Research Article

Biomedical and Healthtech Innovation: The Dilemma Between Purpose, Current Stakeholder Economics, and "Patient" Benefits / Desires — What Might the Future of Health Look Like?

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This paper discusses the prevailing challenges in healthcare innovation, emphasising the need to prioritise patient benefits over economic gains. It highlights the current focus on incremental improvements rather than disruptive innovations addressing broader health outcomes. There is a disconnect between healthcare stakeholders and patients, exacerbated by opaque economic models and profit-driven incentives. The disparity between high and low-income nations in accessing quality healthcare is also a major issue that needs to be solved. A shift towards a prevention-oriented healthcare system, leveraging technological advancements and interdisciplinary collaboration, should be an additional focus of innovation generation. Sustainable business models aligned with societal well-being and environmental preservation will likely develop initially in parallel to the existing ones. Future health delivery envisions a future healthcare paradigm centred on affordability, accessibility, and equitable distribution of healthcare services with a global purpose to "KEEP EVERYONE AND THE PLANET HEALTHY".

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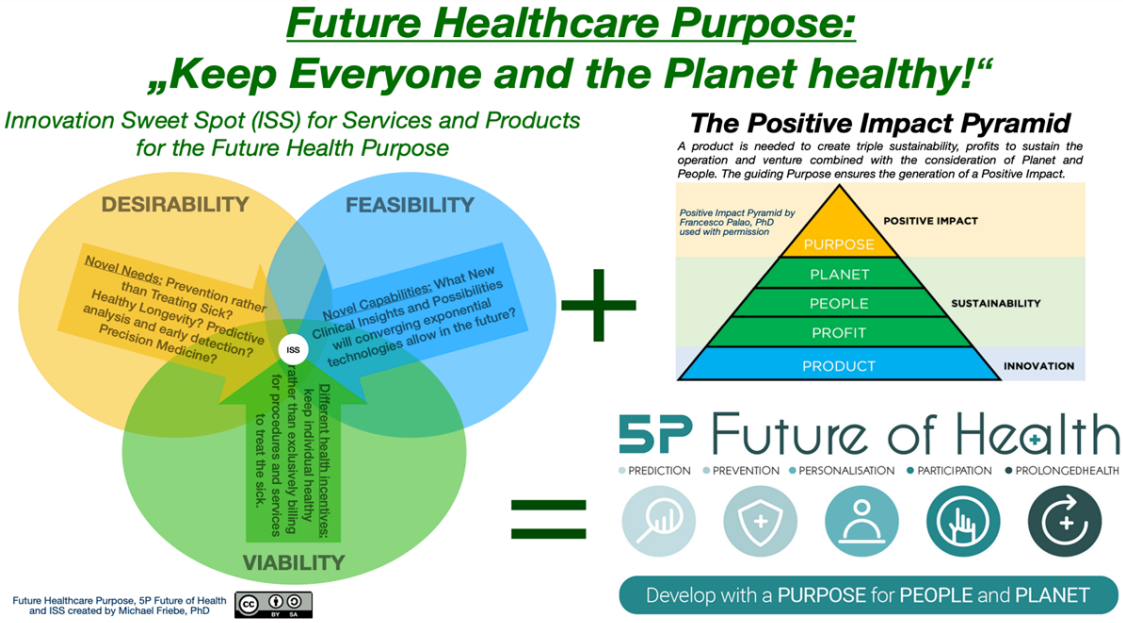
 doi.org/10.32388/8D33M5



Where Are We with Respect to Health Innovation Generation?

The main question for a health innovator was up to now - and likely will remain in the near future - what kind of innovation is needed and what the business model for the product, process, or service will look like.

Will it allow clinical users to reduce time, increase quality at a lower cost? ... or offer a new service that the clinician can bill an insurance company for? The actual patient benefit was very often not a main argument, especially if it did not come with an immediate economic benefit. The main innovation goal was to create better medicine based on the existing approaches, something we refer to as incremental innovation. This is relatively risk-free, as the market is known, the dynamics are predictable, and the main stakeholders need it to differentiate themselves from the competition.

... today's healthcare system is sickcare. Antiquated and expensive, it supports a massive and bloated bureaucratic system that will ultimately crumble under its own weight. There is no way that "traditional medicine" survives the coming AI revolution.

