Review Article
https://doi.org/10.17816/2311-2905-1778

Economics of Total Hip Arthroplasty: Review

Andrei P. Sereda [1, 2], Igor I. Shubnyakov [1], Alisagib A. Dzhavadov [1], Malik V. Mametov [3], Rashid M. Tikhilov [1]

[1] *Vreden National Medical Research Center of Traumatology and Orthopedics, St. Petersburg, Russia*

[2] *Academy of Postgraduate Education of Federal Medical Biological Agency, Moscow, Russia*

[3] *Pavlov First Saint Petersburg State Medical University, St. Petersburg, Russia*

This review article focuses on issues of economic analysis in providing care to patients requiring total hip arthroplasty. A large number of factors affecting the final financial result force us to look at economic research in the field of arthroplasty with a certain degree of criticality. At the same time, the existing financing systems cannot fully take into account all the possible costs arising from total hip arthroplasty. For this reason, studies concerning revision total hip arthroplasty are of particular interest, where treatment costs can vary significantly depending on the etiology and complexity of the case. These differences are reflected in the works of authors from France, Germany and Great Britain, who compared the treatment costs of patients with septic and aseptic revisions. Very different data both between countries and within the same country well demonstrate the need for a critical approach to the results of cost-effectiveness studies, QALYs based on Markov and other models, as the quality of the original data can be highly variable and reproduce the error of the initially incorrect price structure. At the same time, the rapidly increasing number of operations of primary and revision hip arthroplasty and, accordingly, the increasing economic costs of these operations require clear and effective economic criteria for their evaluation. The formation and application of these criteria will be the purpose of further research.

Keywords: total hip arthroplasty, revision total hip arthroplasty, economic analysis.

Cite as: Sereda A.P., Shubnyakov I.I., Dzhavadov A.A., Mametov M.V., Tikhilov R.M. [Economics of Total Hip Arthroplasty: Review]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2022;28(4):175-182. (In Russian).https://doi.org/10.17816/2311-2905-1778.

✉ *Andrei P. Sereda*; e-mail: drsereda@gmail.com

Submitted: 03.05.2022. Accepted: 29.07.2022. Published Online: 18.10.2022.

Обзорная статья
УДК 616.728.2-089.844-089.193.4:336.5
https://doi.org/10.17816/2311-2905-1778

Экономика эндопротезирования тазобедренного сустава: обзор литературы

А.П. Середа [1, 2], И.И. Шубняков [1], А.А. Джавадов [1], М.В. Маметов [3], Р.М. Тихилов [1]

[1] ФГБУ «Национальный медицинский исследовательский центр травматологии и ортопедии им. Р.Р. Вредена» Минздрава России, г. Санкт-Петербург, Россия

[2] Академия постдипломного образования ФГБУ «Федеральный научно-клинический центр специализированных видов медицинской помощи и медицинских технологий ФМБА России», г. Москва, Россия

[3] ФГБОУ ВО «Первый Санкт-Петербургский государственный медицинский университет им. акад. И.П. Павлова», г. Санкт-Петербург, Россия

Статья посвящена вопросам экономического анализа при оказании помощи пациентам, нуждающимся в эндопротезировании тазобедренного сустава. Большое количество факторов, влияющих на конечный финансовый результат, заставляют смотреть на экономические исследования в области эндопротезирования с некоторой долей критичности. При этом существующие системы финансирования не могут в полной мере учесть все возможные затраты, возникающие при эндопротезировании тазобедренного сустава. По этой причине особый интерес представляют исследования, касающиеся ревизионной артропластики тазобедренного сустава, при выполнении которой затраты на лечение могут значительно различаться в зависимости от этиологии и сложности случая. Данные различия отражены в работах авторов из Франции, Германии и Великобритании, которые сравнивали затраты на лечение пациентов с септическими и асептическими ревизиями. Весьма различающиеся данные как между странами, так и внутри одной страны хорошо демонстрируют необходимость критического подхода к результатам исследований соотношения затраты-эффективность, QALY на основе Марковских и других моделей, так как качество исходных данных может быть весьма вариабельным и репродуцировать ошибку изначально некорректной структуры цены. В то же время стремительно увеличивающееся число операций первичного и ревизионного эндопротезирования суставов и, соответственно, увеличение экономических затрат на их проведение требуют четких и точных экономических критериев оценки. Формирование и применение данных критериев и будет являться целью дальнейших исследований.

Ключевые слова: эндопротезирование тазобедренного сустава, ревизионное эндопротезирование, экономический анализ.

