2044: BLOOD INDUSTRY FUTURES

What if the collapse of AI threatened the blood industry tomorrow?

SCENARIO

It is the year 2044. After the revolutionary development of AI technology, almost all industries have embraced an unprecedented wave of automation in their business operations. And the blood industry is no exception: blood collection, analysis and processing are now all automated, needs are predicted and targeted, distribution and monitoring are connected, and data is mined to the extreme. From blood collection centers to blood banks and hospitals, for many of the parties concerned, automation, robotization and algorithmic management have dramatically reduced the need for human intervention.

"TOTAL AI": THE TECH DREAM'S BUBBLE HAS BURST

Unfortunately, the insatiable energy demands of AI, combined with society's inability to prioritize how it uses AI, have disrupted this well-oiled system. Susceptible to fluctuations in energy supply and an increase in cyberattacks, these new automated systems now function only intermittently and even experience prolonged periods of shutdown. We are witnessing what experts call "partial technological collapse."

SUCCESS AND FAILURE OF THE PLAN B ERA

The crisis hit blood center organizations hard, as they had relied heavily on automation without implementing clearly defined manual alternative protocols. Production shut down completely, leaving collected blood unprocessed, stocks unusable and critical distribution delays ensue: the lack of resilience and the loss of certain human skills were costly. However, those who anticipated such scenarios through business continuity planning were able to respond. By reverting to manual solutions and downgraded protocols, such as a paper-based stock management system, they continued to produce and distribute blood, calling to mind lessons learned from past crises, such as the Covid-19 pandemic.

THE ADAPTABLE BLOOD SECTOR DESIGNED TO COPE

Post-crisis, the blood sector has emerged more resilient thanks to increased decentralization and greater autonomy given to local service providers, putting knowledge transfer at the center of their strategy. Systems now combine the advantages of automation alongside manual, human-led management processes, ensuring flexibility in times of disruption. And solution providers have decided to increase transparency of the technology they use, to make machines less opaque and make maintenance and troubleshooting easier.

STRIKING A BALANCE BETWEEN EFFICIENCY AND RESILIENCE

Now, for everyone, modernizing a blood bank or process optimization is no longer just about technology, but also human support. The "total AI" diversion has finally made it possible to overcome tech inertia and restore the human element, thereby putting social value back into blood donation centers, something that had long been in decline. Now more than ever, the industry is questioning the balance to be struck between tech-driven efficiency and human resilience, a crucial issue for its future.

INTERVIEW

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How would a giant failure of AI systems impact blood collection, treatment and distribution?

A. A. AI is the only reasonable way to implement several innovations that are transforming the way we use blood for healthcare towards precision transfusion medicine, such as omics-based tests, including genomics, but also biological factors and exposome associated signature from the donor to the recipient. Handling all of that information manually or semi-automatically is logistically unfeasible. It's either too time-consuming, too expensive, or just beyond human capabilities — we're talking about 120 million units a year around the world and tens of millions of recipients.

That being said, the impact of an AI failure depends on the extent to which this AI is involved in the system. If it is just a tool for central management, or if it's involved at every step, from the donor to the processing, to the blood typing, to the systems, even for the request of the blood at the hospital level. In the latter case, an AI failure would definitely bring us back to the 1950s.

How, then, could we enjoy the benefits of AI whilst making the system more resilient?

A. A. One can think of infrastructures that are AI-based, but more decentralized or offline. That way, two systems would have to be compromised for the whole thing to completely go down. Like for nuclear power plants and electric grids — if you have a decentralized structure, there will always be one up providing services. However, the complexity of blood donation logistics, such as geographical or uneven donor population distributions across regions, makes this hard to achieve.

Logistics could be facilitated by increased access to universal blood. Some experiments suggest the potential to turn any type of blood into the blood group O negative, the universal donor type. The idea is to introduce enzymatic digestion to remove this blood group's antigen from blood cells. The theory, to some extent, has already been demonstrated in the lab and some interesting papers have been released, including a recent one in the Journal of Biological Chemistry. But it hasn't been tested for safety and feasibility at scale, especially in clinical trials, making it a long way from implementation.

A radical alternative to this approach would decrease reliance on altruistic blood donors to supply blood bank inventories. In this view, another promising technology is the generation of ex vivo farmed red blood cells (RBCs), leveraging breakthroughs in stem cell research. It may sound like science-fiction, but it's already happening in the labs — mini blood units have already been transfused in the UK by the Bristol team, led by Ashley Toye, for example.

For now, the technology is still quite expensive, but in the future, large-scale bioreactors could reliably produce pathogen-free RBC units, significantly reducing dependency on traditional blood donations and ensuring a consistent, scalable supply critical during disruptions, bolstering the supply chain of blood donation and reducing the risk posed by an AI failure.

Beyond these innovative solutions, could there also be some logistics improvements to make the system more resilient, in terms of storage, for example?

A. A. Super-cooled storage (around -30° Celsius) offers a very interesting opportunity. It is already widely used, except for plasma, which is in very high demand. Plasma blood cells are currently stored under refrigerated conditions — on average 4° Celsius — like your normal fridge. The reason why we don't go lower than that is because the water in the plasma blood cells crystallizes and that tension hemolyzes their blood cells, breaks them. The water inside their blood cells follows the same trend.

However, if you add specific oils at the interface between the liquid phase and the empty portion of the bag, that shields the crystallization layer. So it preserves their blood cells. This technology is available right now and would allow us to store the blood for much longer. Under experimental conditions, shelf-life has been extended to a hundred days using this method — current shelf-life is 35–42 days in most countries.

So now, you are simplifying the logistics of donation by turning all types of blood into universal donor types, expanding the production with ex vivo farming, increasing the inventory with longer preservation with super cool storage… With all of that, you start to have a system that is more decentralized and resilient to a technical failure or cyberattack that would wreak havoc on AI solutions.

"AI Revolution Shattered by Power Shortages and Cyber Warfare"
The Macronomist

"AI powered Blood Donation: A Revolution Thwarted by Technological Collapse"
The Warden

"Blood Supply in Crisis: NewGen Labs Fail to Deliver on Its Promises"
The Hall Street Journal

"Danish Lab Defies AI Shutdown with 25-Year-Old Continuity Plan"
Vox Vitis

"Rebuilding the Blood Supply: Open Source Technologies Step In as Automation Fades"
TechMunch

"Human Expertise vs. Technology: The Return of Hands-On Skills in the Blood Sector"
ABC News

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