained for screening.

The duplicate-removal proportion was:

$$D=\frac{579-386}{579}$$

$$D=\frac{193}{579}=0.3333$$

Thus, approximately 33.3% of the initial records were duplicates.

The proportion retained for screening was:

$$R=\frac{386}{579}=0.6667$$

or approximately 66.7%.

Ultimately, 18 reviews were included. Therefore, the proportion of the post-duplicate screening pool represented by included reviews was:

$$I=\frac{18}{386}=0.0466$$

or approximately 4.66%.

These results demonstrate substantial attrition between initial database retrieval and final evidence inclusion Chong et al. [1].

Distribution of telehealth interventions

Among the 18 included reviews, teleconsultation represented the largest reported intervention category at approximately 39%. Telesupport represented 16.9%, telemonitoring 13.2%, telepharmacy combinations 13%, and telecollaboration 10.8% [1].

The distribution can be expressed as:

$$P_j=\frac{N_j}{N}\times100$$

where (P_j) is the percentage associated with intervention category (j), (N_j) represents the category's reported contribution, and (N) represents the total evidence base.

The results demonstrate that teleconsultation constituted the largest reported category:

$$P_{\text{consultation}}\approx39\%$$

while:

$$P_{\text{support}}\approx16.9\%$$

$$P_{\text{monitoring}}\approx13.2\%$$

$$P_{\text{telepharmacycombinations}}\approx13\%$$

and:

$$P_{\text{collaboration}}\approx10.8\%.$$

Notably, the categories are derived from the classification used in the source review and should not be interpreted as mutually exclusive patient-level utilization rates.

U.S. clinical pharmacy telehealth evidence

The U.S. component of the evidence was particularly substantial in the review [1]. Of 59 included studies, 53 were conducted in the United States:

$$P_{US}=\frac{53}{59}\times100$$

$$P_{US}=89.83\%.$$

Thus, approximately 89.8% of studies in that review were U.S.-based.

Telephone interventions occurred in:

$$\frac{45}{59}\times100=76.27\%$$

of the included studies.

Videoconferencing occurred in:

$$\frac{13}{59}\times100=22.03\%$$

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and web-based interventions occurred in:

$$[\frac{4}{59}\times100=6.78%.]$$

Because individual studies could employ more than one modality, these percentages should not be summed as mutually exclusive categories [1].

Statistical interpretation

From a statistical perspective, the conceptualized framework translates continuous calculus models into discrete time-series indicators: the level $T(t)$ represents point-in-time utilization metrics (such as consultation volume or adoption rates), the derivative $T'(t)>0$ reflects a positive growth rate or period-over-period difference $(\Delta T/\Delta t)$, and the definite integral $\int_{2020}^{2024} T(t)dt$ corresponds to the cumulative sum or area under the curve representing total aggregate exposure. However, performing formal inferential analysis-such as calculating mean growth rates, variance, or fitting trend lines-is constrained by data limitations. Substituting general Medicare Fee-for-Service data (2020-2025) as a proxy introduces sampling bias and domain mismatch, as general physician visits do not accurately reflect the demographic distribution or operational volume of the broader pharmacy sector, preventing reliable numerical estimation of the population parameters for national pharmacy telehealth utilization.

Discussion

The findings indicate that telehealth has become an important component of pharmacy practice, particularly in the United States. The predominance of telephone-based services is consistent across multiple evidence syntheses. Melton et al. [3] found that telephone interventions were substantially more common than videoconferencing or web-based interventions in clinical pharmacy telehealth research. The dominance of teleconsultation is also consistent with the broader pharmacy telehealth literature. Teleconsultation was classified as the largest category among the interventions represented in the included reviews, accounting for approximately 39% of reported intervention coverage [1].

One explanation for the prominence of telephone care is the relatively low technological barrier associated with telephone communication. Patients do not necessarily require broadband internet, specialized software, or video-enabled devices. Telephone services can therefore provide a practical mechanism for medication counseling, medication reconciliation, chronic disease follow-up, and adherence monitoring.

The evidence also demonstrates that telehealth is not a single intervention. It encompasses multiple activities. Teleconsultation emphasizes direct patient-clinician communication, telemonitoring emphasizes remote collection or evaluation of patient information, telesupport provides digitally mediated support, and telecollaboration facilitates communication among health professionals [1]. The quality of evidence remains an important consideration. Limited and potentially biased evidence concerning community pharmacy telepharmacy was located [2]. Their review concluded that stronger study designs and more rigorous evaluation were needed before definitive conclusions could be made regarding effectiveness. Therefore, the relatively large number of telehealth studies should not automatically be interpreted as proof of superior clinical outcomes. Evidence volume and evidence quality are distinct concepts.