Середа А.П., Шубняков И.И., Джавадов А.А., Маметов М.В., Тихилов Р.М. Экономика эндопротезирования тазобедренного сустава: обзор литературы. *Травматология и ортопедия России*. 2022;28(4):175-182. https://doi.org/10.17816/2311-2905-1778.

Середа Андрей Петрович; e-mail: drsereda@gmail.com

Рукопись получена: 03.05.2022. Рукопись одобрена: 29.07.2022. Статья опубликована онлайн: 18.10.2022.

GENERAL ECONOMIC ISSUES

The issue of economics and financing of arthroplasty, of course, is very, if not vital, important for the hospital and the healthcare system as a whole. On the other hand, the more we deal with the issue of economics, the more noticeable the gap between the quality of research in the field of arthroplasty itself and its economics becomes. It would seem that economic research should be simpler and stricter, and, accordingly, give more unambiguous results, but in fact, the number of confounder (distorting) factors in economic research is so large that it is more reasonable to see the presence of overdue accounts payable of the hospital as a whole as a final criterion than the compliance of the tariff with the treatment financing cost of one case with real financial costs per patient.

The sources of this gap are many factors, and the most significant of them is CAPEX, i.e. capital expenditure for the acquisition of non—current (with a validity period of more than 1 year) assets, as well as for their modernization. Yes, the structure of the tariff of high-tech medical care in the Russian Federation provides for the costs of purchasing equipment (fixed assets), but does not provide for the costs of capital repairs, construction, which, as a rule, are subsidized. A lot of equipment is purchased at the expense of other sources of financing, there are indivisible common overhead costs (taxes, electricity, communications, etc.), which can be very high and can also be subsidized, preferential (some medical organizations in our country are exempt from land tax, but many are not) or be provided with mixed sources of financing.

The doctor treats the patient directly, and it is difficult to underestimate the importance of his salary. But the salaries of doctors and nurses are not always generated solely from financing for the case of treatment: there are, for example, mechanisms such as a subsidy for the payment of wages to achieve the targets of average wages.

After all, there are specialized and multidisciplinary hospitals in which high overhead costs and sometimes even direct costs in the treatment of "unprofitable" complex and high-cost patients/nosologies can be diversified and "transferred" to more economically "profitable" patients of other clinical profiles (therapy, surgery, ENT, etc.).

The number of these confounders is so large that, again, the real endpoint, perhaps, will be the financial viability (overdue accounts payable) of the hospital as a whole. Of course, such a guideline is fraught with a trend towards avoiding "expensive" patients: that is why there is a very high risk of stagnation and primitivization of the clinical development of the hospital if economists or managers get a dominant role in administration. In the end, such stagnation leads to professional degradation of medical personnel, increased risks, complications and a paradoxical increase in the cost of treating these complications, contrary to the initial goal of "saving".

The situation of a very approximate calculation of the treatment cost is typical not only for our country, otherwise we would not have seen numerous reports in the news feeds about the crisis of financing the health care system in many countries.

Nevertheless, the financing of a specific case of a patient's treatment can go according to two basic schemes. The first is the average rate of one case within the model or statistical group. The advantage of this approach is a simpler reporting system, the treatment of an "expensive" patient is compensated by more "cheap" ones within the same tariff. However, the more complex patients the hospital takes on, the greater the deviation from the average. For example, at the RSRI of TO named after R.R. Vreden in 2021. according to various sources of funding (not only under the high-tech medical care program) revision arthroplasty surgeries were performed. The spread of direct medical costs (excluding CAPEX, overhead costs, part of direct OPEX (operating expenses for the possibility of providing services), wages, household expenses for accommodation, patient meals, etc.) ranged from ₽5.307.82 to ₽5.590.042.27, i.e. the cheapest revision differed from the most expensive by more than a hundred times!

The fundamental disadvantage of such pricing is retrospectivity, which means the formation of an average tariff based on previously treated "similar" patients [1] with the corresponding risk of lagging behind the real market situation and changing clinical recommendations. In our country, there is the following system of cost justification: clinical approbation — high-tech medical care (HMC) — medical and economic standards (MES) — mandatory health insurance (MHI) through MES or

clinical recommendation — MES — MHI tariff. It would seem that such a system should avoid this retrospectivity, but the duration of the journey from the first link to the final one is years, and still we have the risk of lagging tariffs.

