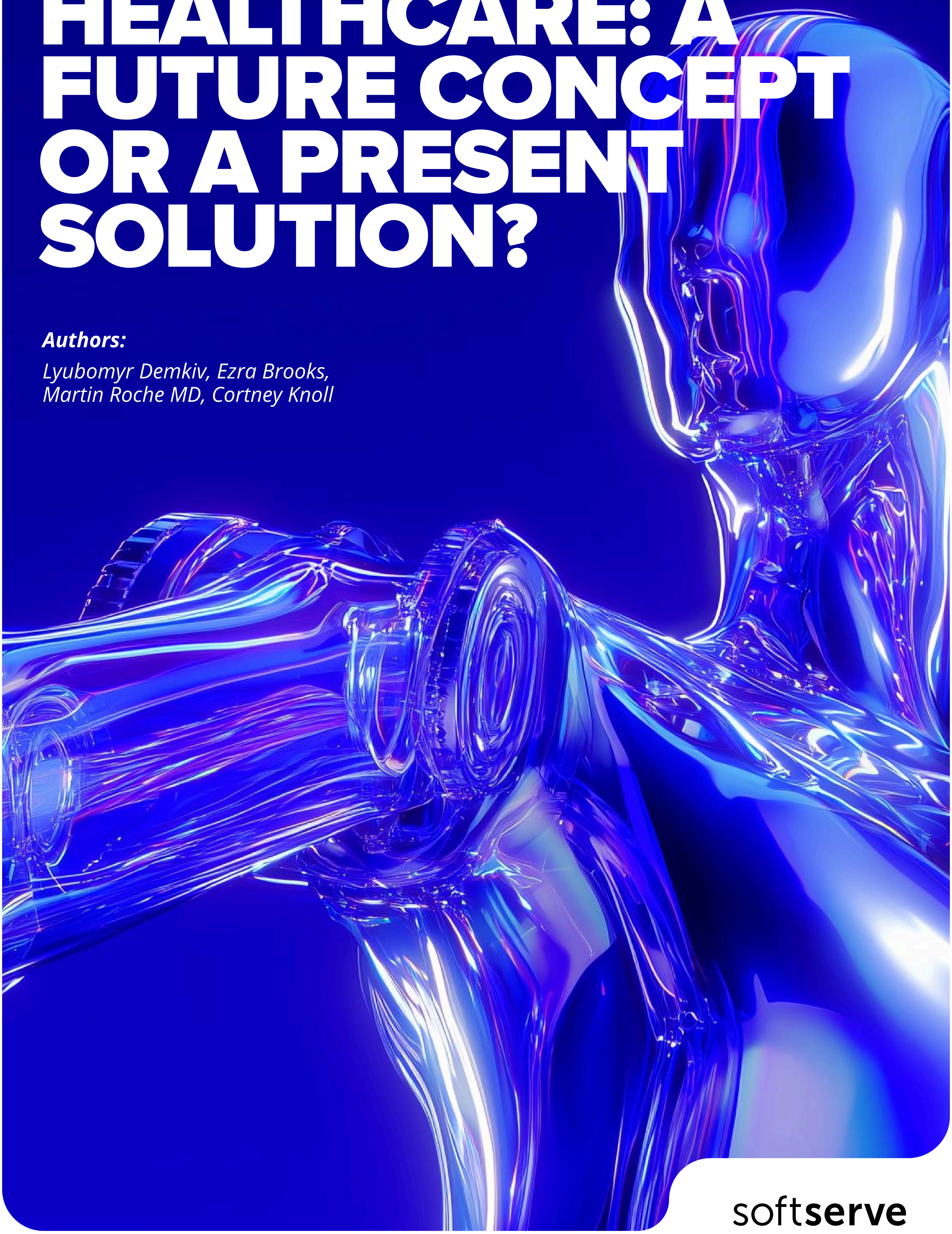
HUMANOIDS IN HEALTHCARE: A FUTURE CONCEPT OR A PRESENT SOLUTION?

Authors:

Lyubomyr Demkiv, Ezra Brooks,
Martin Roche MD, Cortney Knoll



softserve

EXECUTIVE SUMMARY

Humanoid robots are moving from **experimental demos into early real-world deployments**, and healthcare is one of the most compelling environments to evaluate them. The reason is simple: hospitals, labs, and care facilities are highly human-centered systems. Many workflows still depend on physical movement, handoffs, and repetitive handling of supplies, samples, and equipment. At the same time, healthcare leaders face persistent staffing constraints, rising service demands, and pressure to improve throughput and safety without expanding footprint or headcount.