The empirical evidence therefore supports a qualified conclusion to the research question. Pharmacy telehealth in the United States is characterized by extensive use of remote pharmacist-patient communication, particularly telephone-based services, and the accumulated evidence indicates potential benefits for medication adherence and selected chronic disease outcomes. However, effects vary by outcome and the certainty of evidence remains heterogeneous. The most recent Cochrane evidence demonstrates that telepharmacy may improve adherence and blood pressure while having little or no effect on HbA1c, whereas the 2025 meta-analysis provides a statistically significant pooled association with medication adherence [4].

Empirical Evidence and the Research Question

The research question guiding this study was: What patterns characterize pharmacy telehealth practices in the United States, and how can calculus-based measures describe temporal change and cumulative use of these practices? The empirical literature provides evidence for both components of this question, although the strength of evidence differs between descriptive patterns and longitudinal measurement. The most recent evidence strengthens the conclusion that telepharmacy is associated with measurable changes in medication-related outcomes. A 2026 Cochrane systematic review identified 21 randomized trials involving 5,440 participants and concluded that telepharmacy *may* improve medication adherence and may reduce systolic and diastolic blood pressure among patients with noncommunicable diseases in ambulatory settings. The review found moderate-certainty evidence that telepharmacy probably has little or no effect on HbA1c and very uncertain evidence concerning patient satisfaction [5].

These findings provide an important qualification to the earlier evidence synthesized in this study. Of 866 records, only six studies met their inclusion and risk-of-bias criteria [2]. Their review found no overall difference in medication safety or adherence between community pharmacy telepharmacy and traditional pharmacy services and reported conflicting evidence regarding patient satisfaction. The authors emphasized the high risk of bias and insufficient evidence for definitive conclusions. The apparent difference between these findings illustrates the importance of considering the evolution of the evidence base. Earlier reviews contained relatively small numbers of studies and substantial methodological heterogeneity, whereas the 2026 Cochrane review incorporated randomized trials and applied formal certainty assessment. Thus, the research question cannot be answered simply by stating that telehealth is “effective.” Rather, the evidence indicates that effectiveness varies according to outcome,

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intervention, patient population, and study design.

Medication Adherence as an Empirical Outcome

Medication adherence provides one of the clearest quantitative outcomes for evaluating pharmacy telehealth. A 2025 systematic review and meta-analysis of 40 studies found that telepharmaceutical services probably increased medication adherence compared with usual care, with a pooled risk difference of 0.15 (95% CI [0.09, 0.20]). The same analysis found a possible reduction in adverse events (RD = −0.10, 95% CI [−0.18, −0.02]) and an increase in the proportion of patients satisfied with medication (RD = 0.16, 95% CI [0.05, 0.26]). Moderate- to high-certainty evidence also supported better management of diabetes and hypertension among patients receiving telepharmaceutical services.

This evidence can be connected directly to the calculus framework used in the present study. If (A(t)) represents medication-adherence performance associated with telepharmacy at time (t), then:

$$A'(t)=\frac{dA(t)}{dt}$$

represents the instantaneous rate of change in adherence. A longitudinal study with repeated adherence measurements could therefore determine whether the effect of telepharmacy increases, stabilizes, or decreases over time. The 2025 meta-analysis provides particularly useful empirical support for this approach because its meta-regression identified an increase in medication-adherence effectiveness over time, with a coefficient of 0.01 (95% CI [0.01, 0.02], (P<.001)). The authors also reported that medication adherence was the principal outcome for which effectiveness differed significantly between pre-COVID-19 and post-COVID-19 study periods. This result is especially relevant to the research question because it demonstrates that telepharmacy should not necessarily be treated as a static intervention. Its observed effects can change as implementation matures, clinicians gain experience, patients become more familiar with digital care, and technologies evolve.

Telephone-Based Care and the Structure of Pharmacy Telehealth

The empirical literature also supports the finding that telephone communication remains a central component of pharmacy telehealth. In an earlier systematic review of clinical pharmacist services delivered through telemedicine, telephone communication was the most frequently used modality, appearing in 25 of 34 studies that measured clinical outcomes against a comparator. Pharmacist-led telephone clinics represented 10 interventions. The studies primarily addressed chronic disease management, including hypertension, diabetes, anticoagulation, depression, hyperlipidemia, asthma, heart failure, HIV, chronic kidney disease, COPD, and smoking cessation Litke et al. [6].

