

AI-Driven Gerotechnology for Reducing Language Barriers in European Long-Term Care*

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Abstract— Language barriers in long-term care (LTC) affect diagnosis, safety, access, and social inclusion among older immigrants. This structured narrative review examines how artificial intelligence (AI), Internet of Medical Things (IoMT), assistive robotics, and natural language processing (NLP) can support linguistically diverse older adults in European care settings. A structured search of IEEE Xplore, PubMed, Google Scholar, arXiv, and social science databases identified 36 sources published between 2005 and early 2025. The synthesis classifies technologies by function: monitoring, communication, decision support, social support, and care coordination. Evidence suggests that federated Edge-IoMT frameworks, assistive robotics, and voice-to-voice translation tools are technically feasible, with reported F1 scores of 0.86-0.94 for activity recognition and fall detection in selected systems. However, technical metrics do not by themselves demonstrate clinical safety, equity, or scalability. The review highlights three implementation priorities: support for low-resource languages and dialects, age-sensitive user interface design for adults aged 80 and above, and human oversight through professional interpreters and culturally competent care.

Keywords: artificial intelligence, gerontechnology, long-term care, language barriers, immigrants, IoMT, machine translation, older adults

I. INTRODUCTION

European long-term care systems increasingly serve older adults whose linguistic, cultural, and migration backgrounds differ from those assumed by mainstream care models. Language barriers can affect consent, medical history taking, medication safety, dementia care, emergency response, and social participation [1], [5], [8], [16].

At the same time, LTC systems face workforce shortages, demographic ageing, and pressure to expand home-based and digitally supported services. AI and gerontechnology are therefore frequently presented as tools for monitoring, communication, and care coordination. These technologies can be useful only if they are implemented with attention to

usability, privacy, cultural competence, and professional interpretation.

This paper provides a structured narrative review of AI-driven gerotechnology and IoT architectures relevant to language barriers in European LTC. The review organizes technologies by function and critically compares them across evidence strength, linguistic adaptability, privacy, usability, and implementation complexity.

II. REVIEW METHOD

A structured narrative review was conducted to capture evidence at the intersection of migration, ageing, LTC, and digital health technology. Searches were performed in IEEE Xplore, PubMed, Google Scholar, arXiv, and the Social Science Citation Index, complemented by European and national policy sources.

Search strings combined three conceptual blocks: ageing and LTC; migration and language barriers; and AI, IoT, gerontechnology, NLP, or digital health. Examples included: “language barriers” AND “long-term care” AND “immigrants”; “artificial intelligence” AND “older adults” AND “long-term care”; “federated learning” AND “elderly healthcare” AND “IoMT”; and “machine translation” AND “clinical communication”.

Sources were included if they addressed experiences of migrant or linguistically diverse older adults, technical architectures for elderly care, machine translation or communication-support tools, or policy frameworks relevant to digital LTC. Sources were excluded when they were not related to older adults or LTC, lacked relevance to language or migration, or did not provide sufficient technical, empirical, or policy detail. The final synthesis included 36 sources. Because this is a structured narrative review rather than a registered systematic review, the selection process is presented as a transparent mapping exercise rather than as a full PRISMA review.

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TABLE I. REVIEW SELECTION SUMMARY

<i>Element</i>	<i>Description</i>
Databases	IEEE Xplore; PubMed; Google Scholar; arXiv;
Search blocks	LTC/ageing; migration/language barriers; AI/IoT/NLP/gerontechnology
Inclusion	Older migrants; language barriers; AI/IoT architectures; clinical communication; digital LTC policy
Exclusion	Not related to LTC; no language/migration relevance; insufficient methodological or technical detail
Final set	36 sources synthesized thematically by technology function and implementation relevance

III. LANGUAGE BARRIERS IN LTC

The literature consistently identifies communication as a core determinant of access and safety. Older immigrants may underuse preventive services, encounter difficulties during triage, or receive incomplete explanations of treatment and care routines [1], [5], [17]. In LTC, communication is continuous and relational: residents must express pain, preferences, emotional distress, religious needs, food requirements, and end-of-life wishes.