Humanoids are not a replacement for clinical judgment or bedside care. Their near-term value is operational: supporting staff by taking on tasks that are repetitive, physically demanding, or time-consuming. The most realistic path today is “augmented operations,” where humanoids work within defined boundaries, complete standardized tasks, and operate under clear supervision and safety rules.

While AI-powered tools help reduce individual developer effort, they rely on continuous human oversight. Full-cycle automation brings challenges, including accurate interpretation of requirements and maintaining quality across all stages. Addressing these challenges requires strong governance and validation mechanisms. Nevertheless, the benefits — faster time-to-market, increased productivity, and seamless collaboration — outweigh the risks.

WHY HUMANOIDS: AND WHY HEALTHCARE?

Humanoids solve a specific problem traditional automation struggles with

Healthcare environments are “brownfield” by default. Buildings are already constructed, workflows are already running, and spaces are designed around people, not machines. Traditional automation often works best when you can redesign the process around the robot (for example, fixed industrial robots in a controlled cell). In hospitals and labs, that redesign is usually expensive, slow, and disruptive.

Healthcare, in particular, faces structural pressure that makes this shift relevant. Rising demand, workforce constraints, and cost containment efforts are pushing leaders to reconsider how physical work is performed. The strategic opportunity is not to replace clinicians, but to introduce intelligent physical support systems that extend operational capacity without expanding facilities or headcount.

The shift toward humanoids is not driven by hardware alone, but by a broader technology stack that has matured in recent years. Several advances have made deployment more realistic in complex environments:

- Better perception and sensor fusion
- More capable planning and control software
- Faster validation through simulation and digital twins
- **Synthetic data generation** that reduces reliance on costly real-world data collection

Healthcare, in particular, faces structural pressure that makes this shift relevant. Rising demand, workforce constraints, and cost containment efforts are pushing leaders to reconsider how physical work is performed. The strategic opportunity is not to replace clinicians, but to introduce intelligent physical support systems that extend operational capacity without expanding facilities or headcount.

WHERE HEALTHCARE IS READY FOR HUMANOIDS TODAY

Healthcare is ready for humanoids in workflows that are repeatable, physically structured, and operationally measurable. The most practical starting points are not clinical decisions, but operational support functions that depend on movement, handling, staging, and transport. These areas allow organizations to pilot humanoids within controlled scope while generating concrete performance data.

Today's readiness is highest where tasks are frequent, labor-intensive, and constrained enough to validate safely. Internal logistics, lab support processes, environmental services assistance, and structured life sciences manufacturing tasks represent realistic entry points. In these environments, success depends on clear workflow mapping, defined handoffs, and integration with existing operating procedures rather than high levels of autonomy.

Use Case Area	Readiness Today	Why	What Makes it Succeed
Internal logistics and unit support	High	Repeatable, measurable, non-clinical	Defined routes, clear handoffs, exception handling
Lab and pre-analytical support	Medium-High	Standardizable tasks with clear KPIs	Tight workflow definition, validation, instrument integration
Environmental services support	Medium	High value but policy-sensitive	Strong governance, strict boundaries
Life sciences manufacturing support	Medium	Brownfield constraints plus need for flexibility	Clear validation approach, controlled environments, SOP alignment

