

# The Immortality Update: Deep Research on the Most Important Discoveries and News in Longevity Sciences from the Past 7 Days

## 1. Introduction: The Age of Precision in Healthspan Science

This report analyzes pivotal developments in longevity science from the week of September 18-24, 2025. The central theme emerging from this period's research and announcements is the field's definitive shift from broad-spectrum, generalized anti-aging strategies toward a new paradigm of *precision healthspan science*. The focus of the global research community is increasingly on interventions that enhance functional capacity, physiological resilience, and quality of life, rather than merely extending chronological age.

This period was marked by a convergence of foundational science, clinical consensus-building, and crucial ecosystem development. Key events that define this trend include a landmark study identifying functionally distinct subtypes of senescent cells, which has profound implications for the development of targeted senotherapeutics. Concurrently, a global expert consensus statement was published, clarifying the clinical status of NAD+ metabolism and calling for a higher standard of evidence. New clinical research has also emerged, highlighting profound sex-specific differences in the mechanisms of functional aging, thereby challenging monolithic approaches to intervention. Finally, this week saw the launch of critical initiatives aimed at solving non-biological bottlenecks in the field, including novel platforms for continuous biomarker data acquisition and a systematic, technology-driven effort to measure and improve public acceptance of longevity science.

This analysis will deconstruct these developments across three core vectors that illustrate the maturation of the field:

1. **Biological Precision:** The move toward targeting specific cellular states and acknowledging fundamental physiological differences between sexes as a primary

variable in research and therapeutic design.

2. **Translational Rigor:** The evolution of the field from a reliance on preclinical data and speculative claims to a structured, evidence-based approach to clinical validation and consensus-building.
3. **Ecosystem Integration:** The recognition that scientific discovery must be supported by a robust socio-technological infrastructure—encompassing data platforms, public engagement strategies, and industry-academia collaboration—to achieve real-world clinical and public health impact.

## 2. Key Findings: New Interventions and Foundational Discoveries

The past week's developments span from fundamental cellular biology to large-scale clinical observation and strategic industry announcements. The following table provides a high-level summary of the most significant items, which are analyzed in detail in the subsequent sections.

**Table 1: Summary of Key Research Findings and Announcements (Week of September 18-24, 2025)**

Finding/Announcement	Source(s)	Domain	Key Insight	Implication for Functional Life Extension
Identification of Functionally Distinct Senescent Cell Subtypes	Neri et al., <i>Aging-US</i> <sup>1</sup>	Cellular Senescence / Senotherapeutics	G2-arrested senescent cells are more pro-inflammatory and more sensitive to the senolytic ABT263 than G1-arrested cells.	Enables development of precision senolytics targeting the most harmful cell subtypes, potentially increasing efficacy and safety.
Expert	<i>Nature Aging</i>	Metabolic	While	Establishes a

<p>Consensus on Clinical State of NAD+ Augmentation</p>	<p>Expert Opinion <sup>2</sup></p>	<p>Regulation / Clinical Trials</p>	<p>promising, current human data on NAD+ precursors (NR, NMN) is preliminary; larger, longer-term trials are needed to validate efficacy and safety.</p>	<p>standard of evidence for the field, steering it from a supplement market toward pharmaceutical-grade validation for metabolic interventions.</p>
<p>Discovery of Sex-Specific Differences in Functional Aging</p>	<p>Sestu et al. &amp; Li et al., <i>Frontiers in Aging</i> <sup>3</sup></p>	<p>Cardiovascular &amp; Cognitive Aging / Biomarkers</p>	<p>The protective effects of physical activity on arterial stiffness are pronounced in men but not women; the link between cognition and activity patterns is stronger in women.</p>	<p>Mandates a shift to sex-specific research and interventions for maintaining cardiovascular and cognitive function, invalidating "one-size-fits-all" approaches.</p>
<p>Launch of a Public Trust &amp; Sentiment Analysis Platform</p>	<p>Lifespan Research Institute <sup>4</sup></p>	<p>Public Policy / Health Technology</p>	<p>A new initiative, the Public Longevity Group, will use data-driven tools to measure, track, and improve public acceptance of</p>	<p>Addresses a critical non-biological barrier to adoption, aiming to de-risk investment and accelerate the path from lab to public</p>

