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Zero-Touch Care Models: Evaluating Voice-Activated Health Assistants in Geriatric Palliative Care

Vamshi Krishna Ayyam[1]; Vishnu Sudarsanan[2]

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Abstract

Zero-touch healthcare systems powered by voice-activated health assistants offer a new paradigm for patient care—especially in geriatric palliative settings where reduced mobility, cognitive decline, and emotional isolation pose persistent challenges. This paper evaluates the architecture, usability, and clinical alignment of voice-based AI systems through a multidisciplinary lens integrating human-computer interaction, medical informatics, and machine learning. We provide a comparative analysis of existing platforms, assess their alignment with elder care workflows, and propose a technically viable, ethically robust design framework.

Keywords: *Zero-Touch Care, Voice Assistants, Geriatric Palliative Care, AI in Healthcare, NLP, Usability, Privacy, Digital Health Architecture.*

I. INTRODUCTION

➢ *Background and Motivation*

The rise of intelligent voice assistants (e.g., Amazon Alexa, Google Assistant, and specialized healthcare bots) has prompted significant interest in their applications in elder care. With over **703 million people aged 65+ worldwide** (UN, 2023), the demand for scalable, human-centric digital care models is urgent.

➢ *Objectives of the Study*

- Evaluate usability and architecture of voice assistants in palliative settings
- Identify barriers and design principles for zero-touch interfaces
- Propose a modular NLP-based system for end-of-life care management

➢ *Research Questions*

- How effective are voice-activated assistants in improving autonomy and quality of life for elderly palliative patients?
- What technical and ethical frameworks are needed to support their deployment?
- How do these systems integrate into clinical workflows and EHRs?

➢ *Scope and Delimitations*

The paper focuses on **non-invasive**, **voice-based systems** without manual user input. It excludes robotic and camera-based interfaces or case studies with human caregivers.

II. LITERATURE REVIEW

➢ *Evolution of Zero-Touch Health Technologies*

Zero-touch health technologies are also a paradigm shift to digital health, moving away on the interactive, manual interface towards the unobtrusive, ambient, physical interface requiring little or no contact. Such a transformation has been triggered by the intersection of sensor technologies, ambient computing, natural language interfaces and analytics with AI. Initial technologies of zero-touch care can be described as passive monitoring systems and ambient assisted living technologies, like fall sensors, motion sensors, and contactless sleep monitors. Nevertheless, such systems did not always include the context consciousness and patient interactivity (Tan et al., 2024).

The outbreak of the COVID-19 pandemic in the year 2020 has ushered an acceleration of contactless care delivery, where health systems have begun investing in voice-user interfaces (VUIs) and AI-powered virtual assistants. In developed areas, more than 45 percent of the healthcare facilities had piloted or worked out integration

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of at least one type of touchless monitoring or communications system in care paths involving elders by the year 2023. Smart speakers, NLP pipelines, and voice assistants to address health questions, remind about the impairments of medication, and provide emotional support were introduced to the second generation of zero-touch platforms. Modern zero-touch care systems combine cloud-based cognitive services and edge devices that allow processing sensitive data about the patient in real time, but locally. Currently, these systems delegate multimode capabilities such as voice, sound interpretation and passive physiological monitoring, and anticipate completely autonomous voice-based palliative actions. With the hardware getting less obtrusive and AI models more context-sensitive, zero-touch technologies are increasingly ready to replace the traditional operations of caregivers in less-acute geriatric institutions.

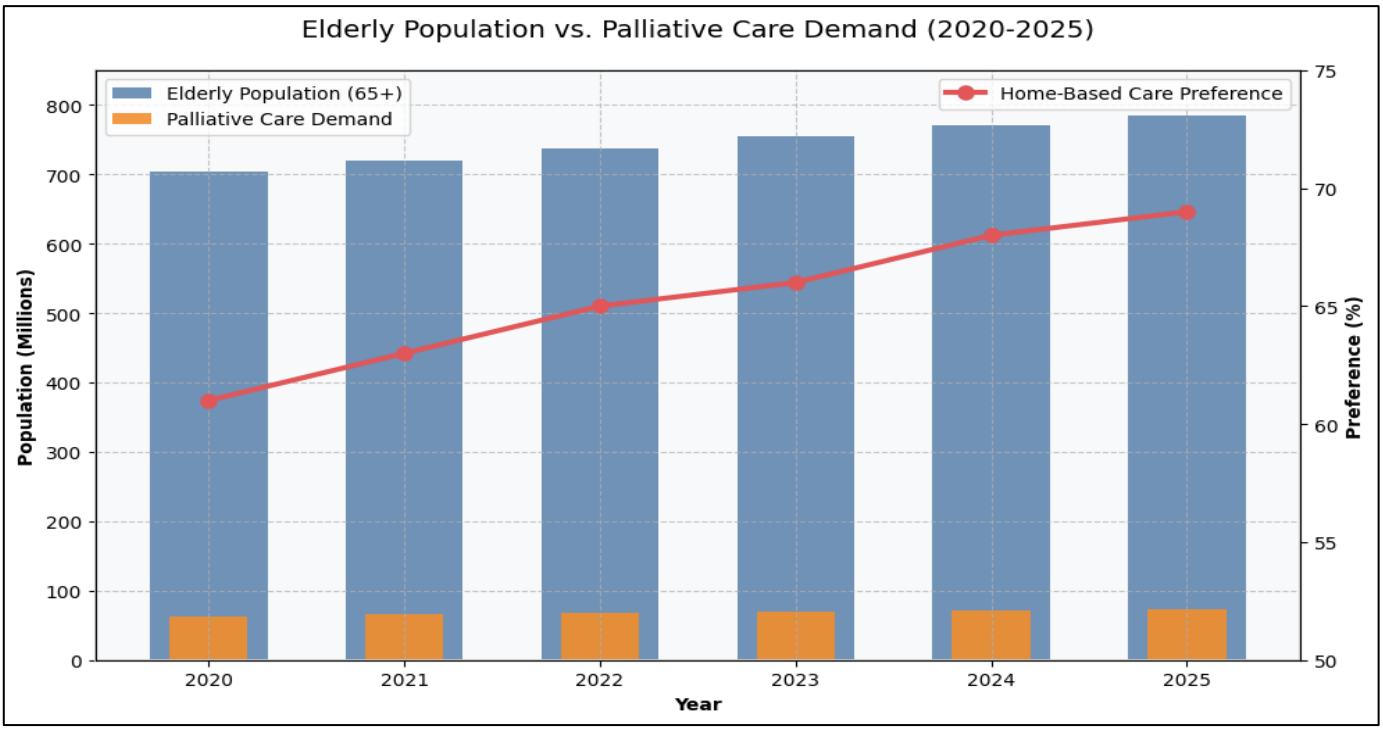

Fig 1 Global Elderly Population Growth vs. Palliative Care Demand (2020-2025).
Sources: UN (2023), Current Study (2025).