Table 1. Practical readiness matrix for humanoids in healthcare

DEPLOYING HUMANOIDS IN REAL ENVIRONMENTS

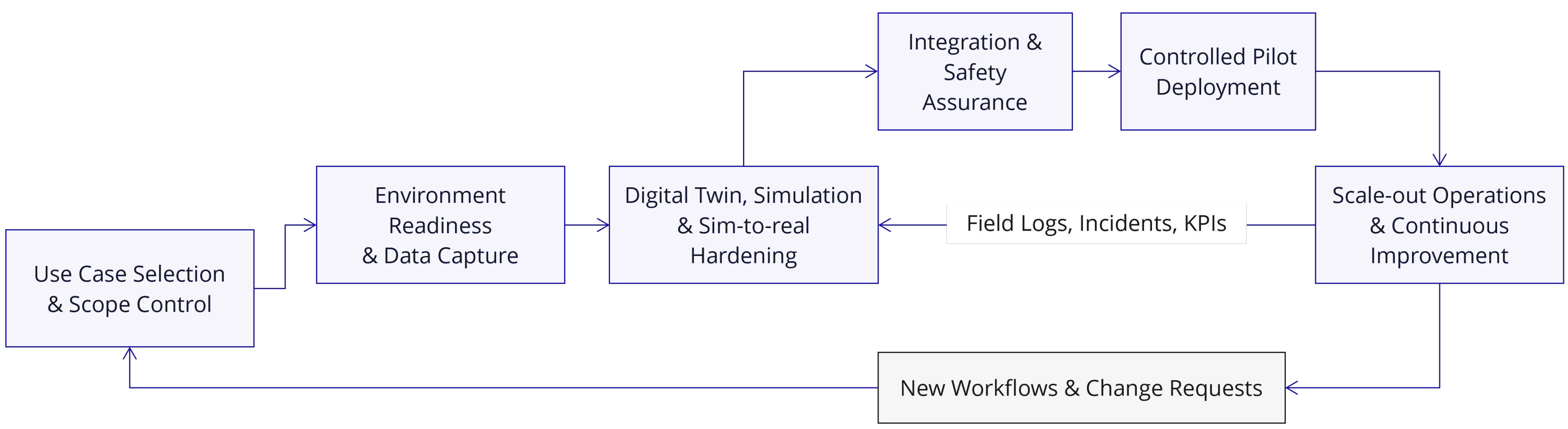


Diagram 1. High-level six-stage humanoid deployment lifecycle

Deploying humanoids in healthcare **requires more than placing a robot into a corridor and assigning it tasks**. Real-world environments are dynamic. Staff move unpredictably. Workflows shift by hour. Physical layouts vary by building. Successful deployment begins with clearly defining where the humanoid operates, what it does, and under what constraints.

The most effective deployments start with tightly scoped workflows. Instead of broad autonomy, organizations define:

- Specific task boundaries
- Approved routes and interaction zones
- Clear handoff points between robot and staff
- Escalation procedures for exceptions

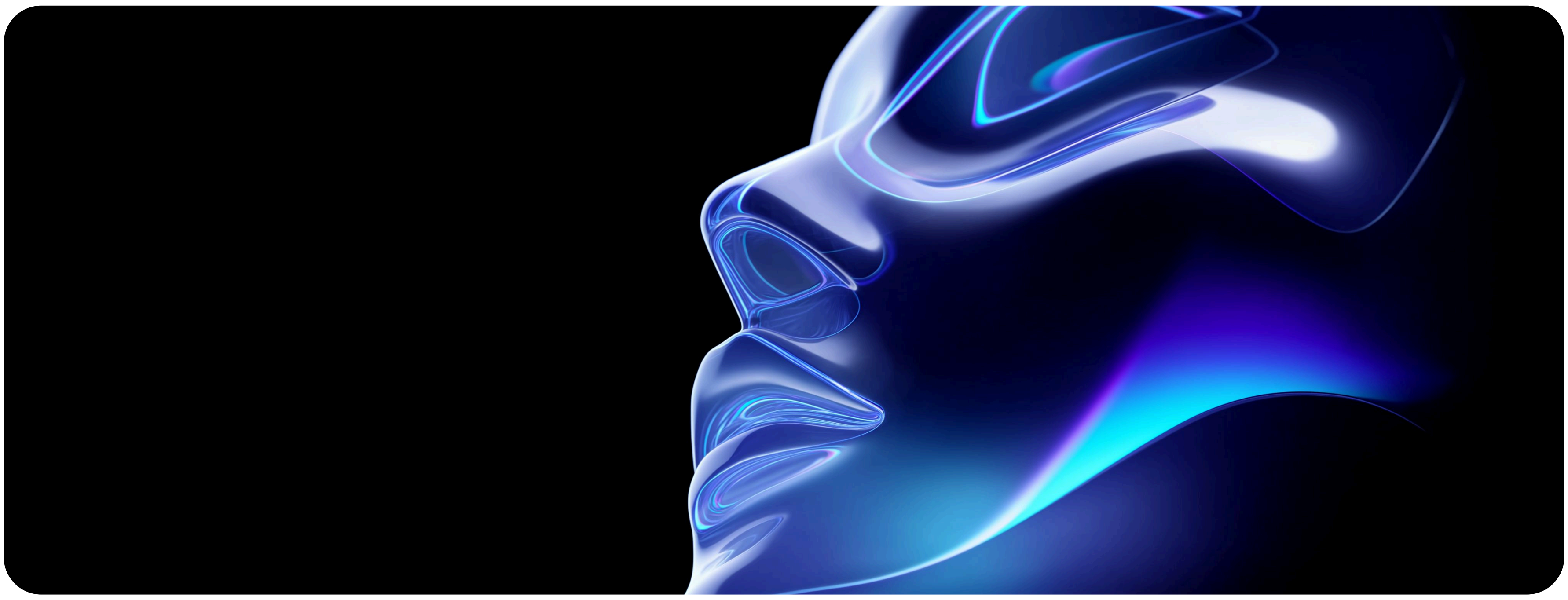
Humanoids perform best when expectations are explicit. Tasks such as **transport, staging, or material handling** can be mapped in detail before live rollout.

