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Follow-Up After Hip and Knee Arthroplasty: a Review of the Literature and a Report on a Pilot Project at the Vreden National Medical Research Center of Traumatology and Orthopedics

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Background. Today in Russia, the follow-up of patients after arthroplasty is carried out in accordance with clinical guidelines, the wording of which is based on monographs from 2006, 2008, and 2014, in addition, clinical guidelines for follow-up do not take into account the results of treatment assessed by the patient himself.

The purpose of this study was to examine existing systems and develop a proprietary follow-up system for patients after hip and knee arthroplasty.

Results. A review of the literature revealed that follow-up of patients after arthroplasty is an unsolved problem, within which there is low coverage, reluctance or forgetfulness of the asymptomatic patient, the problem of accessibility of medical examinations, and an excessive financial burden on the health care system. Since 2022, fixed recommendations for follow-up after arthroplasty have been used in the clinical practice of our center in discharge epicrisis. Recommendations for the frequency of follow-up were formulated by experts based on a comprehensive review of the literature and their own experience. In the first three months, 221 hip and 235 knee evaluation questionnaires were collected through the proposed mechanism, with a progressive increase in the number of questionnaires based on weekly monitoring data.

Conclusion. Unfortunately, the outpatient clinic system is not always able to provide qualitative monitoring of patients after arthroplasty due to various reasons, therefore, in our opinion, the implementation of the mechanism of remote monitoring of patients will allow detecting various complications at the stage of early diagnosis, which will contribute to prompt solution of these problems. The remote monitoring system is also an important source of scientific data.

Keywords: knee arthroplasty, hip arthroplasty, remote monitoring, follow-up.

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Наблюдение пациентов после эндопротезирования тазобедренного и коленного суставов: обзор литературы и доклад о пилотном проекте Национального медицинского исследовательского центра травматологии и ортопедии им. Р.Р. Вредена

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Актуальность. На сегодняшний день в России диспансерное наблюдение за пациентами после эндопротезирования осуществляется в соответствии с клиническими рекомендациями, формулировки из которых основаны на монографиях 2006, 2008 и 2014 гг. Кроме того, клинические рекомендации по диспансерному наблюдению не учитывают результаты лечения, оцененные самим пациентом.
Целью данного исследования было изучение существующих систем и разработка собственной системы наблюдения за пациентами после эндопротезирования тазобедренного и коленного суставов.
Результаты. Обзор литературы выявил, что наблюдение за пациентами после эндопротезирования представляет собой нерешенную проблему, составляющими которой являются низкий охват, нежелание или забывчивость асимптомных пациентов, проблема доступности медицинских осмотров, избыточная финансовая нагрузка на систему здравоохранения. С 2022 г. в клинической практике НМИЦ ТО им. Р.Р. Вредена в выписных эпикризах используются рекомендации по наблюдению после эндопротезирования. Рекомендации по периодичности наблюдений были сформулированы экспертами на основе всестороннего обзора литературы и собственного опыта. За первые три месяца собрана 221 анкета по оценке тазобедренного сустава и 235 — коленного сустава, причем число анкет по данным еженедельного мониторинга прогрессивно возрастает.
Заключение. К сожалению, поликлиническая система не всегда может обеспечить качественное наблюдение за пациентами после эндопротезирования в силу различных причин, поэтому реализация механизма удаленного наблюдения за пациентами, на наш взгляд, позволит выявлять на этапе ранней диагностики различные осложнения, что будет способствовать оперативному решению данной проблемы. Также система удаленного наблюдения представляет собой важный источник научных данных.

Ключевые слова: эндопротезирование коленного сустава, эндопротезирование тазобедренного сустава, диспансерное наблюдение.

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BACKGROUND

The number of hip and knee arthroplasties is steadily increasing worldwide [1]. According to the report of the Priorov National Medical Research Center of Traumatology and Orthopedics, in 2018, 116 597 surgeries were performed in the Russian Federation, including 70 316 hip arthroplasties and 42 904 knee arthroplasties, with a ratio of 1.6:1.0 [2].

