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Education in Transfusion Medicine – Why Are Gaps Not Filled?

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Abstract

A major problem in most Low- and Medium-Human Development Index countries (LMICs) is in quality of management, operations and governance, lack of well-educated and trained teaching, health care and societal cadre and the continuation of child labor and poverty. But also, the persisting gender inequality. The United Nations Development Programme (UNDP) does a regular and updating survey on the three human development domains – Long and healthy life, Knowledge, A decent standard of Living, and publishes the results in a Human Development Report. The 2025 Report focuses on the application of artificial intelligence tools to advance development. The manuscript tends to provide answers to the burning question in transfusion medicine education why gaps are still existing and not filled? When there are gaps to fill, basic structures and an education environment and climate needs to be developed first to allow filling gaps with sustainable and quality learning.

Keywords: UNDP, Human Development Domains, Transfusion Medicine, Education, Artificial Intelligence (AI).

Introduction

The United Nations Development Program (UNDP) developed three major dimensison and related indices to measure and compare the state of development of people (HDI) in different countries: Life expectancy, education and gross national income (GNP) (Fig, 1) and adjusted these later for gender inequality.

The 2018 UNDP Human Development Indices and Indicators 2018 Statistical Update (UNDP, statistical update, 2018) illustrates a dramatic picture on the pupil flow through primary, secondary and tertiary education offered in Low- and Middle-Income Countries (LMIC) as compared to the High and Very High-Income Countries (Table. 1). Although the report also shows the progress that was observed since 1990 till 2017 (Fig. 2), the graph shows that progress has not always been steady because some countries suffered reversals due to conflicts (e.g., Syria, Libya and Yemen), epidemics (e.g., HIV/AIDS and Ebola in Sub-Saharan Africa) or economic crises (e.g., collapse of the Soviet Union in Eastern Europe and Central Asia, hyperinflation and the expansion of market mechanisms and neocolonialism (e,g., source materials and a cheap working force/child labor)

What are The Problems and Challenges?

A major problem in most Low- and Medium-Human Development Index countries is in quality and governance, lack of well-educated and trained teaching, health care and societal cadre and the continuation of child labor and poverty. But also, the persisting gender inequality.

Table 1: UNDP 2018 Education enrolment ratio for primary, secondary and tertiary education in the four Human Development Index groups.

Human Development Groups	Education Enrolment Ratio		
	Primary School-Age Population (%)	Secondary School-Age Population (%)	Tertiary School-Age Population (%)
Low HDI	98	43	8
Medium HDI	110	73	24
High HDI	103	96	50
Very-High HDI	102	106	72

With the inclusion of data by UNDP from gender inequality and the global programs like women's (girls') empowerment of Rotary International the picture shows still shortcoming and gaps in poverty, health care, life expectancy and education despite the observation that across the globe people are living longer, are more educated and have greater livelihood opportunities and comfort of life. The average lifespan is over seven years longer than at the end of the previous century and more than 130 countries now have universal enrolment in primary education although this aspect is still not universally legally mandatory [1].

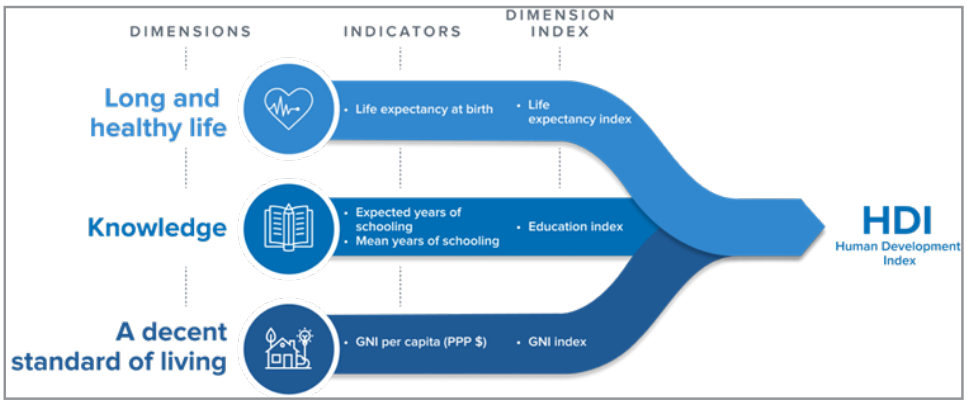

Figure 1: Dimensions and Indicators That Form the HDI (Unadjusted).

