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Ensuring the Sustainability of Health Care Management Expert Support and Decision Making in Modern Conditions

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Abstract: Current technological and environmental changes requiring new approaches for healthcare data generation and assessment as well as decision-making support. The analysis performed using Delphi method indicated that sustainability of healthcare decision-making by using a number of approaches based on existing opportunities for proactive risk-based assessment of population health and healthcare interventions. Non-numerical qualitative expert opinions are of the same value as quantitive data while the balance between them and the methodology of mutual transformation form an integrated evidence-based support for the sustainable data generation and healthcare decision-making. Qualitative expert opinions make it also possible to decrease the asymmetry and lack of quantitative data between model studies on animals and the characteristics of the human body. The balance between qualitative expert assessment and the digital evidence changes during the lifecycle of the intervention or possibly process (like pandemic). Sustainability of healthcare decision-making in changing environment depends on availability and methods of qualitative expert support. Currently, there are no generally accepted methods for the final qualitative expert assessment, which makes it possible to reduce the diversity of interdisciplinary big data to a transparent and understandable assessment and these methodology and methods are to be developed. Automated systems for early detection of emergent cases based on medical statistics data are also of great importance and capable increasing sustainability of healthcare management and this information should be linked to pre-prepared action plans to avoid COVID-19 lessons in future.

Keywords: Healthcare management, healthcare decision making, expert support for decision making, Public health emergencies and contingency planning.

1. INTRODUCTION

Healthcare systems around the world experience difficulties meeting any deviations from the standard situation. This applies both to negative changes like the emergence of new diseases as well as the positive ones like the development of new interventions.

The fight against the pandemic has shown enough examples of positive and effective actions that have reduced the burden of the disease. However, it is necessary to consider and

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analyze negative experiences in order to avoid them in the future. Healthcare systems could not identify appropriately react the early signs and description of COVID-19 pandemic as well as performing effective management and clinical decisions. First personal messages from healthcare practitioners indicated an increase in deaths from SARS as early as March 2019. Next the actual signs of SARS-CoV-2 circulation in Northern Italy (Lombardy) were officially detected as early as September-October 2019 and in France in November-December 2019 [1]. A description of the upcoming pandemic as a threat to global health and a list of countermeasures were presented by the Hopkins Institute in October 2019 but they did not lead to a noticeable response from the health systems in any country. [2]. The ineffective management decisions and the irrational use of available resources, as well as the distortion of medical statistics, became apparent within a few months of the outbreak of the pandemic. [3,4].

The treatment of patients infected with COVID-19 was accompanied by clinically unjustified use of antibiotics, which are not only useless for viral infection, but can cause immune suppression and worsen the condition of such patients. Additionally, antibiotics lead to the emergence and spread of resistant bacterial strains, contributing to the spread and complicating bacterial infections [5-7].

Even a few years after the outbreak of the pandemic, confronting the clinical, economic and social burden of the disease requires innovative thinking and the development of strategies aimed at improving health efficiency, at the level of policy decisions and national health management, including a complete revolution in the entire system of medical care [8-13].

The development and introduction of medical interventions is expected to have a positive impact on health systems contributing the increase of safety, efficacy, efficiency and effectiveness. However, insufficient accessibility and irrational use of medical technologies occur in different countries, regardless of the payment model or healthcare system, and in various clinical institutions, from rural clinics to specialized hospitals. [14]

Health systems in low- and middle-income countries face additional challenges that hinder innovation. Such problems include insufficient awareness of barriers and accessibility factors reducing the possibility and effectiveness of innovations. Unsuccessful implementation of innovations, in turn, requires additional resources and affects the possibility of future implementations and as well as decrease the accessibility of medical care in other clinical areas [15]. The development of interventions is also experiencing difficulties. Over the past 60 years, the pharmaceutical industry has provided the world with more than 1,220 new drugs that have played an important role in improving the Global health and increasing life expectancy by 2 months per year [16]. However, the existing R&D model that fueled this success now is providing a set of symptoms has often been a harbinger of major failures in other industries [17]. The experience of these industries shows that the latter can withstand such upheavals based on the accidental appearance of several products, the so-called «black swans», and the pharmaceutical industry has a chance to «rethink the culture of functioning in connection with these modern conditions. [18]

Thus, the current state of health management systems at the global and national levels is unable to respond both the creation of new health interventions and technologies as well as the new threats.