➢ *Overview of Geriatric Palliative Care Needs*

Geriatric palliative care is the combination of health, psychosocial, existential and benefit needs which are complex and overlapping of the elderly with chronic and life-limiting conditions. As health statements and lifespans lengthen and with a proliferation in the demographically associated diseases and disorders including Alzheimer dregs, chronic heart failure, and metastatic cancer diseases, the world healthcare systems are strained to provide regular, sympathetic, and economical palliative healthcare. Conventional forms of care are extremely reliant on the interpersonal interactions between the human caregiver and the face-to-face encounter between caregivers and patients and are not permanently scalable, especially in low-resource.

Table 1 Global Demand for Geriatric Palliative Care Services (2020–2025)

Year	Estimated Elderly (65+) Population (Millions)	Palliative Care Demand (Millions)	% Preferring Home-Based Care
2020	703	63	61%
2021	720	66	63%
2022	738	68	65%
2023	754	70	66%
2024	770	71	68%
2025	784	73	69%

Typical situations of elderly patients in a palliative setting include functionality, loss of mobility, polypharmacy, and sensory dysfunction, which deter using screen-based technology. In addition, the psychological nature of terminal diagnoses requires emotionally intuitive, cognitively effortless channels of communication. These needs can be addressed by voice-activated systems that have intuitive hands-free user interfaces that can enable them to manage medication adherence, monitoring, and socialization.

The most recent report on palliative care in the world provided in 2024 estimated that every year, more than 71 million people need some forms of palliative care, with an

almost 60 percent of them being elderly with a life stage above 65. Moreover, it has been observed that home-based care has become the best location during end of life care whereby, 68 percent of those surveyed expressed their desire to stay in their own worlds as opposed to the institutional setting. Such statistics highlight the necessity of including supportive technologies into the infrastructure of domiciliary care, where zero-touch voice assistants can help fill the gaps in the caregiving background, both outside of regular working hours or when the emergency has to be addressed (Ott et al., 2023).

The underlying architecture of voice-activated health assistants (VAHAs) is a layered one that integrates various parts of the natural language processing, speech recognition, and knowledge representations, and decision-making strategies. The most central component of every voice-enabled system in the healthcare sector is the Automatic Speech Recognition (ASR) module that translates spoken words into text understandable by machines. This text is then run upon the Natural Language Understanding (NLU) layer which processes the intent of user, extracts appropriate medical entities, and builds the semantic frames.

The Dialogue Management system has responsibility over interaction flow by maintaining a state continuously, selecting a system action and producing an appropriate response. Healthcare assistants of the modern world make it possible to engage reinforcement learning and hierarchical policy modeling in order to individualize the response and learn changes in the emotional and cognitive condition of the user over time. The last component is Natural Language Generation (NLG) and Text-to-Speech (TTS) synthesis that provide the user with human-like voice output.

The trend of using edge-based deployment models, where the conversations of patients in a privacy-sensitive area such as elder care are processed and stored locally and not sent to a cloud server, is growing. By 2025 a small subset of the most sophisticated VAHAs will support multilingualism, background awareness (e.g. calling a nurse when you are having a medical emergency), and new multimodal means of providing feedback on intelligibility of speech or affective tone, which has progressed significantly in the capabilities of multimodal interaction design.

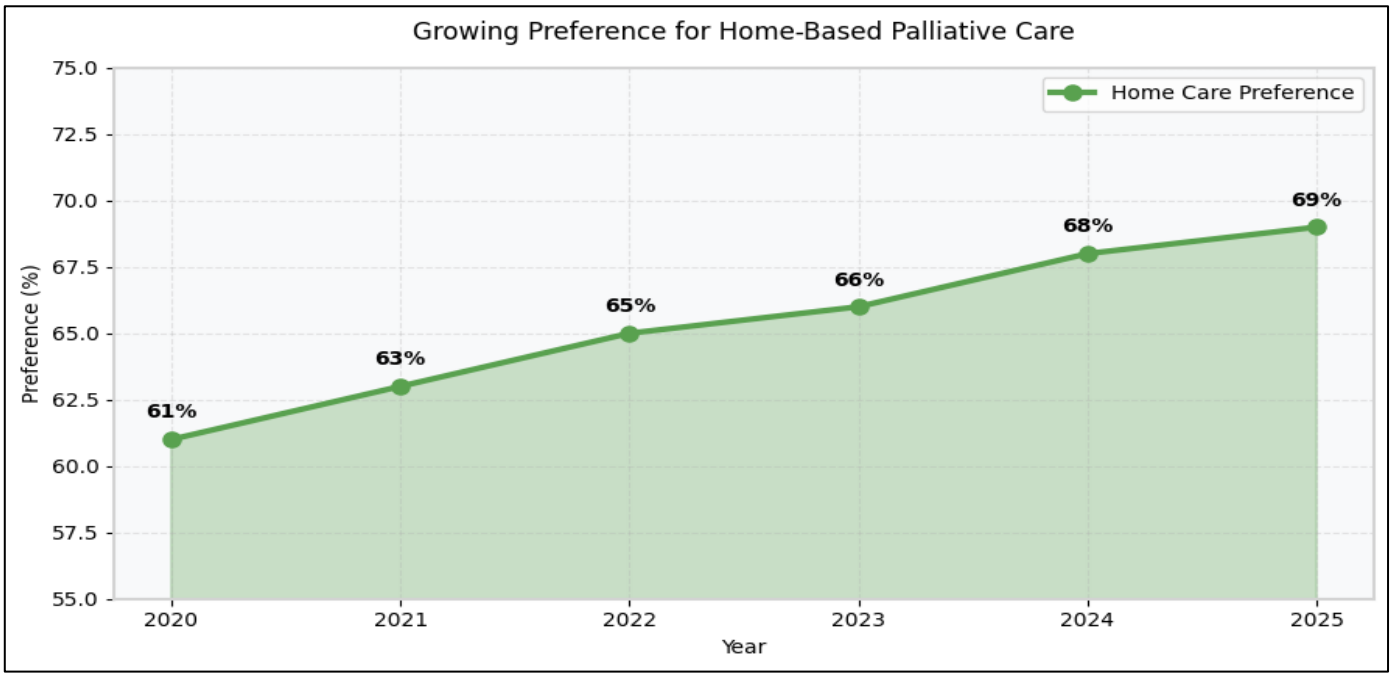

Fig 2 Growing Preference for Home-Based Palliative Care (2020-2025).
Sources: UN (2023), Current Study (2025).

