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Original research article

DIGITAL HEALTH

DIGITAL HEALTH
Volume 12: 1–16
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DOI: 10.1177/20552076261487078
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From silos to shared plans: A complex intervention development and specification study of the GAPA digital infrastructure for cross-organisational oralhealth care planning in home care

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Abstract

Aim: Oral health care planning for frail older adults receiving home care is often fragmented across organisational, professional, and documentation boundaries. This study aimed to develop and specify a cross-organisational digital infrastructure to support shared oral health care planning across municipal home-care services and public dental services. **Methods:** This multimethod complex intervention development and specification study was conducted conducted from January 2022 to February 2026, guided by the Medical Research Council framework for complex interventions. Development was informed by a programme theory linking shared access to oral health assessments, preferences, consent, responsibilities, and follow-up information to coordinated cross-organisational care planning. Development progressed through five iterative prototype cycles, moving from paper-based workflow modelling to digital prototyping and final high-fidelity platform specification. **Results:** Development produced a structured requirements set specifying shared access to validated oral health assessment, conditional oral-hygiene-ability assessment, consent status, older adults' preferences, agreed oral health actions, responsible actors, follow-up points, and unresolved recommendations. The final platform was specified as a bounded shared care-planning environment with role-based access, auditability, longitudinal traceability, and support for interprofessional communication and remote consultation. The system was designed to support structured assessment, care planning, responsibility allocation, and follow-up, thereby preparing the intervention for subsequent formal evaluation. **Conclusion:** The GAPA digital platform was developed as a bounded cross-organisational infrastructure for oral health care planning in home care. By translating legal, organisational and informational constraints into system requirements, the platform operationalises coordinated assessment, planning, and follow-up across home-care and dental-service boundaries. Formal evaluation is now required to assess implementation, user experience, care coordination and oral health outcomes.

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Keywords
co-design, care coordination, digital health, home care, interprofessional collaboration, person-centred oral health planning

Received: 21 May 2026; Revised: 18 August 2026; Accepted: 20 August 2026

Introduction

Population ageing contributes to an increasing number of older adults living with complex care needs in home care settings. Many older adults receiving home care have multimorbidity, functional limitations, and contact with multiple health and social care providers.[1,2] Oral health in this group is often poor, yet remains insufficiently integrated into routine home care workflows and interprofessional care planning.[2–5] This is important because oral health is closely linked to nutrition, comfort, communication, systemic health, and quality of life.[3–5] When documentation and workflows are fragmented, oral health recommendations may not be consistently communicated, implemented, or followed up across organisational boundaries.[6,7]

In home care, oral health is often weakly connected to broader care plans and interprofessional communication structures.[7,8] In Sweden, oral care cards are intended to support structured documentation of oral health status, but their use is limited by fragmented organisational structures, unclear responsibility allocation, and insufficient integration into everyday workflows.[7,8] These limitations reflect broader socio-technical fragmentation: separate organisations, professional mandates, and documentation systems operate without a shared planning artefact that can make assessments, responsibilities, and follow-up visible across care boundaries. More generally, limited information sharing and unclear responsibility allocation have been identified as barriers to continuity and coordination in care planning.[9,10]

Sweden exemplifies this fragmentation, with municipal home care services and public dental services operating under parallel governance and documentation infrastructures. A national publicly funded dental support system provides outreach oral health assessments for people with extensive care needs; in 2022, approximately 151,000 persons were reached.[11] These assessments, typically conducted by licensed dental hygienists in collaboration with municipal care staff, generate recommendations for daily oral care and indications for dental treatment.

These paper-based recommendations are poorly integrated into electronic record systems, constraining continuity, accountability, and follow-up.[7,8] The need to include older adults' preferences and participation in oral-care planning during the oral assessments has also been highlighted.[12]

Despite policy initiatives emphasising person-centred, coordinated, and preventive services organised around individuals' needs,[13] oral health remains insufficiently integrated into broader health systems. The World Health Organization (WHO) Global Strategy and Action Plan on Oral Health 2023–2030 calls for stronger integration of oral health into health systems.[14] Digital infrastructures are increasingly proposed as enablers of such integration, particularly in complex cross-organisational settings.[6–8,15,16] However, persistent micro-, meso-, and macro-level barriers continue to limit interprofessional collaboration in oral health care for frail older adults.[17,18]

This study was conducted within the GAPA programme (in Swedish: Gemensam Arbetsmodell för Personcentrerad sAmverkan; in English: Integrated Oral Health Care Model for Person-Centred Collaboration), which aims to integrate oral health care into home care services through an interprofessional work model.[19] The development assumption was that improving oral health care planning requires more than digital documentation alone; it requires a shared planning infrastructure that makes assessments, preferences, responsibilities, and follow-up actions visible across organisational boundaries. Accordingly, the aim of this study was to develop and specify a cross-organisational digital platform to support shared oral health care planning between municipal home care services and public dental services.

Methods

Study design

This study was a multimethod intervention development study designed to specify a cross-organisational digital platform for oral health care planning in home care settings. Development followed the updated Medical Research Council framework for developing and evaluating complex interventions, with an emphasis on context, programme theory, stakeholder engagement, key uncertainties and iterative refinement.[20] Reporting was informed by the GUIDED checklist and TIDieR framework.[21,22] Co-design and integrated knowledge translation principles guided iterative involvement of end users, professionals, organisational stakeholders, and researchers.[23,24] The study was conducted from January 2022 to February 2026, encompassing all five development cycles, from the initial needs assessment and paper-based workflow modelling to the final high-fidelity platform specification.

The programme theory proposed that fragmented oral health care planning could be improved through shared access to structured assessments, preferences, consent, responsibilities, and follow-up information.[25] This was expected to support three proximal mechanisms: shared situational awareness, explicit task allocation, and traceable follow-up across municipal home care and dental services. presents the conceptual model guiding the GAPA programme.[19] These mechanisms were operationalised through shared access to structured assessments, older adults' preferences and consent, agreed actions, responsible actors, and longitudinal follow-up information (Figures 1 and 2).