The 2023 published data on 'expected years of schooling' and 'mean years of schooling' still shows remarkable discrepancies between the four HDI groups (Table 2).

Table 2: 2023 Expected Years and Mean Years of Schooling Per HDI Group; Total and Per Gender (F= female, M=male). Expected = SDG 4.3, Mean = SDG 4.4 (SDG =, Sustainable Development Goal'

	Average Periodic HDI Growth (%)			
	1990-2000	2000-2010	2010-2023	1990-2023
Development groups				
Very-high HDI	0.50	0.48	0.30	0.42
High HDI	1.12	1.16	0.65	0.95
Medium HDI	1.13	1.65	1.05	1.22
Low HDI	1.28	1.74	0.76	1.21
Developing countries	1.03	1.20	0.72	0.96

Table 3 HDI Trends Between 1990 and 2023 as Averages in Percentages.

Although most of the current and persisting challenges relate to the existing blood supply systems in the LMICs, the first one is a general and obstinate problem causing a major challenge. WHO conducted in 2015 a survey (Global Status Report on Blood Safety and Availability, 2021), which benefited from an 89% response rate, that provided high-level insights and guidance to global efforts to ensure access to safe, effective and quality blood products, identifying a series of current challenges:

• Deficiencies in national policy, governance and financing;
• Insufficient supply of safe, effective and quality-assured blood products for transfusion;
• Deficiencies in blood product safety, effectiveness and quality;
• Insufficient availability of plasma derived medicinal products (PDMPs);
• Suboptimal clinical practices in transfusion of blood components;
• Insufficient access to blood during emergency situations.

• Poor and non-structured education (teaching and training) due to improper education environment and climate. These 2015 challenges are still existing.

How to Introduce Artificial Intelligence (AI)

Over the last decades artificial intelligence (AI) developed and is racing ahead at high speed. However, as AI speeds forward, human development is hardly moving. Decades of progress, reflected in the Human Development Index, have slowed down, with no clear recovery from the COVID-19 pandemic and subsequent global crises. While AI promises to redefine our future, it also risks deepening the gaps of a world already imbalanced. Too often, newspaper headlines, governmental policies and public debates fix on what AI might achieve in some distant future, utopian or dystopian. These deterministic views are not only disempowering, they are profoundly misleading; obscuring the fact that the future is being shaped now, by the choices we make today. The 2025 Human Development Report 'A Matter of Choice: People and Possibilities in the Age of AI' (UNDP Report, 2025), reminds that 'it is people not machines who determine which technologies thrive, how they are used and whom they serve' through machine and deep learning algorithms. The impact of AI will not be defined by what it can do but by the decisions we make in its design, development and deployment.

Central to these decisions is how the role of people is viewed in an AI-driven world. Assuming that AI will inevitably sideline and support, mankind will overlook the force driving its progress. AI's capacity to automate nonroutine tasks has stimulated fears of human replacement (labor) but this is only when we reduce people to mere task-performers. This UNDP Report argues that humans, "the true wealth and investment of nations," are far more than the sum of the tasks they perform. Rather than measuring AI by how closely it mimics mankind, the Report emphasizes how the differences between humans and machines can create powerful complementarities that expand human potential and strength. This people-centred perspective becomes even more critical in a moment of overlapping global crises. It is tempting to believe that AI alone can solve our development challenges and problems. But that belief invites complacency. It asks humans to surrender responsibility and ignore the political, social and systemic barriers that have long impeded progress.