Modern conditions require healthcare systems to be ready functioning in changing conditions related to the risks of infectious diseases caused by new pathogens, the emergence of new medical interventions, organizational and information technologies. Contemporary technology development makes it possible to ensure proactive risk-based public health management [19]. The term technology should in this case must be understood as the entire complex of substances, devices and activities performed by qualified personnel, including diagnosis, treatment, safety and prevention of adverse events including and supporting the intervention itself. [20]. Ignoring a comprehensive concept of technology in healthcare decision making leads to an irrational expenditure of resources and a negative result of its application [15].

The use of separate elements of this model in healthcare decision making make it possible to increase clinical efficacy, social benefits and economic effectiveness providing additional benefits of integrated development to the countries that have already implemented this approach [21]. These facts indicate that the complex consisting of public health monitoring, expert support for healthcare decision making and healthcare management itself, despite the available technological and information capabilities, is in practice a fragile structure that does not meet both the challenges of global health risks and technological capabilities, and thus requiring the development and implementation of data generation management and utilization principles meeting the modern challenges and ensuring the sustainability of healthcare management in modern conditions.

2. OBJECTIVES

Development of key statements and recommendations ensuring the sustainability of health care management expert support and decision making in modern conditions.

The following tasks were accomplished for the purpose:

1. Evaluation of existing approaches to data management and creation of predictive scenarios providing information about both the status and risks to population health and the development of medical technologies, and capable providing proactive risk-based management within a specific existing administrative and legal system (country, region) in modern conditions.
2. Analysis of possible problems and gaps related to these approaches and caused by the peculiarities of the formation and transformation of interdisciplinary multiformat numerical evidence data into qualitative non-numerical expert opinions that are used for healthcare decision making.
3. Analysis of the of digital data transformation into non-numerical qualitative conclusions over time in the process of data generation during preclinical and clinical studies as well as during the commercial use.
4. Assessment of the impact of this consequent data transformation on sustainability and fragility of the decision-making process in healthcare.
5. Assessment of availability of the generally accepted methods of expert assessment making possible justifying decisions based on interdisciplinary multi-format data under the conditions of stakeholders conflicting interests.
6. Assessing the opportunities of early detection of population health changers and alerts using automated systems or in any other way.
7. Assessing potential activities and countermeasures regarding healthcare threats with of uncertainty elements that allowing us to quickly respond to any risks and avoiding inappropriate actions typical of the initial stage of the COVID-19 pandemic.

3. METHODS

Modified Delphi investigation was used to for the investigation [22].

The initial information was obtained using the Environmental scanning procedure abased on the review of literature (PubMed and EMBASE; 467 articles and reviews selected) and other modes of communication including personal messages [23-25].

Based on the Environmental scanning data, we formulated the provisions and presented them to a group of analysts for 4 iterations of discussion before the final 7 provisions were agreed by all analysts upon essence and wording. The group of analysts consisted of 12 people, clinical specialists specialized in the field of health management (4), biology (3), statistics (1), management theory (2), economics (1), information technology (2). After several iterations, 7 main provisions were formulated, approved by all participants of the group of analysts.

4. RESULTS

A Data Management Model for proactive risk management in healthcare is most appropriate approach and the tool capable increasing the sustainability of healthcare systems.