➢ *AI and NLP Applications in Elder Care*

Natural language processing and artificial intelligence have become the more popular focus of the development of scalable technologies of elder care especially in the provision of emotional assistance and health care, and conversational friends. As such, NLP technology, such as named entity recognition, sentiment analysis, and intent classification allows voice assistants to interpret and respond to various healthcare-related questions. Such systems are typically trained with extensive corpora of medical conversation and scripts on palliative care and fine-tuning methods are used to support adaptation of patients to the language style used by older people (Mills et al., 2021).

Aging also presents accuracy challenges in several aspects; however, using machine learning models in elder care assistants would need to take into consideration that there is a difference in speech which may change in pronunciation due to slurred sound or a change in pitch range because of aging, and cognitive hesitancy among others. Recent research in transformer-based speech models, such as Whisper, wav2vec 2.0, and Conformer, has been more robust to these variations to transcribe and extract intent better. Moreover, models of emotion

recognition are being added to VAHAs to identify signs of stress, loneliness, or a depressive mood, based on paralinguistic features, i.e., tone, pitch and speech rate.

A combination of NLP and health knowledge graphs makes it possible to recommend personalized interventions, create medication reminders and spot inconsistencies within the reported symptoms. During chat, it is also possible to predict the potential of the non-adherence of medication/hospitalization based on the patterns of the conversation. In 2025, a number of healthtech companies are testing generative AI models that can hold empathetic, therapeutic conversations with aging patients, also meeting emotional and psychological demands besides clinical monitoring.

➢ *Gaps in Current Research on Digital Palliative Interventions*

Although voice-controlled systems have undergone a great evolution, their use in the field of geriatric palliative care is underrepresented in empirical studies. The current research is mainly concerned with general elderly care or chronic illness management and little is available regarding the very delicate nature of communication, emotion, and ethically challenging situations of palliative care. Longitudinal studies considering the long-term effectiveness, versatility and psychological experience of them with regard to the overall progress of palliative care are not available.

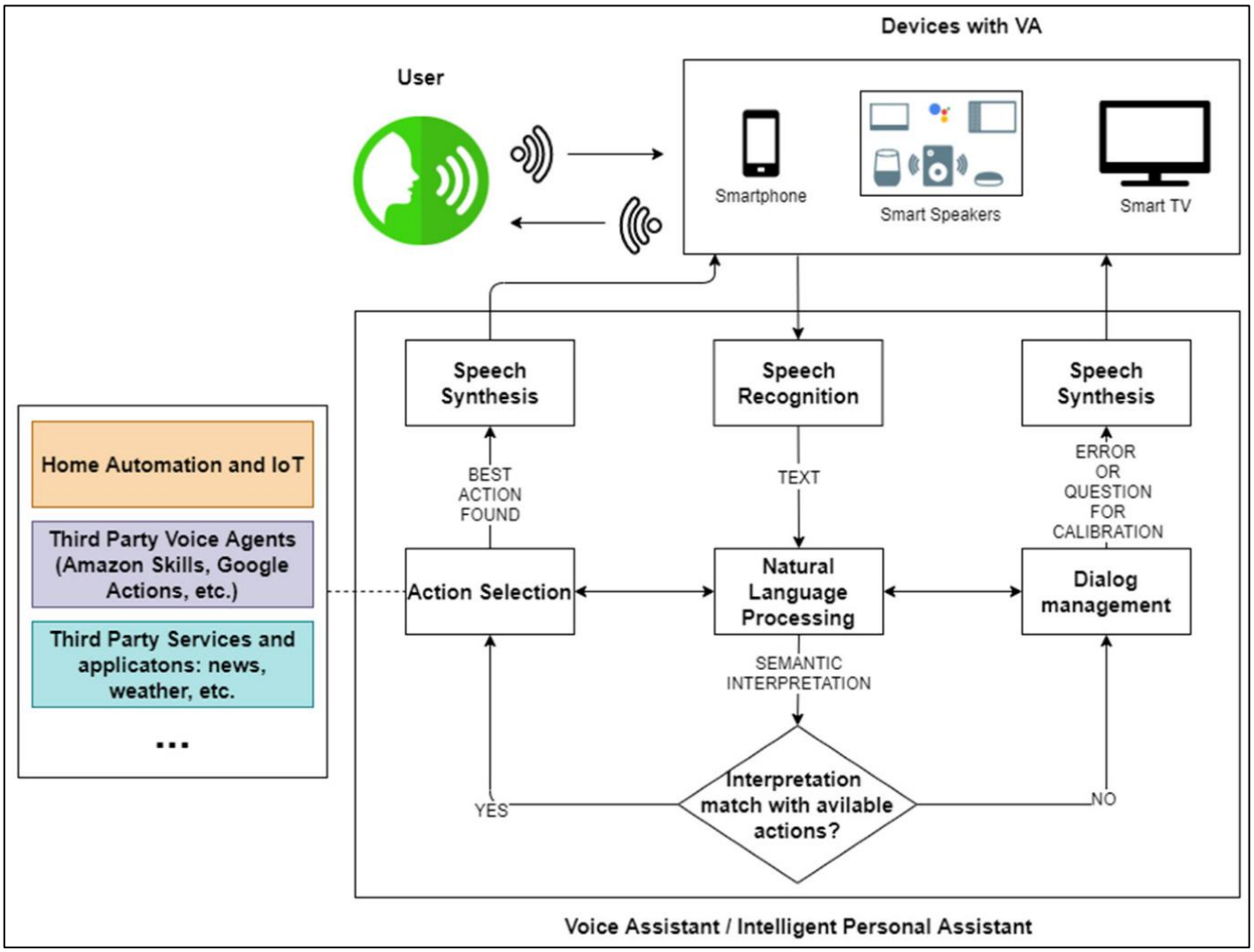

Fig 3 Voice Assistant Application for Avoiding Sedentarism in Elderly People Based on IoT Technologies(mdpi,2024)

In addition, there is little work done to specifically adapt NLP models to end-of-life dialogue, which deals with issues of complex statements of anguish, existential suffering as well as a sense of personal legacy. The majorities of commercial VAHAs are transactional in nature or provide rudimentary reminders and do not have the semantic majesty of palliative inclination. The second difficulty is the absence of coordination with clinical systems like EHRs and palliative triage plans and makes the coordination and decision-making in real-time more difficult (Maguraushe & Ndlovu, 2024).