The report of the Vreden National Medical Research Center of Traumatology and Orthopedics showed even higher numbers of arthroplasties in 2019 in Russia, with 83 311 primary hip arthroplasties, 63 750 knee arthroplasties (ratio 1.3:1.0), 5 197 hip revision arthroplasties, and 2 573 knee revision arthroplasties. The ratio of revision to primary surgeries for the hip joint was 1:16, and for the knee joint was 1:25. Thus, knee revisions were performed 1.55 times less frequently than hip revisions [3]. The higher numbers in the report of the Vreden National Medical Research Center of Traumatology and Orthopedics were due to the inclusion of medical organizations of federal subordination and private medical organizations in the analysis, unlike the report of the Priorov National Medical Research Center of Traumatology and Orthopedics.

According to clinical recommendations, after hip arthroplasty [4] it is recommended to perform X-ray examination of the hip joints in two projections at 3 and 12 months, and then once every 5 years [5, 6]. Clinical recommendations for knee arthritis [7] dictate the need for X-ray examination after arthroplasties at 6 and 12 months, and then once every 5 years [8].

As can be seen, the formulation of clinical recommendations on the frequency of postoperative radiological examination after arthroplasties of both hip and knee joints is based on monographs from 2006, 2008, and 2014 [5, 6, 8], which are not scientific studies focused on the question of the periodicity of postoperative follow-up. Furthermore, clinical recommendations on follow-up completely ignore patient-evaluated clinical outcomes, known as Patient Related Outcome Measures (PROM), the patient's quality of life, and its dynamics. As a result, a vicious idea may emerge that only dispensary radiological evaluation will serve as a measure of whether the patient needs revision or whether the operation was effective.

PROM has an important feature — it is an entirely subjective assessment that only takes into account the patient's evaluation of their own results. Therefore, PROM can be conducted remotely without burdening the patient with visits to healthcare institutions. This not only opens up new horizons for actual patient follow-up, but also theoretically increases patient compliance with prescribed recommendations and reduces the burden on the healthcare system by excluding visits that do not have any impact.

Since, according to normative documents, dispensary follow-up is limited only to X-rays and does not include PROM, in this article, we will use the term "follow-up", which implies not only a complex of dispensary follow-up but also a system of decision-making and information transfer.

The aim of the study is to investigate existing systems and develop our own system for following up with patients after arthroplasty of the hip and knee joints.

Is patient follow-up necessary after arthroplasty?

The system of patient follow-up after arthroplasty should take into account the following dilemma:

- radiographic examinations can reveal asymptomatic patients who require revision;
- not all radiographic changes in asymptomatic and minimally symptomatic patients require revision.

According to foreign authors, the frequency of early revisions (within 5 years after the primary operation) after total arthroplasty of the hip joint is currently only about 24% of all repeat operations [9]. The structure of revisions includes the following main causes: dislocations, aseptic loosening, and infection [9, 10, 11].

In the context of patient follow-up, the diagnosis of osteolysis is particularly important, as it can be completely asymptomatic before loosening occurs. In the 1990s and 2000s, the frequency of revisions due to aseptic loosening caused by osteolysis was very high and reached 47% of all revisions [12]. B.M. Wroblewski et al. observed 22 066 primary endoprostheses for a maximum period of 38 years and found that 72.6% of cases of loosening or polyethylene wear occurred between 7 and 20 years after surgery [13]. This indicates that the main goal of follow-up such

patients should be to identify asymptomatic patients with osteolysis before there is a clear reason for revision. On the other hand, there are currently no studies that have demonstrated the effectiveness of prophylactic revisions for osteolysis. The absence of such studies, in our view, is due to the difficulty of designing such studies and should not call into question the advisability of observation and early diagnosis of osteolysis in general.