The model consists of elements or blocks related to a specific evidence-based cluster of information and the links between these elements indicating the sequential data flows. Almost all of these elements (population health and health interventions monitoring, disease burden assessment, pre-clinical and clinical studies, systematic reviews, Health Technology Assessment and others) exist and can be used in almost any country, but they are not fully used in any country in the world [19]. Using or not using of these elements as well as the extent of the use depend on the level of economic development of countries and, in turn, the evidence-based healthcare decision-making affects the economic and social development of countries via human resources [21]. Countries with low level of economic development (GDP per capita) are characterized by a lack of priorities at national levels, making it difficult to form a unified approach to assessing the effectiveness and the quality of medical care; strict legislation aimed at reducing costs without taking into account their effectiveness and making it difficult to form flexible and evidence-based decision-making mechanisms; a weak information infrastructure that makes it difficult to obtain national evidence-based data on morbidity and mortality; and an low number of specialists capable of preparing expert opinions. All these issues impact an opportunity for effective management in healthcare and leading to an increase in morbidity and treatment costs. [26-29]. The model can be used for development of national healthcare systems forecasting depending on existing economic development of these countries and the use of a set of evidence-based methods in its healthcare. It allows you also to identify problem areas and develop recommendations for improving evidence-based decision making. The model also indicates patterns of sequential transformation of data and their transition from quantitative digital estimates to non-numerical qualitative expert opinions. Such transitions take place both the elements (information blocks) of the model and at the final level of interaction with regulatory authorities. The need to use non-numerical methods of estimation and forecasting serves as a natural separation of the information clusters of the model, within which quantitative digital probabilistic estimation is possible.

Non-numerical qualitative expert opinions and the methodology of mutual transformation of qualitative data into quantitative and vice versa are of the same importance as numerical research data and form all together an integrated evidence-based support for the healthcare decision making.

The results of a comprehensive assessment and prognostic scenarios that are submitted to regulatory authorities depend also on non-numerical qualitative assessments assuming numerical data obtained during pre-clinical and clinical studies and creating hypotheses for the next numerical quantitative step of the integrated research. The formation of evidence-based data for expert support of management decisions in healthcare at the example of medical intervention consist of several stages including pre-clinical (pathogenesis and mechanism of action data) and clinical studies (testing the hypothesis of comparability of animal and human data during the phase I; testing the hypothesis about the therapeutic effect based on surrogate indicators during phase II and testing the hypothesis about the therapeutic effect based on clinical indicators during phase III studies) [30].

The safety and efficiency data obtained at this stage is sufficient to obtain market authorization. The inclusion of the intervention into reimbursement lists in many countries is associated with obtaining additional data on effectiveness, economic and social outcomes as part of the Health Technology Assessment. In addition, as pre- and clinical data accumulates, this information is summarized and structured in the form of clinical guidelines and systematic reviews. The values of digital quantitative assessments and qualitative non-digital expert opinions for each element of the model are changing in the process of the medical technology global value pack creation. The value of qualitative assessment is the highest at the decision-making stage. There is no real-world data (RWD) obtained at this stage as well as the correlations between RWD and controlled trials. Moreover, the decision must be based on a number of other interfering technological, economic, administrative, psychological factors which cannot be expressed in a single numeric format [19,31].

Qualitative expert opinions make it possible to decrease the asymmetry and lack of quantitative data between model studies on animals and the characteristics of the human body.

Animal-based research makes possible to simulate the majority of pathologic conditions providing a detail about the mechanisms of pathogenesis and treatment which cannot be performed in human subjects due to ethical or technological barriers [30]. At the same time, we can obtain statistically reliable data on human physiology and treatment outcomes which can be different from the animal one. As a result, we have a distribution of our knowledge about the problem and the possibility of solving it, illustrated in Figure 1. The only way to reduce this uncertainty at the decision-making stage may be a qualitative expert opinion filling the gap between human and animal information clusters, ensuring the continuity of data flow formation and allowing generalizing conclusions to be drawn. The expert opinion, along with regulatory procedures, determines management decisions on the use of medical intervention, which can be expressed in the format of authorization on the market or inclusion in reimbursement lists [32-34].

The value of qualitative expert assessment decreases as digital evidence accumulates, but any changes in the decision-making system increase its importance.