Simulation plays a critical role at this stage. Digital twins of hospital units, labs, or manufacturing spaces allow teams to test navigation, manipulation, and edge cases before physical deployment. Through simulation, organizations can validate routes, evaluate failure scenarios, and refine behavior under controlled conditions. This reduces operational disruption and accelerates readiness.

Deployment is therefore not a single event but a phased process: **define the workflow, simulate and validate, conduct limited live trials, collect performance data, and then expand scope carefully**. Real environments reward precision, not experimentation at scale.

SAFETY, COMPLIANCE, AND RISK MANAGEMENT

In healthcare, safety is non-negotiable. Any humanoid operating in a hospital, laboratory, or manufacturing facility must behave in a predictable and controlled manner. The objective is not to maximize autonomy, but to **ensure consistent, reliable task execution within clearly defined operational limits**.



Safety considerations typically fall into three areas:

Physical Safety

The humanoid must navigate crowded environments, avoid collisions, and operate at speeds and force levels appropriate for patient-facing settings.

Operational Safety

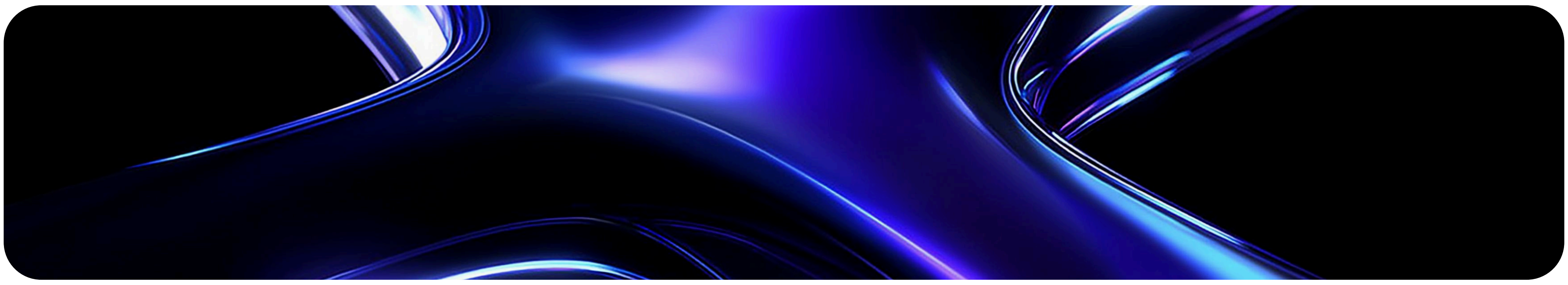
Tasks must be performed consistently, with clear procedures for pausing, escalating, or handing control back to staff when something unexpected occurs.

System & Data Security

Any integration with hospital IT systems must comply with cybersecurity standards and internal governance policies.

Effective risk management begins well before deployment. Workflows need to be mapped in detail, operating zones must be defined, and staff must understand exactly what the humanoid is designed to do. Clear accountability is equally important. Performance should be monitored, incidents reviewed, and responsibilities assigned so that issues are addressed systematically rather than informally.

Introducing humanoids in lower-risk, non-clinical workflows allows organizations to **build confidence while maintaining strict oversight**. As reliability is demonstrated, scope can expand in a controlled and measured way.



FROM PILOT TO ENTERPRISE-GRADE DEPLOYMENT

A pilot demonstrates feasibility. Enterprise-grade deployment demonstrates **stability, repeatability, and operational fit**.

Well-designed pilots concentrate on a specific, contained use case. They typically focus on a **single department or task category**, with **clearly defined objectives and measurable outcomes**. During this phase, organizations should track metrics such as task completion rates, time savings, frequency of human intervention, and the number of exceptions or disruptions.

If performance is consistent, the focus shifts to standardization. Workflows must be documented, training formalized, and operational procedures aligned across units. What works in one department should be reproducible in another without major redesign or improvisation.

Realistic Constraints and Adoption Risks

The move from contained success to broader operational presence introduces new forms of friction. Conditions that were stable during a pilot often become more variable as exposure increases.

Environmental Variability at Scale

Broader deployment exposes the humanoid to fluctuating traffic patterns, temporary layout changes, peak demand periods, and edge cases that were not fully represented during initial trials.

Physical Durability and Wear

Sustained daily operation introduces mechanical stress, battery cycling demands, and component fatigue that are not fully observable in short pilots. Longevity becomes a performance factor.

Policy and Departmental Heterogeneity

Different units may operate under distinct protocols, infection control practices, or handling rules. What is acceptable in one setting may require adaptation in another.