The frequency and structure of early revisions of the hip joint, according to the registry of the Vreden National Medical Research Center of Traumatology and Orthopedics, differ from foreign publications. As of 2019, the proportion of early revisions increased from 32.9% to 56.7% in 2013, with early revisions accounting for 37.4% of all primary revisions, which is significantly higher than the 24% reported by J.S. Melvin et al [9]. The main reasons for revisions, according to the registry of the Vreden National Medical Research Center of Traumatology and Orthopedics in 2019, were aseptic loosening of arthroplasty components (50.3%), infection (27.6%), polyethylene wear and osteolysis (9.0%), and dislocation (6.2%).

According to the National Joint Registry for England, Wales, Northern Ireland, and the Isle of Man, the risk of revision surgery within the first 12 years after knee arthroplasty surgery is relatively low, at approximately 5%. Early revisions, which make up 27% to 69% of all revision surgeries, are most commonly performed within the first two years, with infection being the most frequent reason for revision.

Some authors suggest that, unlike hip arthroplasty, osteolysis is a rare cause of early failure after knee arthroplasty, with a revision rate of less than 10%. However, in their review of data from multiple registries, M. Khan et al. reported that aseptic loosening (29.8%), infection (14.8%), and pain (9.5%) were the most common reasons for revision, both early and late.

When analyzing the knee joint arthroplasty registry of the Vreden National Medical Research Center of Traumatology and Orthopedics from 2011 to 2021, a trend towards equalizing the percentage ratio of aseptic and infectious revisions is observed (Fig. 1). This is likely due to a learning curve and the resulting gradual reduction in risks, namely intraoperative blood loss and time of primary operative intervention. However, these data are difficult to extrapolate to other clinics, as in this case, the Vreden National Medical Research Center of Traumatology and Orthopedics serves as a revision center, to which a large proportion of specialized patients from all regions of the Russian Federation are referred, regardless of the place of primary arthroplasty.

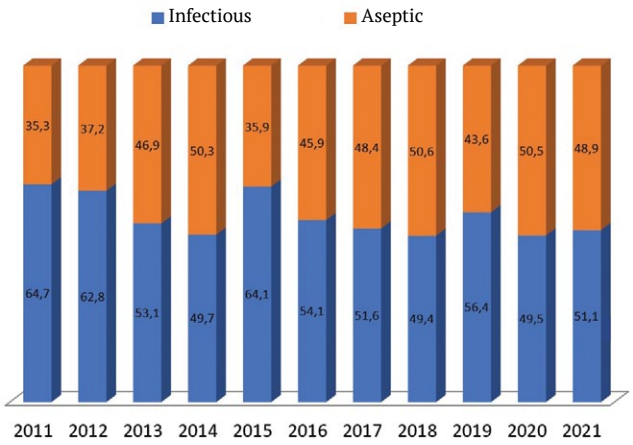

Fig. 1. Structure of the main causes of revision total knee arthroplasty in the Vreden National Medical Research Center of Traumatology and Orthopedics from 2011 to 2021

Meanwhile, in the Vreden National Medical Research Center of Traumatology and Orthopedics registry, aseptic instability became the primary cause of non-infectious revisions of the knee as of 2021 (60.4%). Other significant reasons included joint imbalance or instability (8.1%) and pain in the anterior compartment of the joint (7.2%), although they were observed in significantly fewer cases.

The lower frequency of revisions due to osteolysis of the knee compared to the hip may suggest a lower need for radiographic evaluation after knee arthroplasty. This is reflected in the discharge summary recommendations for patients of the Vreden National Medical Research Center of Traumatology and Orthopedics — there is no recommendation for knee radiography after 7 years, unlike the hip joint.

Review of existing recommendations for follow-up after arthroplasty

The British Hip Society recommends performing follow-up examinations at one year, seven years, and every three years thereafter if the pa-

tient is asymptomatic and has no radiological issues. During each examination, X-rays in the anteroposterior and lateral projections should be taken and evaluated using the Oxford scale for the X-rays (by phone or traditional mail). If a new implant was used, additional follow-up exams are recommended at 5 years, then at 7, 10, and every 3 years thereafter, in addition to the regular follow-up exams recommended by the British Hip Society [18].