The dynamics of this process is illustrated in Fig. 1 using the example of the life cycle of a medical intervention. As preclinical studies progress, data is generated on the mechanisms of pathogenesis and the intervention mechanism of action the in conditions which are close to the real-world impacts, but in models that differ from humans. The results of clinical trials provide safety and efficacy data about medical intervention in humans, but under controlled conditions that differ from real-world conditions. Market authorization of the intervention is made on the basis of regulatory procedures and expert opinion, which compensates for the lack of data on the intervention effects in humans under the real-world conditions. After market authorization, this medical technology begins to be used in people in real conditions. After the market authorization real-world data (RWD) is accumulated in digital format, which is more evidence-based from the point of view of regulatory authorities and replaces expert assessment. With any external changes, positive (the emergence of a new medical technology, competitive or vice versa, increasing the effectiveness of the considered one) or negative (a new infection) and the formation of gaps in digital evidence, the value of expert assessment increases. Changes in regulatory procedures also require reassessment of the intervention and may increase the value of qualitative expert review. Any change increases the degree of uncertainty, and in conditions of uncertainty, increases the role of the expert capable providing and implementing management decisions. [35-37].

Sustainability of healthcare decision-making in changing environment depends on availability and methods of qualitative expert support

The long period without pandemics or other changes leads to a reduction of the expert support value and a simplification of the decision-making mechanism. Under these conditions, the effectiveness of management decisions depends more on reducing costs within an existing and well-established mechanism and less on the response to external influences and the emergence of «lean management» is justified. On the other hand, the development of information and healthcare technologies leads to continuous changes as well as the increase of uncertainty identifying the challenge the healthcare decision-making adaptation to new conditions and the emergence of «change management». Theoretically, the alternating approaches of lean management and change management could have allowed us forming a model of cyclical evolution of healthcare systems, but the uncertainty associated with the emergence of technological innovations and appearance of new pathogens forces us to be critical of this possibility, as well as the successful coexistence of lean and change management. Obviously, the model of the healthcare system will be successful, in which standard processes are effectively managed as an element taken from lean management, but there are sufficient resources and developed action plans in case of even unlikely or uncertain events, as the COVID-19 pandemic seemed before it began. The model of proactive risk-based expert support for management decisions in healthcare supported by appropriate methods of qualitative expert review are the most suitable for existing situation [2, 16-18].

Currently, there are no generally accepted methods for the final qualitative expert assessment, which makes it possible to reduce the diversity of interdisciplinary big data to a transparent and understandable assessment.

It is quite easy to translate quantitative research results into qualitative conclusions, but the process of translating qualitative data into quantitative ones is extremely difficult. The need for qualitative peer review eliminating gaps between the structural elements of the model representing digital interdisciplinary data in different formats, as well as between the integrated results of the assessment and the regulatory authorities deciding on the reallocation of resources, is critical in any healthcare system. Currently, there are no generally accepted standardized methods for that purpose. Multi-Criteria Decision-Making (MCDM) is most often proposed for this purpose and mentioned in specific publications but it has has significant limitations for biological and social systems [38-42].

Automated systems for early detection of emergent cases based on medical statistics capable increasing sustainability of healthcare management.

The automatic system based on the International Classification of Diseases (ICD-10) coding and capable providing real-time data was presented at the WHO conference in 2015. It had been already created and tested in a number of locations but did not meet any interest after that [43]. The information on the increase in deaths from SARS would have been available in March 2019 or earlier, i.e. more than 6 months before the officially declared COVID-19 pandemic in case of existence of such a system in at least one country. An alternative is automated search systems for specialized publications or information presented at web-sites. Since the ontological model of a potential epidemic was formulated in October 2019, and publications date back to the same date this approach would make it possible to draw conclusions about the risks to public health 3 months before the official start of the pandemic and take preventive measures with the appropriate capacity of health systems [1,2].

Action plans are needed for the most unpredictable and uncertain cases related to public health.

Paradoxically, commercial companies had an action plan for various issues (ISO 31000 and/or others), while healthcare systems around the world took actions that did not correspond to the situation during the pandemic. Obviously, humanity is facing more than one epidemic. The probability of these events are high but we do not know when such an epidemic will begin (uncertainty). It is useless and costly to prepare infection hospitals and vaccines for an unknown pathogen in advance. But you can have an action plan prepared in advance, in which, at a minimum, it will be written that it is not effective and safe to use antibiotics for patients with acute viral infection [5-7].

