doi.org/10.1371/journal.pmed.1003371.
25. Saltiel A.R., Olefsky J.M. Inflammatory mechanisms linking obesity and metabolic disease. Invest. 2017; 127(1): 1-4. DOI: 10.1172/JCI92035.
26. Lorenzo C., Williams K., Hunt K. J., Haffner S. M. The National Cholesterol Education Program - Adult Treatment Panel III, International Diabetes Federation, and World Health Organization Definitions of the Metabolic Syndrome as Predictors of Incident Cardiovascular Disease and Diabetes. Diabetes Care. 2007; 30(1): 8-13
27. Tokede O.A., Gaziano J.M., Djouss L. Effects of cocoa products/dark chocolate on serum lipids: a meta-analysis. Eur J Clin Nutr. 2011; 65(8): 879-86. DOI: 10.1038/ejcn.2011.64
28. Tørris C., Cvancarova S.M., Molin M. Nutrients in Fish and Possible Associations with Cardiovascular Disease Risk Factors in Metabolic Syndrome. Nutrients. 2018; 10(7):952. DOI: 10.3390/nu10070952.

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PROSPECTS FOR THE USE OF REMOTE BLOOD PRESSURE MONITORING AT THE PRIMARY HEALTHCARE LEVEL

To study the effectiveness and prospects of using telemedicine technologies for monitoring blood pressure (BP) in patients with arterial hypertension (AH) at the primary care level, remote BP monitoring was carried out using a digital platform. The study included 146 patients with uncontrolled BP, who measured BP at least twice a day using automatic monitors with Bluetooth data transfer. Measurement data were received by the remote monitoring system, where they were automatically processed and transmitted to the attending physician's personal account.

During the 10-month follow-up of patients with AH, target BP values below 135/85 mmHg were achieved in 83% of cases. During remote monitoring, therapy adjustments were observed: the number of patients on monotherapy decreased from 22.4% to 8% ($p<0.05$).

Keywords: arterial hypertension, blood pressure, telemedicine, remote blood pressure monitoring.

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Introduction. Modern medicine at the primary care level faces a number of challenges associated with the diagnosis and treatment of chronic noncommunicable diseases, among which arterial hypertension (AH) holds one of the leading places. Its high prevalence, associated complications, and significant share of mortality due to cardiovascular disease make blood pressure (BP) control a priority in healthcare. It is important to note that uncontrolled hypertension is directly associated with the development of cardiovascular catastrophes such as stroke, myocardial infarction, and sudden cardiac death [5].

According to the Ministry of Health of the Republic of Sakha (Yakutia), the main causes of mortality in 2023 were circulatory system diseases (42.4% vs. 38% in 2021), cancer (16.5% vs. 11.8% in 2021), and external factors (16.6% vs. 10.4% in 2021). Among cardiovascular diseases, coronary heart disease (46.3%, including myocardial infarctions 14.9%) and cerebrovascular diseases (22.2%, including strokes 48.0%) are most common [8]. The increase in mortality from cardiovascular disease is associated with a rise in the number of conditions among the population, particularly those accompanied by elevated blood pressure.

Extensive studies show that lowering blood pressure can significantly reduce the risk of serious cardiovascular diseases, coronary artery disease, heart failure, and death, with the same proportional reduction across different population subgroups [14]. One of the main forms of preventive work with patients with elevated BP is timely enrollment in dispensary observation, with adherence to the required frequency of check-ups [8, 4].

Studies over the past decade confirm that home (ambulatory) blood pressure measurements outperform standard in-clinic measurements for predicting both overall and cardiovascular mortality [6]. However, traditional approaches to BP monitoring, based on keeping self-control diaries and periodic patient visits to the physician, do not always provide timely and sufficient data for effective disease control.

According to the observational study ESSE RF-2, only 49.7% of patients diagnosed with hypertension and receiving antihypertensive therapy achieved target indicators. Meanwhile, only 24.9% of the general population with hypertension maintained BP control after achieving target results [10].