Peter Diamandis (12/2023)

doi.org/10.32388/8D33M5

If you ask a radiologist what kind of innovation is needed in the future, the answer will likely be "better radiology", and here the definition of "better" is not clear. It could be that the image quality needs to be better and the system faster so that many more patients can be examined every day. Does the radiologist mean it should get significantly cheaper so that many more could afford and use such systems? Likely not, as that would also allow non-radiologists to get these systems. You get one of the issues of the dilemma? [1][2][3]

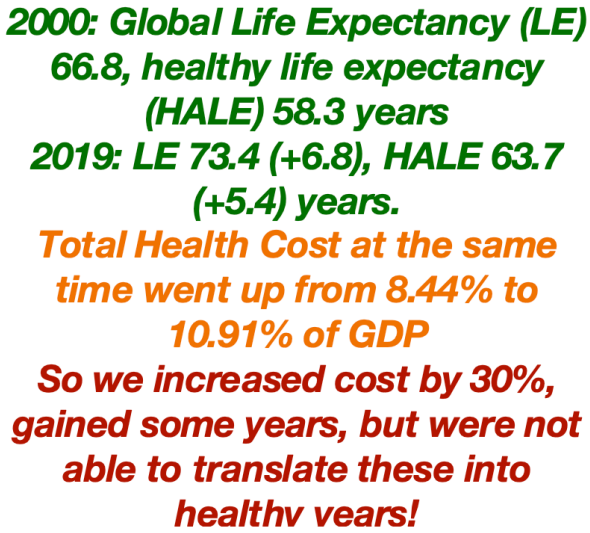
You clearly know the answer to what a urologist or gynaecologist would like to have as innovation and the answer.

And a hospital? They would wish for innovations in optimising the clinical workflow, tools, and devices that would reduce their operational expenses and administrative burden or allow them to differentiate themselves from other hospitals.

And if you ask the patient ... what does the patient want?

Answer: Not to get sick and not to have to go to any of these specialists or a hospital! But we are currently not innovating for the patient; we are innovating for the system! This is another part of the innovation dilemma: we are making things incrementally better in a system that is focused on the sick individual, rather than ensuring that this individual does not get sick or catching a disease development early to reduce the negative effects of treatment. For the first part, there is an established economic model; the second part is still not developed, embraced, and incentivised.

The current healthcare delivery system, however, was quite effective in the last decades. Child and neonatal mortality is significantly down and continues to go down, with the main problem remaining in Africa and South-East Asia. Infectious diseases - thanks to education activities and dedicated medications - are globally at a low point, as are deaths related to violence, road injuries, and suicide (except for the suicide and homicide numbers in the US). And we made significant progress in the



age-related prevalence of hypertension and diseases attributable to substance abuse. Global life expectancy (LE) reached 73.3 years in 2019, up from 31 in 1900 and 49 in 1950, respectively (see Figure 1). [4]