The 2023/2024 Human Development Report, 'Breaking the Gridlock'made it clear: human limitations are not technological but sociological. Many of the crises and inequalities we face persist not because solutions are lacking but because we have failed to act accordingly; with AI we must choose differently. We might resist the temptation to humanize AI, yet in many ways it acts like a mirror reflecting and amplifying the values, structures and inequalities of the societies that shape and feed it. AI does not act independently; it evolves through our decisions and our priorities. If we fail to address the injustices and divides that persist today, AI will only entrench them further. But if we invest in human capabilities and commit to greater equity, AI can magnify the best of what mankind can achieve. Ultimately, the 2025 Human Development Report (UNDP Report, 2025) on AI is not about technology, it is about people, and our ability to reinvent ourselves in the face of profound and improving change.

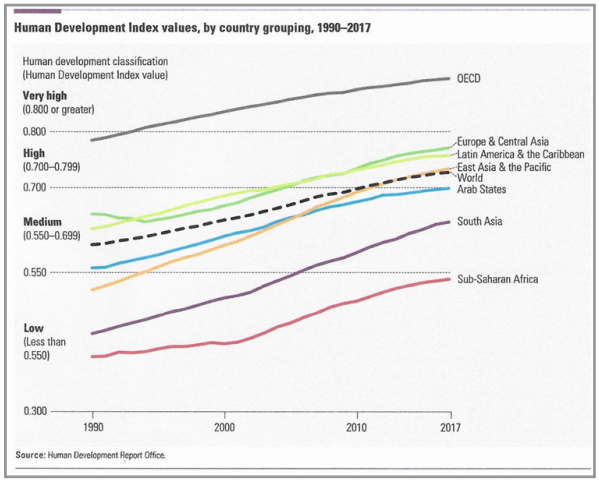

Figure 2: HDI Progress 1990 – 2017 by Country Grouping. The Fastest Growing Groups are - South Asia (purple): 45.3%; East Asia and the Pacific (yellow): 41.8%; and Sub-Saharan Africa (red): 34.9%, Where the Organization for Economic Co-operation and Development (OECD) Countries (black) Showed a Progress of only 14,0%. Europe and Central Asia (green) Showed the most Impressive Dip in the 1990s. The Average Progress in the World is Shown in the Black Dotted Line in the Middle.

Each morning seems to bring new AI-powered algorithmic news. As a general-purpose technological tool, AI has been called "the new electricity." Regardless of whether the utopian, techno-solutionist visions of AI's most enthusiastic advocates come to fruition or fizzle as snake oil (or worse), the world is pulsating with a powerful new technology, a new kind of dynamism or vitality, that differs from technologies of the past. Headlines fix on military arms races, policymaking on risks. These are real, but they are not and should not be the whole story. We need to go beyond races and risks to possibilities and opportunities for people, possibilities shaped by people's choices. The choices that people have and can realize, within expanding freedoms, are essential to human development, whose goal is for people to live a life they have reason to value.

A world with AI is flushed with choices the exercise of which is both a matter of human development and a means to advance it. Trying to predict what will happen is self-defeating, privileging technology in a make-believe vacuum over the frictional realities and messier promises of people's agency and their choices.

From a human development perspective, the relevant question instead is what choices can be made to make AI work for and support mankind. How to examine what distinguishes this new era of AI from previous digital transformations and what those differences could mean for human development, including how AI can enhance or subvert human agency [3].

People are already interacting with AI in different ways at different stages of life, in effect scoping out good and bad possibilities and underscoring how intellectual context and effective choices can make all the difference. Human agency is the price when people buy into the AI hype, which can exacerbate exclusion and harm sustainability [4].