Language barriers also interact with dementia, hearing loss, low digital literacy, and institutional routines. For residents with dementia, the inability to communicate in a familiar language may increase agitation, withdrawal, and dependence on staff interpretation of nonverbal signals [8]. Language is therefore not only an information channel but also a condition for dignity, trust, and participation.

IV. TAXONOMY OF TECHNOLOGY

To avoid treating AI as a single solution, the technologies reviewed here are classified into five functional categories: monitoring, communication, decision support, social support, and care coordination. This taxonomy distinguishes tools that directly address language barriers from those that indirectly improve safety when communication is limited.

TABLE II. TAXONOMY OF AI AND GERONTECHNOLOGY IN LTC

Function	Examples and relevance
Monitoring	FEEL, wearables, Edge-IoMT. Supports fall and activity detection; indirectly improves safety when communication is limited.
Communication	Voice-to-voice machine translation, digital communication aids, communication apps. Directly reduces routine language barriers.
Decision support	NLP analysis of case notes. May identify isolation, distress, or unmet needs, but depends on data quality and language coverage.
Social support	Assistive robotics and social interfaces such as MoveCare. Supports engagement if multilingual and acceptable to residents.
Care coordination	E-care, portals, telecare, digital records. Links users, relatives, staff, and institutions; depends on accessibility and interoperability.

A. Monitoring: Federated Edge-IoMT

The FEEL framework illustrates how federated learning and Edge-IoMT can support monitoring while reducing centralization of sensitive health data [21]. Wearable sensors collect physiological and movement data; local edge or fog nodes perform inference; and the cloud aggregates model updates rather than raw data. Reported F1 scores between 0.86 and 0.94 for activity recognition and fall detection indicate technical feasibility in selected settings [21].

However, these metrics should not be interpreted as proof of clinical safety across linguistically diverse LTC populations. Monitoring technologies can reduce safety risks when residents cannot easily communicate, but they do not solve language barriers by themselves.

B. Communication: Machine Translation and Apps

NLP and voice-to-voice machine translation directly target language discordance. Clinical studies suggest that translation systems can help complete routine consultations and improve information exchange in controlled contexts [24], [25], [35]. Digital communication aids may also support people with dementia or hearing impairments [22], [26], [34].

The main limitation is safety in complex or culturally sensitive communication. Machine translation may be useful for routine questions, orientation, daily preferences, or basic symptom descriptions, but professional interpreters remain necessary for consent, diagnosis, medication changes, safeguarding, mental health, end-of-life care, and conflict mediation.

C. Decision and Social Support

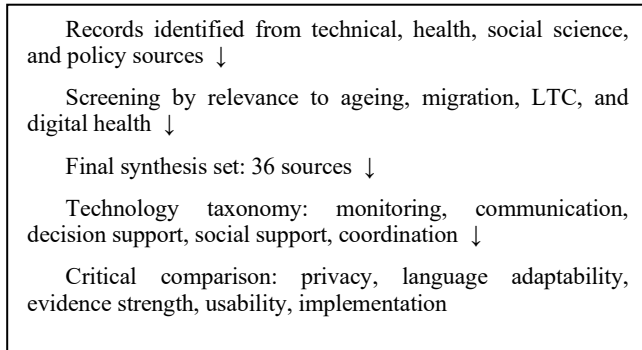
NLP models can analyze free-text case notes to identify patterns such as loneliness or social isolation in LTC users [29]. Assistive robotics platforms such as MoveCare combine environmental sensors, robotic interaction, and social interfaces to encourage activity, detect risks, and connect older adults with family or professionals [32].

Nevertheless, evidence remains uneven. Many studies are pilots, focus on technical feasibility, or are conducted outside

linguistically diverse LTC settings. Acceptability depends on trust, staff training, perceived usefulness, and the ability to integrate alerts into everyday care without increasing workload [27], [31].

D. Structured synthesis used in this review

Figure 1. Mapping from source selection to thematic synthesis and implementation recommendations.



V. CRITICAL COMPARISON

The comparison in Table III shows that technological promise and implementation readiness are not the same. Federated systems may offer strong privacy advantages but require infrastructure and technical capacity. Translation tools are easier to deploy but raise safety and equity questions. Social robots may support engagement, but their value depends on acceptance and context-specific design.

