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**External Scientific Consultant's Opinion
on the doctoral research of BEKZHAN A. PERMENOV
entitled "Organizational and Development Strategy of Extracorporeal Membrane
Oxygenation Services"
submitted for the degree of Doctor of Philosophy (PhD)
in the educational program 8D10139 "Public Health"**

The doctoral research of Bekzhan A. Permenov, presented in the form of a coherent series of publications, addresses important and rapidly evolving issues at the intersection of critical care medicine and public health, namely the organization and development of extracorporeal membrane oxygenation (ECMO) services. ECMO is a complex, resource-intensive, and lifesaving technology. Its use requires highly skilled clinical decision-making and advanced healthcare infrastructure, including workforce training, patient safety systems, ethical oversight, equitable access, evidence-based implementation, and effective multidisciplinary coordination. In modern healthcare systems, ECMO should be regarded not only as a highly specialized clinical intervention, but also as an organizationally demanding service that requires strategic planning and sustainable development within the broader public health framework.

The aim of this doctoral research is to conduct a comprehensive analysis of the organization, workforce provision, informational support, and strategic development of extracorporeal membrane oxygenation services within the public health system.

The objectives of the doctoral research are as follows:

1. To analyze contemporary directions in the application of extracorporeal membrane oxygenation and to identify key unresolved clinical and organizational challenges associated with its use;
2. To evaluate existing approaches to the organization of ECMO services, including health professionals' training, operational standards, multidisciplinary approaches, and resource availability;
3. To examine the role, functions, and level of professional training of critical care nurses within the structure of ECMO teams;
4. To assess the quality and reliability of information on ECMO available in open digital sources and to determine its significance for public health;
5. To formulate practical recommendations for the organizational development and phased implementation of ECMO services in multidisciplinary hospitals on the basis of international evidence and institutional experience.

A critical review of the literature and relevant sources was conducted to analyze unmet needs in the field of ECMO. This part of the research comprehensively addressed interdisciplinary issues, with results published in a leading medical journal (*Rheumatology International*, Q2; Clarivate). The doctoral candidate has demonstrated deep knowledge of ECMO-related issues and perspectives by synthesizing available evidence-based data

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retrieved from reputable bibliographic databases such as Medline, Scopus, and Web of Science. Importantly, this review-based component served as a conceptual foundation for the subsequent empirical studies and enabled the author to place the development of ECMO services within a broader clinical, organizational, and public health context.

Overall, the results of the submitted research have been presented in several impactful peer-reviewed journals: one narrative review and one original research report in *Rheumatology International* (Q2), one original research report in *Journal of Korean Medical Science* (member journal of the International Committee of Medical Journal Editors [ICMJE], Q1), one original research report in *Croatian Medical Journal* (past member journal of ICMJE, Q2), and one publication in *Central Asian Journal of Medical Hypotheses and Ethics* devoted to practical recommendations for ECMO implementation in multidisciplinary hospitals. All published articles are globally visible, thematically interconnected, and consistent with relevant research reporting standards. Taken together, they form a coherent body of evidence that adequately reflects the key directions of the doctoral research and supports its principal scientific and practical conclusions.

The results of the doctoral research are presented in the following valuable publications:

1. Narrative review titled «Extracorporeal membrane oxygenation: unmet needs and perspectives» (*Rheumatology International*, Q2 according to the Journal Citation Reports (Clarivate); Bekzhan Permenov is the first author);
2. Original research report titled «Healthcare professionals' views on training, standards, and resources for extracorporeal membrane oxygenation: a cross-sectional survey» (*Croatian Medical Journal*; Q2 according to the Journal Citation Reports (Clarivate); Bekzhan Permenov is the first author);
3. Original research report titled «Healthcare professionals' perceptions of nurses' qualifications and roles in extracorporeal membrane oxygenation: an online cross-sectional survey» (*Rheumatology International*; Q2 according to the Journal Citation Reports (Clarivate); Bekzhan Permenov is the first author);
4. Original research report titled «Evaluating the Quality and Reliability of YouTube as a Source of Information on Extracorporeal Membrane Oxygenation: A Call to Publish More Quality Videos by Professionals» (*Journal of Korean Medical Science*, member of the ICMJE; Q1 according to the Journal Citation Reports (Clarivate); Bekzhan Permenov is the first author);
5. Publication titled «Practical Recommendations for Extracorporeal Membrane Oxygenation Implementation in Multidisciplinary Hospitals Without Cardiac Surgery: Lessons Learned from Five-Year Experience of Heart Center Shymkent» (*Central Asian Journal of Medical Hypotheses and Ethics*; the journal is indexed by the Directory of Open Access Journals [DOAJ], Global Health [CABI], Chemical Abstracts Service [CAS], EBSCO, Ulrich's Periodicals Directory and ERIH PLUS; Bekzhan Permenov is the first author), in which the author integrated international evidence with a retrospective analysis of institutional ECMO experience from 2019 to 2024 and formulated a practical organizational framework for phased ECMO implementation in multidisciplinary hospitals without in-house cardiac surgery.