			longevity science.	use by quantifying social acceptance.
Advancement of Non-Invasive Biomarker Monitoring Technology	Truelli Press Release <sup>6</sup>	Health Technology / Diagnostics	A smart menstrual pad is in development to analyze key health biomarkers from menstrual blood, providing continuous, longitudinal data for women.	Creates a novel platform for passive, large-scale data collection on female healthspan, enabling personalized interventions and accelerating research on female aging.

## 2.1 Precision Senolytics: A Landmark Study Reveals Functional Heterogeneity in Senescent Cells

A study by Neri, Zheng, and a multi-institutional team, reported in the journal *Aging-US* and disseminated via press releases on September 23, 2025, provides the first clear evidence of functionally distinct subpopulations within a seemingly uniform population of senescent cells.<sup>1</sup> Using high-content imaging and quantitative analysis of thousands of primary human endothelial and fibroblast cells, the researchers demonstrated that senescent cells arrested in the G2 phase of the cell cycle are fundamentally different from those arrested in the G1 phase.<sup>9</sup>

The investigation revealed two critical distinctions. First, G2-arrested cells exhibit a more aggressive pro-inflammatory phenotype, secreting significantly higher levels of interleukin-6 (IL-6), a key cytokine component of the damaging Senescence-Associated Secretory Phenotype (SASP).<sup>1</sup> Second, these G2-arrested cells are markedly more sensitive to clearance by the senolytic drug ABT263 (Navitoclax).<sup>10</sup> This finding provides a potential mechanistic explanation for the inconsistent and often modest results observed in human senolytic trials

to date. It suggests that first-generation, broad-spectrum senolytics may be inefficiently clearing the full range of senescent cells or, more critically, may fail to effectively target the most pathogenic subtypes that drive chronic inflammation and tissue degradation. This research fundamentally shifts the paradigm from viewing cellular senescence as a monolithic state to understanding it as a heterogeneous collection of cell states with varying contributions to age-related decline.

The timing and context of this discovery are highly significant, as it was announced during the week of the 10th Annual International Cell Senescence Association (ICSA) Conference and the 2nd Phaedon SenoTherapeutics Summit held in Rome from September 16-19.<sup>13</sup> The explicit mission of the Phaedon summit is to bridge the gap between foundational science and the clinical and commercial development of senotherapeutics, bringing together academic researchers with industry leaders.<sup>14</sup> Companies presenting at or involved with this ecosystem, such as Rubedo Life Sciences, Unity Biotechnology, and Oisín Biotechnologies, are at the forefront of developing drugs to clear senescent cells.<sup>18</sup> These firms face the immense challenge of demonstrating clear and consistent efficacy and safety in human clinical trials. The Neri et al. study delivers a direct and actionable piece of strategic intelligence to this commercial ecosystem. It scientifically validates the hypothesis that the "target"—senescent cells—is not uniform. This creates a new strategic imperative for the entire senotherapeutics sector. Research and development efforts must now pivot to focus on either developing drugs that selectively eliminate the highly pro-inflammatory G2-arrested cells or creating companion diagnostics to identify patients with a high burden of this specific, pathogenic subtype. This finding is therefore not an isolated academic curiosity; it is a critical piece of intelligence that directly informs the next phase of drug development, clinical trial design, and investment strategy in the multi-billion-dollar senotherapeutics market. It provides a compelling scientific rationale to transition from first-generation "blunt" senolytics to second-generation "precision" therapies.

