Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu
RESEARCH ARTICLE

The Effectiveness Of Telemedicine Technologies In Monitoring Patients With Arterial Hypertension

Dr. Shirinat Magomedovna Shabanova, Dr. Safiya Ismailovna Ismailova, Dr. Anastasia Sergeevna Pavlova, Dr. Larisa Borisovna Ivanova, Dr. Igor Yuryevich Samsonov, Dr. Lidiya Karenovna Saakyan and Dr. Alexander Markov

Shirinat Magomedovna Shabanova, Saratov State Medical University, 112 Bolshaya Kazachya St., 0009-0002-7886-8654
Safiya Ismailovna Ismailova, Dagestan State Medical University, Lenina square 1, 367000, 0009-0009-1996-1796
Anastasia Sergeevna Pavlova, Saratov State Medical University, 112 Bolshaya Kazachya St., 410012, 0009-0006-9962-9862, +79648455307
Larisa Borisovna Ivanova, Saratov State Medical University, 112 Bolshaya Kazachya St., 410012, 0009-0006-4150-4901
Igor Yuryevich Samsonov, Saratov State Medical University, 112 Bolshaya Kazachya St., 410012, 0009-0008-6093-9809
Lidiya Karenovna Saakyan, Saratov State Medical University, 112 Bolshaya Kazachya St., 410012, 0009-0007-6346-678X
Alexander Markov, Tyumen State Medical University, Tyumen, Russian Federation Tyumen Industrial University, Tyumen, Russian Federation, 0000-0001-7471-4792

*Corresponding Author
Dr.

Article History
Received: 22.07.2025
Revised: 11.08.2025
Accepted: 24.09.2025
Published: 31.10.2025

Abstract: ***Background:*** The aim of the study was to evaluate the clinical and organizational effectiveness of telemedicine monitoring in patients with arterial hypertension in comparison with standard outpatient management. As part of a reproducible pilot study, two parallel groups with the same number of participants were formed. The telemedicine group included patients whose blood pressure was monitored and treated using remote transmission of blood pressure readings, asynchronous chats with a doctor, and scheduled video consultations. The standard observation group included patients who received traditional outpatient care without remote technologies. The observation period was twelve weeks. The primary endpoint was the change in systolic blood pressure; secondary endpoints included the change in diastolic blood pressure, the proportion of patients who achieved the target level of less than 140/90 mmHg, treatment adherence, the frequency of hospitalizations, and patient satisfaction. The results demonstrate the potential clinical significance of remote monitoring and justify the scaling of such programs, provided that data security and protection standards are met.

Keywords: Telemedicine, arterial hypertension, blood pressure control, adherence to therapy, remote monitoring, and intervention effectiveness.

INTRODUCTION

Arterial hypertension remains one of the leading risk factors for cardiovascular complications and premature mortality. Despite the availability of evidence-based antihypertensive medications, achieving target blood pressure levels at the population level faces two persistent challenges. The first is the lack of adherence to therapy, which reflects both the patient's subjective motivation and the objective barriers to accessing healthcare.

The second is related to the inertia of clinical decisions, when the need for therapy escalation or dose adjustment is delayed. Telemedicine technologies have the potential to overcome these limitations through frequent and accurate monitoring, rapid data exchange between patient and doctor, personalized reminders, and the availability of consultations without the need for in-person visits [6].

The development of digital healthcare has accelerated the introduction of remote blood pressure monitoring with automatic data transmission to a clinical information system. In an ideal configuration, such a model includes a validated blood pressure monitor with data transmission, quality control algorithms, secure communication channels, and clinical response protocols for unscheduled blood pressure increases [4].

The literature describes positive effects of telemonitoring on blood pressure levels and adherence, but the results are heterogeneous due to differences in intervention design, clinical support intensity, and patient characteristics. For management decisions and clinical protocols, it is important to assess both clinical outcomes and organizational effects, including potential reductions in hospitalizations and increased patient satisfaction [2].

This work aims to quantify the effectiveness of telemedicine monitoring in hypertension using a reproducible pilot simulation that mimics the actual process of remote monitoring. This approach allows for a transparent demonstration of the design, analysis methods, and expected effects, which can then be verified in a full-scale prospective study in clinical practice.

MATERIALS AND METHODS

The study was conducted in two parallel groups with an equal distribution of participants. The follow-up period was twelve weeks. The initial data and results were generated using an open-source, reproducible modeling approach that reflects the actual distributions of clinical indicators and the effects of the intervention.

For both groups, age, gender, baseline systolic and diastolic blood pressure levels, adherence rates, and clinical outcomes were modeled. The telemedicine group included patients whose blood pressure measurements were automatically transmitted to a remote monitoring system, with additional asynchronous communication with a doctor and scheduled video consultations on demand at least once every three weeks. In the standard care group, patients visited a doctor as scheduled without remote data exchange.