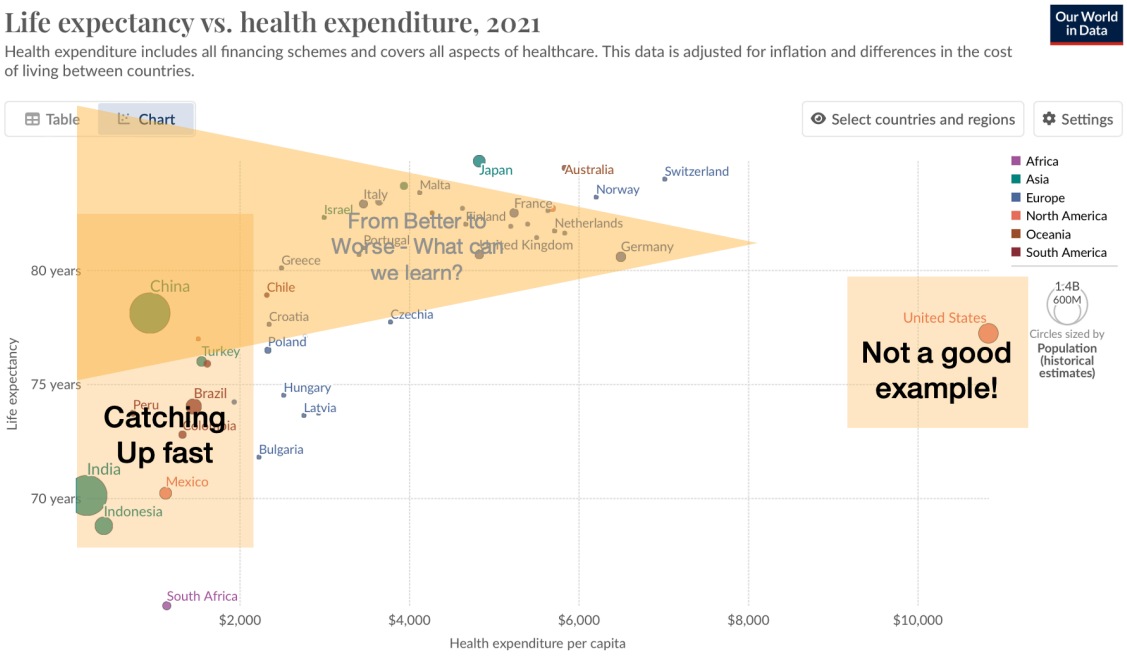


Figure 1. *Simply increasing healthcare spending may not always and continuously lead to significant improvements in life expectancy, as the effectiveness of healthcare systems and the allocation of resources plays crucial roles. Also, lifestyle choices, socioeconomic aspects of the individual, and environmental aspects are very relevant to increasing life expectancy. The negative example of the US shows that by far the highest spending comes with a relatively low number for life expectancy. We should carefully analyse, however, what the countries on the left side of the arrow are doing better than those towards the point on the right, and the actions and initiatives of countries like China that are catching up fast at a much lower per capita health cost than the high-income nations from Europe, Japan, Australia, and the Americas. [UN, World Population Prospects (2022); OECD Health Expenditure and Financing Database (2023) – OurWorldInData.org/financing-healthcare | CC BY]* [4]

What are the negative developments? While we have increased LE, we were not able to equally increase the healthy years or health-adjusted life expectancy (HALE). HALE is a comprehensive indicator because it introduces the concept of quality of life. It is interpreted as the number of years in full health that an individual can expect to live given the current morbidity and mortality conditions.

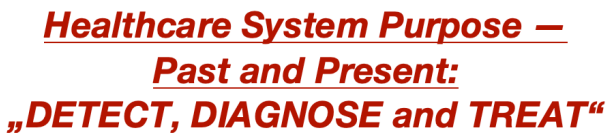
While our LE increased over the last 20 years by almost 7 years, the HALE just increased by 5.4 years. In other words, we are living longer, but the time in sickness also increased.

What else? Obesity prevalence is significantly up in all geographical areas, which will likely cause significant problems down the line. Non-communicable diseases are up (partly due to the increased LE, but to a large extent due to environmental conditions, personal behaviour, and socioeconomic effects), and the cost of health care has increased significantly faster than the gross domestic product (GDP), making it unaffordable for a large number of global citizens.

While we know that health is to a large part dependent on the environment a person lives in, the financial resources that are available, quality of nutrition, exercise or lack thereof, and drug abuse, we are spending around 9.2% of our GDP in the OECD world on the diagnosis and treatment of illnesses (in the US, it reached 17.3%) and very little on solving the other health factors listed. [5][6]

We have developed a healthcare delivery system over the last 70 years that has become effective at treating the sick, but that has also cannot solve the issues of demographic change-related aging issues in the current setup. [7][8][9][10][11][12][13]

Consider Current and Future Health Challenges



In the last decades, we saw many innovations in the healthcare space and in health delivery. The purpose of the system was - and to a large extent still is - something like "DETECT, DIAGNOSE, and TREAT" with the associated value propositions of improving the RESOLUTION, ACCURACY, SPEED, and EFFICACY of devices and services used or performed by healthcare professionals in case of health problems.

There is nothing wrong with trying to improve existing processes, but in the case of healthcare, the economics, and with that, innovation generation incentives, are different than in most other economies that are governed by the free market model of SUPPLY and DEMAND, where the buyer is actually evaluating the value of a service or product, agrees on a transaction, and subsequently pays the seller.