The present paper reports the development phase, including system-requirement specification, iterative prototype refinement, and consolidation into a high-fidelity platform. No effectiveness outcomes, implementation outcomes, or patient outcome data were analysed in this study. Development progressed iteratively, moving from problem identification in existing oral-care-card routines to paper-based modelling, digital prototyping, and a final high-fidelity platform specified for subsequent formal feasibility, implementation and outcome evaluation.

The programme theory underlying GAPA was that fragmented oral health care planning could be reduced by creating a bounded shared planning environment in which authorised municipal and dental users could access the same structured assessment, care-planning and follow-up information.[19,25] In operational terms, the platform was specified to document validated oral health assessments (Revised Oral Assessment Guide, ROAG),[26] conditional oral hygiene ability assessments (OHAI), older adults' stated preferences, consent status, agreed actions, responsible actors, follow-up dates, and declined recommendations, while making unresolved oral health needs visible across organisational boundaries. In this development study, the programme theory was translated into system requirements; implementation, effectiveness, and impact on patient outcomes were not evaluated.

Findings from an initial needs assessment within the GAPA programme, including identified decisional needs among stakeholders,[12] informed the development of a paper-based prototype. The prototype was evaluated in conjunction with 24 home-based oral health assessments involving older adults. Based on the findings, a digital prototype was developed and subsequently piloted in three municipal home care teams in 2024.[7,12,19] In 2024–2025, platform architecture, access logic, and cross-organisational workflows were refined through developer dialogue, governance-group input, structured workshops, and sprint-based consolidation.

Integration of the Medical Research Council framework

The MRC framework for developing and evaluating complex interventions was used as an explicit design logic to structure development activities, identify uncertainties, and guide decisions between prototype cycles (Table 1).

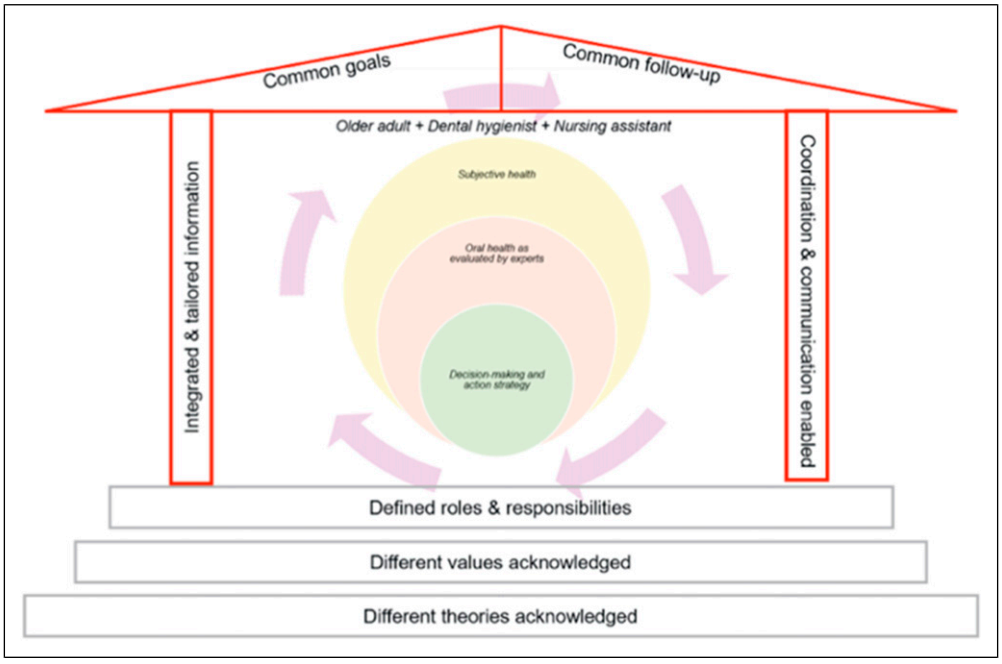

Figure 1. GAPA programme theory and conceptual model.[25]

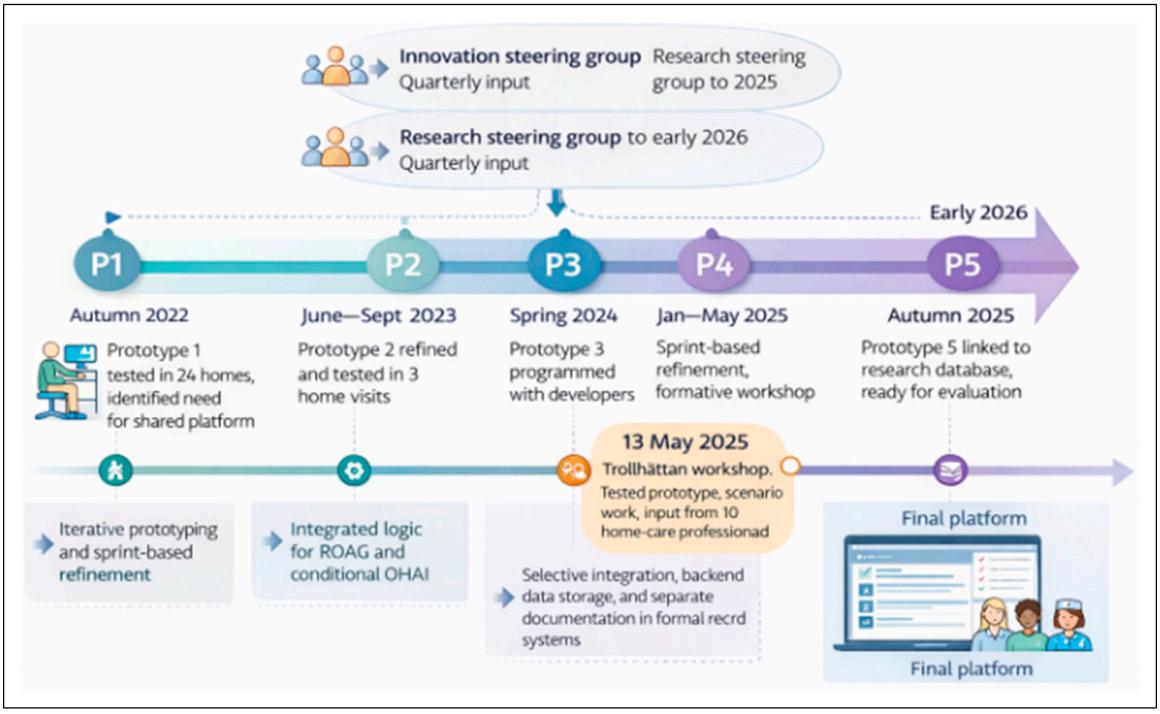

Figure 2. The five prototype cycles (P1-P5) of the GAPA digital platform from 2022 to early 2026.