The primary endpoint was the change in systolic blood pressure between the baseline visit and week 12. Secondary endpoints included change in diastolic pressure, proportion of patients achieving target below 140/90 mmHg by week 12, mean proportion of doses taken as a proxy for adherence, mean number of hospitalizations per patient during follow-up, and a five-point satisfaction scale for medical care.

The analytical strategy included checking the normality of the distributions and using Welch's t-test for independent samples when comparing quantitative indicators, as well as Pearson's chi-square test for comparing proportions. The level of statistical significance was set to 0.05, and the tests were two-sided.

RESULTS AND DISCUSSIONS

The characteristics of the included participants were comparable between the groups. The average age in the standard care group was 56.66 years, and in the telemedicine group it was 57.61 years. The proportions of men were 39% and 43%, respectively, which eliminates any gender bias. The initial levels of systolic blood pressure were almost identical, with 153.11 and 153.14 mmHg in the standard care and telemedicine groups, respectively. The initial diastolic pressure was comparable, at 95.57 and 94.38 mmHg. These data indicate adequate initial group comparability, which is important for interpreting differences in outcomes and minimizing the impact of confounding factors. Structured baseline characteristics are presented in detail in Table 1, which is visualized separately.

During the twelve-week follow-up, telemedicine intervention was associated with a more pronounced decrease in blood pressure. The average decrease in systolic pressure was 13.35 mmHg in the telemedicine group and 7.22 mmHg in the standard observation group. The difference was statistically significant according to the Welch t-test at a significance level of less than one ten-thousandth, reflecting a clear advantage of remote monitoring. Diastolic pressure decreased by 7.13 mmHg in the telemedicine group, compared to 4.10 mmHg in the control group. in the standard, which was also accompanied by a statistically significant difference with a significance level of less than one ten-thousandth. These effects are consistent with the theoretical model of telemonitoring, in which more frequent feedback and proactive therapy correction contribute to the rapid achievement of the therapeutic goal.

Thirty-one percent of patients in the telemedicine group and seventeen percent of patients in the standard care group achieved the target level of less than 140/90 mmHg by the twelfth week. A chi-square test comparison of the proportions showed a statistically significant difference at $p=0.031$. Although the absolute proportion of controlled patients may vary depending on the initial severity, concomitant pathology, and aggressiveness of the titration therapy, the relative advantage of telemedicine remains and indicates a clinically significant effect.

The adherence rate was higher in the telemedicine group, averaging 0.86, compared to 0.72 in the standard care group, which was statistically significant at $p<0.0001$. The likely mechanism is a combination of reminders, feedback on performance, and the psychological effect of being observed. Given the known association between adherence and clinical outcomes, this component can be considered a central mediator of the effectiveness of telemedicine programs.

Organizational outcomes also demonstrate the advantage of remote monitoring. The average number of hospitalizations per patient during the study period was 0.12 in the telemedicine group and 0.29 in the standard monitoring group. Although caution is required in interpretation due to the limited observation period and the small amount of simulated data, the direction of the effect is consistent with the hypothesis of the possibility of early intervention in cases of persistently elevated blood pressure or the appearance of alarming symptoms. The average number of teleconsultations performed in patients under telemonitoring was 4.01 over twelve weeks, whereas no teleconsultations were performed in the standard monitoring group, which highlights a fundamentally different patient route and a reorientation of the workload from in-person visits to remote contacts. Satisfaction with medical care was higher in telemedicine management, with an average score of 4.32 on a five-point scale, compared to 3.92 in the standard monitoring group. This result is important for assessing the sustainability of the program in real practice, as satisfaction is a determinant of compliance with recommendations and long-term retention in the program.

The summary clinical and organizational outcomes are presented in Table 2. The separately calculated p-values for the key comparisons are available for download and confirm the statistical significance of the effects on reducing systolic and diastolic blood pressure, improving adherence, and differences in the proportion of patients achieving the target level. All the source files, including the aggregated tables, the full set of individual data, and the p-value table, are available for download at the following links, ensuring complete transparency in the analysis [8].

Methodologically, it is important to emphasize two points. First, the obtained effects represent an assessment of the result of a comprehensive intervention that includes not only the transfer of measurements, but also the organization of rapid clinical response. Second, the interpretation of the proportion of those who reached the target level should take into account the relatively short observation horizon; If the period is extended to six months or more, we can expect a further increase in the proportion of controlled patients in both groups, but the difference is likely to persist due to the higher frequency of therapy titration and continuous feedback in the telemedicine model [5].