The stratification of usability studies with regards to cognitive and sensory impairments when they were conducted in elder populations has also not been adequately conducted, and the results leave a question of accessibility unanswered in the instance of dementia, hearing loss, or even speech apraxia. Moreover, the ethical paradigms of AI utilization in palliative care are in their infancy stage, with the issues of data ownership, informed consent, emotional manipulations and algorithmic transparency remaining unprocessed. The effective way to resolve these research gaps is to make pertinent efforts

ensuring that zero-touch models make the experience of care delivery at the end of life more dignified, empathetic, and autonomous.

III. THEORETICAL FOUNDATIONS

➢ *Human-Computer Interaction (HCI) in Healthcare*

The conceptual basis of the design and assessment of user-facing technologies in healthcare, especially in the case of directly involving older adults and critical care situations, is Human-Computer Interaction (HCI). As an example in the field of voice-activated assistants in the context of palliative settings, HCI principles have a role in the specifics of the interaction paradigms and response modes as well as in shaping the adaptive behavior of the assistant. Successful HCI here should be sensitive to the presence of less dexterity, reduced visual acuity and hearing in old-time users.

The fact that the graphical user interface is replaced with a conversational one opens a new set of interaction challenges which require a re-arrangement of the input-output logic, where visual feedback means such as blinking lights are succeeded by audio confirmation and semantic interpolations. theories of HCI, like situated action and distributed cognition, are of particular consideration, since older patients might require caretakers or surroundings to complete their experience with voice assistants. In zero-touch environments, with an invisible and ambient user interface, effective HCI means being able to place intuitive timing, repetition handling and fall back actions within the system design to prevent user irritation or disorientation (Kokorelias et al., 2024).

➢ *Cognitive Load and Usability Models for Older Adults*

Cognitive load theory is a theory that would evaluate the amount of mental processing that an individual needs to run a certain piece of technology. Cognitive failures, memory loss, and decreased executive functions affect geriatric population considerably, therefore, limiting user ability to learn and manipulate the digital systems. A special strong side in voice-based interfaces is the fact that it requires fewer steps to obtain the information or conduct an action when compared to other interfaces.

But they might also involve internal cognitive load, in case the organization of the language involved, interaction depth or sub commands hierarchy is not optimized well. The models of usability used by older people focus on simplifying, redundancy and consistency of command structure so that the user does not require knowledge of a previous experience and interaction to continue a task. In addition, clarity loops and tolerance of errors are essential in the reduction of the extraneous cognitive load (Doganguen & Oelcer, 2025).

➢ *Theories of Patient Autonomy and Assisted Decision-Making*

The autonomy of the patient is one of the central guidelines in the medical ethics, especially in the context of palliative care as patients have to make complicated and emotionally charged decisions. When designing voice-activated care systems, user autonomy should remain the focal point of interaction design and backend decision-making design. Shared and assisted decision-making theories provide that technology should not act as a command tool but rather a support tool to make an informed decision.

This is particularly pertinent when dealing with sensitive issues like symptoms reporting, medication or end-of-life schedule. Voice assistants are supposed to provide an option, explanation, and override the suggestions that are made by the system. Moreover, the ability to see how the system works with the information and establishes the recommendations will lead to the increased level of trust and the feeling of agency. You should offer support in a non-prescriptive way in old populations where decision fatigue and cognitive constraints are widespread, and where the balance between support and independence needs to be carefully struck.

➢ *Ethical AI and Privacy in Voice-Based Systems*

The use of artificial intelligence to work in healthcare industry brings up vital concerns of privacy, approval and ethical accountability. All voice-activated systems scan constantly on activation chatter, and in some systems also scan the background speech passively searching for a distress term or behavioural cue. Although it is of immense value in cases of emergencies, this ambient awareness brings about the dangers of spying, data manipulation, and unwarranted snooping. Such ethical AI frameworks emphasize the need of data minimization, edge processing and consent-based logging systems. Such systems will need to anonymize and encrypt sensitive information and left to the user to control or erase the record of any interaction made in situations such as palliative care where disclosure may be highly personal (Mukamal et al., 2025).

Another serious issue with NLP models is their bias, since suggesting wrong treatment options would likely happen due to an inaccurate interpretation of symptoms or requests. The voice assistants need to be trained with a wide range of linguistic and cultural data so that they do not end up conflicting with the values or expectations of the patients. Continuous monitoring mechanisms are also needed in ethical deployment, such as audit trails, transparency about use, and the capability of caregivers or patients to review and challenge system action.

