

Commentary

The Future of Longevity Medicine: Repairing the Parts or Preserving the Whole? Holmes' Carriage as a Metaphor for Two Fundamentally Different Models of Aging

Veljko Veljkovic^{1,2}, Miroslav Radman³

1. Biomed Protection (United States), Galveston, United States; 2. BioInovio, Serbia; 3. University of Paris Descartes, France

Modern longevity medicine is increasingly focused on repairing age-associated biological damage through gene therapies, epigenetic reprogramming, regenerative medicine, senolytics, and AI-driven interventions. While these approaches may significantly extend lifespan, they predominantly address aging as a process of fragmented molecular and cellular failure. In this conceptual essay, we propose an alternative perspective based on the distinction between “fragmented aging” and “coherent aging,” illustrated through the metaphor of Holmes' carriage. Fragmented aging describes progressive systemic decline driven by sequential failures of individual biological subsystems requiring continuous technological intervention. In contrast, coherent aging describes a state in which biological systems preserve long-term functional integration and systemic harmony, resulting in delayed morbidity and a compressed terminal decline. The manuscript explores the possibility that the central problem of aging may not solely be the accumulation of biological damage, but also the progressive loss of systemic coherence ^{[1][2][3]} within highly complex adaptive organisms. We argue that contemporary biomedical research has devoted enormous effort to studying mechanisms of damage while comparatively little attention has been directed toward the mechanisms responsible for maintaining long-term organism-level coordination. This perspective suggests that future longevity medicine may require a broader conceptual framework integrating not only repair technologies, but also the physical and biological principles underlying functional coherence, resilience, and long-term systemic stability.

Corresponding author: Veljko Veljkovic, veljko@biomedprotection.com

If we take Holmes' carriage as a model of aging, we can imagine two different scenarios. In the first, the carriage gradually breaks down because individual parts begin to fail. However, thanks to technology and skilled mechanics, those parts are repaired or replaced, allowing the carriage to continue moving until the number of failures eventually exceeds a critical threshold, when one breakdown begins to overtake another and the carriage can no longer function. In the second scenario, we have Holmes' "wonderful carriage" — a carriage that does not suffer from premature local failures, but whose components wear out gradually and relatively uniformly until the very end of its functional life. In the first case, the morbidity period is long, while in the second it is short. Interestingly, the first model of aging appears characteristic of wealthy societies, while the second is more often seen in rural or traditional populations that lack access to advanced medicine and modern anti-aging technologies, yet sometimes achieve equal or even greater lifespan than far wealthier populations.

This metaphor introduces two fundamentally different ways in which biological systems may age. The first model could be called "fragmented aging." The carriage continuously develops failures: (i) wheels, (ii) axles, (iii) springs, and (iv) structural joints. Yet each individual failure is repaired or replaced. The system therefore continues functioning for a very long time, but only through constant intervention. Eventually, however, the number of failures becomes so large that repairs can no longer preserve the integrity of the whole system. One malfunction overtakes another, the system enters a spiral of dysfunction, and the carriage ultimately stops.

This strongly resembles aging in modern wealthy societies. Today people often live for decades with: (i) hypertension, (ii) diabetes, (iii) atherosclerosis, (iv) osteoporosis, (v) neurodegeneration, (vi) cancer, and (vii) chronic inflammatory diseases. The organism is no longer maintained primarily through preservation of integral functionality, but through continuous partial interventions: (i) drugs, (ii) surgeries, (iii) stents, (iv) implants, (v) joint replacements, and (vi) increasingly sophisticated biotechnological therapies. Such approaches undoubtedly extend lifespan, but often at the cost of a prolonged morbidity period — a long phase of progressive functional decline.

The second model could be called "coherent aging" or even "Holmes' wonderful carriage." In this case, the system does not fail through premature fragmentation. Individual components do not collapse early and there is no constant need for repair. Instead, all parts wear down relatively uniformly and synchronously. The carriage remains functional almost until the very end, after which it loses functionality relatively rapidly.