Role Clarity Across Teams

As exposure expands, ambiguity around task boundaries can emerge. Without clear definitions, staff may over-rely on or underutilize the system.

These constraints do not contradict the enterprise path. They **define the operational realities that emerge only when humanoids move beyond controlled conditions and into everyday complexity**.

Scaling also requires ongoing oversight. Performance should be visible through structured reporting and routine review. **Maintenance processes, governance structures, and clear ownership** ensure that humanoids remain aligned with operational goals over time.

Enterprise deployment succeeds when the technology integrates smoothly into daily operations and delivers predictable results. At that point, humanoids transition **from experimental initiatives to dependable components of the healthcare workflow**.

THE BUSINESS CASE: ROI AND STRATEGIC ADVANTAGE

Humanoid robots in healthcare are emerging as a strategic lever for institutions facing chronic workforce shortages, rising labor costs, and performance pressures. Early deployments, particularly in structured environments such as hospital logistics and repetitive service roles, have demonstrated **measurable operational benefits**.

The economic logic rests on a simple observation: **highly trained clinical professionals spend a measurable portion of their time on transport, retrieval, and staging tasks that do not require clinical expertise**. When humanoids reliably assume these activities within defined operational boundaries, the organization recovers productive capacity without expanding headcount.

Value Dimension	Mechanism of Impact	Example Operational Effect	Financial Relevance
Labor capacity recovery	Offloading repetitive transport and handling tasks	Reduced nurse walking time; fewer manual deliveries	Avoided overtime, deferred hiring, improved labor utilization
Throughput improvement	Faster, more predictable internal logistics	Reduced delays in specimen routing or supply restocking	Higher unit productivity and improved service capacity
Operational consistency	Standardized task execution	Fewer workflow interruptions or missed handoffs	Reduced variability and improved KPI performance
Workforce sustainability	Lower physical strain and cognitive overload	Decreased burnout exposure in support-heavy units	Reduced turnover-related costs and absenteeism
Infrastructure leverage	Operation within existing human-built spaces	No major facility redesign required	Capital efficiency compared to fixed automation

Table 2. Core ROI value drivers for humanoids in healthcare

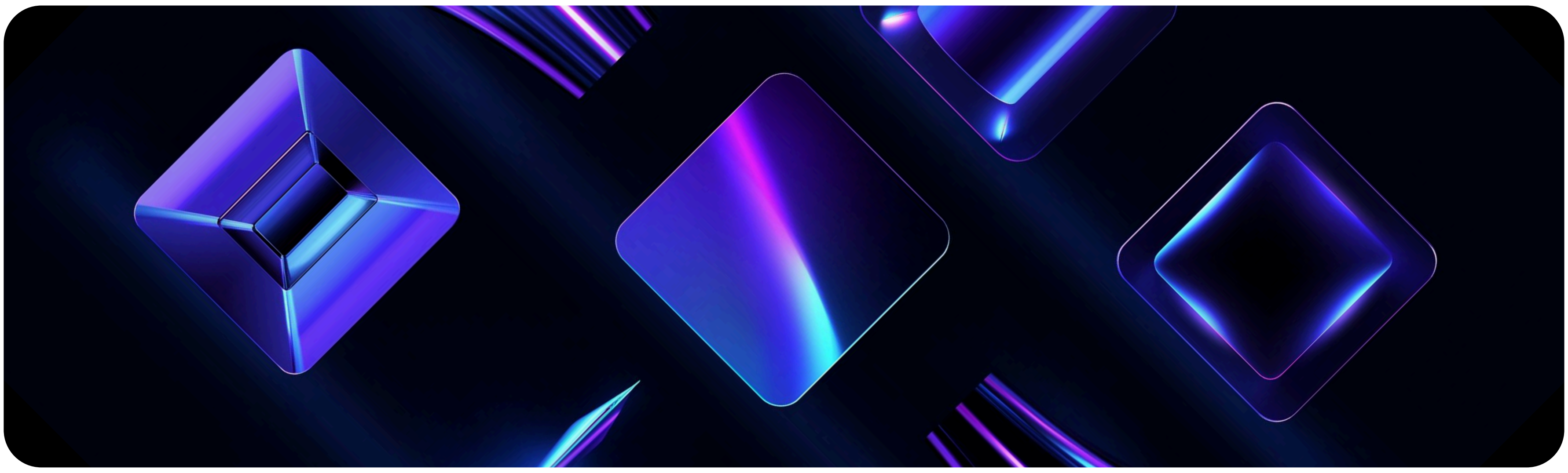
From a capital budgeting perspective, ROI depends on **disciplined scope and reliable uptime** rather than broad autonomy claims. In structured, high-frequency use cases with measurable baselines, early payback periods are attainable when integration, supervision, and maintenance are modeled realistically.