Who designs and produces AI and for what, matters a lot for everyone. Letting people take the reins makes good sense, because they expect AI to be a growing part of their life, a beneficial tool. The global survey (UNDP Report, 2025) for this Report found that, at all levels of the Human Development Index (HDI), AI-use is already substantial for about 20 percent of respondents and is expected to increase fast. About two-thirds of respondents in low, medium and high HDI countries expect to use AI in education, health and work, the three HDI dimensions, within one year from now.

Are Gaps Widening and is Progress Loosing Tempo?

Gaps between Very High and Low HDI countries, which for decades had been shrinking, have been widening over the past years since the outbreak of the COVID-19 pandemic. The dramatic slowdown in HDI-progress cuts across all developing regions. Development pathways that have created jobs at scale, improved economies of scale, stimulated knowledge economy and reduced poverty, thanks to expanded and regionalizing manufacturing are narrowing [5]. Results from inadequate external financing and guidance (US CDC and USAID), fewer opportunities in manufacturing due in part to automation are well recognizable [6].

It is a matter of choices. Development depends less on what AI can do, not on how human it appears but more on mobilizing people's imaginations to reshape economies and societies to make the most of it. Sobering development realities, including protracting violent conflicts and stresses on human security and dictatorial policies and governance. Wounds from the 2020-2021 (COVID-19) declines in global HDI value have not healed, and the resilient rebound since may be losing strength. Just a few years ago we were on track (Sustainable Development Program) to live in a very high HDI world by 2030. That world was delayed by a few years based on the 2021–2024 trend [7].

Today it is projected to be delayed by decades. AI does some tasks uniquely well, such as seeing patterns in huge datasets (big data) that are difficult or impossible for humans to observe. It does other things pretty poorly, sometimes making things up [8,9].

It cannot frame problems, as humans can do. Whatever new algorithmics are in store, there will always be spaces. However, in flux where humans shine, where humans do things that machines cannot do or are bad at, where societies value people rather than machines doing things and where people and machines go farther and faster together than separately. However, to appropriately and efficiently use AI. knowledge economy (sharing) and a well-functioning infrastructural environment and climate are paramount.

It is time to break the period of technological inevitability: no path forward is about technology in isolation but rather how it is deployed, by whom, with whom, for whom and with what kind of responsibility and accountability. Different choices can help turn things around for which knowledge and experience are needed: people. Rather than try to predict the future, policy makers should be creative and shape it, breaking away from trying to guess how humans will be replaced by AI, to see the potential of what humans can do with AI as a supportive tool. That includes driving productivity gains through intelligence augmentation, leveraging the complementarities between people and AI. Ensuring that AI is a proworker, limiting curbs on agency and empowering workers to use AI to augment what they can do. Deploying AI in sectors where positive spillovers to other sectors can be leveraged, helping with economic diversification and job-creating structural transformation. Implementing fiscal measures and strengthening social dialogues that incentivize AI to safeguard decent work and supporting incumbent workers displaced by AI.

AI should be harnessed to accelerate science through curiosity-driven basic and applied research, as well as technological innovation, not by automating creative processes but by augmenting these [10].

AI innovation can be steered through incentives that embed human agency in AI from design to deployment by aligning socially desirable and privately profitable innovation and supplementing existing AI benchmarks with new ones that capture AI's potential to advance human development and education.

AI's flexibility and adaptability should be leveraged to personalize education and healthcare in different contexts including transfusion medicine, while attending to risks and concerns related to bias, privacy, affordability and equity. By tailoring learning or expanding health care, AI can also generate demand for complementary human labor [11-13]

Together, these areas invite policymakers at different levels and in different regions to shake off unhelpful narratives that swing between utopia and dystopia, to depart from disempowering trends that sideline most people or reimagine their choices and expand their freedoms.

Who, When, Where and How?