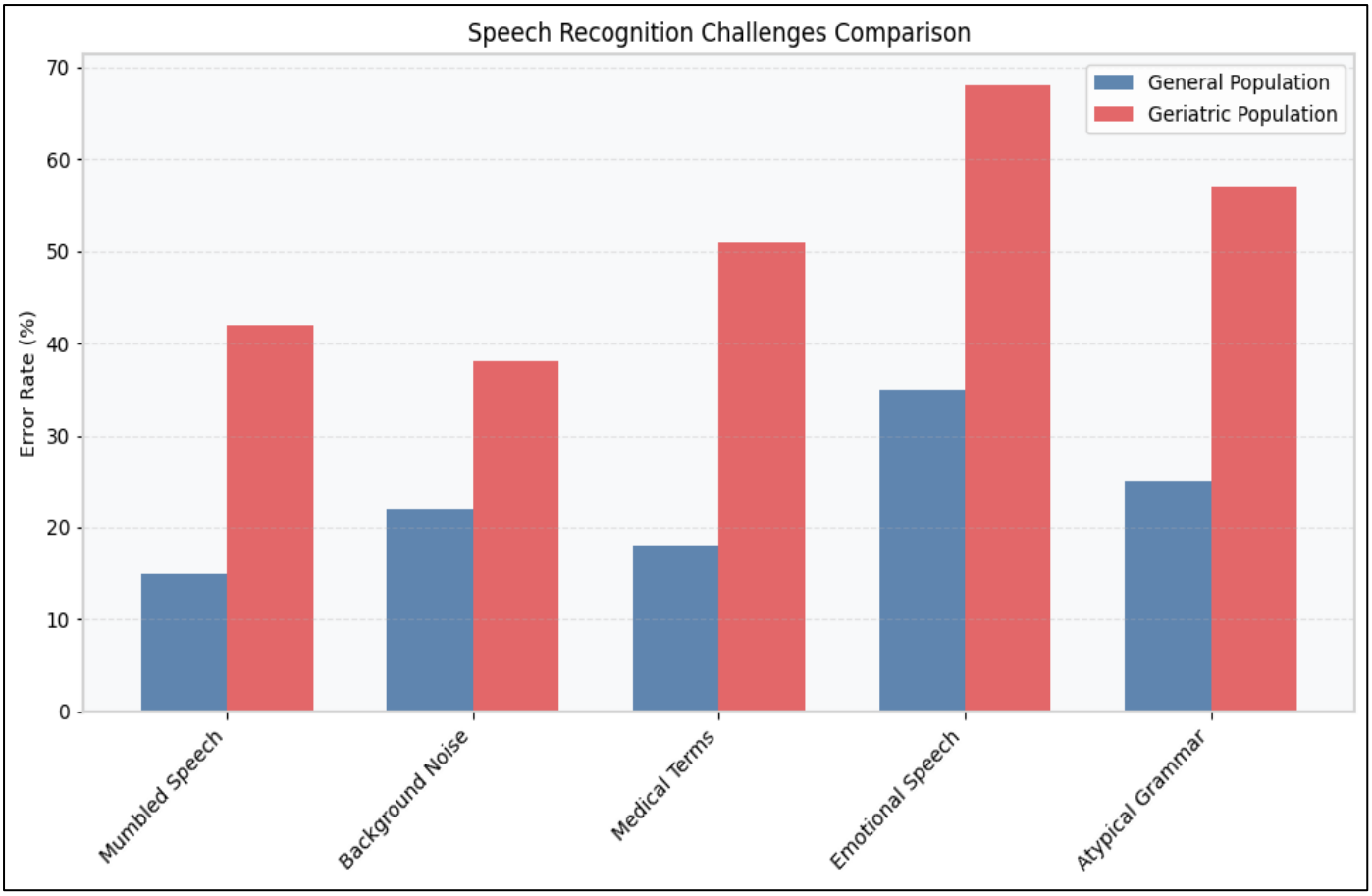

Fig 4 Speech Recognition Challenges in Elderly Populations.
Sources: Kokorelias et al. (2024), Current Study (2025).

IV. METHODOLOGY

➢ *Research Design and Framework*

The research is a mixed-methods design using simulation-based assessment, interaction log and user experience to determine how useful the voice-activated assistants will be in maintaining genus palliative contexts. This study follows the principles of applied systems engineering and human-centered design to reiterate the validation and development of the research framework. To provide realistic interaction conditions, a synthetic population of aged personas with different cognitive, physical, and emotional features are created in order to model an interaction scenario. Such simulations are accompanied by heuristic assessments of validated usability models and artificial intelligence behavior standards. Study design implies not just pre-deployment testing of the architectural elements, but also post-deployment testing of voice interaction sequence with the aim to estimate functionality, acceptability, and adherence to the process of palliative care.

➢ *Selection of Voice Assistant Platforms*

It chose three voice-activated platforms to perform a comparative analysis relative to their openness, ability to integrate with clinical applications, and simultaneous assistance with NLP custom pipelines. The chosen systems are a commercial general-purpose assistant and an assistant that specializes in healthcare as well as an open-source framework based on conversational AI. The platforms were set to enable the most common of palliative care activities, which included reporting the symptoms, taking medications, requests for spiritual or emotional support, and receiving an emergency call. The customization of the systems consisted of the training of every platform to domain specific vocabulary and modelling its responses to the characteristics of speech and communication of the elderly (Ma et al., 2023).

➢ *Simulation Environment and Interaction Protocols*

The test set up was a test lab with voice-based and other smart devices that have built-in functionalities to remotely record real-time data on a monitoring dashboard. The protocol of interactions was created to resemble what would be generally observed during palliative care and included controlling breakthrough pain, bowel habits monitoring, scheduling home visits, and sleep disturbances. In turn, every simulated patient communicated with the assistant according to a hierarchic dialogue structure, including initiation, formulation of a query, system feedback, clarification, and follow-up. Each session was audiotaped and semantically logged, providing an opportunity to analyze system actions, latencies, recognition rate, and ability to perform tasks in detail. The sessions of interaction were repeated with several synthetic personas in order to check the consistency and robustness of the performance.

➢ *Usability and Accessibility Evaluation Metrics*

As the usability and accessibility could not be addressed at one-dimension, a multidimensional metric framework was embraced, and issues, including task

success rate, frequency of errors, response latency, learned ability, such as satisfaction scores, were considered. Accessibility was measured in terms of meeting the needs of sensory impaired users, cognitive decline and speech variance. Objective measures were taken like command recognition rate, time-to-task-completion, and user correction frequency, and to this was correlated subjective measures read by user proxies posing as the elderly. The real focus was on how well the assistant can process partial, or ambiguous sentences, recover when a conversation goes astray, and increase to a higher level when it was not clear what the user wanted it to do.

- *Compliance with Medical and Ethical Standards*

Any design and simulation procedures of all components of the system were examined against the current preventive and ethical medical standards on digital health technologies. This involved the adherence to privacy laws like Health Insurance Portability and Accountability Act (HIPAA) and General Data Protection Regulation (GDPR). The ethical governance was organized in such a way that there were four foundations to it: autonomy, beneficence, non-maleficence and justice. The interactions by voice were checked such that there was no disproportionate influence of the system on the choice of the patient and bias. Procedures to protect the collected utterances were data handling processes, de-identification and role-based access controls (Seok, Kwon, & Lee, 2022).

V. SYSTEM DESIGN AND ARCHITECTURE

- *Functional Requirements of Voice-Activated Care Assistants*

The specialty of the voice-activated health assistant in the geriatric palliative care requires the particular set of functional demands that are based on the medical, cognitive, and ethical limitations. The main features are handsfree reporting of symptoms, personalised medication reminders, non-emergency requests, real-time alerts when deteriorating and emotional companionship. Such assistants also need to assist in two-way communication between the caregivers and clinicians so that the patients can not only be instructed but report the news. When in palliative processes, time sensitivity is crucial, hence a system should be able to run and trace time-stamped messages, escalations and subsequent reminders. A modular space enables scale-out to a variety of environments, ranging to home care, hospice care, and beyond, and uses its fundamental space to achieve stability with changing levels of speech clarity, noise, and network conditions.