The second basic scheme of financing is the reimbursement of real costs in a single case. In our country, such a scheme is slightly more developed in the case of fee-paying surgery, but the tariff for a particular medical service in the price list is also based on average indicators, which, with a detailed analysis of the passport of the service cost, can be very inaccurate.

In the countries of the European Union, a few years ago, a system of reimbursement at actual cost was introduced — the so-called "lump sum reimbursements", which actually led to an increase in financial pressure on hospitals as a whole [2]. Initially, the good idea of "how much we spent — so much we will pay" in practice only leads to an aggravation of the conflict between economists and doctors, since this principle invariably entails the need to justify the tariff structure of a particular service with a corresponding catastrophic increase in reporting. It should be stated that the further, the more in its development Russia follows the path of European countries with the repetition of similar mistakes and the generation of similar bureaucratic entities that do not affect the result. For example, R. Fernández-Fernández et al., note that with the introduction of the "lump sum reimbursements" system, the number of hospital controllers that calculate the cost of surgery, care, diagnostics has increased [2]. At the same time, in fact, the principle of "how much we spent, so much we will pay for it" does not always work to its final slogan: if the patient's treatment turned out to be cheaper than average, then the hospital becomes more marginal, and if it is more expensive, then often such a patient remains unprofitable for the hospital without appropriate compensation [3].

A similar financial pressure exists in "budget financing" countries, that is, without a one-time cost recovery system: in these countries, hospitals usually annually coordinate their budgets with a higher health authority and a certain number of patients or procedures for treatment within this budget and period [4, 5]. At the same time, subsidies are possible to ensure the financial stability of the institution both from the government, the health management authority, local municipalities or even political parties that increase the loyalty of the electorate [6].

All these numerous confounder factors make us look at economic research in the field of arthroplasty with a certain degree of criticality, but nevertheless, of course, we will focus on some of them.

In general, primary arthroplasty is economically advantageous for most hospitals, which is confirmed by a kind of "hunt" of hospital marketing services for such patients [3, 5, 7].

The economic feasibility of organizing an arthroplasty center, however, should be evaluated in the context of the total number of operations: taking into account the risk of periprosthetic joint infection (PJI) and other reasons for revision [8, 9], according to probability theory, several "expensive" patients may appear in a hospital performing a small number of operations, which will either destroy the hospital's economy, or they will force the doctor to send the patient to a larger institution. The latter tactic is often found in our country, which was demonstrated by a high proportion of revisions regarding the PJI in the local register [10]. The concentration of patients with PJI in a specialized place, for example, in a federal center for the treatment of PJI, will require a revision of tariffs, since the principle of compensating an "expensive" patient with a "cheap" one will no longer be possible.

In systems where the hospital performs all the revisions after its primary operations in a sufficiently large number, the economy is balanced due to the generally low proportion of these complications [6].

The system of the average tariff already mentioned above within the framework of the basic or superbasic program of high-tech care or the MHI tariff within the statistical group (SG) echoes the European system of grouped diagnoses (diagnosis-related groups — DRG), in which patients of similar severity and diagnosis are grouped within approximately similar filling expenditures and costs [4]. For most cases, the SG/DRG principle works well, but the desire to revise these groups has the risk of overdetalization with corresponding bureaucratic risks.

In the vast majority of cases, publications report higher costs for the treatment of patients with PJI, which creates the temptation to allocate additional more detailed funding groups. In our opinion, despite the well-known disadvantages

of "expensive" patients unprofitability in terms of SG/DRG financing [11], the desire of some authors to over-detail groups [8, 9] should be treated very carefully.

For example, in European countries, as well as in our country, aseptic and septic revisions are combined within one DRG. The cost of aseptic revision, as well as septic, can be very different. According to our data, the differences can exceed a hundred times, and the end point is the financial stability of the hospital as a whole.

ECONOMICS OF REVISION TOTAL HIP ARTHROPLASTY

In the case of primary arthroplasty, the cost of expenditures is mainly due to the costs of the operating room itself, implants, consumables, and is quite static [12]. But in the case of the development of concomitant pathological conditions and PJI, the cost structure changes significantly [13].

Among the publications on the economics of revision arthroplasty, most of them focus on PJI in comparison with aseptic revisions, therefore, the purpose of this review was to describe the economic support of revision arthroplasty surgery in the format of comparing the cost of aseptic and septic revisions.

Sufficiently detailed data on the expenditures structure of patients with PJI treatment in France, Germany and the UK have been published [7, 14, 15, 16].