Total cost of ownership must account for **hardware, integration, maintenance, oversight, and software governance**. Overestimating autonomy or underestimating integration complexity can extend payback timelines, while tightly scoped, repeatable deployments reduce financial exposure and support phased expansion. Beyond cost recovery, humanoids create capacity elasticity within fixed infrastructure and help organizations respond to workforce and volume pressures. Early adopters also build institutional knowledge that strengthens long-term operational advantage.

In this context, humanoids are not simply an automation investment. They represent a **deliberate shift toward scalable, AI-enabled physical operations** within the constraints of real healthcare environments.

SCALING PHYSICAL AI IN HEALTHCARE

SoftServe helps organizations move from robotics experimentation to operational deployment. Our **physical AI practice** combines robotics engineering, AI model development, digital twins, and high-fidelity simulation to design, validate, and scale humanoid and autonomous systems in real clinical environments.



We support clients across the full lifecycle:

- **Use-case definition and feasibility modelling:** We identify workflows where humanoids can deliver measurable operational impact and build ROI-backed deployment strategies aligned to healthcare KPIs.
- **Simulation-first validation:** Using digital twins and physics-accurate simulation, we test navigation, manipulation, safety behaviors, and edge cases before live deployment. This reduces risk, shortens iteration cycles, and limits disruption to hospital operations.
- **Autonomy stack development and integration:** We design and integrate perception, planning, and control systems tailored to brownfield healthcare environments, ensuring compatibility with existing infrastructure and IT systems.
- **Synthetic data and AI training at scale:** We accelerate model robustness using synthetic data and large-scale simulation, improving reliability without relying solely on costly real-world data collection.
- **Enterprise readiness and scalability:** We implement cybersecurity controls, observability frameworks, and operational governance structures that allow humanoids to operate as production-grade systems rather than isolated pilots.

For healthcare providers, this translates into faster time-to-value, lower deployment risk, and scalable physical AI systems that extend operational capacity without expanding footprint or headcount.

CASE STUDY: IMPLEMENTATION OF HUMANOIDS IN PERIOPERATIVE CARE

Challenge: Introducing Humanoids Into Perioperative Workflows

Perioperative services span **sterile processing (SPD), hospital logistics, and operating rooms (OR)**, yet execution across these domains has relied on manual coordination and fragmented workflows. To address this, PeritasAI™ is using intelligence to improve visibility and synchronization while retaining physical execution as a human-dependent process.

The objective was not simply to add robotics, but to introduce embodied support that:

- Operated within existing hospital workflows
- Maintained safety and infection-control compliance
- Functioned under orchestration governance
- Supported surgical teams without disrupting them

Approach: Developing And Deploying PERI Humanoid

With SoftServe's support, PeritasAI progressed in stages. Intelligence capabilities were first consolidated into a **unified "One Brain" architecture**, aligning SPD, logistics, and OR signals within a shared operational model.

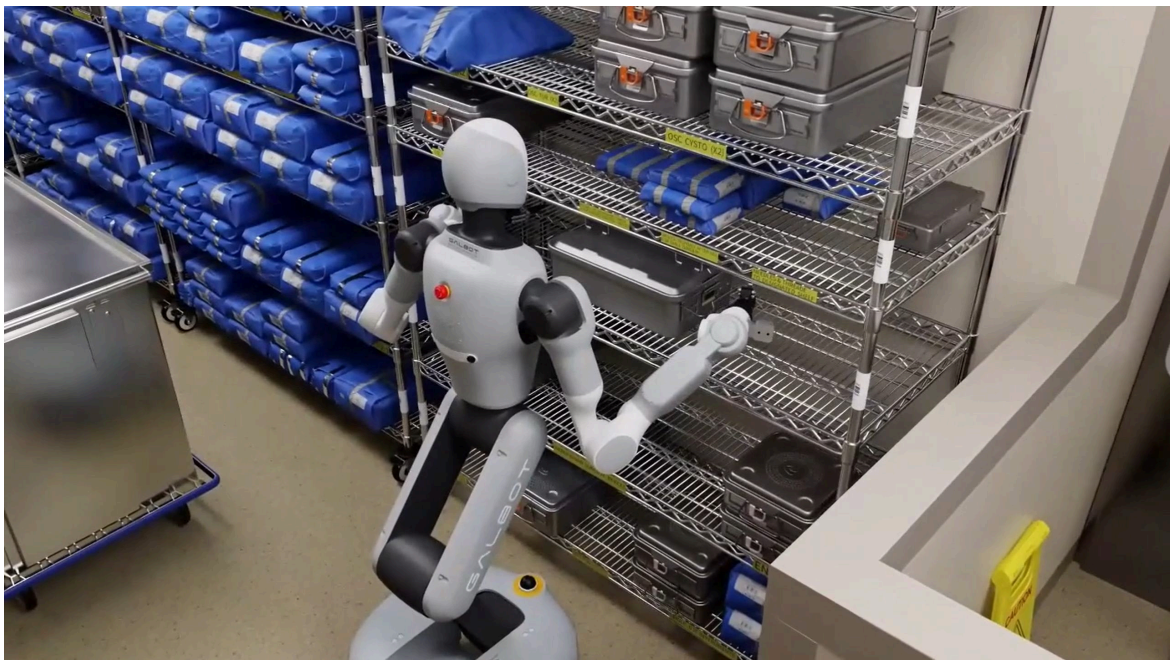
Peri is powered by the **PeriVerse™ platform: the agentic surgical platform for perioperative orchestration, connecting real-time clinical awareness with the digital agents and physical systems that support surgical teams across the surgical environment.** This ensures that embodiment operates under structured governance rather than as isolated automation. This ensured that embodiment would operate under structured governance rather than as isolated automation.