Development framework and decision logic

Development was organised around the MRC elements of context, programme theory, stakeholder engagement, key uncertainties, intervention refinement, and resource considerations.[20] Predefined uncertainties were specified a priori and categorised as:

contextual: organisational and legal constraints;
mechanistic: whether shared access to structured assessments, preferences, consent, responsibilities, and follow-up information could plausibly support the intended coordination mechanisms across municipal and dental users;
technical: whether access logic, consent handling, role-based permissions, local storage, backend transfer and bounded interoperability could support the programme theory without creating an electronic health record or bypassing organisational mandates; and
resource-related: whether the specified workflow risked adding documentation burden, double registration, training demands or follow-up responsibilities beyond what participating services could feasibly absorb.

The final platform was not treated as a stand-alone digital tool, but as a socio-technical intervention embedded in a fragmented care system to be understood in relation to organisational context, professional roles, scale-up conditions, and sustainability.[10,15]

Participants and setting

Development was conducted in western Sweden in collaboration with municipal home care services and the Public Dental Service in Region Västra Götaland. Academic partners provided methodological and clinical expertise.

Two governance structures guided development: an Innovation Steering Group and a Research Steering Group, including municipal care leaders, dental professionals, system developers, older adult with lived experience, and researchers. Both groups met quarterly and contributed to workflow logic, requirements specification, and feasibility assessment (Table 2).

Governance-group input was used to test whether the programme theory was plausible within the participating organisations. Municipal representatives assessed whether responsibility allocation and follow-up functions were compatible with home care workflows. Dental representatives assessed whether structured assessment, photographic documentation and dental-contact functions were clinically meaningful. Older-adult input informed the need to document preferences, consent,

Table 1. Operationalisation of the MRC core elements during development of the GAPA digital platform.

MRC core elements	Development activities in GAPA digital platform	Methodological role
Context	Policy and regulatory review; workflow mapping; exploratory stakeholder input; contextual scanning of organisational and digital infrastructures	Context treated as an active system component shaping mechanisms and feasibility; digital, organisational, and legal constraints incorporated into design logic
Programme theory	Specification and iterative refinement of a mechanism pathway linking shared access to structured assessment data, preferences, consent, responsibilities, and follow-up information to the intended coordination mechanisms.	Programme theory used to decide which functions were necessary, which uncertainties had to be reduced before progression between prototype cycles, and which requirements were retained in the final platform specification.
Stakeholder engagement	Multi-actor workshops, stakeholder participation in prototype development, field observations, structured feedback sessions, and steering-group oversight	Engagement viewed as co-productive, ensuring contextual fit, legitimacy, and accurate modelling of real-world workflows
Key uncertainties	Formative prototype testing, workflow-fit assessment, technical appraisal, and analysis of feasibility-related development uncertainties.	Development uncertainties were identified, examined and reduced before progression between prototype cycles. These activities informed platform specification but did not constitute formal usability, feasibility, implementation or outcome evaluation.
Resource and feasibility considerations	Resource-flow mapping and early consideration of implementation feasibility, data capture, and scalability	Resource and feasibility implications considered in relation to data capture, workflow burden, scalability, and requirements for subsequent evaluation.

The programme theory was operationalised through four design propositions. First, structured oral health assessment data would need to be visible to both dental and municipal users to support shared situational awareness. Second, each identified oral health need would need to be linked to an agreed action, responsible actor and follow-up point to support accountability. Third, older adults' preferences, consent and declined recommendations would need to be documented to preserve person-centred planning across organisational boundaries. Fourth, longitudinal visibility of previous assessments and actions would be required to support continuity under conditions of staff turnover and distributed care.

declined recommendations and conditions for participation. Digital and legal expertise informed whether these functions could be specified within a bounded shared planning environment rather than through integration with existing record systems.

Both groups met quarterly and contributed to workflow logic, information requirements, and platform scope. Stakeholder involvement was used to support contextual fit and to ensure that the platform reflected the perspectives of municipal care, dental care, older adults, researchers, and digitalisation stakeholders.[23,24]

The Research Steering Group identified validated instruments to structure assessment and planning. The Revised Oral Assessment Guide (ROAG) was selected as the primary oral health assessment tool because it provides a structured approach to oral assessment in older adults.[26] The relevance of structured oral health assessment was further supported by Swedish elder-care data showing that nursing-based oral assessments can identify oral health problems among older adults receiving elder care.[27] The Oral Hygiene Ability Instrument (OHAI) was selected as a conditional follow-on instrument to assess older adults' ability to manage daily oral hygiene and to identify causes of impaired oral-hygiene ability.[28–30] Older adults and home care staff also informed the importance of integrating subjective oral health information, preferences, and self-determination into the overall oral health assessment and planning process. This was consistent with previous GAPA work identifying decisional needs among older adults, home-health-care nurses, and dental hygienists during team-based oral health assessments in home settings.[12]

Data sources

Development was informed by multiple empirical and contextual inputs:

prior studies on oral care cards, decisional needs, and GAPA development[7,12,19];
field observations in 24 home care settings

Table 2. Composition of the innovation steering group and research steering group.