Why is that?

Mainly because there is an information gap and asymmetry between the health providers (medical doctors, hospitals, ...) and the patients, and as a second reason, because there often is an entity, in the form of an insurance company, in between that makes the process intransparent from an economic perspective and also triggers wrong behaviours with the patient (little motivation to take care of their own health, overutilisation, to just name a few). But it also can lead to inefficiencies, unnecessary expenses, inflated prices for services and procedures that subsequently might lead to decisions profit-oriented rather than benefit the patient. So the PATIENT is actually NOT the CUSTOMER, but the clinical service provider. The incentive to do the best, least invasive, at the lowest cost is not in the interest of a profit-oriented economy. [2][14][15][16]

The main question for a health innovator was up to now - and likely will remain in the near future - what the business model for the product, process, or service will look like. Will it allow clinical users to reduce time, increase quality at a lower cost? ... or offer a new service that the clinician can bill an insurance company for? The actual patient benefit was very often not a main argument.

We are currently NOT innovating for the Patient ... we are innovating for the Health Stakeholders ... and the current business model!

And we are innovating for the high-income nations and are not economically motivated to come up with products that may only do 80 or 90% of what the top systems can do, but at a price point of 10 or 20%. This would allow new markets to develop and also bridge the inequality gap between the high- and low-income nations, but it also comes with unknown and unpredictable business models. When we use an existing technology in a new business model, it is called DISRUPTIVE INNOVATION, and if we focus in that disruptive segment on reducing the cost significantly, it is called FRUGAL INNOVATION. Do we actually want these innovations as stakeholders or a medical technology company? Rather not, as this dramatically changes market conditions, creates new and unpredictable markets and business models.

Investing in prevention, for example, may have a huge effect on future healthcare costs, but it does not come with a business model at the moment. Only 3% of the total healthcare expenditure goes into preventive measures. But a clinician is not incentivised to keep you healthy at the moment, or a hospital to not perform a procedure and be happy that no one needs invasive surgeries.

But is it really true that just because it has no business model at the moment, it is not worth investing in? If people (you, me, everyone else) want it, then a business model will develop. And staying healthy is certainly in the interest of every one of us.

What is clear is that we are currently not innovating for the future patient, for all of us; we are innovating for the Health Stakeholders and for the current business model of health that comes into effect when you are sick.

And this unfortunately only describes the majority of the health care systems in the high-income nations. It looks different in the low-income areas, where good health and access to specialists is scarce, limited to a few urban areas, and excessively expensive for a large part of the population. People living in poor countries not only face lower life expectancies than those in richer countries but also live a higher proportion of their lives in poor health.

Globally, there are many more challenges that we need to deal with in the coming years, combining the issues of all geographies: *delivery inefficiencies, unequal access, and varying delivery qualities depending on where you live, healthcare provision is too expensive for many and is getting more and more expensive, increased life expectancy and with that a demographic change towards a much older population, no focus on prevention and early detection, no current focus on living healthy.* [16][17]

Towards a Transformation to a New Purpose for the Future of Health?

What we have presented and discussed may not happen immediately, but it is clear that a currently missing business model and wrong incentives, combined with an unwillingness of the stakeholders to change, will only delay the needed transformation towards a more prevention-oriented real health system.

Future Healthcare Innovation: focus on the wellbeing and the needs of the individual and not on the profit that can be made with them. Exclusively dealing with sickness in healthcare needs to stop! Adding healthy years for everyone and maintaining the planetary health should be the goal!
Michael Friebe, 2024

When that ultimately will happen is obviously unclear, but technological development and new medicine will open up opportunities that will lead to market disruptions. Maybe

it's a good idea to prepare for that as a company in that space, or to invest - as a government, as a forward-looking investor - in disruptive ideas that are addressing the health challenges and issues of the future with a different approach than just by trying to improve the current setup.