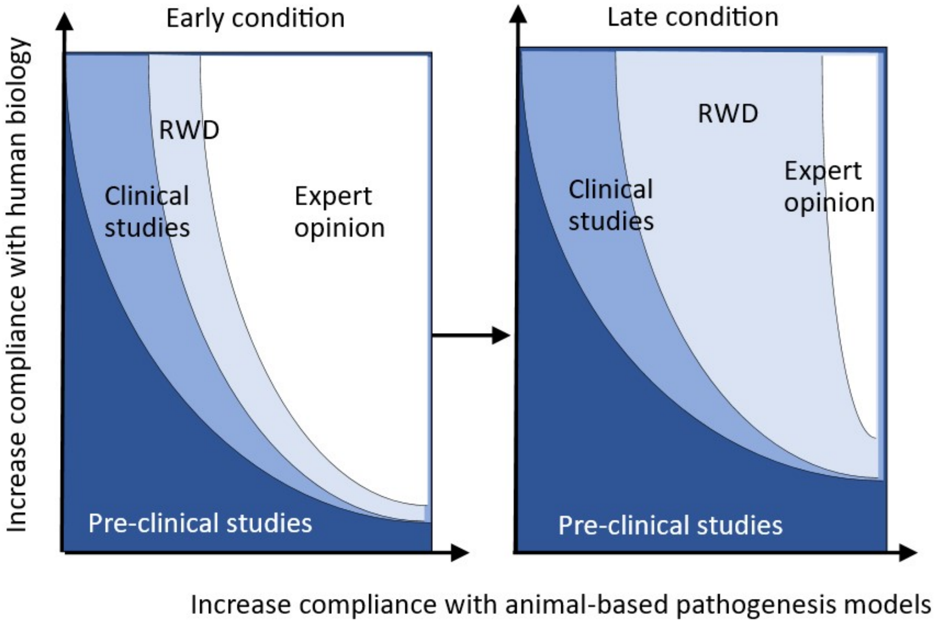

Fig. 1. Illustration of the changes in values of qualitative (expert assessment) and quantitative (preclinical, clinical studies, data from real clinical practice) assessments during the early and late phases of the intervention lifecycle.

5. CONCLUSION

A Data Management Model for proactive risk management in healthcare is most appropriate approach and the tool capable increasing the sustainability of healthcare systems. Nonnumerical qualitative expert opinions and the methodology of mutual transformation of qualitative data into quantitative and vice versa are of the same importance as numerical research data and form all together an integrated evidence-based support for the healthcare decision making. Qualitative expert opinions make it possible to decrease the asymmetry and lack of quantitative data between model studies on animals and the characteristics of the human body. The value of qualitative expert assessment decreases as digital evidence accumulates, but any changes in the decision-making system increase its importance. Sustainability of healthcare decision-making in changing environment depends on availability and methods of qualitative expert support. Currently, there are no generally accepted methods for the final qualitative expert assessment, which makes it possible to reduce the diversity of interdisciplinary big data to a transparent and understandable assessment. Automated systems for early detection of emergent cases based on medical statistics capable increasing sustainability of healthcare management. Action plans are needed for the most unpredictable and uncertain cases related to public health.

REFERENCES

1. Reis, J., Faou, A. L., Buguet, A., Sandner, G. & Spencer, P. (2022). COVID-19: Early Cases and Disease Spread, *Ann Glob Health.*, **88**(1), 83. DOI: 10.5334/aogh.3776. PMID: 36247198; PMCID: PMC9524236
2. The Johns Hopkins Center for Health Security, World Economic Forum, the Bill and Melinda Gates Foundation (2019). *Event 201* (New York, NY), [Online]. Available: https://centerforhealthsecurity.org/our-work/tabletop-exercises/event-201-pandemic-tabletop-exercise
3. Martínez-Córdoba, P. J., Benito, B. & García-Sánchez, I. M. (2021). Efficiency in the governance of the COVID-19 pandemic: political and territorial factors, *Global*

Health, **17**(1), 113. DOI: 10.1186/s12992-021-00759-4. PMID: 34548073; PMCID: PMC8454294