Innovation steering group *Role/function*	*Number*	*Perspective/competence*
Local head nurse	1	Care process in municipal care
Senior system developer	1	Digital systems
Public health strategist for older adults in municipal care	1	Health strategies
Head of research and development in primary care, region Västra Götaland	1	Research and development
Senior strategist for older adults in public dental care service, region Västra Götaland	1	Oral health strategies
Project manager, GAPA innovation	1	Lead the overall project
Research steering group *Role/function*	*Number*	*Perspective/competence*
Local head nurse	1	Care process in municipal care
Statistician	1	Statistics and evaluation
Older adult with lived experience	1	Older adult
Head of research and development in primary care, region Västra Götaland	1	Research and development in region Västra Götaland
Associate professor, gerodontology	1	Gerodontology
Professor of nursing and person-centred care	1	Nursing and person-centred care
Professor in oral health	1	Oral health
Associate professor in oral health	1	Oral health
System developer, 'GAPA' platform	1	Digital system
Project manager, GAPA research	1	Lead the overall project
Total	16	n/a

stakeholder workshops and interviews
mapping of documentation and reimbursement structures
legal and regulatory review
validated instruments, including Revised Oral Assessment Guide (ROAG) and Oral Hygiene Ability Instrument (OHAI).[26,28–30]

These sources informed requirement generation and refinement across prototype cycles and were mapped to programme theory mechanisms and uncertainty domains.

Field observations informed workflow and communication requirements; interviews and workshops informed accountability, access, and cross-organisational communication; and legal review informed consent management, access control, auditability, and the distinction between shared planning artefacts and formal clinical records.

Formative workshop-based prototype testing

Formative testing of the digital prototype was conducted in the west of Sweden in spring 2025. Ten participants (dental hygienists and nursing assistants) worked in mixed pairs. Workshops included:

1. Free exploration of the prototype
2. Scenario-based completion of a simulated home visit
3. Structured reflection on formative prototype testing, workflow, information needs, handover, and future implementation requirements.

The workshops were designed to refine programme-theory-related requirements rather than to evaluate usability formally. Specifically, the simulated home-visit task examined whether users could identify assessment findings, translate them into agreed actions, allocate responsibility, document preferences or declined recommendations, and locate follow-up information within the prototype.

Written comments and the post-workshop synthesis were used to refine navigation, data entry, role allocation, follow-up functions, and continuity features. Feedback was categorised into requirement clusters (e.g., navigation, pre-filled

information, role-based responsibility, consent, follow-up) and compared with existing prototype logic to guide subsequent iterations.

Predefined uncertainties and progression logic

Development progressed through five iterative cycles.

P1–P2: Established a shared workflow from assessment to follow-up using paper-based modelling tested in 24 home visits. ROAG was confirmed as the core assessment tool, with OHAI as conditional follow-up.[26,28–30] At this stage, the programme theory was refined from a general assumption about improved communication to a specific requirement that each assessment finding should be translatable into a documented action, responsible actor and follow-up route.

P3: Digital translation into a prototype with role-based access and sequential workflow logic. Focus on navigation, structure, and shared visibility.

P4: Refinement for routine use, including accessibility, continuity, follow-up visibility, and role-specific views under conditions of staff turnover. These refinements specified the continuity mechanism in the programme theory: the platform needed to preserve previous assessments, actions, responsible actors and declined recommendations so that oral health care planning would remain visible despite staff turnover and distributed home care work.

P5: Consolidation into a high-fidelity platform with shared care plan, role-based accountability, longitudinal traceability, and auditability. Backend storage was implemented via SunetDrive. The system remained a bounded planning environment due to legal constraints and was not integrated into existing EHR systems.

A backend was implemented in SunetDrive, with local devices temporarily storing up to ten records before transfer and deletion. Due to legal and organisational constraints, the platform was not integrated into existing record systems and instead functioned as a bounded shared planning environment. A printable end-of-process health card was added. Exploratory testing of a remote-consultation function identified technical and workflow limitations. By the end of P5, the main development uncertainties had been reduced sufficiently to support progression to formal feasibility and outcome evaluation within the broader GAPA programme. As such, P5 represented the final operationalisation of the programme theory through a single shared care plan, named responsibilities and digital signing, and longitudinal traceability of agreed actions and their completion or non-completion.

Analytic approach and translation into system requirements

Development materials were synthesised using a staged requirements-translation process. First, empirical and contextual inputs were mapped to the predefined uncertainty domains: contextual, mechanistic, technical and resource-related. Second, observations, workshop feedback, governance-group input and legal review findings were summarised into requirement clusters concerning workflow, information visibility, role allocation, consent, access control, formative prototype testing, follow-up and evaluation readiness. Third, each requirement was assessed against the programme theory and the legal-organisational boundary conditions of municipal home care and public dental services. Requirements were retained when they addressed an identified uncertainty, were judged feasible within existing governance structures, and were necessary to support shared assessment, shared understanding or shared planning. Disagreements were resolved through iterative discussion between the research team, innovation team and relevant stakeholders.

Ethical and legal considerations

Ethical and legal considerations were addressed throughout development, including data protection, consent management, and role-based access control across organisations. Data protection impact assessments and legal reviews informed design decisions. No effectiveness data or patient outcomes were analysed.

Results

Results are presented as four interrelated outputs: (1) contextual and legal requirements for cross-organisational oral health care planning, (2) system requirements refined across iterative prototype cycles, (3) consolidation into a high-fidelity digital platform, and (4) alignment with national guidelines and specification for subsequent evaluation.

(1) Contextual and legal requirements for cross-organisational oral health care planning

Development identified structural conditions shaping cross-organisational oral health care planning. Municipal home care services and public dental services operate under separate legislation, documentation systems, and governance structures (Figure 3). As a result, shared planning could not rely on integrated records but required a bounded planning artefact supporting coordinated action across organisational boundaries.

These conditions required:

role-based accountability
auditable documentation of actions
longitudinal traceability of oral health planning

Shared planning was therefore operationalised through a bounded environment rather than through full system integration.