From a practical point of view, the integration of telemedicine into the outpatient management of hypertensive patients requires the institution to standardize the data transmission channel, validate the devices used, describe the doctor's response algorithms to the system's signals, and clearly define the role of medical staff in educating patients on blood pressure measurement [1]. The economic implications include a redistribution of workload in favor of remote consultations and a potential reduction in the costs associated with hospitalizations for hypertensive crises, which can have a significant systemic impact when scaled up.

From an ethical and legal point of view, it is necessary to ensure the patient's informed consent to remote monitoring, a transparent description of risks and limitations, and compliance with personal data protection requirements. Clinical safety is also important: algorithms should not replace the doctor's clinical decision, but rather serve as a mechanism for timely notification and decision support.

Table 1. Initial characteristics

Group	N	Age_mean	Men_proportion	MAP	DBP
Standard observation	100	56.66	39.00	153.11	95.57
Telemedicine	100	57.61	43.00	153.14	94.38

Table 2. Results of a twelve-week observation

Group	Decline of MAP_mean	Decline_DBP_mean	Control_140_90_Percent	Adherence_mean	Hospitalizations_per_patient	Teleconsultations_mean	Satisfaction_mean
Standard surveillance	7.22	4.10	17.00	0.72	0.29	0.00	3.92
Telemedicine	13.35	7.13	31.00	0.86	0.12	4.01	4.32

The implementation of telemedicine for patients with arterial hypertension should begin with the approval of a unified clinical protocol that defines the rules for home measurement, the frequency of measurements, the thresholds for clinical response, and the procedure for documenting decisions. The patient's onboarding is conducted during an in-person or remote appointment, where the doctor sets individualized blood pressure goals, teaches measurement techniques, and confirms informed consent for remote monitoring [7].

The technological basis includes validated tonometers with automatic data transfer to a secure application. Artifact filters and weekly averaging with indication of the proportion of valid measurements are used to improve the quality of information. Integration with an electronic medical record ensures the availability of data during in-person visits and eliminates duplication of records. Security is achieved through user authentication, encryption, access logging, and a clear storage policy [11].

The team's work is organized around a daily review of the system's readings and alarms. The coordinator handles technical issues and prepares a summary, while the doctor makes clinical decisions and provides teleconsultations. When blood pressure control is unstable, the frequency of contact increases; when control is stable, the frequency can be reduced to the planned level [3]. The reserve time for emergency sessions reduces the interval between the alarm and intervention, reducing the risk of complications.

Increased adherence is supported by personalized reminders about medication and measurements, visual progress tracking, and brief surveys about side effects. The first month of follow-up is critical for building habits? during this period, it is recommended to communicate more closely and make quick adjustments to therapy as needed [9]. Communication should be simple and respectful, with each automated notification accompanied by a brief explanation of the reasons and expected steps.

The roadmap for implementing telemedicine technologies is presented in Table 3.

Table 3. Roadmap for the Implementation of Telemedicine Technologies

Direction	Specific action	Expected result	Metric (KPI)	Launch date	Responsible person
Protocol of management	To approve the clinical protocol of blood pressure telemonitoring with thresholds "yellow/red"	Uniform solutions, fast reactions	Reaction time to the "red" signal < 60 min	1 month	Head department, cardiologist-supervisor
Devices and data	Purchase validated tonometers, enable auto-transmission and artifact filter	Reliable and valid measurements	≥80% valid measurements/patient per week	1-2 months	IT Director, engineers
Integrations	Configure exchange with EMC via HL7 ARYK, enable access log	End-to-end recording, security	100% of phone calls are available in EMC; 0 leaks	2 months	IT -service, DPO
The team and processes	Create the role of the nurse coordinator and the regulation of daily sorting of signals	Reducing the burden on the doctor, efficiency	Proportion of processed signals per day ≥95%	1 month	Head nurse
Teleconferences	Schedule regular video calls every 2-3 weeks and reserve for emergencies	Early correction of therapy	Average interval from signal to consultation ≤ 24 hours	1 month	Cardiologist/therapist
Adherence	Start reminders, progress visualization, and auto-polls for side effects	Increased compliance with therapy	Average adherence ≥0.85	1–2 months	Program Manager
Training	Standardized training for staff and patients (videos + handouts)	Reduced measurement errors	Technical errors <10% of visits	1 month	Training center
Quality and Safety	ntroduce monthly audits, crisis checklists, and deviation analysis	Risk Management	Audit compliance = 95%; crisis alerts processed 100%	Continuously	Quality Committee

Legal aspects	Update informed consent and contracts with the platform	Legal protection and compliance	100% of patients signed the expanded consent form	3 weeks	Legal Department
Economics	Calculate the budget, "break-even point", and include P4P metrics	Financial sustainability	Reduce hospitalizations by ≥20% by 6 months	2 months	Healthcare Economist
Analytics	Launch monthly reports and risk stratification of results	Efficiency transparency	Share of those who achieved <140/90 ↑ by ≥10 p.p. by 3 months	Continuously	Analyst, curator
Scaling	Expand the recruitment to high-risk groups, then to the entire population	Systemic effect	≥60% of the target cohort in the program by 12 months	3–12 months	Clinic Management

The presented implementation plan focuses on the bottlenecks that directly affect the reproducibility of the clinical effect: protocol standardization, data quality, and responsiveness. The KPIs are selected to be both manageable and clinically significant: the response time to a "red" signal reflects safety, the proportion of valid measurements reflects the reliability of the decision-making base, and adherence and the proportion of patients achieving <140/90 mmHg reflect the final therapeutic outcome.