This model resembles what is often observed in traditional rural populations or so-called Blue Zones ^[4]. People may lack sophisticated medical care, expensive therapies, or advanced diagnostics, yet they remain functional for remarkably long periods: (i) they continue working, (ii) walking, (iii) maintaining strength, (iv) preserving mental stability, and (v) maintaining social integration. The morbidity period is relatively short. It is almost as if aging does not occur through a sequence of local catastrophes, but through a slow and coordinated decline in overall systemic coherence ^{[1][2][3]}.

At this point an important question emerges: is the ultimate goal of medicine simply to keep the carriage moving for as long as possible, or to preserve the functional integrity of the carriage itself? Current medical approaches to aging and age-related diseases are strongly influenced by engineering logic. Any complex man-made machine consists of prefabricated parts assembled into a functional system. Nature appears to have chosen a fundamentally different strategy: biological complexity emerges progressively during growth from a single cell into approximately 50 trillion highly coordinated cells forming the human organism. The advantage of this biological strategy may lie precisely in the hierarchical emergence of coherent regulatory interactions as tissues and organs develop together over time, allowing continuous correction and stabilization of developmental processes long before pathological consequences become apparent. The contrast is profound. Reversing these organizational principles would require tiny preassembled hearts, kidneys, brains, and livers to be mechanically integrated into a fetus before birth, while, conversely, a toy airplane placed inside a hangar would somehow “grow” into a jetliner. Such comparisons inevitably raise questions regarding the adequacy of purely engineering-based approaches in medicine and longevity research. The same question emerges in Holmes’ carriage metaphor: how should we conceptualize the molecular machinery responsible for continuously repairing, maintaining, and replacing malfunctioning biological components that are themselves made of the same material and remain fully integrated into the living system being maintained? Modern medicine is extraordinarily successful at repairing individual failures. However, it is far less successful at preserving the global organization of the system. It often extends lifespan without proportionally extending functional lifespan. In contrast, traditional lifestyles may not repair failures efficiently, but they may significantly slow the emergence of systemic incoherence.

This could explain a remarkable paradox: technologically advanced populations do not necessarily achieve the best functional aging profiles. Rural or traditional populations may sometimes achieve similar or even greater lifespan despite having far fewer medical interventions, because their “carriage”

persists through a different principle — not through continuous repair of damaged parts, but through preservation of systemic harmony.

This leads to a profound possibility: perhaps the central problem of aging is not primarily the accumulation of molecular damage, but the progressive loss of coherence between the components of the biological system. In this framework, wealthy societies optimize the repair of failures, while traditional societies may unintentionally optimize the preservation of coherence.

The distinction between fragmented and coherent aging becomes particularly visible during the final stage of life — the period of terminal morbidity. In fragmented aging, the organism enters the terminal phase through a prolonged process of partial systemic collapse. The body does not fail all at once. Instead, one subsystem after another progressively deteriorates: (i) cardiovascular, (ii) metabolic, (iii) neurological, (iv) renal, (v) immune, and (vi) musculoskeletal. This produces the familiar picture of modern morbidity: (i) polypharmacy, (ii) multiple chronic diseases, (iii) repeated hospitalizations, (iv) prolonged dependence on medical support, and (v) gradual loss of autonomy. The organism continues functioning, but increasingly through external “technical maintenance.” Medicine effectively becomes an extension of physiology itself.

In Holmes’ metaphor, the carriage is still moving, but: (i) one wheel has been replaced, (ii) the axle reinforced, (iii) the springs are failing, (iv) the structure vibrates, and (v) constant servicing is required. The terminal phase may therefore last for many years.