The Arthroplasty Society of Australia recommends less frequent examinations for patients who had surgery before the age of 70 or when an arthroplasty not evaluated in the Australian NJRR registry was used — once every 1-2 years, once every 7-10 years, and every 3-5 years thereafter [19]. This frequency of examinations is supported by the results of L.E. Bayliss et al.'s study, which found that the risk of revision surgery during a patient's remaining life is 1-6% for those operated on after the age of 70, while for patients under 50 at the time of the first surgery, the risk is 35% [20].

Therefore, more extensive follow-up of older patients may be unnecessary. Extensive recommendations for more frequent, unnecessary examinations of elderly patients may lead to disappointment in the accessibility of medical care, a lower likelihood of patients following recommendations, psychological risks, and a burden on the healthcare system. On the other hand, the frequency of examinations for younger patients should be higher.

In the United States, there are no official recommendations for the frequency of follow-up visits, so doctors make independent decisions. A survey of orthopedic surgeons conducted by the American Association of Hip and Knee Surgeons showed that 95.9% use a "calendar" of scheduled examinations and radiographic studies after joint arthroplasty, with the majority of respondents recommending such observations annually for the first 5 years, then every 2 years up to 10 years after surgery, and then every 2 years or annually for both knee and hip joints thereafter [21].

J.B. Meding and colleagues analyzed 11 019 knee arthroplasties to identify the optimal timing of follow-up visits for revision. They found that the recommended follow-up times are 6 months, 1 year, 3 years, 8 years, 12 years, and 17 years. More frequent visits are required for patients with a body mass index >40 kg/m^2 and for those whose symptoms appear 6 months after surgery. However, this study found an overall revision rate of 7.5% after 20 years, and like all other studies, it does not account for the fact that the decision to undergo revision surgery may have been made for a symptomatic patient who sought care on their own or during routine follow-up [22]. Therefore, recommendations for follow-up visits for asymptomatic patients may be excessive and ultimately have no impact on the decision to undergo revision.

Similarly, there are no studies confirming the effectiveness of prophylactic revisions, including due to the difficulty of their design. Therefore, currently available data are insufficient to refute the claim that asymptomatic patients do not require frequent follow-up, and in absolute cases, do not require any follow-up at all: a reasonable decision about surgery is made for a symptomatic patient, and the effectiveness of prophylactic revisions is not proven. However, completely disregarding recommendations for follow-up visits for asymptomatic patients would be unwise, as it would eliminate an important tool for scientific research that benefits patients. It should be noted that the frequency of follow-up visits after arthroplasty is nothing more than an expert opinion and is not supported by proper research.

How is follow-up conducted after arthroplasty?

Regardless of recommendations on the frequency of examinations, there is a problem with their feasibility and compliance due to the availability of medical care and patient compliance. The study by P. De Pablo et al. is revealing, as it showed that after arthroplasty of the hip joint, 15% of patients did not undergo follow-up X-ray examination, only early examination was performed in 43% of patients, and only 42% of patients underwent a full examination with X-ray after 6 years. Consequently, it can be assumed that the proportion of patients who receive follow-up examinations in later periods of follow-up will be even smaller, until the patient experiences symptoms [23].

Other studies have demonstrated even lower coverage. For example, a survey of members of the British Orthopaedic Association showed that 60% of orthopedists do not see operated patients after one year, only 27% of orthopedists perform examinations after arthroplasty of the hip joint, and only 13% prescribe control X-rays [24].

As noted above, North American colleagues recommend much more frequent follow-up examinations (annually during the first 5 years, then every 2 years until 10 years after surgery, and then every 2 years or annually for both knee and hip joints) [21]. However, 78.3% of the doctors in that study were private practice doctors and received corresponding financial compensation for examining the patient, unlike their British colleagues. In this regard, we reiterate the idea that the postulate" follow-up is necessary for asymptomatic patients" is not at all refuted.