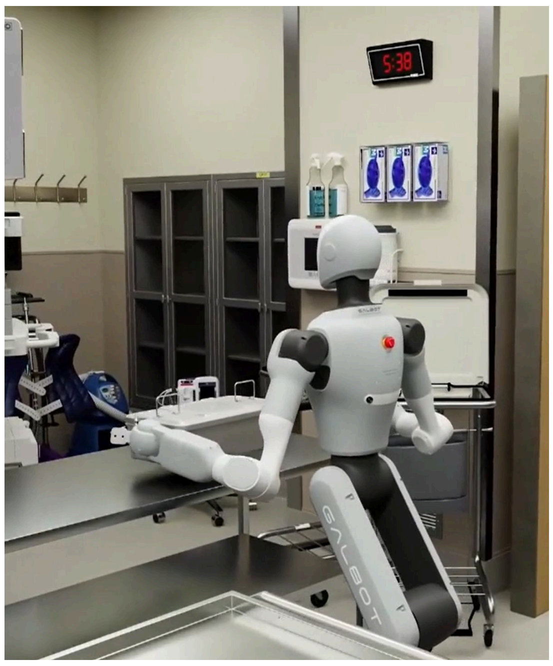
Development then focused on core humanoid competencies:

- Autonomous navigation across hospital spaces
- Semantic mapping and environmental awareness
- Door and lift operation
- Human-aware perception
- Safe handling of trays, carts, and storage units
- Precision surgical tool manipulation

The robot’s behavior is trained through **simulation-first pipelines built on NVIDIA Isaac™**, where a small number of teleoperated demonstrations are expanded using synthetic data generation and then refined in photorealistic simulation environments. This allows thousands of task variations and virtual robot instances to train simultaneously, accelerating skill development before deployment.

Building on enhanced perception and tray intelligence, the system advanced to controlled instrument grasping and context-aware placement, enabling clinically relevant interaction.





Image(-s) 1-2. Peri humanoid performing various tasks

Results

The initiative established a structured pathway for humanoid applicability in healthcare:

1. Embodiment followed orchestration maturity
2. Physical autonomy operated within defined safety guardrails
3. Manual and robotic workflows coexisted predictably
4. Intelligence, coordination, and execution functioned as a cohesive system

