

Genomic and Stem Cell Research for Tuberculosis and Pulmonary Diseases: Experience from Persahabatan Hospital

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Abstract

Background: Chronic lung diseases remain major health challenges in Indonesia. Genomics-based approaches and regenerative therapies have become areas of research to support more precise diagnosis and treatment. Persahabatan Hospital (RSP) plays an important role in the implementation of genomic research through the Biomedical and Genome Science Initiative (BGSi). RSP has also initiated stem cell research programs aimed at establishing a regenerative therapy platform for chronic respiratory diseases. The current focus is on the clinical evaluation of umbilical cord-derived mesenchymal stem cells (UC-MSCs) as an adjuvant therapy.

Methods: This article is an institutional review describing the progress of genomic and stem cell research at RSP. The information is compiled based on the BGSi program report, RSP scientific publications, and the institutional research strategic plan.

Results: Through BGSi, RSP has achieved genomic infrastructure readiness, ranging from specimen collection from health facilities in 26 provinces and specimen processing in 12 DST Labs to sequencing and bioinformatics analysis in 12 tNGS Labs. The implementation of tNGS has supported rapid diagnosis, drug resistance mapping, and strengthening of the national TB surveillance system. Meanwhile, the stem cell research has entered the clinical translation phase, conducting a randomized, double-blind trial of UC-MSCs as adjuvant therapy in COPD patients. The study involves collaboration with an accredited GMP-certified cell processing facility.

Conclusion: Advances in genomic and stem cell research at Persahabatan Hospital demonstrate concrete steps toward integrating precision medicine and regenerative therapy in respiratory care. Sustainability are crucial to achieving clinical implementation that benefits patients and strengthens national biomedical innovation.

Keywords: genomics, tNGS, WGS, stem cells, Persahabatan Hospital

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Tuberculosis (TB) and various other chronic lung diseases such as COPD, asthma, and pulmonary fibrosis remain the leading causes of morbidity and mortality in Indonesia¹. The complexity of these diseases, which includes drug resistance, permanent tissue damage, and a high socioeconomic burden, demands innovation in more targeted diagnosis and therapy.

Advances in genomics have provided a new paradigm in understanding infectious and chronic diseases. Through targeted next-generation sequencing (tNGS), detection of drug resistance can now be performed more quickly, accurately, and comprehensively. Rumah Sakit Persahabatan (RSP) is one of the national referral centers for the implementation of genomic research through the Biomedical and Genome Science Initiative (BGSi)². Under this coordination, RSP plays a role in strengthening the specimen logistics chain, molecular testing, bioinformatics data management, and collaboration with the national laboratory network to support a genomic-based TB surveillance system.

In addition to genomics, Persahabatan Hospital has expanded its research capacity in the field of regenerative medicine, particularly through stem cell-based therapy. Since 2020, the hospital—through its Clinical Research Unit (CRU)—has coordinated several preparatory and translational activities focusing on the use of mesenchymal stem cells (MSCs) for chronic lung diseases. These efforts are based on growing evidence that MSCs possess anti-inflammatory, immunomodulatory, and regenerative capabilities that may repair lung tissue damage caused by chronic inflammation and oxidative stress in diseases such as chronic obstructive pulmonary disease (COPD) and pulmonary fibrosis.³⁻⁵

The current research at Persahabatan Hospital is focused on umbilical cord-derived mesenchymal stem cells (UC-MSCs), which are provided by a licensed GMP-certified external partner, PT Prostem Indonesia. The hospital's ongoing randomized, double-blind clinical study aims to evaluate the safety and efficacy of UC-MSCs as

an adjuvant therapy for COPD, with outcomes that include lung function improvement, reduction of exacerbations, and cytokine modulation.

While this program remains at the clinical research phase, it serves as the foundation for future development of a Respiratory Regenerative Medicine platform, where stem cell therapy may be integrated with genomic profiling from the BGSi program. This integration is expected to support the realization of precision-regenerative medicine—a personalized therapeutic approach based on both genetic and cellular characteristics of respiratory disease patients.

The synergy between genomic research and stem cell research at Persahabatan Hospital is the foundation for the era of precision and regenerative medicine in Indonesia. This article aims to describe the activity of genomic and stem cell research at Persahabatan Hospital and review the prospects of its integration in supporting diagnostic and therapeutic innovations for lung diseases in the future.