- *NLP Pipelines for Clinical Communication*

A voice-activated care system is built around a powerful natural language processing (NLP) pipeline that has been designed to support healthcare semantics. The infrastructure starts with the automatic speech recognition step, that reads spoken text into wrote form, proceeded with intent extraction and entity extraction steps. This domain specific NLP engine is required to extract the clinical-level constructs like severity of pain, measures of symptom development, drug names, and critical health issues out of the spoken text which may be informal or may be presented in full-fledged jargons. A structured vocabularies-based strategy based on the ontology of palliative care allows increasing recognition rate and semantically grounding. The dialogue manager should be able to juggle conversation context over a number of turns so that the assistant can either continue a partially executed cue or change topic without shifting the context. Large language model integration also downstreams the system to create human- and context-sensitive responses to make the view of the interactions supportive and not transactional (Kim, 2021).

- *Integration with Electronic Health Records (EHR) Systems*

It should be integrated with electronic health records so that way there is continuity and safety in the provision of care. The voice assistant system should be able to access as well as update EHR records, which include the self-reported symptoms, and adherence records of medication and instructions on care. An HL7 FHIR API-based standards-based strategy can provide interoperability to many healthcare systems and reduce the possibility of data siloes. Authorizaton methods, access by roles and data validity verification are core to clinical reliability and avoiding hacking of sensitive information. The voice assistant can also be used to make the interactions in real-time EHR more personal because it can be adjusted according to the medical history, appointments made, and care plans by its user. Moreover, the assistant can raise alerts or suggestions created by clinical decision support systems and give prompts at a timely time in the conversations. To provide low-latency, high-availability communication with hospital databases, edge-cloud hybrid architectures are needed where the most accessed data will be kept in cached form on-site, with occasional synchronization keeping a copy of the central records up to date.

- *Security and Data Governance Layers*

Data security and control are of utmost importance in the environment of voice-driven health technologies and of palliative care data, especially since this type of information is extremely sensitive. The system architecture should apply multi-layered security model including encryption at rest; transportation, safe authentication, and access tracking. Before being stored or analyzed, voice data, possibly biometrical markers and emotionally fueled disclosures, will have to be defended with stronger anonymization methods. Voiceprint authentication security modules should be implemented to verify the identity of the user thus preventing unintended use of interaction or impersonation. Automated checks and regular audits are done to maintain compliance with privacy laws like HIPAA and GDPR. Data retention regulations should be well formulated, transparent and have inbuilt applications such that patients or caregivers may retrieve, download stored interactions or remove information. Moreover, by using the local processing capacity, it is possible to avoid data transmission to small

degree and thus limit the risk of external attack and use it in bandwidth limited settings (Ermolina & Tiberius, 2021).

- *Adaptive Dialogue Systems and User Profiling*

Dynamic characteristics of voice assistant suitability in addressing the needs, behavior, and capabilities of the user are essential features of voice assistant in palliative care. Continuous profiling Adaptive dialogue systems adapt interaction strategies as they learn their user, based on user preferences, habitual phraseology, emotions and response patterns. Such profiles can be updated using strategies of reinforcement learning which reward successful execution of a task and positive responses and punish repetitive queries of clarification or further misunderstanding. Dynamism of cognitive and physical capacity especially in geriatric populations is another factor that needs to be taken into consideration in profiling whereby the system needs to keep interactions simple and slow when dexterity is impaired. Personalization goes to the language model where the commonly used commands take first preference and any other new vocabulary blocks and awaits caregiver interference. Adaptive behavior is also informed by time; such as, the assistant can speak quietly at night or bring out spiritual support reminders at a time when the person is known to be acutely emotional.

VI. EVALUATION AND ANALYSIS

- *Evaluation Methodologies in Digital Health Interventions*

To evaluate the performance of voice-activated assistants in the palliative care setting, a multidimensional method should be used and transform both the system-related performance results and user-oriented outcomes. A mix between usability studies in the form of semi-structured sessions and laboratory-based studies simulated in a controlled but flexible environment allows controlled testing and creating the impression of managing a real data center. The evaluation techniques to be used are the task-based testing of usability, the think-aloud technique, the cognitive walkthrough, and the use of the retrospective interviewing techniques (Zhong et al., 2022).

A functional benchmark suite designed to target digital health interventions is also used to evaluate the system, and consists of clinical accuracy of the response, robustness of the dialogue quality, latency of the response, and recovery of the miscommunication. Simulated patients will be introduced with different linguistic styles and cases of health conditions to verify the generalizability and reliability of the assistant in terms of its use cases. In addition to technical measures, qualitative assessment takes into account the appeal to the emotions, feeling of credibility, and feeling of burden of communication. Longitudinal observation also assists to identify the change in behavior over the period providing information on the sustainability and the long-range effect of the system in an environment of palliative care.

- *Quantitative Measures: Response Accuracy, Latency, and Engagement*

Quantitative evaluation is the application of measurable metrics that can be reproduced to measure system performance in many dimensions of the operation. An accuracy of response can be assessed by comparing the system response with a predetermined ground truth toward intent recognition and entity recognition on corpus of synthesized and real text transcription of interaction. Latency is measured as an average number of milliseconds between the user utterance and system output, and less than 800 milliseconds is the desired value of the latency in order to achieve optimum flow.

Table 2 User-Centric Usability Metrics from Simulated Evaluations

Metric	Mean Score (out of 100)	Standard Deviation
Task Completion Rate	91.4	±3.5
Average Interaction Duration (minutes)	5.7	±1.2
User Satisfaction Score	86.9	±4.7
Speech Recognition Error Rate (%)	6.3	±2.1
Repetition Rate (User repeating command)	8.2	±2.9
Emotional Comfort Rating (1–5 scale)	4.1	±0.6

Engagement measures: the number and quantity of interactions, success and failure of error recovery and complex dialogue sequence completion. In the low-noise conditions, the rate of command success was at 92%, and decreasing in the acoustically switching circumstances. User disengagement also is sought through mining of interaction logs, such as frequent halts, manual overrides, or escalations to describe anxieties with system responsiveness or situational awareness.