TABLE III. COMPARATIVE IMPLEMENTATION MATRIX

Technology	Implementation assessment
FEEL/Edge-IoMT	High privacy potential through federated learning; low-to-medium linguistic adaptability; high infrastructure complexity.
MoveCare robotics	May support social engagement; requires multilingual design, staff acceptance, and careful integration into care routines.
Voice translation	Useful for routine multilingual communication; higher risk in complex decisions and low-resource languages.
Communication apps	Relatively deployable; usability barriers remain for adults aged 80+, dementia, low literacy, or poor dexterity.
E-care portals	Useful for coordination; success depends on accessible design, interoperability, and digital inclusion.

VI. LOW-RESOURCE LANGUAGES AND DIALECTS

A major limitation of current NLP and machine translation systems is uneven performance across languages. Models generally perform best in high-resource languages with large corpora, standardized orthography, and available clinical terminology. Many older immigrants use dialects, minority languages, mixed language varieties, or code-switching between a language of origin and the host-country language.

In LTC this problem is intensified by age-related speech changes, hearing loss, cognitive impairment, aphasia, dementia, and culturally specific expressions of distress. Future systems should be tested with older migrants rather than only with general adult users. Priorities include domain adaptation, dialectal data, speech data from older adults, human-in-the-loop validation, and clear escalation pathways to professional interpreters.

VII. TECHNICAL PERFORMANCE AND CLINICAL RESULTS UI/UX REQUIREMENTS FOR THE OLDEST-OLD USERS

For adults aged 80 and above, usability is as important as algorithmic performance. Interfaces should minimize steps, use large high-contrast buttons, avoid time-limited responses, and support voice, touch, pictorial, and caregiver-assisted interaction. Systems should not require users to remember complex sequences, passwords, or menus during urgent communication [20], [30].

Multilingual tools should enable simple language switching, familiar symbols, slow interaction speed, repetition, and confirmation messages in plain language. A caregiver mode is important in LTC because staff may need to assist residents while preserving privacy and autonomy.

VIII. POLICY AND IMPLEMENTATION CONTEXT

European digital health policy increasingly promotes home-based care, interoperability, and integrated information systems. These reforms create opportunities to evaluate AI-supported communication and monitoring tools in real care pathways. Slovenia and other Central and Eastern European countries are relevant examples because empirical evidence from this region remains limited. A brief national implementation example is therefore useful, but the main contribution of this paper is the broader European synthesis rather than a country-specific legal analysis.

Implementation studies should measure more than technical accuracy. Relevant outcomes include resident safety, adverse communication events, interpreter use, staff workload, user satisfaction, digital inclusion, response time, and continuity of care. Interoperability standards such as HL7/FHIR are also important if IoMT systems, care records, and digital portals are to exchange information safely.

IX. FUTURE DIRECTIONS

Future research should move from technical demonstration toward equity-sensitive evaluation. AI translation tools should be tested in LTC with older migrants, low-resource languages, dialects, dementia-related communication changes, and noisy care environments. Monitoring systems should be assessed not only for F1 score but also for false alarms, missed events, and staff response capacity.

Researchers should separate levels of evidence. Technical architectures, pilot studies, qualitative work, policy analysis, and clinical outcome studies answer different questions. A mature evidence base for AI in multilingual LTC will require

longitudinal, mixed-method, and implementation-focused research.

X. CONCLUSION

AI-driven gerotechnology can support safer and more inclusive LTC, but it cannot remove language barriers on its own. Federated IoMT systems, assistive robotics, NLP, and machine translation each address different parts of the problem. Their value depends on privacy protection, linguistic adaptability, age-sensitive design, staff training, and integration with professional interpreters and culturally competent care.

The central implication is that AI should be embedded in a human-centered care framework. Used carefully, it can strengthen monitoring, routine communication, social support, and coordination. Used uncritically, it may reproduce existing inequalities, especially for older adults who speak low-resource languages or have cognitive and physical limitations.

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DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used AI-assisted tools for translation, language editing, and structural revision. The authors reviewed and edited the content and take full responsibility for the final version.