In coherent aging, terminal morbidity appears very differently. The organism preserves: (i) functional integration, (ii) physical autonomy, and (iii) relatively stable physiology for a long time. But when the critical boundary of systemic coherence ^{[1][2][3]} is finally approached, the collapse of the entire organization occurs relatively rapidly. In other words, the organism does not spend decades in a state of fragmented dysfunction. It remains functional for a long time and then relatively quickly loses the capacity to maintain global coordination. This is often described by the simple sentence: “He was fine almost until the very end.”

In this model: (i) the morbidity period is short, (ii) the dependence period is short, and (iii) systemic decompensation occurs later but progresses faster. This pattern strongly resembles the concept of “compression of morbidity ^[5]” proposed decades ago by James Fries, but here it acquires a much deeper physiological interpretation.

In fragmented aging, medicine extends life despite growing systemic incoherence. In coherent aging, the organism delays the emergence of incoherence itself. That may be the essential difference, because the ultimate problem is not simply how long the system exists, but how long it can function as an integrated whole.

Two individuals may therefore both live to the age of 90, yet experience completely different biological narratives. One may spend the final twenty years of life in progressive morbidity, while the other may remain functional until the age of 87 or 88 and then enter terminal decline relatively quickly. The first model maximizes duration of existence, while the second maximizes duration of functional organization.

Perhaps this is why the future of longevity medicine should not be defined only by the question: “How long can we keep the carriage moving?”, but also by another: “How long can we preserve the harmony of the carriage before systemic collapse begins?”

If a billionaire were investing in anti-aging exclusively from personal interest — not for market value, publicity, or short-term return on investment — he would probably have to ask himself a very simple question: “In what condition do I want to spend the final 10-20 years of my life?” And here the difference between these two paradigms becomes profound.

The fragmented aging model appears technologically spectacular: (i) gene therapies, (ii) epigenetic reprogramming, (iii) AI-designed interventions, (iv) organ regeneration, and (v) nanomedicine. Such approaches are extremely attractive because they appear futuristic, promise “victory over aging,” and psychologically provide a sense of control over death itself. Yet the implicit risk is clear: it may become possible to prolong the duration of the system without preserving its integrated functionality. In other words, we may extend lifespan without proportionally extending functional lifespan.

A rational individual observing his own future might eventually conclude that the most important question is not: “How long can I remain alive?”, but rather: “How long can I remain physically, mentally, and functionally whole?” From that perspective, coherent aging becomes extremely interesting.

It does not promise: (i) infinite rejuvenation, (ii) biological reset, or (iii) technological “escape velocity.” But it may promise something biologically more realistic: (i) a long period of preserved functionality, (ii) a short terminal phase, (iii) preservation of autonomy, and (iv) a more stable quality of life.

Paradoxically, from a purely personal perspective, a wealthy individual might ultimately prefer to be able to walk, think, and function normally at the age of 90 rather than remain technologically sustained

within a complex medical infrastructure at the age of 105. Fragmented aging therefore resembles a “war against death,” while coherent aging resembles an “optimization of biological quality.” Perhaps that is the true psychological divide between the two paradigms.

Most of today’s longevity industry is implicitly driven by the desire to: (i) defeat death, (ii) postpone it indefinitely, or (iii) technologically neutralize it. But relatively few approaches seriously ask what it actually means to age well as an integrated organism.

A rational long-term strategy might therefore combine both approaches: (i) using repair technologies when truly necessary, while (ii) placing the primary focus on preserving long-term systemic coherence ^[1]_{[2][3]}. Yet even this compromise may prove difficult, because nature itself may not tolerate such compromises easily.

Many biological systems do not function through compromise, but through dominant organizational logic. When two fundamentally different organizational principles are forced together, stability is often lost.

Coherent aging implies that the organism maintains: (i) stable regulation, (ii) synchronized adaptations, and (iii) physiological harmony over decades. In contrast, fragmented anti-aging interventions frequently introduce strong external manipulations: (i) partial resets, (ii) forced regeneration, and (iii) artificial stimulation of specific systems. Such interventions may ultimately disrupt the very long-term stability we are attempting to preserve.