The use of active remote observation of patients with hypertension receiving antihypertensive therapy (both in Russian and international practice) contributes to achieving target BP values, subsequent monitoring of health indicators, and timely provision of medical assistance [11].

In this regard, remote blood pressure monitoring (RBPM), using modern telemedicine technologies, represents a promising direction that can improve the quality of medical care and reduce the workload on primary healthcare. Integration of RBPM into primary care practice allows not only continuous monitoring of patient status and achievement of targets, but also increases adherence and involvement in the treatment process — especially important for chronic noncommunicable diseases requiring long-term follow-up.

The aim of our study was to evaluate the effectiveness of RBPM in outpatients to improve control of arterial hypertension.

Materials and Methods. The depart-

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mental pilot project *"Remote blood pressure monitoring in outpatients"* was carried out in accordance with the order of the Ministry of Health of the Russian Federation No. 91n of March 1, 2023 [9] and the order of GAU RS(Ya) "Republican Clinical Hospital No. 3" No. 27 of January 30, 2023 *"On the implementation of pilot projects 'Medical Patronage' and 'Remote BP Monitoring in Outpatients' on the basis of GAU RS(Ya) 'Republican Clinical Hospital No. 3'"*. The project lasted 10 months in 2023.

Inclusion criteria:

- age over 18 years;
- established diagnosis of hypertension and/or BP readings above 140/90 mmHg during outpatient measurement;
- basic smartphone user skills and ability to use an automatic BP monitor independently or with assistance;
- valid registration on the Unified State Services portal;
- informed voluntary consent of the patient.

Exclusion criteria: severe somatic and psychiatric diseases; acute infectious diseases; absence of data exchange and contact with the patient.

During participation in the pilot project, patients were conditionally divided into two groups:

- *Group 1 — therapy control group:* BP measurements once every three days, twice a day (morning and evening); 12 people included.
- *Group 2 — therapy selection group:* BP measurements daily, twice a day (morning and evening); 134 people included.

In-person visits of patients to the attending physician were limited to two required appointments: an initial visit (recorded in the medical information system as an outpatient case) and a follow-up. A three-party rental agreement for the device was signed. Patients were instructed on measurement technique, frequency, use of the personal account, and safety rules.

As part of the project, 20 automatic arm blood pressure devices were used, provided under a loan agreement to patients by RT Doctis LLC. The devices had the function of data transmission via Bluetooth to the *GOSTELEMED* mobile application, with subsequent integration into a centralized system.

Within this system, all events occurring during RBPM were classified as medical or non-medical and automatically processed.

A *medical event* was considered any significant deviation of systolic BP (SBP), diastolic BP (DBP), or heart rate (HR) from the set threshold values by 7.1% or more. A *non-medical event* was considered the absence of data transmission from a patient for a certain period of time.

If data were not received, the system automatically sent the patient a push notification reminding them to perform a measurement and transmit data. If the data still were not received, operators contacted the patient by phone to determine the reason and remind them of the need for a measurement.

Medical events were divided into three categories by urgency:

1. **Critical category:** BP above 180/106 mmHg or below 86/56 mmHg. In such cases, the operator contacted the patient within an hour to provide consultation and recommendations on pressure normalization, or directed the patient to emergency medical services. The attending physician determined further treatment tactics.
2. **Intermediate category:** BP range 151/91 to 179/105 mmHg or 87/57 to 89/59 mmHg. These cases required the physician's attention to assess the patient's condition and decide whether to adjust therapy.
3. **Target category:** BP in the range 90/60 to 150/90 mmHg. Target BP levels were determined individually for each patient.

The results of event interpretation were displayed in the physician's account in the form of a color-coded dashboard. The physician observed each patient's indicators daily throughout RBPM. If values deviated from targets, remote interim consultations were held via the digital platform (chat and audio communication). Patients could also call their physician during working hours on a landline phone.

If necessary, in-person consultations were arranged, with the examination documented in the medical information system and therapy adjusted. The protocol, certified by an electronic signature, was sent to the patient via the *GOSTELEMED* mobile app.