To prepare people to strive with AI in transfusion medicine, education (doctors, nurses and professional technologists) needs to focus on learning outcomes, as well as critical, creative and relational thinking, moving beyond simply increasing years of schooling. It needs to be structured with an adequate environment and a comfortable learning climate, and professional oversight and protection by a governmental agency. When integrating AI in education, avoid using AI as a crutch, by teachers and/or students, and treat it as a supportive companion to unleash new and better ways of learning. This involves deploying AI to scale interventions known to enhance education outcomes, such

as customized learning, rather than deploying it for its own sake.

In the healthcare and transfusion medicine professions AI should be deployed to complement knowledge and expertise, particularly when it is scarce, as in lower-income countries and settings, empowering workers to do more in resource- and expertise-constrained contexts.

Blood supply systems and the operational blood establishments should safely and transparently integrate AI technologies strengthening both institutional and frontline provider capacity to use these systems, while clearly communicating to patients how the systems are employed in clinical decision making to build trust and confidence. Because the unintended side effects of AI in blood services may change over time, monitoring AI biases and health inequalities needs to be seen as continuous [14].

Scientific, educational and technological progress propel development. Waves of technological innovation have made us healthier, wealthier and more knowledgeable and skilled, while shifting patterns of economic opportunity and redrawing inequalities. Not because of inherent features of the technologies, but because of active and balanced decisions by people (managerial and operational), blood establishments, and governments responsible for the legal framework and the incentives shaped by newly created regional institutions [15-17].

As AI moves from a niche and hobby technology to a cornerstone of people's life across multiple domains, its potential to advance human development has to be seized. That depends on more than algorithms; it depends on our intellectual and practical choices. The potential everywhere is enormous, including in lower HDI countries, whose narrowing development pathways feel more and more like a development tightrope over a widening gap. AI can act as a bridge to other advanced technologies that can facilitate manufacturing upgrading [18].

To greater diversification and integration up and down global value chains. to better 'markets' and to new knowledge, skills and ideas that can help everyone. Of course, that depends on access not just to "the new electricity" (AI) but also to the old and conventional. However, tapping AI's potential goes well beyond access, whatever important it may be. In a world of AI, divides will also spin along another axis: Which societies can make the most of a manufacture-changing technology, focusing on how AI complements and augments what people do, and which societies cannot, by either mistaking it for supercharged extensions of earlier computing technologies or deploying it in ways that compete with people. However, AI in all its diversities remains a tool [19-23].

Conclusion

The future of transfusion medicine education is in our hands. Technology is about people, not just things. Behind the thrill of invention hide important choices, by the few or the many, knowledge economy, driving innovation with intent sharing and investing in capabilities that count. Societies can use AI to expand people's choices and possibilities. In doing so, new development pathways for all countries will become visible at the horizon, helping everyone to have a chance at thriving in a world with AI. However, first things first – a sustainable foundation offering sound governance and a clear policy, a transparent structure and efficient knowledge and expertise and above all committed and dedicated people to strengthen the management and operations of an AI supported national blood system. When there remain gaps to fill basic structures, environment and climate needs to be developed first to allow sustainable learning.

Conflicting interests

The author has no conflicting interests.