Some authors believe that early follow-up after arthroplasty is very doubtful [1]. C.A. Jacobs and colleagues' study demonstrated that none of the 339 patients who underwent early revision between one and two years had any problems during early examinations up to one year [25]. A similar study showed that only one out of 304 patients had a reason for revision detected during routine examination (aseptic loosening) [26].

Similarly, there is little evidence of the effectiveness of routine medium- and long-term check-ups for asymptomatic patients. C. Hacking et al. reported that in a series of 110 patients who underwent revision hip arthroplasty, only 4 (3.6%) hip joints (in 3 patients) were asymptomatic, while the other patients had symptoms of pain (75%), dislocation (8.2%), periprosthetic fracture (6.4%), and other causes (6.8%) (the percentages were recalculated by the authors of this publication) [27]. It is obvious that these 96.4% symptomatic patients would seek medical help for their symptoms even without routine follow-up visits. In this regard, the study by A.B. Joshi et al. is interesting, as they found that patients who underwent knee arthroplasty and were lost to follow-up had a lower revision rate and higher satisfaction scores [28]. Therefore, a patient in need of revision will seek help even without routine check-ups.

The cost of one consultation and X-ray examination is not established at the federal level in our country — each subject of the Russian Federation has its own territorial program of state guarantees. Therefore, calculating the cost of one additional visit for a patient after arthroplasty on a countrywide scale will have some approximation. Let's take three subjects of the Russian Federation with median gross domestic product: Kaluga Region, Murmansk Region, and Arkhangelsk Region (excluding the districts) — 466.0, 482.5 and 514.0 billion rubles, respectively [29]. It can be assumed that these are truly median subjects in terms of economic situation. A consultation with a traumatologist-orthopedist is priced as primary medical-sanitary aid in outpatient settings for prophylactic and other purposes. The weighted average financial norms of expenditure per unit of volume of medical care in three median subjects in 2022 tariffs amount to 498 rubles, while the weighted average rate for X-ray examination in one projection (pelvis, femoral neck, knee joint) is 593 rubles, and in two projections — 1288 rubles. Thus, each additional follow-up of a patient after arthroplasty in 2022 prices will cost 1786 rubles, excluding CAPEX (capital expenditures), which are not included in mandatory medical insurance tariffs for outpatient visits.

Given that 88 508 hip and 66 323 knee arthroplasties (primary and revision) are performed annually, additional annual costs will amount to (88 508+66 323)*1 786 rubles — 276 528,166 rubles. Taking into account that the number of patients undergoing arthroplasty in our country increases by 155 000 people each year, every two additional follow-up visits (compared to clinical recommendations [4, 7]) over a decade, as indicated in the discharge recommendations of the Vreden National Medical Research Center of Traumatology and Orthopedics, will require additional costs at the national level amounting to 553 million rubles annually. On the one hand, this is not a significant amount, especially since the coverage of such visits is never complete, but on the other hand, this figure does not include CAPEX costs. The most concerning aspect, in our view, is that each additional visit reduces the overall availability of medical care in cases where it is truly necessary, such as for symptomatic patients.

An important question is who performs patient evaluations directly after arthroplasty. In some foreign countries, there are specialized outpatient services that not only follow up with patients after arthroplasty but also effectively manage waiting lists for arthroplasty, known as advanced-practitioner-led clinics [30, 31]. In these cases, physiotherapists can effectively perform evaluations and refer patients for consultations with orthopedic surgeons, thereby relieving the workload of orthopedists. An analysis of such physiotherapist consultations showed

that patients were referred for consultation regarding the operated joint in only 7.4% of cases [32]. Moreover, K.E. Large and colleagues reported better PROM results after knee arthroplasty in patients who were followed up by physiotherapists without being referred to orthopedic surgeons [33].