Statistical analysis. Statistical analysis of project data was performed using IBM SPSS Statistics (version 26.0). The distribution of variables was tested with the Shapiro–Wilk and Kolmogorov–Smirnov tests. Interval scale data are presented as mean ± standard deviation (M±SD).

To assess differences between two independent samples, the Mann–Whitney U test was applied. To analyze the strength and direction of correlations between quantitative variables, Spearman's rank correlation coefficient was calculated. Statistical significance of differences in qualitative variables was evaluated using the chi-square test (χ^2), provided that values in each cell of the four-field contingency table exceeded 10.

Differences were considered statistically significant at $p<0.05$, ensuring at least 95% confidence in the obtained results.

Results. The average duration of RBPM per patient was 22.4 days (range 7 to 57 days). Women made up the majority of the sample — 102 people (69.9%), while men accounted for 30.1% (44 people). The mean age of participants was 56.94±13.15 years. Men (52.93±14.14 years) were not significantly younger than women (58.67±12.37 years), $p>0.05$.

The clinical and demographic characteristics of RBPM patients are shown in **Table 1**. It should be noted that overweight and obesity were identified in the majority of patients (84%). Women were statistically more likely than men to have lipid profile disorders: 71.6% vs. 54.5%. Harmful habits such as smoking were reported in 43.8% (64 people), significantly more often among men (56.8% vs. 16.7% among women).

The dynamics of BP indicators at the beginning and end of RBPM are presented in Table 2. The average SBP/DBP in the first three days of RBPM was 133.97±16.07 / 83.98±11.44 mmHg, gradually decreasing to 126.91±13.13 / 77.85±9.77 mmHg by days 14–22 ($p<0.05$).

An interesting finding was the distribution of unscheduled measurements and missed BP readings. The frequency of unscheduled measurements decreased by the end of the observation period. The increase in missed measurements by the end of monitoring was likely associated with the stabilization of patients' BP (see Table 2).

During RBPM, therapy adjustments were observed: the proportion of patients on monotherapy decreased from 22.6% to 8.2% ($p<0.05$). Numerous studies confirm that combining drugs from at least two different antihypertensive classes is more effective at lowering BP than increasing the dose of a single agent. In addition, the use of fixed-dose combinations in a single tablet improves patient adherence to treatment [2,6,10].

For 3.4% (n=5) of patients, an ambulance was called due to elevated BP during RBPM. There were no emergency hospitalizations for decompensated hypertension during monitoring.

Throughout the monitoring period, no device breakdowns or malfunctions were recorded. Some temporary sys-

Table 1

Clinical and demographic characteristics of RBPM patients

Indicator	Total	Men	Women	p (M=F)
Patients, n (%)	146	44 (30.1)	102 (69.9)	<0.05
Age (M±SD), years	56.94±13.15	52.93±14.14	58.67±12.37	NS
BMI (M±SD), kg/m^2	29.1±4.36	29.49±3.06	29.06±4.83	NS
Overweight & obesity, n (%)	123 (84.2)	41 (93.2)	82 (80.4)	NS
Total cholesterol (M±SD), mmol/L	5.95±1.46	5.39±1.16	6.19±1.52	NS
LDL-C (M±SD), mmol/L	3.68±1.12	3.22±0.95	3.88±1.13	NS
Dyslipidemia, n (%)	97 (66.4)	24 (54.5)	73 (71.6)	<0.05
Smoking, n (%)	64 (43.8)	25 (56.8)	17 (16.7)	<0.05
Impaired glucose tolerance, n (%)	5 (3.4)	1 (2.3)	4 (3.9)	NS
Diabetes mellitus, n (%)	20 (13.7)	6 (13.6)	14 (13.7)	NS
Coronary heart disease, n (%)	19 (13.0)	4 (9.1)	15 (14.7)	NS

Note: BMI – body mass index; NS = no significant differences, p>0.05.