At the organisational level, requirements centred on traceability, accountability, and continuity of care across multiple caregivers. At the technical and governance level, cross-organisational collaboration required secure access control, role-based permissions, and compliance with national data-protection regulations. These contextual and legal requirements defined the foundational constraints within which the platform was developed.

(2) System requirements specified across prototype cycles

System requirements were refined across prototype cycles P1–P5 to address predefined uncertainties related to workflow integration, role clarity, formative prototype testing, accessibility, and continuity of care.

Workflow and responsibility foundation (P1–P2)

Early cycles established a shared workflow from assessment to follow-up. ROAG[26] was confirmed as the core assessment instrument, with OHAI[28–30] as conditional follow-up. Requirements emphasised structured translation of findings into actions, responsibilities, and follow-up points.

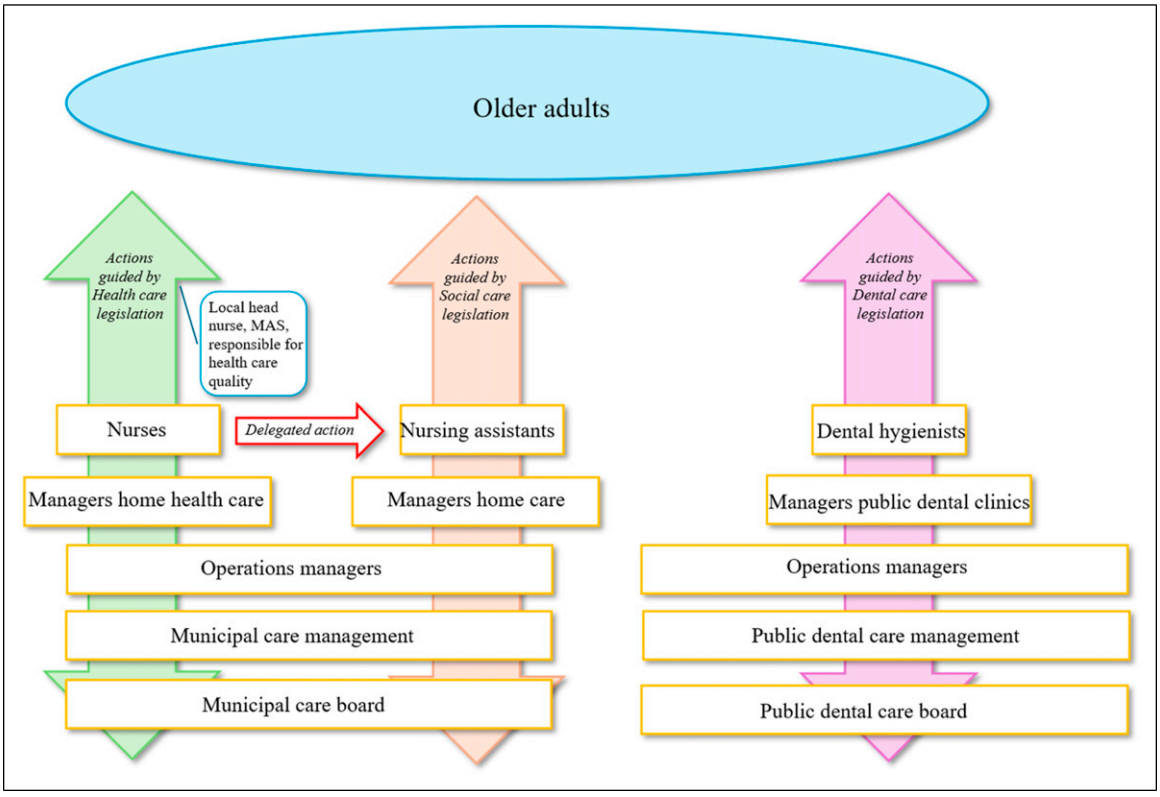

Figure 3. Organisational and legislative context shaping oral health care planning in home care settings.

Field testing during 24 interprofessional home care visits indicated a need for clearer coordination, structured handover, and greater visibility of responsibilities across professional roles.

Digital translation and formative prototype testing requirements (P3)

The paper model was translated into a digital prototype with role-based access and sequential workflow logic (Figure 4). Requirements focused on navigation clarity, information hierarchy, and persistent visibility of the shared care plan.

Role separation between municipal and dental users was implemented, with consent-based access for older adults and relatives.

Data were stored locally at this stage, with no shared backend.

Accessibility and accountability (P4)

P4 (Figure 5) addressed uncertainties related to sustained use in routine home care contexts. Requirements included readable content, support for varying digital literacy, cross-organisational communication, follow-up prompts, historical visibility of assessments and plans, and mechanisms to document change over time. Role-specific views and shared notifications were added to support coordination under conditions of staff turnover and distributed care.

Participants emphasised the need for pre-filled or linked information (e.g., medication lists), documentation of contact persons and relatives, visibility of self-determination when a person declined care, and explicit allocation and follow-up of actions. The platform was also shaped to make discontinuity in dental attendance visible and actionable, reflecting the vulnerability of older adults who lose contact with dental services.

Table 3 shows how the system requirements were grouped into three domains: coordination, ethical/participatory care, and accessibility. Across domains, the central requirement was a shared, structured, and traceable planning environment supporting interprofessional coordination without integration into existing EHR systems.

(3) Consolidation into a high-fidelity digital platform (P5)

System behaviour and core functions

The final platform functioned as a shared planning and coordination environment rather than a standalone documentation tool. It implemented a single shared care plan accessible to authorised municipal and dental users, enabling coordinated interpretation of assessments, explicit role allocation, and tracking of agreed actions over time. Role-based accountability, longitudinal traceability, and auditability were treated as core system properties.