Both studies reported no cases of adverse events when patients were solely managed by a physiotherapist [32, 33]. Patient compliance and adherence to appointments with physiotherapists were found to be high, exceeding 80%, according to M.J. Walton et al. and B. Cavka et al. [32, 34]. Physiotherapy can be a viable alternative to orthopedic care for early postoperative management of joint arthroplasty patients [34, 35], although the economic feasibility of this model is questionable. M.J. Walton et al. concluded that managing and supervising patients through a clinic system under the guidance of an experienced physician only resulted in a 1% financial saving compared to traditional orthopedic surveillance [32].

The general practitioner is another important healthcare provider involved in the management of arthroplasty patients, and this model of care is becoming increasingly popular [36]. However, general practitioners lack the necessary qualifications for early diagnosis of periprosthetic infection and osteolysis, which are critical for timely treatment [37]. Timely diagnosis of periprosthetic infection can make a one-stage revision a more attractive option. There are also legitimate concerns about general practitioners' ability to diagnose osteolysis, as they rely on the radiologist's conclusions, who in turn, are less adept at verifying early signs compared to orthopedic surgeons. In patients undergoing hip revision surgery, radiologists only compared preoperative images in 42% of cases, and failed to identify loosening of the femoral component in 12% of cases and acetabular component in 10% of cases, and failed to verify femoral and acetabular osteolysis in 26% and 28% of cases, respectively [38].

The advantage of observing a patient after arthroplasty by orthopedists themselves is that it allows for a more precise evaluation of the results, even allowing the orthopedists to directly see the results of their operations, including during the evaluation of new implants [39, 40]. On the other hand, the Beyond Compliance and Scottish Arthroplasty Project studies have shown that general practitioners are effective in monitoring new implants and timely diagnosing failures [41, 42].

Prospects for patient follow-up: "virtual" clinic

In the past 10 years, remote data collection systems for patients after arthroplasty, which include X-ray and PROM, have been progressively developed. Typically, these systems are based on a web-based questionnaire to which X-rays can be attached. The pioneers of such systems were G. Wood et al. with 40 patients [43] and J.D. Marsh et al. with 118 patients [44]. These pilot studies demonstrated a decrease in the need for in-person consultations and that teleconsultation at least during the first year after surgery can help avoid missed opportunities for revision [43, 44]. Later, J. Marsh et al. also showed the economic efficiency of this model [45].

Such teleconsultation shows good patient engagement in the early stages after surgery, but there are legitimate concerns about the completeness of information collection in the longer term [46]. Of the 154 patients who declined to participate in J. Marsh et al.'s pilot project [44], 14% cited the reason that they "want to see the surgeon in person," and patient satisfaction with in-person orthopedic consultations was higher than that of "virtual" clinic patients [44, 47]. This issue may be addressed through the use of video conferencing or the ability to attach video files [48]. In addition, a significant number of patients in both studies had difficulties with computers and needed assistance with filling out the questionnaire [43, 44].

The COVID-19 pandemic has given a powerful boost to the development of telemedicine. Development is taking place both through the efforts of IT giants, such as Zoom for Health [49], through the platforms of health ministries, such as the National Health Service attend anywhere [50], and through custom developments by clinics [51, 52]. Additionally, monitoring systems based on smartphone apps are being developed by joint replacement manufacturers such as Zimmer Biomet (Warsaw, USA) [53, 54].

Remote system for evaluating arthroplasty outcomes at the Russian Vreden National Medical Research Center of Traumatology and Orthopedic

Since 2022, discharge summaries at the Vreden National Medical Research Center of Traumatology and Orthopedics in clinical practice include recommendations for follow-up observations (Table 1). As can be seen, the frequency of recommended observations in discharge summaries exceeds that of observations in clinical guidelines [4, 7]. The formulation of recommendations for the discharge summary was done by the authors of this article, who are doctors at the Center. On one hand, the high frequency of radiographic imaging recommendations may result in resistance from insurance companies, but on the other hand, clinical recommendations are subject to periodic review.

There are three principal ways for remotely assessing the results of arthroplasty:

- Using web forms (questionnaire on the website, feedback form variant).
- Using applications for smartphones.
- Using state information systems: the Unified State Information System in Healthcare (EGISZ) and government services (Gosuslugi).

