We Need RI and Not Just AI! Thoughts on the Implementation of Artificial Intelligence in Medicine and Spine Surgery Specifically

"AI will not replace people, but people who use AI will replace people who don't". Nati Amsterdam.[1]

Of all of the new developments in Spine surgery, such as (so called) minimally invasive spine surgery, navigation +/− robotics, stem cell therapies and virtual/augmented reality, to name a few current examples, the single most profound game changer is the rapid and - as of yet - highly unpredictable influx of 'Artificial Intelligence' (AI) into our field. As we have evolved into an increasingly digitized world, applications of AI have become an everyday reality in our lives. In fact, we frequently don't even realize that we are personally using AI based technologies in every aspect of our daily chores. For instance, there is literally no cell phone interaction, search tool use or advanced car operation that doesn't use highly integrated AI based applications and most of our physical movements within cities and across public spaces are now tracked in a number of ways.

We realize that we have published several editorials in the more recent past about the topic of AI in the recent past[2-5] from a number of perspectives. In recognition of the mounting number of AI related studies we at GSJ have also created a special collection for AI with 16 articles posted as of June 11, 2024.[6] In light of the intensifying momentum of AI we thought it to be relevant to reexplore some of the ramifications its impact into Health Care in general and Spine Surgery more specifically in greater detail in a question/answer format within this editorial.

Everybody Talks About It – But Nobody Really can Define what It is

One of the most compelling aspects of AI domain is the accelerating rapidity of its evolution. Where we were used to a linear progression of data technology capabilities following Moore's law, we are now witnessing a logarithmic rise of the AI field.[7] Before we delve into the AI field further it stands to reason to reflect on human intelligence (HI) as a foundational matter. Interestingly humankind has never really settled on a universally accepted definition of 'intelligence'. This matters as we are now thrust into an 'Artificial Intelligence' era without ever having come to grips with what HI actually is.[8]

As we now have officially entered the Sci Fi future that writers dreamed of since the beginning of the last century, do we actually have a useful operational AI definition? '*Tesler's Theorem*', named after the late American computer scientist Larry Tesler, is quoted that **'AI is whatever hasn't been done yet'**.[9] While this is a helpfully vague thought model that potentially future-proofs its core concept against the unpredictability of further evolutions, it is also not specific enough to provide actual guidance in understanding the genuine revolution we are witnessing.

A more recent conceptual approach differentiates ANI (Artificial narrow intelligence), which is a highly task specific application of AI with narrowly defined boundaries from AGI (Artificial Generative Intelligence) which is a human like iteration of computing power empowered with creative potential that is theoretically capable of ethical adjudications. On the horizon looms the next giant step towards ASI (Artificial Super Intelligence) – a creative computing entity that is clearly superior to human intelligence.[10] That said – the actual foundation of AI remains vague and has evolved from simple task oriented controllable capabilities into something much more profound - promising to some, while threatening to others.

We Have No Idea when and where We are Heading with AI

The reality of AI has arrived to the point where we are witnessing the discovery of a new 'super power' that has been recognized by corporations and nations around the world as an critical path towards attaining global dominance in their fields. Computing powers are being aggregated on an unprecedented scale accompanied by increasingly substantial demands on energy grids to fuel the tsunami like surge of processing proficiency needed to attain access into the higher echelons of AI. In his essay titled '*Situational Awareness – The Decade Ahead*' Leopold Aschenbrenner makes the point that the jump from Chat GPT -2 (2019), which he put at PreSchooler level, to Chat GPT -4 (2023) which he rated as smart High Schooler level was a nonlinear quantum leap in processing power that was not anticipated by anyone.[11] Using OoM calculations (Orders of Magnitude) he concluded that we will have arrived

at the Super Intelligence level of Computer Science Engineers by 2027 and that we will actually run out of comparative human reference points to measure the performance of such computing systems. A logarithmic 'Intelligence explosion', as predicted by Leopold Aschenbrenner and his colleagues is not a question anymore but is destined to become a reality.