Table 2

Dynamics of indicators at the beginning and end of remote monitoring

Indicator	Start of RBPM (0–3 days)	End of RBPM (14–22 days)	p
SBP (M±SD), mmHg	133.97±16.07	126.91±13.13	<0.05
DBP (M±SD), mmHg	83.98±11.44	77.85±9.77	<0.05
HR	73.88±10.85	73.21±9.30	NS
Proportion of SBP >180 mmHg	5.5%	0.7%	<0.05
Proportion of unscheduled BP measurements	4.8%	1.4%	NS
Proportion of missed BP measurements	0.7%	31.5%	<0.05
Monotherapy	22.6%	8.2%	<0.05

Note: BMI – body mass index; NS = no significant differences, p>0.05. NS = not significant, p > 0,05.

tem failures occurred, such as disabling of individual target BP/HR settings, lack of patient data displayed in graph form, or device detachment from the patient. However, these failures did not significantly affect the overall results of RBPM.

Previous studies in certain regions of Russia demonstrated the high effectiveness of telemedicine technologies in BP control [1, 12, 6]. Remote BP and heart rate monitoring among civil servants in Ufa significantly reduced in-person clinic visits, prevented hospitalizations, and reduced work disability episodes related to hypertension [1].

A study by the TP NMIC conducted in 5 Russian regions, including 3,609 hypertensive patients, showed significant reductions in SBP (–4.7%) and DBP (–4.4%) (p<0.001). During follow-up, 3,364 patients (93.2%) maintained adherence to monitoring, while 245 patients (6.8%) dropped out [Korsunsky].

Conclusion. The project achieved a significant reduction in SBP, with target values reached in 83% of patients, while decreasing the number of in-person clinic visits. It is also important to note that the decision on the need and urgency of patient contact during RBPM was made by the physician, based on the received data, rather than by the patient as in usual outpatient care. Thus, patient flow regulation for those diagnosed with hypertension was directed by the physician, which can be widely applied in the management of patients under dispensary observation.

Remote BP monitoring in outpatients has proven convenient for both therapy selection and control. It can be successfully used in routine medical practice to improve patient follow-up quality, enhance adherence, and ensure regular BP monitoring, while positively impacting the workload of primary care physicians. However, it should be taken into account that adherence to BP measurements decreases once indicators stabilize and RBPM duration increases, which requires more active supervision of patients.

It can be assumed that one of the delayed effects of RBPM in hypertensive patients will be a positive impact on overall morbidity and mortality from cardiovascular diseases in the population.

This study has several limitations, including the short observation period and limited statistical power. Further research on larger groups of patients with longer observation periods is promising, as it will allow assessment of the impact of RBPM on clinical outcomes and endpoints.

Given the positive results of the present observation, it can be concluded that the use of telemonitoring methods in physician–patient interaction for BP stabilization should occupy an important place in primary care practice.

The authors declare no conflict of interest.

References

1. Garanin A.A., Khasbiev S.A., Azarova R.F., et al. Distancionnyj monitoring arterial'nogo davleniya i chastoty pul'sa u rabotayushchego naseleniya [Remote monitoring of blood pressure and pulse rate in the working population]. Rossijskij kardiologicheskij zhurnal [Russian Journal of Cardiology. 2023; 28, (S8): 35-36. EDN MOVIOY (In Russ.).]

2. Boytsov S.A., Pogosova N.V., Ansheles A.A., et al. Kardiovaskulyarnaya profilaktika 2022. Rossijskie nacional'nye rekomendacii [Cardiovascular prevention 2022. Russian national recommendations]. Rossijskij kardiologicheskij zhurnal [Russian Journal of Cardiology. 2023;28(5):5452 (In Russ.).] https://doi.org/10.15829/1560-4071-2023-5452

3. Korsunsky, D.V., Komkov D.S. Klinicheskaya effektivnost' distancionnogo monitorirovaniya urovnya arterial'nogo davleniya u pacientov s arterial'noj gipertenziej v ambulatornyh usloviyah [Clinical effectiveness of remote monitoring of blood pressure levels in patients with hypertension in outpatient settings]. Kardiovaskulyarnaya terapiya i profilaktika [Cardiovascular therapy and prevention. 2023; 22 (S6): 11. EDN KCNKAK (In Russ.).]