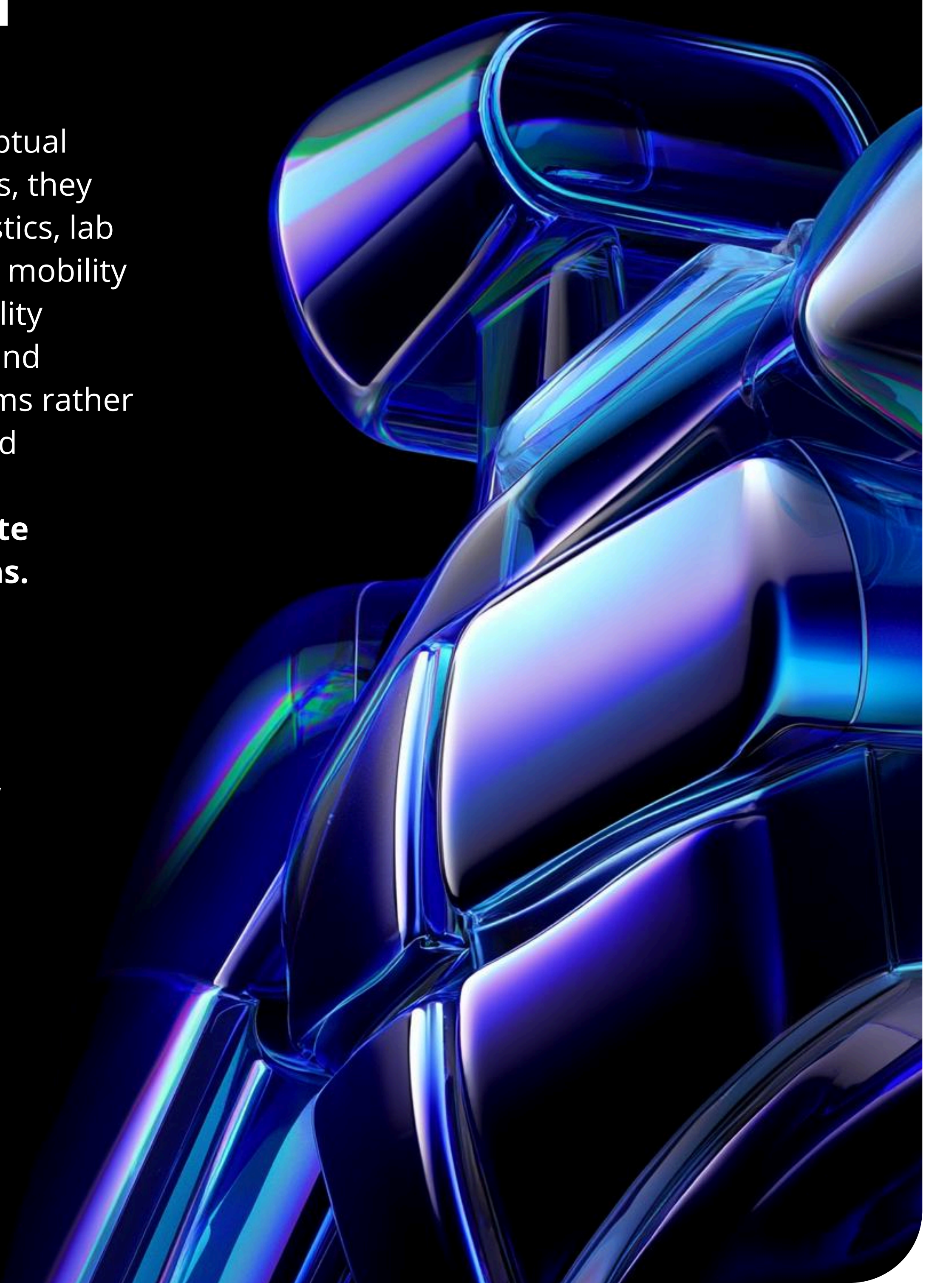
Rather than positioning humanoids as standalone robots, PeritasAI implemented them as **embodied extensions of perioperative orchestration**, enabling coordinated, governed physical execution across SPD, logistics, and the operating room.

Visit the **PeritasAI website** to explore how embodied intelligence and Peri humanoid system are advancing perioperative operations.

CONCLUSION

Humanoids are no longer confined to conceptual pilots. In structured healthcare environments, they can already deliver measurable value in logistics, lab support, and perioperative workflows where mobility and manipulation are critical. Their applicability depends on disciplined scope, governance, and integration within existing operational systems rather than broad autonomy claims. When deployed thoughtfully, humanoids **extend workforce capacity, improve consistency, and operate within infrastructure designed for humans.**

SoftServe supports vendors and healthcare organizations across this transition. Through **simulation-first validation, autonomy stack development, systems integration, and enterprise governance frameworks**, we help transform humanoids from experimental technologies into reliable, production-grade operational assets.



CONTACT US

About SoftServe

SoftServe is a premier IT consulting and digital services provider. We expand the horizon of new technologies to solve today's complex business challenges and achieve meaningful outcomes for our clients. Our boundless curiosity drives us to explore and reimagine
the art of the possible. Clients confidently rely on SoftServe to architect and execute mature and innovative capabilities, such as digital engineering, data and analytics, cloud, and AI/ML.

Our global reputation is gained from more than 30 years of experience delivering superior digital solutions at exceptional speed by top-tier engineering talent to enterprise industries, including high tech, financial services, healthcare, life sciences, retail, energy, and manufacturing.

Visit our **website**, **blog**, **LinkedIn**, **Facebook**, and X (**Twitter**) pages for more information.

Contact

Global HQ

201 W 5th Street, Suite 1550
Austin, TX 78701 USA
+1 866 687 3588 (USA)
+1 647 948 7638 (Canada)

European HQ

30 Cannon Street
London EC4 6XH United Kingdom
+44 333 006 4341

softserve