Structured documentation, actionability, and printable output

Structured oral-status documentation was refined to match professional practice. Users could mark multiple teeth simultaneously and distinguish between missing teeth, fractures, implants, infection-related findings, and prosthetic status. Findings were carried forward into the shared health plan. A clear, printable summary of identified issues, agreed actions,

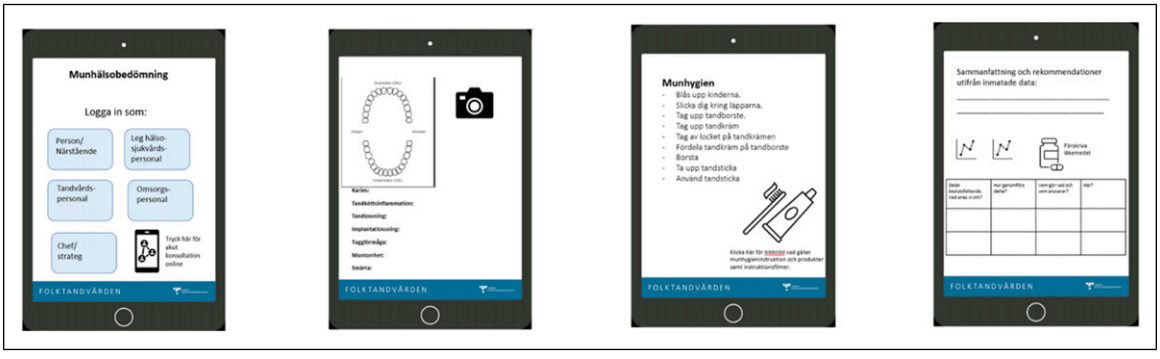

Figure 4. Prototype interface of the GAPA digital platform including role-based login, structured oral health assessment, oral-hygiene guidance, photographic documentation, and a summary page for recommendations and follow-up.

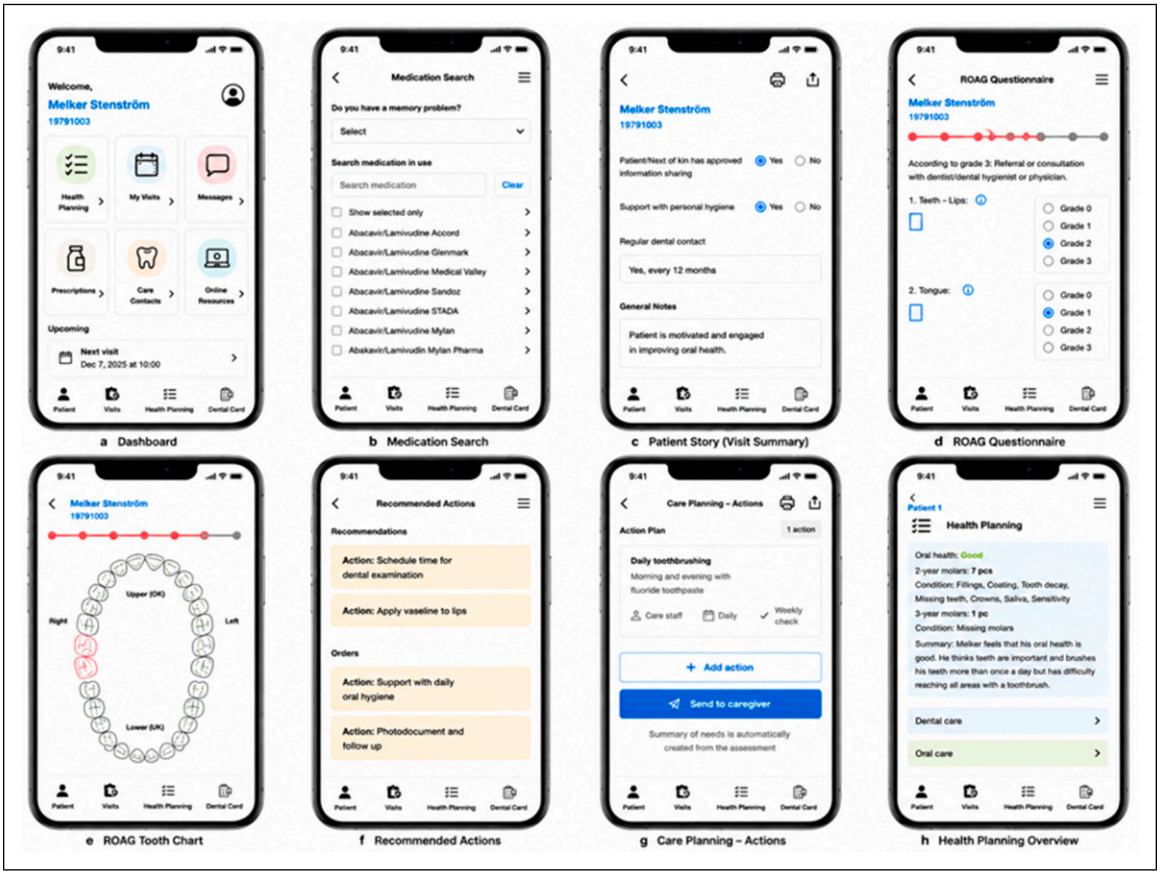

Figure 5. Selected interfaces of the final digital platform. (a) Dashboard providing access to the main platform functions (b) Medication search supporting structured collection of current medication use (c) Patient story capturing relevant background information and care context (d) ROAG-based structured oral health assessment (e) Tooth chart supporting visual documentation of oral status and remote dental consultation with dentist (f) Recommended actions generated from the assessment (g) Care planning interface for assigning actions, responsibilities, and follow-up (h) Health planning overview summarising assessed needs and planned care.

responsible actors, and follow-up plans was added. Action completion and declined recommendations remained visible over time.

Data handling and bounded interoperability

The final platform connected to a secure backend (SunetDrive) for structured storage, with local devices temporarily storing up to ten records before transfer and deletion. Due to legal and organisational barriers, the platform was not integrated into existing record systems and instead functioned as a bounded coordination layer supporting shared planning, role-based action tracking, and structured information transfer.