## **2.2 Metabolic Regulation: Global Experts Synthesize the Clinical State of NAD+ Augmentation**

A consortium of over 25 leading international researchers in aging and metabolism published a comprehensive expert opinion and systematic review in the high-impact journal *Nature Aging*, with its findings amplified by global media on September 22, 2025.<sup>2</sup> The consensus statement authoritatively confirms that nicotinamide adenine dinucleotide (

NAD+) is a fundamental coenzyme essential for cellular energy production and DNA repair, and that its systemic decline is a hallmark of aging linked to functional deficits such as memory loss and muscle weakness.<sup>2</sup> The review systematically analyzed the existing

landscape of human clinical trials investigating

NAD<sup>+</sup> precursor molecules, primarily nicotinamide riboside (NR) and nicotinamide mononucleotide (NMN). The authors concluded that while early results are encouraging—with some trials reporting modest improvements in memory, movement, and metabolic parameters—the overall body of evidence remains preliminary.<sup>2</sup>

The most critical takeaway from this publication is not the summary of existing data, but the collective and authoritative call for a new, higher standard of evidence in the field. The authors explicitly state that larger, longer-term, and more rigorously designed randomized controlled trials are essential to definitively validate the efficacy, determine optimal dosing strategies, and ensure the long-term safety of NAD<sup>+</sup> augmentation therapies.<sup>2</sup> This publication serves as a crucial and necessary market correction to the widespread consumer hype and the "booming global commercial market" for these supplements, which has far outpaced the generation of robust clinical proof.<sup>2</sup>

This expert opinion represents a deliberate act of scientific leadership aimed at steering a popular but scientifically noisy sub-field toward pharmaceutical-grade validation. The consumer market for NAD<sup>+</sup> boosters has created a significant gap between public perception and validated clinical evidence, a situation that risks undermining the credibility of the entire longevity enterprise. By publishing a consensus statement in a top-tier journal, these global experts are establishing a clear "scientific roadmap" for what constitutes valid evidence going forward.<sup>2</sup> This signals a maturation of the metabolic regulation domain. It marks a strategic shift away from reliance on preclinical animal data and small-scale human studies toward the stringent standards required for regulatory approval and mainstream medical adoption. For investors, pharmaceutical companies, and other stakeholders, this consensus provides a clear and powerful framework for evaluating new ventures in the metabolic healthspan space: any project not committed to executing large-scale, long-term human trials should be considered highly speculative and carrying significant scientific and market risk.

### **2.3 Functional Aging Biomarkers: New Research Uncovers Critical Sex-Specific Differences**

Two independent studies, both published in the peer-reviewed journal *Frontiers in Aging* on September 24, 2025, reveal that key processes of functional aging differ fundamentally between men and women, challenging the validity of "one-size-fits-all" approaches to healthspan interventions.

The first study, by Sestu et al., investigated the complex interplay between arterial aging (measured by arterial stiffness via pulse wave velocity, or PWV), autonomic nervous system

activity, and the moderating effect of physical activity.<sup>3</sup> The results showed that in men, higher levels of physical activity were associated with significantly lower PWV and blunted the detrimental association between autonomic nervous system arousal and arterial stiffening. This protective cardiovascular effect of exercise was not observed in the female participants of the study.<sup>23</sup>

The second study, by Li et al., analyzed the 24-hour activity patterns of 814 older adults and their relationship with cognitive function.<sup>3</sup> The research found a strong association between higher cognitive performance and a more active, less sedentary lifestyle. Crucially, this association was statistically significant and highly sensitive in women, but not in men.<sup>25</sup> For female participants, better scores on memory and verbal fluency tests directly correlated with more time spent in moderate-to-vigorous physical activity (MVPA) and less time in sedentary behavior.<sup>24</sup> For example, women with excellent memory spent nearly 4% less of their day in a sedentary state compared to those with poor memory.<sup>24</sup>