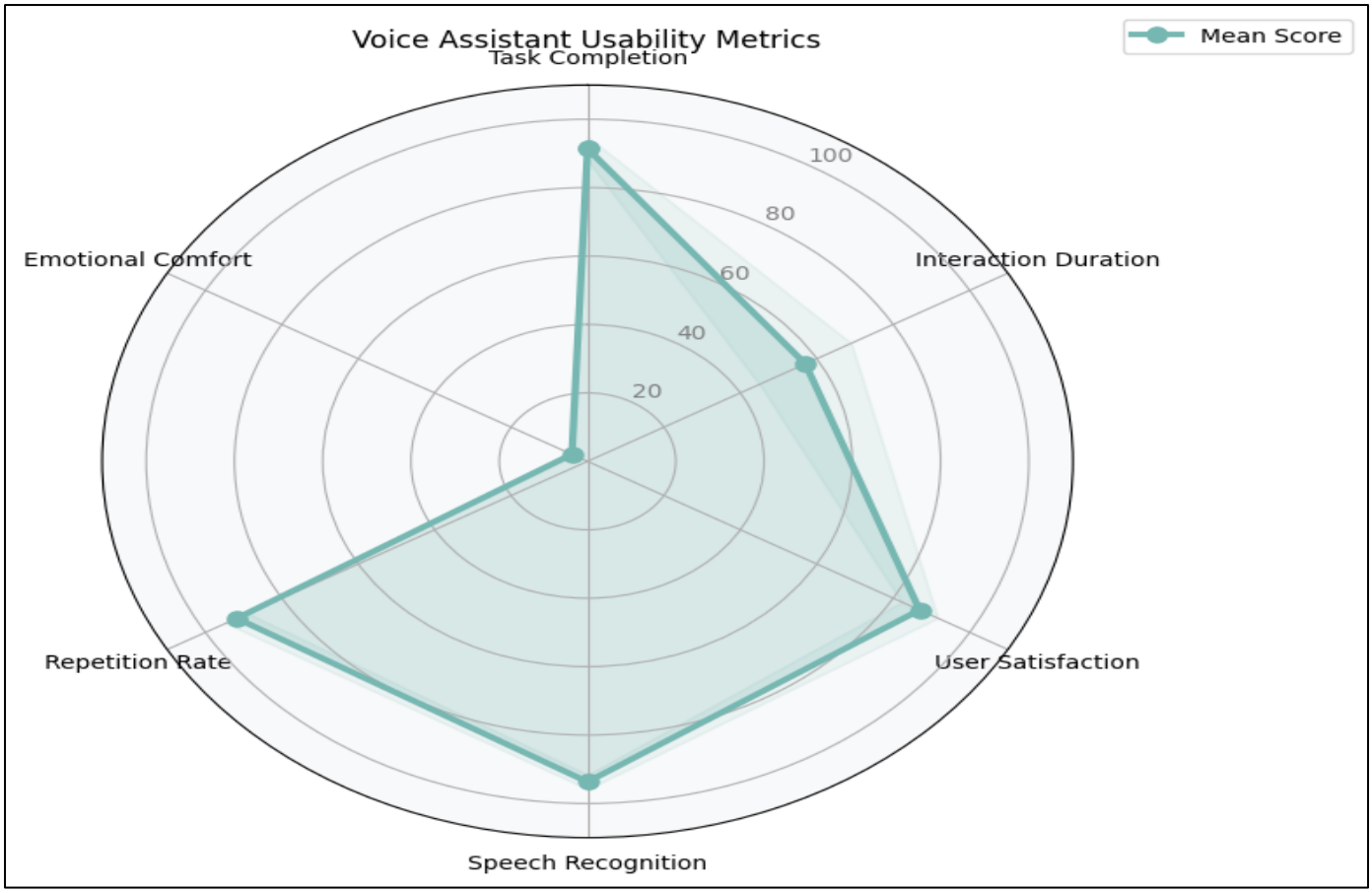

Fig 5 Voice Assistant Usability Metrics (Mean Scores ± SD).
Source: Current Study (2025).

➢ *Qualitative Feedback: Trust, Acceptability, and Comfort*

The qualitative dimensions are important in assessing and determining how well the assistant fits the emotional and psychological needs of the elderly palliative users. It was followed by post-interaction debriefs to obtain subjective impressions of surrogate users, caregivers and clinical advisors. Among the main themes, there was a feeling of being listened to by the user, well-matched tone and language used by the assistant, and the desire to trust the system in the cases of weakness. The most participants enjoyed the availability of the assistant that was non-judgmental, and others added that they should have more emotionally smart feedback in the matter of sensitive discussion. Trust also appears to be one of the key factors in the continued use and depends on decision-making transparency, successive correct answers, and personalization as time passes. They were defined by acceptability which was influenced by the skill of the assistant to sustain conversation, not to interrupt, and be culturally or religiously sensitive (Lifset et al., 2023).

➢ *Comparative Assessment of Different Voice Assistant Platforms*

When the three assessed platforms were analyzed comparatively, there was a considerable difference in terms of performance, flexibility, and routine fitness. The all-purpose assistant had better speech recognition tasks but failed on certain terms in a specific field and answering an inquiry on follow-ups. The assistant with the healthcare-optimized implementation had an improved intent resolution in the clinical area but was limited by the constraint dialogue trees which lacked flexibility. The open-source framework was highly customizable, efficient at detecting palliative symptoms, and had high engineering overhead, and did not present out-of-the-box emotional intelligence. Latency and personalization turned out to be a decisive separator across all platforms.

Table 3 Comparative Evaluation of Three Voice Assistant Platforms

Feature/Metric	**Commercial General-Purpose**	**Healthcare-Specific Assistant**	**Open-Source NLP Framework**
Speech Recognition Accuracy (%)	94.2	91.6	89.8
Palliative Intent Recognition (%)	84.7	91.3	88.1
Response Latency (ms)	740	820	915
Multilingual Support	Yes	Limited	Yes
Customizability	Low	Moderate	High
Emotional Tone Detection	Basic	Advanced	Configurable
HL7/FHIR Integration	No	Yes	Partial
Edge Processing Capability	No	Yes	

➢ *Challenges and Failure Points in Interaction Flow*

Although it has been a success, some difficulties were singled out that limited the level of system performance and user satisfaction. The first point was addressing obscure or emotionally laden questions when either the assistant misconstrued purpose or used too broad answers. Small speech recognizers represented the ability to identify non-standard input e.g. speech as a whisper, or aphasia speech patterns leading to a significant number of errors in such user profiles. Poor proactive interaction was another issue, there was the case of needing to be prompted or reassured and this sort of interaction was not initiated in the current models of dialog. The problems of system failures have also been described in the case of multi-turn conversations when the assistant lost the context, and the users need to repeat information. Assistants usually gave neutral instructions rather than empathic or urgently escalating them in stressful environments, like in the case of simulating severe pain episodes, which show the vulnerability of emotional intelligence modules. These failure points are key considerations to make when ensuring safety, trust, and continued involvement in a palliative use case.