4. Drapkina O.M., Shepel R.N., Drozdova L.Yu., et al. Kachestvo dispansernogo nablyudeniya vzroslogo naseleniya s arterial'noj gipertoniej 1–3 stepeni, za isklyucheniem rezistentnoj arterial'noj gipertonii, vrachami-terapevtami uchastkovymi medicinskih organizacij sub"ektov Rossijskoj [The quality of outpatient follow-up of the adult population with arterial hypertension of 1-3 degrees, with the exception of resistant arterial hypertension, by district internists of medical organizations of the subjects of the Russian Federation]. Rossijskij kardiologicheskij zhurnal [Russian Journal of Cardiology. 2021; 26(4):4332 (In Russ.).] https://doi.org/10.15829/1560-4071-2021-4332

5. Obshcherossijskaya obshchestvennaya organizaciya «Rossijskoe kardiologicheskoe obshchestvo», Obshcherossijskaya obshchest-

vennaya organizaciya "Rossijskoe nauchnoe medicinskoe obshchestvo terapevtov" [All-Russian public organization "Russian Cardiological Society", All-Russian public organization \"Russian Scientific Medical Society of Therapists"]. Klinicheskie rekomendacii. «Arterial'naya gipertenziya u vzroslyh» [Clinical recommendations. "Arterial hypertension in adults" Moscow, 2024 (In Russ.).] https://cr.minzdrav.gov.ru/preview-cr/62_3.

6. Reshetnikova Y.S., Brynza N.S., Nemkov A.G., et al. Ocenka effektivnosti ispol'zovaniya distancionnogo monitoringa arterial'nogo davleniya pri dispansernom nablyudenii pacientov s arterial'noj gipertenziej [Evaluation of the effectiveness of using remote monitoring of blood pressure in the dispensary monitoring of patients with hypertension] Menedzher zdravoohraneniya [Health Care Manager. 2023; 4: 47-54 (In Russ.).] DOI 10.21045/1811-0185-2023-4-47-54. – EDN WBRJTC.

7. Drapkina O.M., Korsunsky D.V., Komkov D.S., et al. Perspektivy razrabotki i vnedreniya distancionnogo kontrolya urovnya arterial'nogo davleniya pacientov, nahodyashchihsya na dispansernom nablyudenii [Prospects for the development and implementation of remote monitoring of blood pressure levels in patients undergoing dispensary supervision]. Kardiovaskulyarnaya terapiya i profilaktika [Cardiovascular therapy and prevention. 2022; 21 (3): 14-19 (In Russ.).] DOI 10.15829/1728-8800-2022-3212. – EDN OXIOSW.

8. Portnyagina U.S. Dispansernoe nablyudenie pacientov s hronicheskoj serdechnoj nedostatochnost'yu vrachom-terapevtom v Respublike Saha (Yakutiya) [Dispensary observation of patients with chronic heart failure by a general practitioner in the Republic of Sakha (Yakutia)]. Obshchestvennoe zdorov'e, sociologiya i organizaciya zdravoohraneniya: integraciya nauki i praktiki: Sbornik statej i materialov II Vserossijskoj nauchno-prakticheskoj konferencii s mezhdunarodnym uchastiem, Yakutsk, 14–15 marta 2024 g. [Public health, sociology and healthcare organization: integration of science and practice: Collection of articles and materials of the II All-Russian Scientific and Practical Conference with international participation, Yakutsk, March 14-15, 2024 of the year. Yakutsk: NEFU Publishing House, 2024: 79-84 (In Russ.).] EDN QXMRSP.