Table 1

Standardized recommendations for postoperative follow-up after arthroplasties in discharge summaries of patients at the Vreden National Medical Research Center of Traumatology and Orthopedics

Hip joint	Knee joint
To enable us to follow-up the condition of your joints and make timely decisions for the benefit of your health, please do the following:	
Follow-up X-ray images should be taken at 3 months, 1 year, 3 years, 5 years, 7 years, 10 years, 13 years, 16 years, and so on, every three years after the operation.	Follow-up X-ray images should be taken at 3 months, 1 year, 5 years, 10 years, 13 years, 16 years, and so on, every three years.
Please send us the images along with your answers to the questionnaire. You can find the questionnaire on the website rniito.ru, in the section "For Patients" - "Questionnaires for Patients". In the questionnaire, please indicate the medical record number, which is printed at the beginning of this discharge summary in the upper right corner. If necessary, the doctor will respond to you through the specified communication channel.	

We gave preference to "archaic" web forms for several reasons. Despite the attractiveness and "wow-effect" (attention to customer-specific details or any other actions that can make your customer feel important and exceed their expectations) of smartphone applications, there are certain risks involved, such as low coverage due to elderly patients' reluctance to use them. Additionally, in the overwhelming majority of cases, patients will have to reinstall the application when they replace their smartphone, which becomes an increasingly significant problem over the years of patient follow-up after arthroplasty, as the patient ages. However, we do not deny the prospects of smartphone applications and are currently conducting preparatory work to develop them; we just gave priority to web forms in the development process.

Currently, the development of post-arthroplasty monitoring through state information systems (EGISZ, Gosuslugi) is impossible due to the absence of a protocol for patient cards for those who have undergone arthroplasty in the format of structured electronic medical documents (SEMID). The Center's employees have developed a corresponding SEMID protocol project, but its implementation within the framework of EGISZ/Gosuslugi is impossible until it is adopted.

The patient fills in their passport data, specifies their attending physician, and the electronic medical record number, which is printed in the discharge summary (Fig. 2).

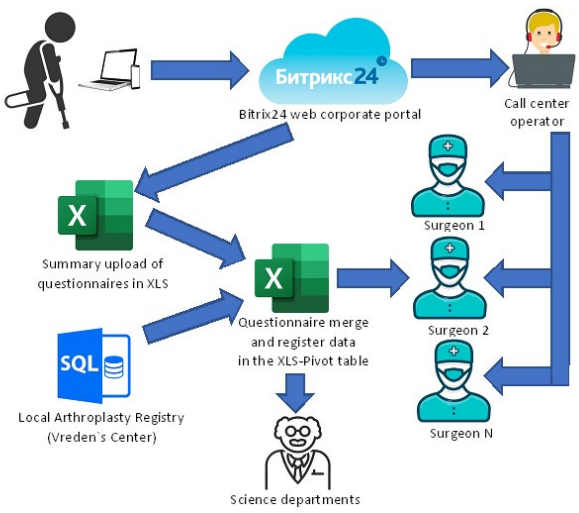

Fig. 2. Scheme of remote monitoring patients after arthroplasty at the Vreden National Medical Research Center for Traumatology and Orthopedics

Then the patient answers the questions of the Oxford scale in the modification of the Vreden Center, attaches files (attachment from a smartphone camera is possible), and specifies feedback options, including the most common messenger, WhatsApp. The completed web form is then submitted as a separate task to the public services portal, where it is reviewed by an operator. We consider this stage to be very important and do not see the possibility of excluding the operator for the following reasons: the confident identification of the patient's data, who filled out the questionnaire, is only possible through the public services portal's protocol of the single system of identification and authentication (ESIA). Implementing ESIA in the web form is possible, but we are afraid that it will deter some patients. Automatic linking via the electronic medical record number may also be difficult for some patients. Automatic linking via the attending physician or operating surgeon is also not very promising, as many patients simply do not remember the doctor's name or the doctor may resign. In addition, some patient questionnaires may require administrative participation. Therefore, we believe that it is impossible to exclude the stage of the operator who sorts the questionnaires. We plan to maintain this mechanism for at least two years to understand the actual involvement of patients, and only after that, we will introduce either authentication through the public services portal (ESIA) or another authentication option (such as linking to social networks, email, etc.).