If the organism has spent decades establishing a particular dynamic equilibrium, aggressive interventions may repair one subsystem in the short term while increasing global incoherence in the long term. This resembles old complex machines: (i) one may insert an ultramodern component, but (ii) if it is not perfectly synchronized with the rest of the structure, (iii) it may alter force distributions and destabilize the entire system. In biology this problem may be even more severe, because the organism is not a modular machine but a deeply integrated adaptive network.

Nature therefore may favor: (i) slower, (ii) more coordinated, and (iii) energetically stable processes, even when they do not maximize short-term performance. This can be observed everywhere: (i) chronic hyperactivation leads to exhaustion, (ii) excessive regeneration increases cancer risk, (iii) extreme growth destabilizes metabolism, and (iv) overstimulation of one subsystem burdens others.

Perhaps organisms do not age because nature “does not know” how to repair them, but because the long-term stability of highly complex systems is only possible within a limited range of organization and

energetics. Aggressive anti-aging technologies may therefore attempt to push biological systems beyond the natural range within which stable coherence can exist.

This does not mean such approaches are useless. Many will likely prove highly successful for: (i) individual diseases, (ii) tissue regeneration, and (iii) extension of lifespan itself. But they may not automatically solve the deeper problem: how to preserve the long-term harmonious organization of the organism as a whole.

And this is precisely where Holmes' carriage becomes such a powerful metaphor: nature preserves the carriage through global coordination, while humans increasingly attempt to outsmart it through partial interventions. The central question may therefore become: At what point does the number of interventions begin to alter the very logic of the system we are trying to save?

Perhaps the most important conclusion emerging from this discussion is that modern science has devoted enormous effort to studying the mechanisms of biological damage, while paying comparatively little attention to the mechanisms responsible for maintaining long-term systemic coherence ^{[1][2][3]}. Contemporary biomedicine has become extraordinarily successful at identifying failures: mutations, oxidative damage, inflammation, protein aggregation, mitochondrial dysfunction, cellular senescence ^[6], epigenetic drift, and countless molecular abnormalities associated with aging. However, far less attention has been directed toward understanding the processes that allow billions of molecular and cellular events to remain functionally coordinated over decades despite constant thermodynamic pressure toward disorder.

The ultimate purpose of such research would not be merely philosophical. Understanding the mechanisms responsible for maintaining systemic coherence ^{[1][2][3]} could eventually make it possible to slow the very processes that drive progressive functional wear within the organism. In the metaphor of Holmes' carriage, the goal would not simply be to repair damaged parts more efficiently, but to understand how to reduce the rate at which the parts themselves lose functional integrity over time. If the biological system could preserve coherence longer, individual components might deteriorate more slowly, more synchronously, and with less destructive fragmentation. In that case, the carriage itself could remain functional for a significantly longer period while simultaneously preserving a higher quality of functional life.

If systemic coherence ^{[1][2][3]} indeed represents a central determinant of healthy aging, future research will need to address not only its biological foundations, but also the possibility of its practical monitoring

and modulation.

References

1. [a](#), [b](#), [c](#), [d](#), [e](#), [f](#) [g](#) Fedichev PO (2024). "Longevity and Aging as a Systemic Process." *Front Aging*. 5:13245.
2. [a](#), [b](#), [c](#), [d](#), [e](#), [f](#) [g](#) Barabási AL (2016). *Network Science*. Cambridge: Cambridge University Press.
3. [a](#), [b](#), [c](#), [d](#), [e](#), [f](#) [g](#) Alon U (2006). *An Introduction to Systems Biology*. Chapman & Hall.
4. [a](#) Buettner D (2008). *The Blue Zones*. National Geographic.
5. [a](#) Fries JF (1980). "Aging, Natural Death, and the Compression of Morbidity." *N Engl J Med*. 303:130–135.
6. [a](#) López-Otín C et al. (2023). "Hallmarks of Aging: An Expanding Universe." *Cell*. 186:243–278.

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