The reasons for considering that are pretty obvious:

a. Health transformation is wanted by pretty much everyone (if you empathise as a potential PATIENT!),
b. a current rigid business model is in place that is controlled by several stakeholders that have little interest in transformation,
c. the current setup in high-income nations comes with continuously increasing costs (over the BIP increase) coupled with decreasing results, leading to unequal access,
d. the actual individual as customer is to a large extent not in charge of the decision making with respect to their own treatments and health dealings,
e. the convergence of exponential technologies promises novel health insights and approaches at significantly lower prices, and with that, more equal access,
f. health provision is not very effective - so far - at increasing health for an increased longevity ... or in other words, the life expectancy is longer now, but the time of sickness in older age is also longer

And as additional actions to prepare for and actively work towards such a transformation [16][18],

g. we should not only increase life expectancy but also our healthy lifespan, which can be achieved by earlier and better diagnosis, of course, by better therapies, but to a large extent by a personalized focus on prevention.
h. Embrace Entrepreneurship and Innovation Generation with a future perspective on exponential technologies and what these could do! Include teaching these in Biomedical Engineering, Health Economics, and Medical curricula together with 21st-century soft skills (teamwork, empathy, problem analysis and creating solutions, storytelling and future orientation, and many more typically not taught at universities).
i. Embrace interdisciplinary innovation generation between Science, Engineering, Economics, and Clinical disciplines towards novel approaches for maintaining and improving health rather than exclusively focusing on better medicine for the sick.

j. Address the big challenges that are health related: keep the planet liveable, reduce or eliminate inequalities, and allow everyone access to health services (democratise), increase the healthy years, and use exponential technologies to come up with new medicine!

Future Healthcare Purpose and What Might the Future of Health Look Like

Yes, profits are necessary to stimulate the creation of new devices / concepts and to engage in novel and uncertain activities, but they should not be the only and most important aspects.

The 5P purpose pyramid, bottom up, gives the direction to develop a PRODUCT that creates a PROFIT for sustainable operation, serving the PEOPLE, saving the PLANET, guided by the PURPOSE.

In the case of Future Health Innovations, this purpose could be "KEEP EVERYONE AND THE PLANET HEALTHY", while the mission to achieve that is based on an equation that takes the following parameters into account (see Figure 2):