4. Ferigato, S., Fernandez, M., Amorim, M., Ambrogi, I., Fernandes, L. M. M., et al. (2020). The Brazilian Government's mistakes in responding to the COVID-19 pandemic, *Lancet*, **396**(10263), 1636. DOI: 10.1016/S0140-6736(20)32164-4. PMID: 33096042; PMCID: PMC7575269
5. Moyano, L. M., Leon-Jimenez, F., Cavalcanti, S. & Ocaña, V. (2022). Uso responsable de los antibióticos en COVID-19 en Perú: ad portas de otra pandemia!! [Responsible use of antibiotics in COVID-19: To the gates of a new pandemic!!], *Aten Primaria*, **54**(2), 102172. DOI: 10.1016/j.aprim.2021.102172. PMID: 34798399; PMCID: PMC8285267
6. Giacomelli, A., Ridolfo, A. L., Oreni, L., Vimercati, S., Albrecht, M., et al. (2021). Consumption of antibiotics at an Italian university hospital during the early months of the COVID-19 pandemic: Were all antibiotic prescriptions appropriate? *Pharmacol Res*, **164**, 105403. DOI: 10.1016/j.phrs.2020.105403. PMID: 33359914; PMCID: PMC7836543
7. Salgado Peralvo, A. O., Kewalramani, N. & Mateos-Moreno, M. V. (2023). Antibiotic Resistance: The Silent Pandemia (in the COVID-19 Era), *Int Dent J.*, **73**(2), 328–329. DOI: 10.1016/j.identj.2023.01.003. PMID: 36737266
8. Banfi, G. & Lippi, G. (2021). COVID-19: which lessons have we learned? *Clin Chem Lab Med*, **59**(6), 1009–1011. DOI: 10.1515/cclm-2021-0384. PMID: 33823090
9. Mattiuzzi, C. & Lippi, G. (2020). Which lessons shall we learn from the 2019 novel coronavirus outbreak? *Ann Transl Med*, **8**, 48. DOI: 10.21037/atm.2020.02.06
10. Stuckler, D., McKee, M. & Kentikelenis, A. (2021). Are we making the same mistakes in fighting COVID-19 as in past pandemics? Lessons from HIV show the urgent need to invest in HPSR, *Public Health Res Pract.*, **31**(4), 3142116. DOI: 10.17061/phrp3142116. PMID: 34753161
11. Greer, S. L., King, E. J., da Fonseca, E. M. & Peralta-Santos, A. (2020). The comparative politics of COVID-19: The need to understand government responses, *Glob Public Health*, **15**(9), 1413–1416. DOI: 10.1080/17441692.2020.1783340. PMID: 32564670
12. Becerra-Posada, F., Dos Santos Boeira, L., García-Godoy, B., Lloyd, E., Martínez-Sánchez, H. X., et al. (2021). Politics and political determinants of health policy and systems research funding in Latin America and the Caribbean, *Public Health Res Pract*, **31**(4), 3142120. DOI: 10.17061/phrp3142120. PMID: 34753166
13. Riley, E. D., Hickey, M. D., Imbert, E., Clemenzi-Allen, A. A., & Gandhi, M. (2019). Coronavirus Disease 2019 (COVID-19) and HIV Spotlight the United States Imperative for Permanent Affordable Housing, *Clin Infect Dis.*, **72**(11), 2042–2043. DOI: 10.1093/cid/ciaa1327. PMID: 32887980
14. Glasziou, P., Straus, S., Brownlee, S., Trevena, L, Dans, L., et al. (2017). Evidence for underuse of effective medical services around the world, *The Lancet*, **390**(10090), 8–14, 169–177.
15. Leonard, E., de Kock, I. & Bam, W. (2020). Barriers and facilitators to implementing evidence-based health innovations in low- and middle-income countries: A systematic literature review, *Eval Program Plann.*, **82**, 101832. DOI: 10.1016/j.evalprogplan.2020.101832.