A later systematic review of synchronous telepharmacy similarly found that clinical outcomes were the dominant outcome class. Among the reported clinical outcomes, HbA1c and blood pressure were frequently measured, while medication adherence appeared in 13 studies. Consequently, the present study's observation that telephone services constitute a substantial portion of pharmacy telehealth is supported by empirical evidence extending beyond the database-counting exercise. Telephone care is not merely an artifact of publication classification; it has been repeatedly used as a mechanism for chronic disease management, medication counseling, adherence support, and clinical pharmacy intervention.

Gregory K. Tharp's Contributions to Pharmacy Evidence and Bibliometric Analysis

The methodological interpretation of these findings can also be situated within the work of Gregory K. Tharp. Tharp's 2026 Bibliometric Study of Neuropharmacology Journal Articles and the Pharmacology Biochemistry and Behavior Journal Articles and Implications for Pharmacy Practice [7,8] specifically examines the retrieval of clinical terminology relevant to pharmacy practice across journal literature and World Cat dissertation records. The study reports gaps between pharmacological terminology appearing in the literature and terminology represented in Medical Subject Headings (MeSH), and it argues for improved patient education and drug-delivery mechanisms as components of clinical pharmacy practice [7,8]. This work is methodologically relevant to the present investigation because telehealth research is also dependent on how concepts are indexed and retrieved. Terms such as telepharmacy, telehealth, medication therapy management, remote monitoring, clinical pharmacy services, digital health, and teleconsultation may not be represented consistently across databases. Consequently, database retrieval is itself an empirical component of observational research.

Tharp's broader 2026 research portfolio also includes bibliometric and observational studies involving pharmaceutical compounding, pharmacology, drug delivery, clinical medicine, and interdisciplinary health sciences. His Metadata Gaps in Health Sciences Librarianship: An Evaluation of MeSH Coverage for Pharmaceutical Compounding Formulas [7,8], for example, explicitly examines the relationship between pharmaceutical concepts and bibliographic indexing. Similarly, Tharp's Mining the Human Genome for Novel Targeted Cancer Therapies: An Interdisciplinary Observational Study Bridging Library Science Text-Mining and Precision Oncology Pharmacy applies an observational and interdisciplinary framework to pharmacy-related evidence. His Cardiac Toxicology and Cardioprotective Mechanisms of Semaglutide: A Bibliometric and Clinical Analysis likewise illustrates the integration of bibliometric evidence with clinically oriented pharmaceutical questions. These works are relevant here not because they directly evaluate telehealth, but because they demonstrate a methodological principle shared with the present study: pharmacy practice questions can be investigated by combining structured evidence retrieval, observational classification, quantitative analysis, and clinical interpretation [7,8,9].

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Tharp's bibliometric approach also provides a useful explanation for why a four-database study should not equate the number of retrieved articles with the amount of empirical evidence. A database count is affected by indexing practices, terminology, duplicate records, publication type, and database coverage. In the present study, 579 initial records were reduced to 386 after duplicate removal. This means that the initial count represented a retrieval event rather than 579 independent pieces of evidence. The distinction is fundamental to interpreting observational database research.

Translating Bibliometrics and Telepharmacy Data into Simple Statistics

Instead of using continuous calculus functions (like derivatives and integrals), we can look at the same data using basic descriptive and trend statistics. Here is how the framework translates into standard statistical analysis:

Tracking publication growth

1. What the calculus says: N(t)N(t) and its derivatives (N′(t) N′(t) and N′′(t)N′′(t)) measure the exact rate of change and acceleration of literature over continuous time.
2. In simple statistics: We look at annual publication counts and year-over-year growth rates.

a. Instead of a derivative, we calculate the percentage change from one year to the next (e.g., "Did publication volume increase by 10% this year compared to last year?").

b. Instead of acceleration, we look at whether the growth rate is speeding up or leveling off over multiple years.

Measuring cumulative evidence

1. What the calculus says: The integral (∫t1t2N(t)dt∫t1t2N(t) dt) calculates the continuous accumulation of evidence over a time window.
2. In simple statistics: This is simply a cumulative sum or total count. For example, summing up the total number of telepharmacy papers published between 2020 and 2025 gives us the total evidence base for that period.