Future Healthcare Purpose:
„Keep Everyone and the Planet

doi.org/10.32388/8D33M5

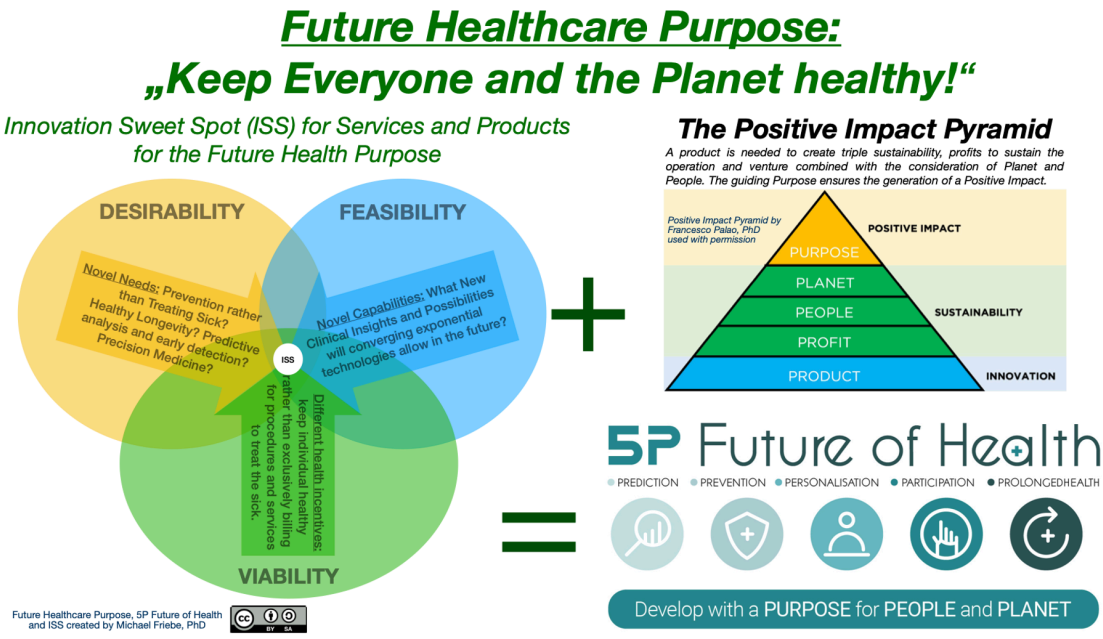


Figure 2. *The Purpose of Future Healthcare Delivery should be changed from the current "DETECT, DIAGNOSE AND TREAT" to "KEEP EVERYONE AND THE PLANET HEALTHY". For Innovation Generation towards that purpose, we need to find the Innovation Sweet Spot (ISS) in the intersection between DESIRABILITY, FEASIBILITY, and VIABILITY … and all of these will change due to technological advances, changed value propositions and desires by the health users, and will also develop new business models, likely initially in parallel with the current ones. The future focus of our development should follow the POSITIVE IMPACT PYRAMID (credit Francisco Palao [19]), with the commitment to create a better world for Earth and all her creatures (SYNTROPIC WORLD [20]) leading to the 5P FUTURE OF HEALTH CONCEPT (credit Michael Friebe). The image is copyright Michael Friebe, licensed with CC BY-SA.*

Find the innovation sweetspot of DESIRABILITY (is it wanted?) / FEASIBILITY (can it be created?) / VIABILITY (is there a sustainable business model?), but consider for the DESIRABILITY the Health Needs of the Future that come from novel medical insights through converging exponential Technologies (FEASIBILITY), and for the VIABILITY the framework of triple Sustainability [19], Syntropic Principles [20] and Global Health Democratisation.

We will, of course, still need clinical experts to help detect, diagnose, and treat sick people, assist the injured, and ensure that a patient will get the best treatment possible. For that, we need to continuously improve the existing systems and processes, improve the health experience for the patient as well as for the clinical staff, and we also need to have a stronger focus on the value

proposition of affordability. Only affordable products and services will help to eliminate health inequalities and lack of access.

Technologies will also help to overcome the lack of clinical experts and provide sensor- and machine learning-created inexpensive expert opinions to those who have no or only restricted access to it at the moment. There will be many discussions in the following years about loss of content and economic control for some, ethical issues and data protection, trust, and confidence.

But that has happened every time disruptive technologies have emerged and threatened to change the existing models!

This paper is not meant to tell what healthcare and innovation in that space will be, but what they should be based on the most important stakeholder and actual user, the individual - you, me, everyone. And it is intended to shift the focus from creating profits to creating impact by rethinking the current approach and the current value propositions.

Key Learning Points

1. *Primary Focus of Health Innovation currently is on Economic Benefit: Historically, health innovation has prioritised economic gain over direct patient benefits, leading to a lack of emphasis on improving patient outcomes, and*
2. *Prevailing health innovation efforts have mainly focused on incremental improvements rather than disruptive changes, resulting in relatively safe yet limited progress.*
3. *There is a Patient-Centric Innovation Gap: Current innovation efforts primarily target system improvements rather than focusing on preventing illness or enhancing overall patient well-being.*
4. *Healthcare Achievements and Challenges: Despite significant advancements in healthcare, challenges like increasing life expectancy without improving healthy years, rising obesity rates, and escalating healthcare costs persist.*
5. *Misaligned Incentives: The current healthcare system's profit-oriented structure often leads to inefficiencies, inflated prices, and decisions that prioritise financial gain over patient well-being.*
6. *Innovation Disparities: High-income nations primarily drive healthcare innovation, neglecting the needs of low-income regions where access to quality healthcare is limited.*
7. *Need for Prevention Focus: Investing in prevention is crucial for reducing future healthcare costs and improving overall well-being, despite the lack of immediate business models incentivising such*

initiatives.

8. *Interdisciplinary Collaboration: Encouraging collaboration across scientific, engineering, economic, and clinical disciplines is essential for developing holistic approaches to healthcare innovation.*
9. *Future Health Vision: The future of healthcare should prioritise sustainability, equity, and affordability while leveraging exponential technologies to address global health challenges and democratise access to quality care.*
10. *Education: Interdisciplinary and challenge-based health entrepreneurship education should be introduced to create new product and service innovations not only for better, but also for new medicine and health offerings outside the professional setting.*
11. *Business Model Prevention and 5P: While it is unlikely that the current business model health will change quickly, a parallel business model focusing on prevention and healthy longevity will develop … because we (everyone) want that!*

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Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.