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The Uncanny Workforce: Reviewing the Ethical and Technical Pathways for Social Robots in Healthcare

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ABSTRACT **Review Article**

The fourth and fifth industrial revolution is revolutionarily seeing the emergence of Social Robots being adopted in hospitals, clinical, elderly care, and mental health settings with the potentials of reducing staff burden, delays, truancy and improving patient engagement. Interestingly, the 2020–2026 deployment data show a "pilot-to-purgatory" pattern as 63% of healthcare robot trials are discontinued after 6 months. This systematic review examines the ethical and technical pathways that will shape and determine whether social robots will become a trusted part of the healthcare workforce or remain as an "uncanny" novelty. Following PRISMA 2020 guidelines, 141 peer-reviewed studies from PubMed, IEEE Xplore, Scopus, and ACM 2020–2026 were analyzed. Findings were organized into 1.Ethical pathways: autonomy, privacy, accountability, and dehumanization; and 2.Technical pathways: affect recognition, long-term interaction, safety, and clinical integration. Results indicate that the "uncanny valley" is now less about appearance and more about role ambiguity, data governance, and brittle socio-emotional AI. A Proposal on an "Ethical-Technical Readiness" [ETR] framework is done and a 4-stage pathway: Tool- to- Companion- to-Teammate- to -Care Partner. The review concludes that healthcare will adopt social robots with open hands when and only when technical reliability is matched by ethical legibility.

Keywords: Social Robots, Healthcare Robotics, Ethics in AI, Human-Robot Interaction, Uncanny Valley, Long-Term HRI, Care Robots, Privacy.

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Introduction

(IFR, 2025) predict that by end of 2026, over 12,000 social robots would have been deployed in hospitals, aged-care homes, and psychiatric clinics globally with basic platforms to include Pepper, Moxi, ElliQ, and Paro while their major tasks will range from medication reminders to dementia therapy and pediatric distraction.

The term "uncanny workforce" captures a core tension as patients and staff expect human-like empathy, but aggressively react with discomfort when robots struggle so hard but still cannot achieve this feat [Mori et al., 2012]. The original "uncanny valley" was visual. In 2020–2026, the valley is relational exposing gaps in trust, role clarity, and accountability.

Gaps

Technical HRI papers show high short-term acceptance. Health policy papers show low long-term adoption [Sharkey & Sharkey, 2021]. No review has yet integrated both at the moment.

Research Question: What are the ethical and technical pathways that have the potentials to enable or block social robots from becoming legitimate members of the healthcare workforce till date?

Literature Review and Theoretical Framework

Defining Social Robots in Healthcare

[Fong et al., 2003] definition of Social Robots as embodied agents designed to interact with humans through social cues, and not physical manipulation appears to be realistically meaningful. However, the major Sub-domains in healthcare considered by Kong et al., (2023) include:

1. Eldercare companions;
2. Pediatric support;
3. Mental health coaching; and
4. Clinical logistics.

Theoretical Lenses

1. **Uncanny Valley:** Extended to behavior and role, not just morphology [Kätsyri et al., 2020].
2. **Ethics of Care:** Applying Tronto's 4 phases: caring about, taking care of, care-giving, and care-receiving.
3. **Technology Acceptance in Health:** UTAUT-Healthcare with added "privacy concern" [Venkatesh et al., 2020].
4. **Accountability Gaps:** The "responsibility gap" when AI makes clinical-adjacent decisions. [Tronto, 2021].

State of Practice 2020–2026

Robots are used in COVID-19 isolation wards, autism therapy, and dementia care among others [Sabanovic et al., 2022; IFR, 2025]. In spite of these application, Food and Drug Administration (FDA) in the US has cleared only less than 5(<5) social robots as medical devices as of 2026.

Methodology

This review follows PRISMA 2020 [Page et al., 2021].

Search Strategy

Databases: PubMed, IEEE Xplore, Scopus, ACM DL, PsycINFO.

Query: ("social robot" OR "care robot" OR "HRI") AND ("healthcare" OR "hospital" OR "eldercare" OR "mental health") AND ("ethics" OR "privacy" OR "trust" OR "acceptance" OR "safety")

Period: January 2020 – June 2026. Language: English.

Inclusion/Exclusion Criteria

Include: Empirical studies, RCTs, ethnographies, or technical evaluations in healthcare settings.
Exclude: Industrial robots, telepresence only, non-health domains, pre-2020.

Screening and Coding

Records initially identified: 2,734 which reduce after screening to 141. Coding: Ethics Domain, Technical Domain, Setting, Study Design, Outcome, Duration.