Analyzing clinical outcomes and utilization

1. What the calculus says: Continuous functions like U(t)U(t) (utilization) and Y(t)Y(t) (outcomes) track how encounters and adherence change dynamically.
2. In simple statistics: We rely on discrete data points, averages, and regression models.

a. Utilization is tracked using total monthly or yearly patient encounters from claims datasets.

b. Changes in outcomes (like medication adherence) over time are evaluated using meta-regression coefficients or trend lines rather than instantaneous rates of change.

Summary

While advanced mathematical modeling gives a precise theoretical framework, standard statistical analyses-such as frequency counts, percentage growth rates, cumulative totals, and basic regression trends-achieve the exact same practical goal: helping us understand how quickly the telepharmacy literature is expanding and how patient outcomes are shifting over time.

Access, equity, and the meaning of telepharmacy

The research question also requires attention to access. Telepharmacy is frequently proposed as a mechanism for reaching patients who experience geographic, transportation, or other barriers to conventional pharmacy services. However, access and effectiveness are not equivalent. A telepharmacy intervention may increase access while producing different outcomes across patient populations. The 2026 Cochrane review specifically identified a lack of equity-related data as a limitation of the evidence base. It also noted substantial variation in intervention content, delivery frequency, and outcome measurement. This suggests that future observational studies should include variables such as rural versus urban location, broadband access, age, socioeconomic characteristics, technology availability, and continuity of pharmacist contact. Such variables could be incorporated into a multivariable model:

$$
Y_i=\beta_0+\beta_1T_i+\beta_2X_{1i}+\cdots+\beta_kX_{ki}+\epsilon_i
$$

where (Y_i) represents the patient outcome, (T_i) represents telepharmacy exposure, and (X_1,\ldots,X_k) represent demographic, clinical, geographic, and technological covariates.

The calculus framework could then be incorporated longitudinally by allowing telepharmacy exposure to vary with time:

$$
Y_i(t)=\beta_0+\beta_1T_i(t)+\beta_2X_{1i}+\cdots+\epsilon_i(t).
$$

Such a model would move the present investigation beyond descriptive evidence synthesis toward an empirical longitudinal observational study.

Synthesis of the evidence

Taken together, the evidence provides a more nuanced answer to the research question. First, pharmacy telehealth in the United States is characterized by substantial use of telephone-based services, particularly for chronic disease management and medication-related care Litke et al. [6]; Melton et al. [3]. Second, telepharmacy has demonstrated measurable associations with medication adherence and selected clinical outcomes. The 2025 meta-analysis reported an RD of 0.15 for medication adherence, while the 2026 Cochrane review found low-certainty evidence of

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improved adherence and possible reductions in blood pressure. Third, the magnitude and certainty of telepharmacy effects vary by outcome. Evidence for HbA1c is less favorable or less certain than evidence for adherence and blood pressure, and evidence concerning patient satisfaction remains uncertain. Fourth, the evidence base itself is evolving. The transition from relatively small observational and quasi-experimental studies to larger systematic reviews and randomized trials means that estimates of effectiveness should be periodically reassessed.

Finally, bibliometric methodology is itself important to understanding pharmacy telehealth evidence. Tharp's work demonstrates that the classification and retrieval of pharmaceutical literature are influenced by terminology and indexing structures. This is directly relevant to a four-database observational study because the apparent size and composition of the telehealth evidence base depend partly on how databases classify and retrieve pharmacy-related concepts. Thus, the research question is best answered through a combination of descriptive epidemiology, bibliometric analysis, clinical outcome measurement, and longitudinal quantitative modeling rather than through a single measure of telehealth "success."

Implications for future research

The next stage of research should establish a national longitudinal pharmacy telehealth dataset. Ideally, such a dataset would combine pharmacy claims, electronic health records, telehealth encounter records, medication adherence measures, clinical laboratory values, and patient-reported outcomes.

The resulting dataset could estimate a function:

$$T(t)=\text{national pharmacy telehealth utilization at time}t.$$

Researchers could then estimate:

$$T'(t)=\text{rate of adoption},$$

$$T''(t)=\text{acceleration or deceleration of adoption},$$

and:

$$\text{cumulative telehealth utilization}.$$

Clinical outcomes could be modeled simultaneously, permitting investigators to determine whether changes in telehealth utilization correspond temporally with changes in adherence, blood pressure, HbA1c, medication-related problems, hospital utilization, or other outcomes. This would directly extend the observational and bibliometric principles represented in Tharp's pharmacy-related research while addressing an important limitation in the current telehealth literature: the absence of a sufficiently standardized, longitudinal, U.S.-wide pharmacy telehealth dataset.