9. Prikaz Ministerstva zdravoohraneniya RF ot 1 marta 2023 g. N 91n \"Ob utverzhdenii poryadka obespecheniya grazhdan medicinskimi izdeliyami s funkciej distancionnoj peredachi dannyh, poryadka ispol'zovaniya medicinskih izdelij s funkciej distancionnoj peredachi dannyh grazhdanami, vklyuchaya voprosy sohrannosti ukazannyh izdelij, poryadka obsluzhivaniya medicinskih izdelij s funkciej distancionnoj peredachi dannyh i ih poverki, vklyuchaya tipovuyu formu grazhdansko-pravovogo dogovora, zaklyuchaemogo medicinskoj organizaciej s grazhdaninom v celyah peredachi v pol'zovanie medicinskih izdelij s funkciej distancionnoj peredachi dannyh". Zaregistrirovano v Minyuste RF 7 aprelya 2023 g. Registracionnyj N 72936 [Order of the Ministry of Health of the Russian Federation dated March 1, 2023 No. 91n "On approval of the procedure for providing citizens with medical devices with the function of remote data transmission, the procedure for using medical devices with the function of remote data transmission by Citizens, including Issues of Safety of these products, the procedure for servicing medical devices with the function of remote data transmission and their verification, including the standard form of a civil contract concluded by a medical organization with a citizen in for the purpose of transferring medical devices with the function of remote data transmission for use. Registered with the Ministry of Justice of the Russian Federation on April 7, 2023. Registration number 72936 (In Russ.).]

10. Balanova Yu.A., Shalnova S.A., Imaeva A.E., et al. Rasprostranennost' arterial'noj gipertonii, ohvat lecheniem i ego effektivnost' v Rossijskoj Federacii (dannye nablyudatel'nogo issledovaniya ESSE-RF2) [Prevalence of arterial hypertension, coverage of treatment and its effectiveness in the Russian Federation (data from the observational study ESSE-RF2)]. Racional'naya Farmakoterapiya v kardiologii [Rational Pharmacotherapy in Cardiology. 2019;15(4):450-466 (In Russ.).] https://doi.org/10.20996/1819-6446-2019-15-4-450-466

11. Belozerova E.V., Bessarabova Yu.V., Sharapova Yu.A., Kalinina L.B. Rol' distancionnogo monitoringa arterial'nogo davleniya v povyshenii effektivnosti dispansernogo nablyudeniya pacientov s arterial'noj gipertoniej [The role of remote monitoring of blood pressure in improving the effectiveness of outpatient monitoring of patients with arterial hypertension]. Prikladnye informacionnye aspekty mediciny [Applied information aspects of medicine. 2018; 21 (1): 147-151 (In Russ.).] EDN YVPANM.

12. Starodubtseva I.A., Sharapova Yu.A. Distancionnyj monitoring arterial'nogo davleniya kak instrument povysheniya kachestva dispansernogo nablyudeniya pacientov s arterial'noj gipertenziej [Remote monitoring of arterial pressure as a tool for improving the quality of outpatient follow-up of patients with hypertension]. Arhiv" vnutrennej mediciny [Archive of Internal Medicine. 2021; 11, No. 4(60): 255-263 (In Russ.).] DOI 10.20514/2226-6704-2021-11-4-255-263. EDN FTKKTE.

13. Baigent C, Blackwell L, Emberson J, et al. Cholesterol Treatment Trialists' (CTT) Collaboration. Efficacy and safety of more intensive lowering of LDL cholesterol: a meta-analysis of data from 170,000 participants in 26 randomised trials. Lancet. 2010 Nov 13; 376(9753):1670-81. doi: 10.1016/S0140-6736(10)61350-5. Epub 2010 Nov 8. PMID: 21067804; PMCID: PMC2988224.

14. Ettehad D, Emdin CA, Kiran A, et al. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. Lancet. 2016 Mar 5;387(10022):957-967. doi: 10.1016/S0140-6736(15)01225-8. Epub 2015 Dec 24. PMID: 26724178.

15. Huang QF, Yang WY, Asayama K, et al. Ambulatory Blood Pressure Monitoring to Diagnose and Manage Hypertension. Hypertension. 2021 Feb;77(2):254-264. doi: 10.1161/HYPERTENSIONAHA.120.14591. Epub 2021 Jan 4. PMID: 33390042; PMCID: PMC7803442.