REFERENCES

- [1] N. Ahaddour, J. van Meel, and B. Broeckaert, "Institutional elderly care services and Moroccan and Turkish migrants in Belgium: A literature review," *Journal of Immigrant and Minority Health*, vol. 18, pp. 912–924, 2016. DOI: 10.1007/S10903-015-0247-4
- [2] H. Tezcan-Güntekin and P. G. Tezcan, "Altenpflege in der Migrationsgesellschaft," in *Migration und Gesundheit*, 2017, pp. 215–234. DOI: 10.1007/978-3-662-54166-1_11
- [3] I. Olbermann, "Pflegebedürftige ältere Menschen mit Migrationshintergrund und deren Angehörige," in *Handbuch Migration und Pflege*, 2020. DOI: 10.1007/978-3-662-60586-8_10
- [4] S. Aşkın, "Kultursensible Altenhilfe und Pflege in der Migrationsgesellschaft," in *Handbuch Interkulturelle Öffnung*, 2018. DOI: 10.1007/978-3-658-19540-3_57
- [5] A. Duguet and J. L. Bernaud, "Access to Care in France for Elderly Immigrants from North Africa: Influence of Socio-cultural Factors (the MATC Survey)," *European Journal of Health Law*, vol. 23, no. 1, pp. 22–35, 2016. DOI: 10.1163/15718093-12341431
- [6] J. Koch-Straube, "Immigrants in geriatric institutional care," *Pflege*, vol. 12, no. 5, pp. 289–295, 1999. DOI: 10.1024/1012-5302.12.5.289
- [7] S. Marquardt et al., "Wenn Migranten alt werden – Das Altenpflegesystem zwischen Versorgungslücken und Entwicklungspotenzialen," 2016.

- [8] M. Sagbakken et al., "How to adapt caring services to migration-driven diversity? A qualitative study exploring challenges and possible adjustments in the care of people living with dementia," *PLOS ONE*, vol. 15, no. 12, 2020. DOI: 10.1371/JOURNAL.PONE.0243803
- [9] H. Valk et al., "Migration patterns and immigrant characteristics in north-western Europe," 2012.
- [10] S. Torres et al., "Migrant care workers in elderly care: what a study of media representations suggests about Sweden as a caring democracy," *International Journal of Ageing and Later Life*, vol. 14, no. 2, pp. 83–109, 2020. DOI: 10.3384/IJAL.1652-8670.3103
- [11] S. Plard and V. Schierano, "Les immigrés au seuil du grand âge. Un questionnement à ancrer dans les territoires de vie," *Hommes & migrations*, 2015. DOI: 10.4000/HOMMESMIGRATIONS.3065
- [12] H. Goettler, "Activity and Social Responsibility in the Discourse on Health Care, Long-Term Care and Welfare Services for Older Immigrants," *BioMed Research International*, 2021. DOI: 10.1155/2021/5241396
- [13] L. Xu et al., "Ageing as older Chinese immigrants in Europe—A qualitative systematic literature review considering perspectives from older immigrants, relatives, and professionals," *Frontiers in Public Health*, vol. 13, 2025. DOI: 10.3389/fpubh.2025.1492356
- [14] M. Mežnarec et al., "Integration of Telecare into the National Long-term Care - System The Case of Slovenia," *Advances in Control and Optimization of Dynamical Systems*, 2022. DOI: 10.1016/j.ifacol.2022.12.062
- [15] N. Hvalič-Touzery et al., "Informal Caregivers' Perceptions of Self-Efficacy and Subjective Well-Being When Using Telecare in the Home Environment: A Qualitative Study," *Geriatrics*, vol. 7, no. 5, 2022. DOI: 10.3390/geriatrics7050086
- [16] B. Čebon, "Language as a trigger for racism: language barriers at healthcare institutions in Slovenia," *Social Sciences*, vol. 10, no. 4, 2021. DOI: 10.3390/SOCSCI10040125
- [17] S. Pavlič et al., "Attitudes to illness and the use of health services by economic immigrants in Slovenia," *Croatian Medical Journal*, vol. 48, no. 2, 2007.
- [18] M. Čebon et al., "Migrants/Refugees in Slovene Healthcare: Many Open Questions and Some Possible Answers," in *Healthcare and Migration*, 2016. DOI: 10.17234/9789531756525.9
- [19] D. Stanimirovic, "Development of eHealth in Slovenia - Critical Issues and Future Directions," *Informatica*, 2015. DOI: 10.17573/IPAR.2014.4.A01
- [20] B. Neves et al., "'My Hand Doesn't Listen to Me!': Adoption and Evaluation of a Communication Technology for the 'Oldest Old'," in *Proc. Human Factors in Computing Systems*, 2015. DOI: 10.1145/2702123.2702430
- [21] P. Ghosh et al., "FEEL: FEderated LEarning Framework for ELderly Healthcare Using Edge-IoMT," *IEEE Transactions on Computational Social Systems*, 2023. DOI: 10.1109/tcss.2022.3233300
- [22] "An Implementation Study on COMPAs – an App Designed to Support Communication Between Persons Living with Dementia in Long-Term Care and their Caregivers," Preprint, 2023. DOI: 10.2196/preprints.47565
- [23] C. Delmastro et al., "Experimenting Mobile and e-Health Services with Frail MCI Older People," *Information*, vol. 10, no. 8, 2019. DOI: 10.3390/INFO10080253
- [24] P. Hudelson et al., "Using Voice-to-Voice Machine Translation to Overcome Language Barriers in Clinical Communication: An Exploratory Study," *Journal of General Internal Medicine*, 2024. DOI: 10.1007/s11606-024-08641-w
- [25] A. Nugteren, "Können digitale Kommunikationshilfen den Informationsaustausch in der allgemeinmedizinischen Sprechstunde verbessern?" 2023. DOI: 10.53846/goediss-9818
- [26] J. Small et al., "Promoting hearing and communication health in long-term residential care through the use of communication apps," *Canadian Acoustics*, 2016.
- [27] B. Loveys et al., "Artificial intelligence for older people receiving long-term care: a systematic review of acceptability and effectiveness studies," *The Lancet Healthy Longevity*, vol. 3, no. 6, 2022. DOI: 10.1016/S2666-7568(22)00034-4
- [28] A. Wilmink et al., "Artificial Intelligence-Powered Digital Health Platform and Wearable Devices Improve Outcomes for Older Adults in