These findings, published concurrently in the same journal, provide robust clinical evidence that the biological pathways linking physical activity to both cardiovascular and cognitive health are sexually dimorphic. This is more than an interesting observation; it is a fundamental challenge to the design of current and future clinical trials and the formulation of public health recommendations for healthy aging. Historically, much of medical research has been male-centric, with findings often generalized to women. These two studies provide a powerful, multi-systemic signal that this approach is deeply flawed in the context of functional aging. The Sestu et al. paper points to a sex-specific physiological mechanism of cardiovascular aging, while the Li et al. paper indicates a sex-specific behavioral response linked to cognitive health. Taken together, this evidence mandates a paradigm shift. The concept of "personalized longevity medicine" must now consider biological sex as a primary stratification variable, not a secondary one. Any future interventional trials aiming to improve cardiovascular or cognitive function in older adults will be scientifically incomplete, and potentially misleading, if they do not include pre-specified analyses of sex-specific outcomes. This will inevitably increase the complexity and cost of longevity research but is an essential step toward developing effective and equitable interventions that benefit the entire population.

### **3. Early-Stage Research vs. Clinical Trials: Mapping the Path to Intervention**

The developments of the past week provide a clear snapshot of the longevity research pipeline, from foundational discovery to clinical translation.

**Foundational Science (In Vitro):** The Neri et al. study on senescent cell heterogeneity is a prime example of hypothesis-generating basic research.<sup>1</sup> Conducted in laboratory cell cultures, its findings are not directly applicable to human patients but provide a critical new biological framework for the field. Its immediate impact is on the research and development strategies of pharmaceutical and biotechnology companies. It guides the design of next-generation senolytics and stimulates the search for new drug targets, such as surface proteins or metabolic pathways that are unique to the highly pro-inflammatory G2-arrested senescent cells.

**Observational Clinical Research:** The *Frontiers in Aging* studies on sex differences in cardiovascular and cognitive aging represent the next crucial step in the pipeline.<sup>3</sup> These studies do not test a specific intervention but identify powerful correlations within human populations. Their primary role is to inform the design of future

*interventional* clinical trials. For instance, the findings from Li et al. strongly suggest that a clinical trial testing a cognitive-enhancing drug or lifestyle intervention should use objectively measured daily activity levels as a primary functional endpoint, particularly in female participants, as this appears to be a highly sensitive marker of cognitive status in that population.<sup>25</sup>

**Clinical Trial Landscape & Translation:** The *Nature Aging* review on NAD<sup>+</sup> summarizes the current state of human interventional trials in the metabolic domain, serving as a meta-analysis of existing clinical efforts that will guide the design of future, more robust trials.<sup>2</sup> The most direct evidence of active clinical translation this week emerged from the ICSA/Phaedon SenoTherapeutics Summit in Rome.<sup>16</sup> This event functions as the critical nexus where foundational science meets clinical application. A clear example is the presentation by Perseus SENOLYTIX on their "MitoXcel™ Geropeptides".<sup>26</sup> The company presented preclinical data from aged mice, making specific claims of reducing senescent cell burden in fat tissue by over 50%, improving body composition (decreasing fat mass while increasing lean muscle mass), and enhancing functional capacity as measured by endurance, balance, and strength tests. This is precisely the type of preclinical data package that is assembled and presented to the scientific and investment community immediately prior to filing an Investigational New Drug (IND) application with regulatory bodies like the FDA to begin human trials.

## 4. Technological Tools: Platforms Enabling Proactive Healthspan Management

This week also saw significant announcements regarding the development of technological tools that form the essential infrastructure for a future of personalized and proactive

healthspan management. These platforms address critical gaps in both data acquisition and social implementation.

## **4.1 Non-Invasive Diagnostics: The Advent of Continuous Biomarker Monitoring**

On September 19, 2025, the healthtech startup Truelli announced a significant advancement in its research and development of the world's first smart menstrual pad with built-in screening technology.<sup>6</sup> The device is engineered to analyze menstrual blood, which the company describes as an "information-rich yet historically overlooked biomarker." The platform aims to routinely and non-invasively assess four key categories of health indicators: nutrient levels, hormonal fluctuations, metabolic function, and sexual health. The results are delivered to the user through a mobile application that provides actionable health insights.<sup>6</sup>