ASI – Threat or Hope?

Not since the discovery of fire, railways or nuclear power has mankind seen such a decisive technology change, and 1 that could be even more far reaching than either of the others. The fundamental question of ASI will be if it will serve mankind or if mankind is destined to serve an abstract autonomous digital master entity. Already we are seeing nations seeking to apply ANI towards increased control of its citizenry and AGI is being used on a larger scale as method to attain political power over rivals. Fear of AI is being stoked by those who want humans to stay away and preferably ignorant of this new form of superpower, thereby surrendering the field to those who continue to be actively engaged. It stands to reason to explore the ulterior motives of those who call for regulations of AI and paint fearsome pictures of an ASI governed future. On the positive side, AI may hold a key towards a more prosperous and safe future for all of us by combining human intelligence into a collective and cumulative greater good, as predicted by Matt Ridley in his 2010 book '*The Rational Optimist. How prosperity evolves'*. He predicted that liberty and welfare would '*march hand in hand with prosperity and trade'* thus benefiting all participants.[12] If seen through the lens of an ASI future, the collective human brain fueled by the creativity of similar minded optimists merged into an ASI sphere has a real chance to create a better future for all of mankind.

Either way, AI has become a reality and 1 that will continue to evolve.

What Does This Mean for Us in Health Care?

If 1 summates the insights from above, we really have no idea where we are heading in terms of digital technologies and their potential applications in Medicine and what the ASI future can or will look like for health care. Of all general industrial sectors healthcare currently is estimated to occupy 30% of the world's data volume and is estimated to create the greatest increase in data storage and processing needs with an annual growth rate of 36% and while expanding his comes at a significant additional previously unreimbursed cost to health care and is growing faster than other industries including manufacturing, financial services, media and entertainment.[13] The per patient price tag for each patient's clinical electronic medical record per year has been estimated at 700Euros in 2023, which probably is a significant understatement.[13] With rising health care costs it is a given to anticipate that increasing efforts will have to be steered towards enhancing data security, improving data integrity while increasing standardization efforts in language terms and scaling

efforts to augment normative efforts. Increasingly, Large Language Models (LLM's) will allow for unprecedented direct information accumulation and data extraction accumulating towards ever larger 'Big Data' bases. In theory, ASI will allow for more real time analytics and solve multivariate problems better than humans can. Rather than looking at how to replace physician decision making as a first order of importance, however, the heavy burden of administrative bureaucracy affecting health care costs in many countries should be reducible in so many ways and lead to more time- and output efficient care management models. A key concept in this matter is that research based data will be increasingly stratified. This will follow accepted general principles of weighting studies based on their level of evidence and lead to living and continuously updated Systematic Review and Meta-analytics capable systems that are going to be used as referencing resources for clinical decision making. The same will apply to cost, clinical outcomes and error assessment data bases. Coalescing these into an increasingly integrated supra-aligned health care resource system is just a matter of time – its end use is not determined as of this writing.

And what Does AI (ANI, AGI, ASI) Mean for Spine Surgery?

'We don't know' is the easy answer. Fascinatingly, increasing computing powers seem to be countered by inversely decreasing relative costs of actual computational costs – as long as ever larger datacenters (organized into data clusters) fueled by ever more energy-intensive power sources come online. Already, larger Spine companies have shifted into leaving the domain of simple hardware and tool based access technologies into using imaging and clinical patient data (and surgeon data!) as their real business model of the future. The irony of duplicating electronic medical records costs for patients and health care systems (who already dearly pay for such systems) by adding a surcharge for access to get to use corporate data clouds for their brand of Spine care has yet to be clearly called out in this evolving scheme. As we look forwards to a future of increasingly relying on navigation and robotic systems an integrated abstraction of typical clinically used advanced images that are sufficient as a basis for more automated systems applications becomes highly desirable. Repeat radiation and cost intensive imaging studies serving the current software shortcomings of many navigation systems are no longer going to be acceptable. For clinical practices large language models have already been put into practice. Such systems can be turned on during patient examinations and record the patient interactions and exam findings while automatically creating a meaningful typed out structured medical record. Such efforts are starting to ease the evermore burdensome clinic documentation needs in a complex field like Spine Surgery and will also provide more meaningful realistic retrievable clinical data. And for us as surgeons the advent of a 'surgical black box' – a flight recorder type technology will put to rest the time honored dictated or typed 'Operative Note'.