Mixed-reality supported collaboration

An emergent capability was mixed-reality-supported remote collaboration using head-mounted displays (Figure 6). This enabled real-time visual communication between home care staff and dental professionals during oral health assessments, supporting joint interpretation of findings in selected situations without physical co-presence.

Early testing indicated potential value for rapid access to dental input but also revealed constraints, including unstable connectivity, limited audio quality, camera malfunction, variable professional availability. This functionality was therefore treated as supplementary rather than core to the platform specification. It served as a useful adjunct in selected situations, contingent on technical reliability, workflow integration, and support for person-centred participation.

Table 3. System requirements specified during development of the GAPA digital platform.

Domain	Coordination challenge	Specified system requirements
Coordination across municipal and dental care	Fragmented information systems and parallel documentation structures	Support for shared visibility of oral health assessments across organisations; structured information transfer without direct integration into existing municipal or dental record systems; access to up-to-date contact information for responsible dental services.
Coordination across municipal and dental care	Unstructured handover between professionals	Digital signing of assessments; documentation of contributing professionals, roles, and responsibilities; structured task allocation and handover to support continuity of care
Coordination across municipal and dental care	Lack of structured follow-up	Tracking of oral health status over time; documentation of planned interventions and evaluation points; role-based access management for follow-up responsibilities
Ethical and participatory care	Informed consent and participation across organisations	Digital support for consent management; documentation of preferences, values, and what matters to the older adult; alignment with care coordination principles.
Ethical and participatory care	Limited support for communication and engagement	Support for photographic documentation of oral findings; functionality for remote consultation when needed; reminder functions for follow-up activities
Accessibility and usability	Limited overview of oral health status	Structured presentation of oral health findings, including visual documentation, to support shared understanding across professions
Accessibility and usability	Unclear oral-care needs and resource allocation	Structured support for assisted oral care planning; ability to flag need for additional home care time; access to information on dental fees, subsidies, and economic considerations

These system requirements reflect the minimum functional specification required to support cross-organisational oral health care planning and informed consolidation of the final platform.

Alignment with national guidelines and evaluation readiness

Operationalisation of national dental-care guidelines

The platform operationalised national oral health guidelines by structuring assessment, planning, and follow-up into traceable workflow steps. This enabled standardised documentation of oral health needs and planned actions across organisations.

Validated instruments (ROAG,[26] OHAI[28–30]) were embedded to support structured assessment and future evaluation.

Figure 6. Meta Quest 3 head-mounted display used for mixed-reality-supported remote collaboration within the GAPA platform.

By the end of development, the system was considered sufficiently specified to support formal evaluation within the broader GAPA programme.

Readiness for formal evaluation

The platform generated structured data suitable for subsequent evaluation within the broader GAPA programme,[19] including ROAG[26] and OHAI.[28–30] By the end of development, uncertainties related to feasibility, governance, and interoperability had been sufficiently addressed to support progression to formal evaluation. Within the programme theory, mixed-reality functionality was treated as a potential adjunct to shared situational awareness.

Discussion

This study developed and specified the GAPA digital platform as a cross-organisational infrastructure for oral health care planning in home care settings. Using the MRC framework, the development process translated contextual, legal, organisational, and technical constraints into concrete system requirements for cross-organisational care planning. The main contribution is the specification of how coordination mechanisms can be operationalised as concrete digital requirements in a fragmented care system where responsibility for oral health care is distributed across municipal and dental services. Rather than attempting to integrate existing systems, the platform defines a bounded shared planning environment enabling structured information sharing, role-based accountability, and longitudinal traceability.

Across prototype cycles, the programme theory was translated into requirements for shared access to structured assessment data, older adults' preferences and consent, agreed oral-care actions, responsible actors, and longitudinal visibility of previous assessments and unresolved needs.[20] Systematic uncertainty reduction supported the specification of a platform designed to operate within existing governance structures and align with national priorities for coordinated, person-centred, and preventive oral health care.[13,14,31]

The contribution extends beyond the platform itself by showing how coordination mechanisms can be translated into digital requirements under conditions of legal and organisational fragmentation. The platform addresses a recurring problem in integrated care: how to create shared visibility, role-based accountability and follow-up when responsibility for everyday care and professional oral health services is distributed across separate organisations. A central contribution of this study is the operationalisation of shared oral health care planning in a context characterised by parallel statutory responsibilities and non-interoperable documentation systems. Rather than treating fragmentation as a background condition, the development process incorporated it as a design determinant. The resulting platform supports coordinated action while respecting organisational boundaries, enabling role-based accountability, longitudinal traceability, and secure cross-organisational access. This approach responds directly to longstanding challenges in integrating oral health into home care workflows, where paper-based routines and disconnected systems have limited continuity, follow-up, and involvement of older adults.[7,8,12] It also builds on previous GAPA-related work showing that interprofessional collaboration between dental care and municipal healthcare can generate learning and change across organisational boundaries.[32]

The study also contributes to the growing literature on digital infrastructures for integrated care. Existing digital-health frameworks emphasise that digital platforms should be understood as infrastructure for integrated information flows, interoperability, and coordinated service delivery rather than as isolated applications.[15] Similarly, research on health technologies highlights that adoption, scale-up, spread, and sustainability depend on the interaction between the technology, the condition, the value proposition, users, organisations, and the wider system.[10] In this study, the GAPA platform was therefore developed not as a stand-alone documentation tool, but as a bounded shared planning environment embedded within an organisationally fragmented care system. By embedding validated assessment instruments, structured planning steps, and explicit responsibility allocation within a single shared environment, the platform addresses several barriers previously identified in interprofessional oral health collaboration for frail older adults.[17,18] The design also aligns with international calls for oral health to be integrated into health systems through intersectoral collaboration, digital health, and people-centred care.[14,15] However, the platform should not be interpreted as solving fragmentation through technical integration alone. Its contribution lies in combining structured assessment, shared visibility, role allocation, consent-sensitive information sharing, and traceable follow-up within the legal and organisational boundaries of Swedish home care and public dental services.