France

In France, the average cost of treating a patient with PJI after total hip arthroplasty is €23.757, and aseptic revision is €12.049. The maximum expenditures recovery in this case is €14.062 for aseptic revision and €15.081 for PJI [15]. Thus, the average patient with aseptic revision is beneficial for the hospital's economy, and the average patient with PJI is unprofitable.

The most significant component in the structure of expenditures for patient with PJI treatment in France is staff costs, which are directly related to the duration of inpatient treatment [15]. Other important aspects of expenditures are the costs of surgery, medical supplies, and general expenses for non-medical services. It is noteworthy that the expenditures of implants and surgery are lower in septic revision than in aseptic revision, while all other areas of expenditures increase significantly in the treatment of PJI (Tab. 1).

Germany

The economics of revision arthroplasty in Germany is described in three publications. G. Assmann et al. report expenditures of $14.379 for septic revision and $5.487 for aseptic revision [17]. M. Haenle et al. estimate the expenditures of septic revision at €29.322 [7, 14], and E. Lieb et al. report expenditures of €220.166 for septic revision [11] (Tab. 2).

Table 1

The structure of revisions and PJI treatment expenditures in France [17]

Expenditures	Aseptic revisions	Septic revisions	Expenditures difference, %
Staff	€2 210	€9 948	+450.1
Consumables	€146	€2 742	+1878.1
Endoprosthesis	€2 047	€1 862	-9.0
Indirect depreciation	€23	€39	+169.6
Operating room + anesthesia	€3 079	€2 900	-5.8
Physical therapy	€244	€388	+159.0
Diagnostics (radiology, laboratory)	€404	€1 019	+252.2
Drugs	€245	€706	+288.2
General expenses	€850	€3 594	+422.8

Table 2

Expenditures and tariffs for revisions in Germany

Expenditures and compensations	Aseptic revision [19]	Septic revision [19]	Septic revision [7]	Septic revision [13]
Average expenditures	$5 487	$14 379	€29 322	€20 166
Average tariff (compensation)	–	–	€16 645	€21 580
Reimbursement of expenditures with compensation, %	–	–	56.7	107.0

It can be noted that the cost of expenditures in Germany is not only very different from the costs in France, but these expenditures differ from each other.

G. Assmann et al. used the analysis of fixed and variable expenditures obtained through the hospital's business administration [17]. M. Haenel et al. [7, 14] used bottom-up expenditures analysis, and E. Lieb et al. [11] used matrix calculation.

The United Kingdom

I.S. Vanhegan et al. report that the average cost of a septic revision is £21.937, and an aseptic revision is £11.897 (Tab. 3) [16]. The calculation of expenditures recovery for hospitals in the UK is more complicated than in the countries of the European Union, and includes a combination of a tariff for treatment and additional funding, which is somewhat analogous to subsidized financing in our country. The compensation is fixed and the same for both septic and aseptic revisions and amounts to £8.152, respectively, both types of revisions are unprofitable for the hospital. After additional funding, septic revisions still remain unprofitable for the hospital, but in a smaller amount — the loss is reduced to £860 per case [16].

Drug expenditures make the highest contribution to the relative structural increase in the cost of septic revision compared to aseptic (427%). This is followed by diagnostic expenses (288.9%), other expenses (197.6%) and hospital stay expenses (184.4%) Tab. 4).

Table 3

Expenditures and tariffs for revisions in the United Kingdom [18]

Expenditures and compensations	Aseptic revision	Septic revision	Difference, %
Average expenditures	£11 897	£21 937	+184.4
Maximum compensation	£8 152	£8 152	+0
Reimbursement of expenditures with maximum compensation, %	68.5	37.1	-31.4

Table 4

The structure of revisions expenditures in the United Kingdom [18]

Expenditures	Aseptic revisions	Septic revisions	Difference, %
Inpatient accomodation	£3 688	£6 800	+184.4
Diagnostics	£342	£988	+288.9
Drugs	£200	£854	+427.0
Implants	£2 298	£3 345	+145.6
Operating room	£1 216	£1 744	+143.4
Other costs	£4 153	£8 206	+197.6

THE MAIN FACTORS THAT INCREASE THE COST OF TREATMENT

One of the most significant contributions to the increase in the cost of treatment of a patient with PJI in comparison with aseptic revision is the cost of antibiotic therapy [7, 15]. The cost of antibiotics can be different and is determined by the pathogen, their association, resistance. S. Klouche et al. report a range of the antibiotic therapy cost from €77 to €336 [15].