THE LEGALITY OF STEM CELL SERVICES IN INDONESIA

The implementation of stem cell services and research in Indonesia is regulated in Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2018 concerning the Implementation of Stem Cell and/or Cell Services. This regulation outlines provisions regarding definitions, the formation of committees, types and sources of cells, the management of activities (including the collection, storage, processing, and clinical application of stem cells), as well as mechanisms for use, funding, recording, and reporting.⁶

The regulation emphasizes that the use of stem cells and/or cells is only permitted for the purpose of curing diseases, both degenerative and non-degenerative, and is prohibited for reproductive purposes or the creation of new individuals. This provision is established to provide guidance, protection, and legal certainty for patients, donors, and health care facilities that provide stem cell

services in Indonesia.⁶

LEGAL BASIS FOR GENOMIC RESEARCH (BGSi) IN INDONESIA

Genomic research activities in Indonesia are conducted based on the Decree of the Minister of Health of the Republic of Indonesia Number HK.01.07/MENKES/505/2024 concerning the Implementation of the Biomedical Genome-Based Science Initiative for Precision Medicines and the Development of Genomic-Based Health Services.² Through this decree, the Ministry of Health has designated the Center for Balai Besar Biomedis dan Genomika Kesehatan (BB Binomika) as the main implementer of BGSi, tasked with building biobank infrastructure, integrated data platforms, bioinformatics analysis, and the development of precision medicine in Indonesia. In its implementation, the Persahabatan Central General Hospital was appointed as the coordinator of the infectious disease hub², which has the mandate to coordinate the network of health facilities in volunteer recruitment, specimen collection and storage, and data integration into the national BGSi system. Genomic research at Persahabatan Hospital is also carried out in accordance with the principles of biomedical research ethics, based on the approval of the FKUI-RSCM Research Ethics Committee (No. 333399-1-18-20250327)⁷ and the 2022 Genomic Analysis Research Protocol⁸. All research activities are conducted with due regard for the protection of human subjects, data security, and national genomic research governance standard.

GENOMIC RESEARCH FOR TUBERCULOSIS AT PERSAHABATAN HOSPITAL

As a national referral hospital for respiratory diseases, Persahabatan Hospital (RSP) serves as one of the coordinators for the Biomedical and Genome Science Initiative (BGSi) infectious disease hub. In implementing the BGSi program, RSP has established and strengthened an integrated genomic research workflow, covering specimen

collection at network health facilities, sputum decontamination at pDST labs throughout Indonesia, DNA extraction, quality validation using Qubit, DNA library preparation, and bioinformatics analysis at 12 labs. pDST across Indonesia, DNA extraction, quality validation using Qubit, DNA library preparation and bioinformatics analysis in 12 tNGS laboratories using the Illumina platform. The entire process is carried out in accordance with Good Clinical Laboratory Practice (GCLP), biomedical research ethics guidelines (Ethical Approval No. 333399-1-18-20250327)⁷, and Illumina's Genoscreen Deeplex protocol⁹.

Additionally, RSP is actively involved in tNGS technical training for its laboratory network, RSP, and Prof. Dr. Sulianti Saroso Infectious Diseases Hospital, in collaboration with BB Binomika, FIND, and the Global Fund as donors. This activity enhances human resource capacity in sequencing data management, quality control, and genomic result interpretation¹⁰. As part of the national BGSi system, RSP also implements the Phenovar platform, which is connected to the biobank system at the National Center for Biomedical and Genomic Health (BB Binomika). This mechanism ensures that every specimen and analysis result is securely recorded, traceable, and ready for use in further translational research¹¹.

The implementation of BGSi at Persahabatan Hospital provides important lessons regarding cross-sector synchronization between health, research, and public policy institutions. Multidisciplinary involvement between pulmonologists, microbiologists, bioinformaticians, and data managers is key to the successful implementation of genomic programs in the field of tuberculosis¹⁰. However, the implementation process still faces several challenges, such as delays in reagent supply and capacity gaps between network laboratories. This experience has become the basis for RSP to strengthen research governance and resource management in the future.

STEM CELL RESEARCH FOR LUNG DISEASES AT PERSAHABATAN HOSPITAL

Stem cell research at Persahabatan Hospital represents a long-term institutional commitment to advancing regenerative therapy in the field of respiratory medicine. Guided by the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2018 on the Implementation of Stem Cell and/or Cell Services⁶, Persahabatan Hospital is authorized to conduct translational research and clinical applications in the area of stem cell therapy.

The program is coordinated by the Clinical Research Unit (CRU) of Persahabatan Hospital, which serves as the central body overseeing multidisciplinary studies across departments. At present, the focus remains on clinical research using externally manufactured stem cell products, rather than establishing in-house production facilities. The study uses GMP-certified umbilical cord-derived mesenchymal stem cell (UC-MSC) products supplied by PT Prostem Indonesia, ensuring product quality, biosafety, and compliance with national regulatory standards.