On the problem side, surgical decision making may very much become subject to AI review and possibly be relegated to a digital entity. Herein it is highly relevant that the data resources used for data abstraction stem from Pub med listed studies, and whether appropriate or not in a surgical field like ours, the evidence pyramid is likely going to be applied with cruel indistinction. Remember the debates about fusion for lumbar spine disorders like low back pain and degenerative spondylolisthesis? As an example and without going into exhaustive detail here, our specialty has struggled to show real superiority of 360° fusions relative to simple posterior fusions in some major randomized trials. While cages have become almost a standard of care for many of us, an AI entity trained to look at abstract evidence levels would likely not rule in favor of using cages for such fusions.

What can We do as Spine Surgeons?

The imperative is quite clear: be involved. And if you are not yet involved, become involved. Sticking our head in the sand and letting brilliant data geeks or administrators define Spine care will not serve anyone, least our patients or health care systems.

Therefore:
- Learn about AI.
- Use AI.
- Publish about AI.
- Teach others how AI can be most helpful in our practices. And more specifically

- Influence the quality of our literature by educating data systems about what matters and what doesn't matter.
- Align with 1 another by using validated classifications and outcomes scores wherever possible.
- Push for supra-aligned data bases, especially for rare diseases (ie Chordomas) and integrate genomics and imaging data with outcomes and cost data

The blueprint is there: What we really need is not AI or its ANI/AGI/ASI variants – what we really need **RI** – **Real Intelligence** composed of a meaningful interaction of HI and AI. And to achieve that we must be prime operators in this space. Just as Nati Amsterdam said: '*AI will not replace people, but people who use AI will replace people who don't*'.[1]

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References

1. Young E. *The AI Revolution: Is Israel Keeping up? Jerusalem Post*; 2024. Accessed May, 2024.
2. Wiechert K, Wang JC, Chapman JR. Changing the game: spine care in the era of artificial intelligence and deep learning algorithms. *Global Spine J*. 2020;10(2):117.
3. Chapman JR, Wang JC, Wiechert K. Into the brave new world of academic publications: new perspectives and good-bye to business as usual. *Global Spine J*. 2023;13(3):595-598.
4. Chapman JR, Wang JC, Wiechert K. Let's put AI to really good use. *Global Spine J*. 2023;14(1):7-10.
5. Chapman JR, Wang JC, Wiechert K. Let's put AI to really good use! *Global Spine J*. 2024;14(5):7-10. doi:10.1177/219256822341242892
6. *Global Spine Journal Collections*: https://journals.sagepub.com/topic/collections-gsj/gsj-1_artifical_intelligence_novel-technology?journalCode=gsj
7. https://ourworldindata.org/moore-law. Accessed June 2, 2024.
8. Gardner H, Moran S. The science of multiple intelligences theory: a response to Lynn Waterhouse. *Educ Psychol*. 2006; 41(4):227-232. doi:10.1207/s15326985ep4104_2
9. https://en.m.wikipedia.org/wiki/AI_effect. Accessed June 2, 2024.
10. Guiness H: What is artificial intelligence (AGI)? 2023. https://zapier.com/blog/artifical-general-intelligence. Accessed June 2, 2024.
11. Aschenbrenner L, Situational Awareness. The decade Ahead. 2024. https://situational-awareness.ai
12. Ridley M. *The Rational Optimist. How Prosperity Evolves*. Harper; 2010.
13. https://www.lek.com/insights/hea/eu/ei/tapping-new-potential-realising-value-data-healthcare-sector#:~:text=between_2020_and_25