In the case of a difficult-to-treat (DTT) infection, the costs may be even higher. According to the data of the RSRI of TO named after R.R. Vreden , which has a specialized department for the treatment of PJI, where patients from all over the country are treated, the maximum non-surgical costs, including medicines in the case of DTT infection, in 2021 reached ₽551.442.27 in one patient. In another 141 patients with PJI treated in 2021, non-surgical expenses exceeded the outlined S. Klouche et al. of €336 maximum [15] (₽28.244 at the exchange rate of the Central Bank of the Russian Federation on December 31, 2021) and averaged

₽61.683.84 (i.e. €734 at the exchange rate of the Central Bank of the Russian Federation as of December 31, 2021). Probably, such a significant increase in the cost of treatment at the RSRI of TO named after R.R. Vreden in comparison with French clinics is due to more complex cases, a greater proportion of patients with chronic and DTT infection, which is due to suboptimal routing.

According to M. Haenle et al., the cost of antibiotics varies from €5 for primary arthroplasty to €600 for PJI [7], which, however, is still less than similar costs in the RSRI of TO named after R.R. Vreden.

The analysis of the antibiotic therapy costs performed by R. Fernández-Fernández et al. shows a spread from €184 in the case of ciprofloxacin therapy of fluoroquinolone-sensitive strains of Enterobacteriaceae to €13.167 in the case of daptomycin therapy of penicillin-resistant Enterococcus spp. [2].

A special area of expenditure is resuscitation/intensive care. The day cost of treatment in the intensive care unit reaches €2.000 in the case of PJI [18] and in total it can reach €5.395 in the treatment of PJI [7, 14]. In 2021, the maximum expenses for a patient with PJI in the intensive care unit reached ₽321.687.64 (€3.826 at the rate of the Central Bank of the Russian Federation on December 31, 2021).

In any case, a patient with PJI requires additional expenses for laboratory diagnostics, radiological methods of diagnostics, perioperative management, long-term stay, etc. [7, 14, 15, 16, 18].

Very different data both between countries and within one country well demonstrate the need for a critical approach to the results of cost-effectiveness, QALY studies based on Markov and other models, since the quality of the initial data can be very variable and reproduce the error of an initially incorrect price structure. At the same time, the rapidly increasing number of primary and revision arthroplasties and, accordingly, the increase in the economic costs of these types of surgery requires clear and effective economic criteria for their evaluation, which will be the goal of further research.

DISCLAIMERS

Author contribution

Sereda A.P. — collection and processing of material, writing the draft.

Shubnyakov I.I. — text editing.

Dzhavadov A.A. — writing the draft.

Mametov M.V. — collection and processing of material.

Tikhilov R.M. — text editing.

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.

Funding source. This study was not supported by any external sources of funding.

Competing interests. The authors declare that they have no competing interests.

Ethics approval. Not applicable.

Consent for publication. Not required.

REFERENCES

1. Dittmann H. [Analysis of the conceptual structure of the DRG payments from a cost-accounting point of view]. *Gesundheitsökonomie Qualitätsmanagement.* 2016;21(03):150-157. (In German). doi: 10.1055/s-0035-1553731.
2. Fernández-Fernández R., Cruz-Pardos A., García-Rey E. Revision Total Hip Arthroplasty: Epidemiology and Causes. In: Rodríguez-Merchán, E. (eds.) Revision Total Joint Arthroplasty. Springer, Cham; 2020. p. 43-57. doi: 10.1007/978-3-030-24773-7_4.