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Ethical Considerations

not applicable

References

1. United Nations Development Programme. (2023–2024). Human development report 2023–2024: Breaking the gridlock. New York, NY: UNDP.
2. Hoffman, R., & Beato, G. (Eds.). (2025). Superagency: What could possibly wrigth with our AI future. New York, NY: Simon & Schuster. (Note: Correct "Wrigth" if it's a typo. Should it be "go wrong"?)
3. Galaz, V. (2025). Dark machines: How artificial intelligence, digitalization and automation is changing our living planet. UK: Taylor & Francis.
4. Rodrik, D., & Sandhu, R. (2024). Servicing development: Productive upgrading of labor-absorbing services in developing economies (Working Paper No. 32738). National Bureau of Economic Research. https://doi.org/10.3386/w32738
5. Rodrik, D., & Stiglitz, J. (2024). A new growth strategy for developing nations. Cambridge, MA: Harvard University.
6. United Nations Development Programme. (2025). Human development report 2025: Overview. A matter of choice: People and possibilities in the age of AI. New York, NY: UNDP.
7. Huang, L., Yu, W., Ma, W., Zhong, W., Feng, Z., Wang, H., ... & Liu, T. (2025). A survey on hallucination in large language models: Principles, taxonomy, challenges, and open questions. ACM Transactions on Information Systems, 43(2), 1–55. https://doi.org/10.1145/xxxxxxx (Add DOI when available)
8. Li, Y., Du, Y., Zhou, K., Wang, J., Zhao, W. X., & Wen, J. R. (2023). Evaluating object hallucination in large vision-language models. arXiv preprint arXiv:2305.10355. https://arxiv.org/abs/2305.10355
9. Cul, H., & Yasseri, T. (2024). AI-enhanced collective intelligence. Patterns, 5(1), 100123. https://doi.org/10.1016/j.patter.2023.100123 (Add actual article number or DOI if different)
10. Adapa, K., Gupta, A., Singh, S., Kaur, H., Trikha, A., Sharma, A., & Rahul, K. (2025). A real world evaluation of an innovative artificial intelligence tool for population-level breast cancer screening. npj Digital Medicine, 8(1), 2. https://doi.org/10.1038/s41746-024-00999-x
11. Dangi, R. R., Sharma, A., & Vageriya, V. (2025). Transforming healthcare in low-resource settings with artificial intelligence: Recent development and outcomes. Public Health Nursing. (In press).

12. Zuhair, V., Babar, A., Ali, R., Oduoye, M. O., Noor, Z., Chris, K., ... & Rehman, L. U. (2024). Exploring the impact of artificial intelligence on global health and enhancing healthcare in developing nations. Journal of Primary Care & Community Health, 15, 21501319241245847. https://doi.org/10.1177/21501319241245847
13. Beleguer, L. (2022). AI bias: Exploring discriminatory algorithmic decision-making models and the application of possible machine-centric solutions adapted from the pharmaceutical industry. AI and Ethics, 2(4), 771–787. https://doi.org/10.1007/s43681-022-00189-z
14. Romer, P. M. (1990). Endogenous technological change. Journal of Political Economy, 98(5, Part 2), S71–S102. https://doi.org/10.1086/261725
15. Romer, P. M. (1994). The origins of endogenous growth. Journal of Economic Perspectives, 8(1), 3–22. https://doi.org/10.1257/jep.8.1.3
16. Solow, R. M. (1956). A contribution to the theory of economic growth. Quarterly Journal of Economics, 70(1), 65–94. https://doi.org/10.2307/1884513
17. Verhoogen, E. (2023). Firm-level upgrading in developing countries. Journal of Economic Literature, 61(4), 1410–1464. https://doi.org/10.1257/jel.20221783
18. Diouf, M. A., Perez, L. P., Simione, F. F., Viseth, A., & Yao, J. (2024). A conceptual policy framework for leveraging digitalization to support diversification in Sub-Saharan Africa. International Monetary Fund.
19. World Health Organization. (2022). Global status report on blood safety and availability 2021. Geneva: WHO. https://apps.who.int/iris/handle/10665/366989 (License: CC BY-NC-SA 3.0 IGO)
20. United Nations Development Programme. (2018). UNDP indices and indicators: 2018 statistical update. New York, NY: UNDP.
21. United Nations Development Programme. (2015). Human development report 2015. New York, NY: UNDP.
22. Mishra, S., Koopman, R., De Prato, G., Rao, A., Osorio-Rodarte, I., Kim, J., & Zaccaria, A. (2023). AI specialization for pathways of economic diversification. Scientific Reports, 13(1), 19475. https://doi.org/10.1038/s41598-023-46674-5
23. Acemoğlu, D., & Johnson, A. (2024). Can we have pro-worker AI? (Policy Insight No. 123). Centre for Economic and Policy Research.