Assisted Living Communities: Pilot Intervention Study," 2020. DOI: 10.2196/19554

- [29] H. Rickman et al., "Understanding patterns of loneliness in older long-term care users using natural language processing with free text case notes," *PLOS ONE*, vol. 20, no. 2, 2025. DOI: 10.1371/journal.pone.0319745
- [30] M. Jimenez et al., "Personalizing Digital Health: Adapting Health Technology Systems to Meet the Needs of Different Older Populations," *Healthcare*, vol. 11, no. 15, 2023. DOI: 10.3390/healthcare11152140
- [31] N. A. Ghosh et al., "FEEL: FEderated LEarning Framework for ELderly Healthcare Using Edge-IoMT," *IEEE Transactions on Computational Social Systems*, 2023.
- [32] N. A. Borghese et al., "Heterogeneous Non Obtrusive Platform to Monitor, Assist and Provide Recommendations to Elders at Home: The MoveCare Platform," 2017. DOI: 10.1007/978-3-030-04672-9_4
- [33] S. Merkel et al., "The Use of Internet-Based Health and Care Services by Elderly People in Europe and the Importance of the Country Context: Multilevel Study," 2020. DOI: 10.2196/15491
- [34] C. Wilson et al., "Care Staff Perspectives on Using Mobile Technology to Support Communication in Long-Term Care: Mixed Methods Study," 2020. DOI: 10.2196/21881
- [35] J. Müller et al., "Overcoming Language Barriers in Paramedic Care With an App Designed to Improve Communication With Foreign-Language Patients: Nonrandomized Controlled Pilot Study," *JMIR Formative Research*, vol. 7, 2023. DOI: 10.2196/43255
- [36] N. A. Redecker et al., "Conclusions of the Workshop on Long-term Care Challenges in an Ageing Society: the Role of ICT and Migrants," *European Commission*, 2012.