Then the operator switches the task in the corporate portal to the doctor who operated on the patient. The task includes the results of the Oxford-Vreden scale survey, images attached by the patient, the patient's questions, and comments. The task has an automatic hyperlink to the patient's direct number on WhatsApp (using open line protocol), so if necessary, the doctor can switch from the corporate portal to WhatsApp messenger with just one click and respond to the patient by text or voice using their phone number or department number.

All surveys are combined into a summary xls-file, which is compared with the export from the local registry of the Vreden National Medical Research Center of Traumatology and Orthopedics. It is important to note that preoperative and postoperative statuses are evaluated using absolutely identical Oxford-Vreden questionnaires. Automatic merging of data from the registry with the summary questionnaires obtained from web forms is currently impossible due to authentication-related issues as described earlier. We plan to decide on the path of automatic merging of preoperative and postoperative data in two years, after clarifying the status of the questionnaires. Without understanding the status, an erroneous implementation of the expensive merging mechanism can be costly, given the involvement of thousands and tens of thousands of patients.

The proposed mechanism was implemented in the summer of 2021. We made a mistake by basing our web form on the platform of one of our foreign partners. Therefore, we had to develop our own custom web form, which was completed in May 2022.

During the first three months, 221 questionnaires for hip joint assessment and 235 for knee joint assessment were collected through the proposed mechanism, and according to weekly monitoring, the number of questionnaires progressively increases, which is not surprising, since the corresponding recommendation for periodicity is contained in the discharge summary (see Table 1).

CONCLUSION

Patient follow-up after arthroplasty remains an unresolved problem, with low coverage, lack of willingness or forgetfulness on the part of asymptomatic patients, problems with access to medical examinations, and excessive financial burden on the healthcare system being the main issues. At present, the real impact of preventive check-ups on the decision-making process for revision arthroplasty, especially in patients over 70 years of age, remains unknown, and the effectiveness of "preventive" revisions for osteolysis without loosening has not been proven.

Nevertheless, follow-up of asymptomatic patients after arthroplasty represents an important source of scientific data that can be used both to refine indications for arthroplasty to address the potential problem of an epidemic of early osteoarthritis arthroplasty, as well as for implant safety monitoring, especially for new implants, and for planning the development of the arthroplasty system as a whole.

Perhaps the problem of low coverage of patient monitoring after arthroplasty will be solved through modern technologies. The advantage is the simplicity for the patient, for which "archaic" but more understandable web forms were preferred in the pilot project of the Vreden National Medical Research Center of Traumatology and Orthopedics. An important feature is the direct transmission of the results of surveys and control X-rays to the operating physician.

Unfortunately, this type of follow-up form does not have legal status, but despite this, in the case of a real orthopedic problem, it can be resolved because there is a direct connection between the doctor and the patient, and we have given the right to initiate communication to the doctor, not the patient.

Currently, there is an unresolved problem of automatically merging postoperative follow-up data with data from the local registry of the Vreden National Medical Research Center of Traumatology and Orthopedics or with the medical information system. A possible solution will be implemented through the Unified System of Identification and Authentication in two years as material accumulates and the commitment and difficulties of patients in implementing the postoperative follow-up mechanism are analyzed. The fact that the first three months of work showed good patient engagement, at least at the stage of short-term results, inspires optimism.

The outpatient system cannot always provide quality follow-up of patients after arthroplasty for various reasons, so we believe that implementing a mechanism for remote follow-up will allow for early detection of various complications, which will facilitate prompt resolution of these issues. Increasing the quantity and analyzing the incoming information will further improve the system of remote patient follow-up after arthroplasties.

DISCLAIMERS

Author contribution

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Bilyk S.S. — research conception and design.
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All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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