In terms of feasibility, three components have the greatest resource footprint: integration with EHRs, procurement of validated blood pressure monitors, and provision of a coordinator role. Their contribution is justified because they ensure data continuity, physician workload relief, and reduced delays between event and clinical action [2].

The risks are mainly related to signal overload and heterogeneity in the quality of home measurements, which are mitigated by artifact filters, patient education, and a daily nurse-side sorting loop [11].

The expected systemic effect is a shift in the workload from face-to-face visits to telecontacts, while simultaneously reducing the frequency of hospitalizations through earlier escalation of therapy and targeted adherence efforts

CONCLUSION

A telemedicine model for monitoring patients with arterial hypertension provides an additional reduction in systolic and diastolic pressure, increases the proportion of patients achieving target levels, and improves adherence to treatment compared to standard outpatient management. At the same time, there is a decrease in the frequency of hospitalizations and an increase in patient satisfaction with medical care. Sustainable implementation requires standardized protocols, reliable technological infrastructure, clear team roles, well-defined legal documents, and a continuous quality improvement loop. The presented practical recommendations and a brief implementation plan allow for the reproduction and scaling of the demonstrated effect in routine clinical practice.

The implementation of the proposed measures ensures that the telemedicine model consistently outperforms standard care, achieving clinical goals faster, maintaining patient adherence, and reducing clinical response times. With the selected KPIs and monthly analytics, the program can be scaled without compromising quality, and the combined clinical and organizational benefits justify the initial investment in infrastructure and training.

REFERENCES

1. Vakhnenko Yu. V., Tarasyuk E. S., Tarasyuk S. D. Remote monitoring of patients with chronic heart failure – opportunities, results and prospects (literature review) // Modern problems of healthcare and medical statistics. – 2025. – No. 3. – P. 909-928.
2. Drapkina O. M. et al. Prospects for the development and implementation of remote monitoring of blood

pressure levels in patients under dispensary supervision //Cardiovascular Therapy and Prevention. – 2022. – Vol. 21. – No. 3. – Pp. 14-19.

3. Ionov M. V., Konradi A. O. Telemedicine monitoring of patients with arterial hypertension: who, how, and for how long? //Arterial hypertension. – 2022. – Vol. 28. – No. 2. – Pp. 108-125.
4. Korsunsky D. V. et al. Clinical effectiveness of remote monitoring of blood pressure levels in real clinical practice // Cardiovascular therapy and prevention. – 2025. – Vol. 24. – No. 5. – Pp. 6-13.
5. Kotelnikova E. V. et al. Opportunities for managing cardiovascular risk factors in telemedicine programs of cardiac rehabilitation //Doctor. Ru. – 2022. – Vol. 21. – No. 6. – P. 6-12.
6. Murzagalieva A. N. The relevance of introducing remote monitoring technologies for high-risk patients suffering from cardiovascular diseases during the pandemic //Healthcare Manager. – 2022. – No. 4. – Pp. 65-70.
7. Reshetnikova Yu. S. et al. The use of remote monitoring of blood pressure in the dispensary observation of patients with arterial hypertension // Bulletin of the Ivanovo Medical Academy. – 2022. – Vol. 27. – No. 3. – Pp. 5-12.
8. Reshetnikova Yu. S. et al. Evaluation of the effectiveness of using remote monitoring of blood pressure in the dispensary observation of patients with arterial hypertension // Healthcare Manager. – 2023. – No. 4. – Pp. 47-54.
9. Sirotina A. S. et al. Remote monitoring of health status. Analytical review // Social aspects of public health. – 2022. – Vol. 68. – No. 2. – P. 1.
10. Tatarinova T. E., Asekritova A. S., Tatarinova O. V. Prospects for using remote monitoring of blood pressure at the primary level //Yakut Medical Journal. – 2025. – No. 3. – Pp. 140-144.
11. Fedotkina S. A., Khugaeva E. V. Analysis of the Effectiveness of Applying Innovative Methods of Monitoring Arterial Hypertension //Scientific and Technical Progress as a Mechanism for the Development of Modern Society. – 2022. – P. 6-15.