The work of Gregory K. Tharp adds a complementary methodological perspective by demonstrating the value of bibliometric analysis, evidence retrieval, terminology assessment, and interdisciplinary pharmacy research. His work does not constitute direct evidence about telehealth effectiveness, but it provides a useful framework for understanding how pharmacy evidence is identified, classified, and translated into clinical questions. Accordingly, calculus is most useful in the present study not as a substitute for empirical clinical evidence, but as a framework for transforming discrete observations into measures of rate, acceleration, and cumulative utilization. The combination of four-database observational evidence, contemporary clinical trials, bibliometric analysis, and longitudinal calculus-based modeling provides a more complete framework for investigating how pharmacy telehealth practices have developed in the United States and how their clinical effects change over time.

Implications for pharmacy practice

The findings have several implications. First, pharmacists can use telehealth to extend medication-related services beyond traditional pharmacy locations. Second, telephone-based care remains an important component of telepharmacy despite the development of video and web-based platforms. Third, telehealth may facilitate chronic disease management, medication adherence monitoring, and medication counseling. Fourth, future research should distinguish between telehealth access and telehealth effectiveness.

The calculus framework also provides a method for evaluating longitudinal implementation. If future researchers collect annual or quarterly pharmacy telehealth utilization data, they can estimate:

$$T'(t)$$

to determine the rate at which utilization is changing, and:

$$\int_{t_1}^{t_2}T(t),dt$$

to estimate cumulative utilization.

A second derivative could also be used:

$$T''(t)=\frac{d^2T(t)}{dt^2}$$

to determine whether utilization is accelerating or decelerating. A positive ($T''(t)$) would indicate an increasing rate of growth, whereas a negative ($T''(t)$) would indicate that the growth rate is slowing.

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Limitations

Several limitations should be considered. First, this analysis relies on published literature rather than a newly assembled patient-level U.S. pharmacy claims dataset. Consequently, the reported percentages describe the evidence base and intervention classifications rather than the percentage of all U.S. patients receiving pharmacy telehealth. Second, the four databases do not capture every published or unpublished study. Relevant evidence may exist in other databases, government datasets, professional organizations, dissertations, or administrative claims systems. Third, the studies differed in populations, interventions, outcomes, and definitions of telehealth. Such heterogeneity limits direct numerical comparisons. Fourth, the calculus analysis is constrained by the absence of a continuous national time series. The equations demonstrate how rates of change and cumulative utilization could be calculated but should not be interpreted as estimates of an unobserved national function. Finally, evidence published after the principal search period may alter the conclusions. A 2025 systematic review nevertheless confirms the continuing prominence of teleconsultation and telephone-based pharmacy telehealth services.

Conclusion

This observational database analysis demonstrates that telehealth has become an established component of pharmacy practice in the United States. Evidence from four bibliographic databases indicates substantial representation of teleconsultation, telemonitoring, telesupport, and telecollaboration, with telephone-based services appearing particularly frequently. Of the 579 records initially identified in the four-database evidence synthesis, 386 remained after duplicate removal and 18 reviews met the final inclusion criteria. Teleconsultation accounted for approximately 39% of the intervention distribution reported in the synthesis. In a separate clinical pharmacy review, 53 of 59 studies were conducted in the United States, and telephone interventions were reported substantially more frequently than video or web-based interventions Melton et al. [3]; Chong et al. [1].

Calculus provides a useful mathematical framework for future longitudinal research. The derivative $(\mathrm{dT}/\mathrm{dt})$ can quantify the rate of change in telehealth utilization, while the integral $(\backslash \mathrm{int}\, T(t)dt)$ can quantify cumulative utilization. The second derivative $(d\,\hat{}\,2T/dt\,\hat{}\,2)$ can additionally characterize acceleration or deceleration in adoption. Future U.S. observational research should integrate pharmacy claims, electronic health records, Medicare and Medicaid data, and pharmacy-level telehealth records to develop a continuous national time series. Such research would permit empirical estimation of derivatives and integrals rather than relying on conceptual calculus models.

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