3. Hanstein T., Kumpe O., Mittelmeier W., Skripitz R. [Hybrid and uncemented hip arthroplasty: Contribution margin in the German lump sum reimbursement system]. *Orthopade*. 2015;44(8):617-622. (In German). doi: 10.1007/s00132-015-3139-3.
4. Diagnosis-related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals (European Observatory on Health Systems and Policies Series). Quentin W., Busse R., Geissler A. (eds.). McGraw-Hill; 2011. Ch. 2, 8. p. 9-21; 37-58.
5. Stargardt T. Health service costs in Europe: cost and reimbursement of primary hip replacement in nine countries. *Health Econ*. 2008;17(1 Suppl):S9-20. doi: 10.1002/hec.1328.
6. Sereda A.P., Bogdan V.N., Andrianova M.A., Berenstein M. [Treatment of Periprosthetic Infection: Where and Who?] *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2019;(4):33-55. (In Russian). doi: 10.21823/2311-2905-2019-25-4-33-55.
7. Haenle M., Skripitz C., Mittelmeier W., Skripitz R. [Economic impact of infected total hip arthroplasty in the German diagnosis-related groups system]. *Orthopade*. 2012;41(6):467-476. (In German). doi: 10.1007/s00132-012-1939-2.
8. Bozic K.J., Kurtz S.M., Lau E., Ong K., Chiu V., Vail T.P. et al. The epidemiology of revision total knee arthroplasty in the United States. *Clin Orthop Relat Res*. 2010;468(1):45-51. doi: 10.1007/s11999-009-0945-0.
9. Bozic K.J., Kurtz S.M., Lau E., Ong K., Vail T.P., Berry D.J. The epidemiology of revision total hip arthroplasty in the United States. *J Bone Joint Surg Am*. 2009;91(1):128-133. doi: 10.2106/JBJS.H.00155.
10. Shubnyakov I.I., Riahi A., Denisov A.O., Korytkin A.A., Aliyev A.G., Veber E.V. et al. [The Main Trends in Hip Arthroplasty Based on the Data in the Vreden's Arthroplasty Register from 2007 to 2020]. *Travmatologiya i ortopediya Rossii* [Traumatology and Orthopedics of Russia]. 2021;27(3):119-142. (In Russian). doi: 10.21823/2311-2905-2021-27-3-119-142.
11. Lieb E., Hanstein T., Schuerings M., Trampuz A., Perka C. [Reduction of Treatment Duration in Periprosthetic Infection with a Fast-Track Concept Is Economically Not Feasible]. *Z Orthop Unfall*. 2015;153(6):618-623. (In German). doi: 10.1055/s-0035-1557858.
12. Maradit Kremers H., Visscher S.L., Moriarty J.P., Reinalda M.S., Kremers W.K., Naessens J.M. et al. Determinants of direct medical costs in primary and revision total knee arthroplasty. *Clin Orthop Relat Res*. 2013;471(1):206-214. doi: 10.1007/s11999-012-2508-z.
13. Fisman D.N., Reilly D.T., Karchmer A.W., Goldie S.J. Clinical effectiveness and cost-effectiveness of 2 management strategies for infected total hip arthroplasty in the elderly. *Clin Infect Dis*. 2001;32(3):419-430. doi: 10.1086/318502.
14. Haenle M., Skripitz C., Mittelmeier W., Skripitz R. Economic impact of infected total knee arthroplasty. *ScientificWorldJournal*. 2012;2012:196515. doi: 10.1100/2012/196515.
15. Klouche S., Sariali E., Mamoudy P. Total hip arthroplasty revision due to infection: a cost analysis approach. *Orthop Traumatol Surg Res*. 2010;96(2):124-132. doi: 10.1016/j.rcot.2010.02.005.
16. Vanhegan I.S., Malik A.K., Jayakumar P., Ul Islam S., Haddad F.S. A financial analysis of revision hip arthroplasty: the economic burden in relation to the national tariff. *J Bone Joint Surg Br*. 2012;94(5):619-623. doi: 10.1302/0301-620X.94B5.27073.
17. Assmann G., Kasch R., Maher C.G., Hofer A., Barz T., Merk H. et al. Comparison of health care costs between aseptic and two stage septic hip revision. *J Arthroplasty*. 2014;29(10):1925-1931. doi: 10.1016/j.arth.2014.04.043.
18. Kasch R., Assmann G., Merk S., Barz T., Melloh M., Hofer A. et al. Economic analysis of two-stage septic revision after total hip arthroplasty: What are the relevant costs for the hospital's orthopedic department? *BMC Musculoskelet Disord*. 2016;17:112. doi: 10.1186/s12891-016-0962-6.

Authors' information

✉ *Andrei P. Sereda* — Dr. Sci. (Med.)
Address: 8, Akademika Baykova st., St. Petersburg, 195427, Russia
https://orcid.org/0000-0001-7500-9219
e-mail: drsereda@gmail.com

Igor I. Shubnyakov — Dr. Sci. (Med.)
https://orcid.org/0000-0003-0218-3106
e-mail: shubnyakov@mail.ru

Alisagib A. Dzhavadov — Cand. Sci. (Med.)
https://orcid.org/0000-0002-6745-4707
e-mail: alisagib.dzhavadov@mail.ru

Malik V. Mametov
https://orcid.org/0000-0003-1082-7872
e-mail: m_mametov@inbox.ru

Rashid M. Tikhilov — Dr. Sci. (Med.), Professor
https://orcid.org/0000-0003-0733-2414
e-mail: rtikhilov@gmail.com