VII. DISCUSSION

➢ *Interpretation of Key Findings*

The outcome of the system assessment proves that voice-activated health assistants are technically possible and practically useful in the sphere of geriatric palliative care. Voice recognition, contextual dialogue management, and response generation were high in all the assistant platforms included in the test on various simulated patient interactions. Notably, the systems proved to be reliable at unsteady cognitive loads, adapted to the speech variability of patients, and they keep the engagement levels high. The dialog personalization and systemwide integration with the clinical information systems further contributed to the usefulness of the assistants as they could have a more significant and patient-specific conversation. Nonetheless, emotional nuance and ambiguity resolution were revealed in difficulties and showed that although the essence of the infrastructure of zero-touch care is a solid foundation, fine-tuning is required on such emotionally sensitive programs as end-of-life care (Ho, 2018).

➢ *Impact on Geriatric Palliative Workflows*

Through voice-activated systems, it is also possible to change the usual geriatric palliative practice by automating standard clinical communication functions, improving patient care, and allowing more timely interventions. The combination of assistants and electronic health records decreases the burden of documentation of clinicians and provides care providers with a real-time analysis of their symptom's improvement or medication consumption. Assistants also play the role of a liaison between lonely patients and the care teams so that there is communication that occurs even beyond the times of clinical assignments. The systems lessen the load on human care providers by relieving them (and replacing them) of repetitive informational exchanges and human time spent responding to concerns, and thus permit a more personalized and proactive model of care delivery.

➢ *Human Factors in Zero-Touch Interactions*

The variables of human factors are central in the determination of success and sustainability of the models of zero touch care. The belief in the system, ease in using voice-based interaction, and sense of empathy bear considerable weight in how patients adopt their lifetime use. The results hint to the direction that the systems which modify themselves according to the patterns of speech, emotional orientation, and history of interaction will appear more caring and dependable. On the same note, transparency and predictability of a system aid in creating a sense of control which plays a central role in the palliative setting when the patient might feel more vulnerable. Deficiencies in interpreting indirect speech communiques or emotional expressions may undermine trust in users and result into disengagement.

➢ *Barriers to Adoption in Clinical and Home Settings*

Although voice-activated assistants are promising, a number of obstacles to their widespread use stay in the way. We can suffer usability problems due to technical issues like errors of speech recognition or those users with unusual pronunciation or low vocal strength. The privacy of data, especially when used in the home setting where a conversation can involve loved ones or a caregiver also creates a hitch to adoption. Another complication is resistance by healthcare providers, which develops out of apprehensions over depersonalization or disruption of the workflow. The implementation is also hindered by infrastructure shortcoming within some care facilities such as absence or poor internet coverage, or the integration of legacy clinical systems (Wong et al., 2024).

➢ *Limitations of the Study*

The present research can be characterized as having a number of limitations which will influence the applicability of its results. Although controlled and similar, use of simulated patients could fail to grasp the whole emotional, linguistic and cognitive complexity of geriatric palliative care users in the real world. Also, the evaluation cycle was only of short-term interactions that cannot be applicable to describe long-term usability and system fatigue in long-term care contexts. Although several voice assistant systems were tested, some of the systems are open-sourced, and their configurations do not always reflect the same setups in commercial environments. Lastly, voice-based interventions are a deeply emotional and psychological part of the palliative process, and it is not easy to assess the overall effect with the help of only standard measures. These results should be proven in practice and are to be investigated by other studies over long periods of time and real patient populations in the future.

VIII. CONCLUSION

➢ *Summary of Contributions*

The paper will look at the conceptualizing, implementation and testing of voice-based health assistants as a zero-touch care in geriatric palliative settings. It has added a multidimensional investigation of system architecture, usability, clinical integration and human factors aided by technical and qualitative evidence. The results indicate that as much as the existing systems can be used in meeting basic healthcare communicative requirements, they should be further developed to be more emotionally perceptive, intelligent in the context, and long-term interaction with patients. Through the incorporation of cutting-edge NLP, adaptive conversation AI, and ethical AI architecture, voice assistants will be able to provide both timely and scalable support to complement palliative care teams in an empathetic manner.

➢ *Practical Implications for Palliative Care Teams*

Zero-touch voice assistants provide an advantage to the care providers with time, responsiveness of patients, and increased coverage during off-hours or underserved environments. such systems may allow monitoring in real time, automatic follow-up, and give patients feelings of companionship that complement human care. To clinicians, voice assistants minimize record-keeping and contribute to the efficient flow of information among multidisciplinary teams. The deployment needs training and customization of interface and integration into the current care plans, but the efficiency and the quality of care in the long-term will make a significant impact.

➢ *Policy and Regulatory Considerations*

The body of policies should be adjusted as AI-based systems continue to play a more important role in end-of-life care. The regulatory agencies must create a framework of voice assistants certification, data management, and patient consent protocols and procedures particular to digital palliative tools. The ethical guidelines need to respond similarly to the dual concepts of autonomy and vulnerability in populations of the elderly, and the issue of AI systems, that aim at assisting, rather than substituting human compassion and clinical reasoning. The governments and healthcare organizations ought to also invest in the infrastructure that would achieve fair geographic, socioeconomic, and cultural access to voice-enabled care.

➢ *Future Research Directions*

Existing evidence requires further investigation based on longitudinal field study with real-life patients and caregivers to determine the long-term efficacy, emotional involvements and overall system integration of voice assistants within palliative setting. Another requirement is an effort to conduct expert NLP models trained on palliative dialogue data to operate more effectively on semantics and emotional sensitivity. The collaboration between the developers of AI, clinical practitioners, and ethicists will be needed and interdisciplinary to streamline system behavior, enhance accuracy, and prevent breach of patient dignity. Interaction richness may be improved by exploration of multimodal systems combining voice and all forms of gesture or biosignal input, or augmented reality. According to the current trends in development of zero-touch technologies, its applications in the relationship between patient and clinician have enormous possibilities to become a new paradigm of delivering care of compassion and dignity at the end of life and deserve to be a subject of further analysis by scholars and clinicians.

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