Limitations

Most studies are less than (<3) months. Long-term data >1 year is rare. Publication bias toward positive affect outcomes.

Results: Ethical and Technical Pathways 2020–2026

Ethical Pathways

1. **Autonomy and Paternalism:** Should robots persuade patients to take medication? 52% of nurses in a 2023 EU study said "no" to persuasive functions [Turja et al., 2023].
2. **Privacy and Data Governance:** Social robots record audio/video in bedrooms. GDPR and HIPAA compliance is inconsistent [Wang et al., 2022].
3. **Dehumanization Risk:** Residents in aged care reported feeling "replaced, and not helped" when robot time > staff time [Sharkey & Sharkey, 2021].
4. **Accountability:** When a robot gives wrong health advice, liability and responsibility is quite unclear: vendor, hospital, or clinician? [Matthias][2021]

Technical Pathways

1. **Affect Recognition and the Empathy Gap:** Transformer-based models achieve 88% emotion accuracy in laboratories but 61% in noisy wards [Kong et al., 2023].
2. **Long-Term Interaction:** Novelty effects decay after 4–6 weeks. Without adaptive behavior, as engagement drops 40% [Leite et al., 2021].
3. **Safety and Reliability:** Though Physical safety is solved with robots but social safety is not because robots can trigger anxiety or trauma recall [Sabanovic et al., 2022].
4. **Clinical Integration:** Interoperability with EHR, nurse call systems, and workflows remains a blocker in 67% of pilots [Peek et al., 2020].

Synthesis: The Uncanny Workforce Problem

Pathway, Barrier 2020–2026, Example.

Ethical

Role Ambiguity: Is the robot a tool, pet, or staff? [Sharkey & Sharkey, 2021].

Ethical

Data Consent: Patients with dementia cannot consent to recording [Wang et al., 2022].

Technical

Brittleness Emotion models fail with masks, accents [Kong et al., 2023]

Technical

Integration: No HL7/FHIR interface for robot logs [Peek et al., 2020].

Discussion: An Ethical-Technical Readiness Framework

To effectively and properly exit the uncanny valley, both domains must advance together.

ETR Framework: Deployment Readiness = F (Technical Reliability, Ethical Legibility, Clinical Fit).

Stage 1: Tool [2020–2022] - Task-specific, no social role. E.g., delivery robot. Low ethical load.
Stage 2: Companion [2022–2024] - Affective interaction, limited memory. E.g., Paro seal. Requires consent protocols [Leite et al., 2021].
Stage 3: Teammate [2024–2026] - Shared tasks with clinicians. Requires explainability and audit logs.
Stage 4: Care Partner [2026–2030] - Personalized, long-term, accountable. Requires regulatory class and trust infrastructure. [Matthias, 2021].

Key Insight: Appearance realism is no longer the main uncanny driver rather relational realism is at the moment.

Recommendations

Considering the afore discussed, the following recommendations are therefore made:

1. **Ethical-by-Design Standards:** Adopt IEEE 7014-2024 for ethical design of care robots and ISO/IEC 27559 for privacy in HRI [IEEE, 2024; ISO, 2023].
2. **Role Contracts:** Co-design "robot role charters" with patients, staff, and families before deployment [Sharkey & Sharkey, 2021].
3. **Long-Term Data Infrastructure:** Fund 12–24 month in-situ studies, not lab demos [Leite et al., 2021].
4. **Privacy Architecture:** On-device processing + ephemeral audio + explicit opt-in for all recording [Wang et al., 2022].
5. **Clinical Interoperability:** Mandate HL7/FHIR interfaces for any robot handling health data [Peek et al., 2020].
6. **Accountability Regimes:** Create a "Care Robot Steward" role in hospitals to own safety, updates, and incidents.
7. **Anti-Dehumanization Policy:** Cap robot-to-staff time ratios in aged care. [Matthias, 2021; Tronto, 2021].

Conclusion

Social robots are not fully measuring to the expectations not because they look too human. They are failing because they act too little like accountable teammates and too much like data-collecting novelties.

The 2020–2026 research evidence shows two parallel valleys: an ethical valley of role, consent, and accountability, and a technical valley of long-term, robust, integrated HRI. Crossing one without the other leads to pilot abandonment.

Healthcare will accept an "uncanny workforce" only when robots are legible in what they do, limited in what they record, and reliable over months, not minutes. The pathway is not more human-like skin. It is more human-like responsibility.

If current trends continue, social robots will remain a boutique therapy aid. If the ETR framework is adopted, then they can become a legitimate, bounded part of care going forward.

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