This technology represents a potential paradigm shift in biomarker collection, moving it from an episodic, invasive, and clinically-centered model (e.g., periodic blood draws) to one that is passive, frequent, and seamlessly integrated into a person's daily life. For approximately half the global population, this could provide a longitudinal health dataset of unparalleled richness and frequency, enabling the tracking of healthspan trajectories over months, years, and even decades. This innovation directly addresses the need for better and more consistent data on female health, a critical gap underscored by the sex-difference studies on functional aging discussed previously. Beyond its utility as a consumer health product, this technology functions as a potential scientific instrument for population-level healthspan research. The automated collection of anonymized, aggregated data on key female health markers at a massive scale could dramatically accelerate our understanding of the mechanisms of female aging, leading to the discovery of new biomarkers and the ability to test the real-world effects of healthspan interventions.

## **4.2 Socio-Technological Platforms: Quantifying and Shaping Public Acceptance**

On September 17 and 18, 2025, the Lifespan Research Institute (LRI), a major non-profit in the field, announced the launch of the Public Longevity Group (PLG), a new initiative focused on bridging the cultural and psychological gap between scientific breakthroughs in aging and their public acceptance.<sup>4</sup> The PLG's core strategy is to build a data-driven "cultural intelligence system" to systematically measure, understand, and engage with public opinion.<sup>5</sup>

This is not a traditional public relations campaign but a technology-centric platform comprising novel tools, including:

- **The Longevity Cultural Clock:** A cultural barometer designed to map public readiness and resistance to longevity therapies across different demographics and geographic regions.
- **Sentiment Dashboards:** Real-time monitoring systems to track the perceptions of the public, investors, and policymakers.
- **Narrative Testing Tools:** A data-driven framework for A/B testing messages to identify which narratives resonate positively and which backfire, allowing for the scientific optimization of public communication.<sup>4</sup>

This initiative is the first systematic, technology-driven effort to treat public opinion not as a simple barrier to be overcome with marketing, but as a complex system to be scientifically analyzed. It acknowledges that one of the greatest risks to a longevity therapy's ultimate success may not be biological, but social. This approach has significant implications for the financial and strategic planning of the entire longevity ecosystem. Venture capital and pharmaceutical investment decisions are fundamentally based on risk assessment, which includes scientific risk, clinical trial risk, and market risk. The PLG's own data, citing that 56% of Americans would reject treatments to extend life to 120+ years, quantifies a massive and previously nebulous market risk: social non-adoption.<sup>27</sup> By creating tools to measure and improve public sentiment, the PLG is essentially creating a new asset class for the industry: "cultural readiness" data. This data can be used by investors to de-risk investments, by companies to design more effective clinical trial recruitment strategies and marketing campaigns, and by policymakers to anticipate and address public concerns. The PLG is therefore building a fundamental piece of the longevity ecosystem's financial and social infrastructure, aiming to make social acceptance a measurable, manageable, and ultimately, a bankable variable.

## 5. Ethical and Practical Considerations: Navigating the Non-Biological Barriers

The translation of longevity science into widespread human use depends on navigating a complex landscape of ethical and practical challenges that extend beyond the laboratory.

### 5.1 The Public Trust Imperative

The launch of the Public Longevity Group (PLG) is a direct and necessary response to a critical ethical and practical challenge facing the field: profound public skepticism.<sup>4</sup> The group's foundational data highlights deep-seated public fears, with two-thirds of Americans worried that longevity technologies will be released before being thoroughly tested and will exacerbate social inequality by being available only to the wealthy.<sup>27</sup> Furthermore, a strong perception of these interventions as "unnatural" persists.<sup>27</sup> The ethical imperative for the scientific community is to ensure that the development of longevity medicine is not a purely technocratic process but one that proceeds with public understanding, engagement, and consent. Practically, this is not an optional exercise in public relations. As the PLG's analysis suggests, without public trust, even a perfectly safe and effective therapy could fail due to low adoption, rendering billions of dollars in research and development investment worthless and, more importantly, failing to deliver its potential public health benefits. Building this trust is as critical to the mission as the science itself.