The flagship research underway is the clinical trial of UC-MSCs as adjuvant therapy for COPD. This single-center, randomized, double-blind trial involves 20 participants (10 receiving UC-MSCs and 10 receiving placebo) and is designed to evaluate: safety and tolerability of intravenous UC-MSC infusion, improvement of pulmonary function (FEV₁, FVC, DLCO), reduction in exacerbation frequency, improvement in quality of life (CAT and mMRC scores), modulation of cytokine levels (IL-1 β , IL-6, TNF- α , IL-10), and radiologic improvement on high-resolution chest CT.

As of October 2025, the trial has entered the subject recruitment and initial implantation phase. Ethical approval has been granted by the Persahabatan Hospital Research Ethics Committee, and follow-up assessments are scheduled at 1, 3, 6, and 12 months post-infusion. Literature review publications—Andari & Damayanti (Respiratory Science, 2021) and Soetartio & Damayanti (Jurnal Respirasi, 2021)—have shown that MSCs can reduce inflammation, mitigate oxidative stress, and promote alveolar regeneration.^{12,13} These findings

underpin Persahabatan Hospital's vision to translate preclinical data into measurable clinical outcomes for patients with degenerative and post-infectious lung diseases.

While the hospital's long-term vision includes developing production laboratory capability and translational facilities for cellular therapy, current activities remain focused on clinical evaluation, scientific publication, and human resource development under CRU coordination. This staged approach allows the institution to build capacity safely before moving toward independent laboratory services in the future.

Persahabatan Hospital plans to establish a precision-regenerative medicine platform by combining genomic data from BGSi with stem cell interventions. This integration will create personalized treatment protocols informed by a patient's genetic risk, inflammatory markers, and cellular reactions, thereby strengthening the hospital's position as a leading national center for respiratory advancements.

LIMITATION

This article is compiled as an institutional review of the development of genomic and stem cell research at Rumah Sakit Persahabatan (RSP). As it is a narrative literature and progress report, the discussion presented does not include quantitative analysis or statistical results from ongoing research activities. The information used is largely sourced from internal documents, program reports, and scientific publications available up to 2025, so the data presented reflects the current situation at the time of writing and may change in line with future developments in the BGSi program and stem cell research. Another limitation lies in the scope of genomic data, where some bioinformatics analysis processes and the utilization of cross-institutional clinical data are still under development. Therefore, the progress description provided is general and does not yet represent the entire national Biomedical and Genome Science Initiative (BGSi) network.

In the stem cell research component, several

limitations are recognized. The ongoing UC-MSC clinical trial for COPD involves a small number of subjects (20 participants) and relatively short follow-up duration, focusing primarily on efficacy and safety. In addition, the exclusion criteria applied in this study are extensive, intentionally designed to obtain a homogeneous patient population and minimize confounding bias. While this approach strengthens internal validity, it also narrows the eligible population and limits the generalizability of findings. Furthermore, Persahabatan Hospital currently relies on externally manufactured GMP-certified stem cell products (PT Prostem Indonesia) and does not yet operate its own stem cell production laboratory. Another ongoing challenge lies in sustaining long-term research funding and developing human resources in cellular biotechnology and translational research. Therefore, the results and observations presented in this article should be interpreted as a reflection of the hospital's current progress and research trajectory, rather than as a definitive evaluation of clinical outcomes or institutional capacity.

CONCLUSION

The development of genomic and stem cell research at Persahabatan Hospital highlights the institution's dual focus on precision diagnostics and regenerative therapy within respiratory medicine.

Through its participation in the Biomedical and Genome Science Initiative (BGSi), Persahabatan Hospital has strengthened genomic infrastructure for the rapid detection and surveillance of infectious diseases such as tuberculosis. Simultaneously, the Clinical Research Unit (CRU) has advanced the hospital's role in regenerative research through its clinical trial of umbilical cord-derived mesenchymal stem cells (UC-MSCs) for COPD—marking an important step toward translating cellular therapy into clinical practice.

Together, these programs reflect Persahabatan Hospital's commitment to bridging genomics and regenerative medicine as part of Indonesia's health research ecosystem. Sustained

multidisciplinary collaboration, regulatory support, and investment in human resource development will be essential to ensure that precision and regenerative innovations translate into real clinical benefits for patients with chronic and degenerative lung diseases.

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Budget (APBN) through the Ministry of Health of the Republic of Indonesia, as well as collaborative support from NGOs, including FIND Diagnostics For All and the Global Fund, for program funding such as program outreach to 38 provinces in Indonesia, tNGS laboratory network training, and sample packaging and shipping for DST laboratories. The entire research process did not receive direct financial support from industry or other commercial entities. All funding is transparent and does not influence the design, content, or interpretation of this manuscript.

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ETHICAL CLEARANCE

This descriptive study obtained ethical approval from the Ethical Committee for Health Research at Persahabatan Hospital (No. 0238/KEPK-RSUPP/11/2025) on November 14, 2025.

CONFLICT OF INTEREST

The authors declare there is no conflict of interest.

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