16. Arias, E. (2007). United States Life Tables, 2004, *National Vital Statistics Reports*, **56**(9), 1–40, PMID: 32585317
17. Anthony, S. D. (2008). Can you spot the early warnings? *Strategy & Innovation*, **3**(2) (March/April 2005.
18. Hartung, A. (2008). *Create Marketplace Disruption*. Upper Saddle River, NJ: FT Press.
19. Christensen, C., Scott, M., Anthony, D. & Roth, E. A. (2005). Seeing What's Next: Using the Theories of Innovation to Predict Industry Change, *Performance Improvement*, **44**(4), 50–51. DOI: 10.1002/pfi.4140440412
20. Wiggins, S. N. (1987). *The Cost of Developing a New Drug*. Washington, DC: Pharmaceutical Manufacturers Association.
21. Meshkov, D., Bezmelnitsyna, L. & Cherkasov, S. (2020). A Data Management Model for Proactive Risk Management in Healthcare, *Advances in Systems Science and Applications*, **20**(1), 114–118. DOI: 10.25728/assa.2020.20.1.864
22. Sidelnikov, Yu. V. (2025). Podhody k prognozirovaniyu ehvolyucii tekhnologii [Approaches to forecasting in technology evolution], *Ehkonomicheskie strategii*, **1**(199), 66–73, [in Russian] DOI: 10.33917/es-1.199.2025.66-73.
23. Meshkov, D., Marley, L. M. G., Makeeva, E. & Lobanov, A. (2024). Economic Development of Countries and Health Technology Assessment (HTA) in Healthcare Decision Making, *Advances in Systems Science and Applications*, **24**(2), 32–39. DOI: 10.25728/assa.2024.2024.02.1646
24. Jandhyala, R. (2020). A novel method for observing proportional group awareness and consensus of items arising from list-generating questioning, *Curr Med Res Opin. Mar.*, **11**, 1–11. DOI: 10.1080/03007995.2020.1734920.
25. Liberati, A., Altman, D. G., Tetzlaff, J., et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration, *BMJ*, **339**, b2700.
26. Moher, D., Liberati, A., Tetzlaff, J., et al. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement, *BMJ*, **339**, b2535.
27. Morrison, J. L. (1992). Environmental scanning. In: M. A. Whitely, J. D. Porter, & R. H. Fenske (Eds.), *A primer for new institutional researchers* (pp. 86-99). Tallahassee, FL: The Association for Institutional Research
28. Falkowski, A., Ciminata, G., Manca, F., Bouttell. J., Jaiswal, N., et al. (2023). How Least Developed to Lower-Middle Income Countries Use Health Technology Assessment: A Scoping Review, *Pathog Glob Health*, **117**(2), 104–119. DOI:10.1080/20477724.2022.2106108
29. Teerawattananon, Y., Painter, C., Dabak, S., et al. (2021). Avoiding health technology assessment: a global survey of reasons for not using health technology assessment in decision making, *Cost Eff Resour Alloc*, **19**, 62. DOI: 10.1186/s12962-021-00308-1
30. Babigumira, J., Jenny, A., Bartlein, R., Stergachis, A. & Garrison, L. (2016). Health technology assessment in low- and middle-income countries: a landscape assessment, *Journal of Pharmaceutical Health Services Research*, **7**(1), 37–42. DOI: 10.1111/jphs.12120