## **5.2 Safety and Efficacy in Senotherapeutics**

The practical implications of the Neri et al. study on senescent cell heterogeneity for the safety and efficacy of senolytic drugs are profound.<sup>1</sup> The discovery that G2-arrested cells are both the primary drivers of inflammation and the most sensitive to at least one major senolytic compound introduces a new layer of complexity to therapeutic development. A successful senolytic therapy must now be evaluated on its ability to selectively clear this pathogenic subpopulation. A poorly designed drug might preferentially clear the less harmful G1-arrested cells, leaving the most damaging cells behind and leading to a suboptimal clinical outcome. An even greater risk lies with overly aggressive, non-specific senolytics that could cause off-target effects, damaging healthy tissues or interfering with essential biological processes where senescence plays a beneficial, protective role, such as in wound healing and tumor suppression. This research underscores the practical necessity of moving beyond blunt instruments and developing highly targeted therapies. The future of safe and effective senotherapeutics lies in precision: maximizing the benefit by clearing the most pathogenic cells while minimizing the risk of harming beneficial cells or processes.

## **6. Future Directions: The Trajectory of Longevity Science**

The convergence of findings from the past week illuminates a clear and accelerating trajectory for the future of longevity science, characterized by a move toward precision, integration, and the construction of a complete translational ecosystem.

## The Next Wave of Therapeutics: From Broad to Bespoke

The era of searching for a single, generalized "anti-aging" pill is ceding to a new paradigm of multi-layered, personalized intervention. The future of therapeutics will be defined by a commitment to precision at multiple levels:

- **Cellular Precision:** The development of next-generation drugs, particularly senolytics, that are designed to target specific pathological cell subtypes, as informed by foundational research like the Neri et al. study.
- **Pathway Precision:** A focus on interventions that modulate specific metabolic and signaling pathways, such as the NAD<sup>+</sup> system, but only after their efficacy and safety have been validated through the rigorous, large-scale human clinical trials demanded by the expert consensus in *Nature Aging*.
- **Population Precision:** The design of healthspan strategies and clinical interventions that are explicitly tailored to the distinct biological aging processes of men and women, a non-negotiable requirement established by the new evidence on sex-specific functional aging from *Frontiers in Aging*.

## The Integrated Healthspan Model

The maintenance of lifelong function will not rely on a single magic bullet but will emerge from an integrated, data-driven system. This model will likely combine three core components into a continuous feedback loop:

1. **Continuous Monitoring:** Passive, non-invasive technologies, exemplified by the Truelli smart pad, will provide a constant stream of personalized health data, moving health assessment from an annual event to a daily reality.
2. **Personalized Lifestyle Prescription:** This rich data stream will inform highly tailored recommendations for diet, exercise, and other lifestyle factors, with an understanding that the optimal prescription will differ based on an individual's unique physiology, including their sex-specific responses.
3. **Targeted Pharmacological Intervention:** When continuous biomarker monitoring

indicates the emergence of a specific pathological process—for example, a rising burden of G2-arrested senescent cells or a critical decline in a key metabolic marker—a precision therapeutic will be deployed not as a chronic treatment, but as a targeted intervention to restore homeostatic balance.

## Building the Complete Ecosystem

Ultimately, this week's developments demonstrate that the longevity field is maturing beyond a singular focus on laboratory research. It is now actively and simultaneously building the three essential pillars required for success:

1. **The Science:** A deeper, more nuanced, and more precise understanding of the fundamental biology of aging.
2. **The Translation Engine:** A collaborative framework, exemplified by the ICSA/Phaedon Summit and the NAD+ consensus statement, designed to move scientific discoveries from the lab to the clinic with the utmost scientific rigor.
3. **The Social & Data Infrastructure:** The development of the novel technological and social tools, such as the Public Longevity Group and Truelli's platform, that are necessary to gather personalized data at scale and ensure the public trust required for widespread adoption.

The convergence of these activities indicates that the field is reaching a new level of maturity. The focus is shifting from the discovery of individual interventions to the far more complex and ambitious task of building the complete, integrated ecosystem necessary to deliver a future of extended functional human healthspan.

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