31. EY Global. (2023). El Salvador's Tax Authority annual guide (Resolution No. MH.UVI.DGII 006.005/2023), [Online]. Available https://www.ey.com/en_gl/taxalerts/el-salvador-s-tax-authority-publishes-list-of-tax-havens-for-2020
32. Lopes, L. C., Godman, B., Bergamaschi, C. C., Barberato-Filho, S. & Silva, M. T. (2020). Editorial: New Horizons in Health-Promoting Technologies: From Development to Rational Use, *Front Pharmacol*, **11**, 1180. DOI: 10.3389/fphar.2020.01180. PMID: 32848783
33. Khabriev, R. U., Isaeva, A. V., Bezmenitsyna, L. Yu., Meshkov, D. O., Berseneva, E. A., et al. (2016). Dostupnost innovacionny`x lekarstvenny`x preparatov i snizhenie pokazatelej smertnosti ot onkologicheskix zabolevanij [The availability of innovative drugs and a reduction in cancer mortality rates], *Bulletin of the National Public Health Research Institute*, **6**, 5–19. [In Russian]
34. van Rossum, L., Aij, K. H., Simons, F. E., van der Eng, N., Ten Have, W. D. (2016). Lean healthcare from a change management perspective, *J Health Organ Manag.*, **30**(3), 475–493. DOI: 10.1108/JHOM-06-2014-0090. PMID: 27119398
35. Simons, P., Benders, J., Bergs, J., Marneffe, W. & Vandijck, D. (2016). Has Lean improved organizational decision making? *Int J Health Care Qual Assur*, **29**(5), 536–49. DOI: 10.1108/IJHCQA-09-2015-0118. PMID: 27256776
36. Drotz, E. & Poksinska, B. (2014). Lean in healthcare from employees' perspectives, *J Health Organ Manag*., **28**(2), 177–195. DOI: 10.1108/JHOM-03-2013-0066. PMID: 25065109
37. Campbell, R. J. (2020). Change Management in Health Care, *Health Care Manag.*, **39**(2), 50–65. DOI: 10.1097/HCM.0000000000000290. PMID: 32345939
38. Solow, M. & Perry, T. E. (2023). Change Management and Health Care Culture, *Anesthesiol Clin*., **41**(4), 693–705. DOI: 10.1016/j.anclin.2023.05.001. PMID: 37838377
39. Silvola, S., Restelli, U., Croce, D. & Basu, D. (2024). Change management for services redesign in healthcare: a conceptual framework, *J Prev Med Hyg*, **65**(3), E410–E433. DOI: 10.15167/2421-4248/jpmh2024.65.3.3023. PMID: 39758770; PMCID: PMC11698107
40. Wahlster, P., Goetghebeur, M., Kriza, C., Niederländer, C. & Kolominsky-Rabas, P. (2015). National Leading-Edge Cluster Medical Technologies ‘Medical Valley EMN’. Balancing costs and benefits at different stages of medical innovation: a systematic review of Multi-criteria decision analysis (MCDA), *BMC Health Serv Res.*, **15**, 262. DOI: 10.1186/s12913-015-0930-0. PMID: 26152122; PMCID: PMC4495941
41. Frazão, T. D. C., Camilo, D. G. G., Cabral, E. L. S. & Souza, R. P. (2018). Multicriteria decision analysis (MCDA) in health care: a systematic review of the main characteristics and methodological steps, *BMC Med Inform Decis Mak.*, **18**(1), 90. DOI: 10.1186/s12911-018-0663-1. PMID: 30382826; PMCID: PMC6211490.
42. Marsh, K., Thokala, P., Youngkong, S. & Chalkidou, K. (2018). Incorporating MCDA into HTA: challenges and potential solutions, with a focus on lower income settings, *Cost Eff Resour Alloc*., **16**(Suppl 1), 43. DOI: 10.1186/s12962-018-0125-8. PMID: 30455602; PMCID: PMC6225551
43. Lasalvia, P., Prieto-Pinto, L., Moreno, M., Castrillón, J., Romano, G., et al. (2019). International experiences in multicriteria decision analysis (MCDA) for evaluating

orphan drugs: a scoping review, *Expert Rev Pharmacoecon Outcomes Res*., **19**(4), 409–420. DOI: 10.1080/14737167.2019.1633918. PMID: 31210065

44. Podinovskii, V. V. (2004). The quantitative importance of criteria with discrete first-order metric scale, *Automation and Remote Control*, **65**(8), 1348–1354.
45. Podinovskii, V. V. (2008). Analysis of multicriteria choice problems by methods of the theory of criteria importance, based on computer systems of decision-making support, *Journal of Computer and Systems Sciences International*, **47**(2), 221–225.
46. Cherkasov, S., Shoshmin, A., Vaisman, D., Meshkov, D Bessrashnova, Ya., et al. (2015). Activities of Russian WHO-FIC Collaboration Centre, *WHO-Family of international classifications network annual meeting* (17–23 October 2015, Manchester, United Kingdom), C216.