Furthermore, existing evidence demonstrates that older adults receiving home health care services have substantial oral health needs, including untreated disease, poor oral hygiene, xerostomia, impaired chewing and swallowing, and limited evidence on oral health-related quality of life. In parallel, digital oral health interventions for older adults are expanding, but the field remains dominated by dental-led tools for diagnosis, education, monitoring and self-care support. The present study

addresses the intersection between these two bodies of evidence by specifying how a co-designed digital infrastructure may support shared oral health planning across dental care, municipal care, caregivers, and older adults living at home[2,33]

The iterative development process highlighted several requirements essential for sustained use in routine care. These included intuitive navigation, role-sensitive data entry, readable content, mechanisms for documenting change over time, clear follow-up routes, and visibility of self-determination when older adults declined care. These findings are consistent with implementation perspectives emphasising that digital interventions must fit local workflows, user capabilities, organisational routines, and sustainability conditions.[10,34] They further suggest that digital tools for frail older adults must support not only documentation but also the relational and participatory dimensions of care planning.[12,35] This is particularly important because recent theory analysis indicates that existing shared decision-making models in oral healthcare are limited and mainly focus on the patient–oral health-professional encounter rather than multidisciplinary and cross-organisational care contexts.[35]

An emergent capability was mixed-reality-supported remote collaboration, which enabled real-time joint interpretation of oral findings. While promising for situations where clinic attendance is not feasible, early testing revealed technical and relational limitations. Previous work on teledentistry for older adults suggest potential for improving access to oral health support, but also indicates that evidence remains limited and that implementation must account for formative prototype testing, infrastructure, professional workflow, and older adults' participation.[36] In the present study, remote consultation should therefore be understood as a complementary function rather than a core workflow component. Its value depends on technical reliability, workflow integration, and explicit support for person-centred participation.

The use of photographic documentation and remote consultation in the GAPA platform can also be understood in relation to recent work on intra-oral camera utilisation. Javadi et al. identified intra-oral cameras as potentially useful for documentation, referral, teleconsultation, patient education and communication within the oral health-care team, while also highlighting technical issues, financial constraints, training needs and patient acceptance as implementation challenges.[37] In the present study, photographic documentation and mixed-reality-supported communication were therefore specified as complementary functions to support shared interpretation of oral findings across home care and dental-care professionals. These functions should not be interpreted as substitutes for clinical assessment, formal dental records or person-centred dialogue with the older adult, but as adjuncts whose value depends on technical reliability, workflow integration, professional competence and acceptability in home care settings.

Strengths and limitations

A strength of this study is the integration of empirical, contextual, technical, and regulatory inputs within a structured intervention-development framework. The multimethod approach, including field observations, workshops, governance-group input, iterative prototyping, and requirement refinement, enabled the platform to be grounded in real-world practice while remaining aligned with the MRC framework for complex intervention development.[20] Reporting was also strengthened by drawing on guidance for transparent intervention-development reporting and intervention description.[21,22]

The involvement of governance groups provided strategic oversight and strengthened the platform's feasibility within existing systems. The inclusion of dental, municipal, academic, digitalisation, and older-adult perspectives strengthened contextual fit and is consistent with co-design and integrated knowledge translation principles.[23,24] Another strength is the explicit use of validated assessment and patient-reported instruments, including ROAG and OHAI, which supports both structured clinical assessment and future evaluation.[26,28–30]

Limitations should be acknowledged. First, development occurred within a single Swedish regional context, which may limit transferability to settings with different governance structures, legislation, financing models, or digital infrastructures. Second, this study did not assess effectiveness outcomes, implementation outcomes in future evaluation, or patient outcomes. These will need to be evaluated in subsequent studies using clearly defined process, implementation, and outcome measures.[19,34] Third, mixed-reality functionality was explored only at a preliminary level, and further work is needed to determine its usability, acceptability, feasibility, effect on professional collaboration, and value for older adults receiving care at home.[34,36,37]

Furthermore, formative prototype testing was conducted as part of the development process and did not include an independent usability evaluation using standardised usability instruments. The findings should therefore be interpreted as development-oriented feedback rather than evidence of usability, acceptability or adoption. Because the research team, steering groups and development stakeholders were closely involved throughout the process, the resulting requirements may reflect programme assumptions and local priorities. This was mitigated by using predefined uncertainty domains, stakeholder feedback and explicit progression criteria between prototype cycles.

Conclusion

This study developed a high-fidelity digital platform that operationalises shared oral health care planning across municipal home care and public dental services. By translating legal, organisational, and technical constraints into concrete system requirements, the platform provides a bounded infrastructure for coordinated oral health assessment, planning, and follow-up across organisational boundaries. The resulting system supports guideline-aligned practice, generates structured data for evaluation, and is now ready for formal testing within the broader GAPA programme. The findings illustrate how complex intervention development can address fragmentation not by bypassing it, but by designing directly for it.

Acknowledgements

We thank the older adults and their loved ones who shared their experiences and made this work possible. We are grateful to Region Västra Götaland, Sweden, and the participating municipal care partners for supporting the development process. We acknowledge Sofia Torstensson, Elisabeth Söder, Annsofie Brattbäck-Atzori and Kerstin Karlén for their contributions. We also thank the Research Steering Group and the Innovation Steering Group for their guidance. We acknowledge the University of Gothenburg and Professor Peter Lingström for facilitating access to technical equipment that supported the development. We also acknowledge Peter Wessberg for his technical support, commitment and expertise during platform development.

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Ethical considerations

The study forms part of the broader GAPA research programme investigating person-centred oral health care planning in home care settings. Ethical approval was obtained from the Swedish Ethical Review Authority, Sweden [2020–047240209]. The project was conducted in accordance with the Declaration of Helsinki.

Consent to participate

No identifiable individual-level participant data are presented in this manuscript. Platform screenshots and images were anonymised before submission.

Author contributions

Conceptualisation: SB, JPK. Methodology: SB, JPK. Software / Platform Development Liaison: SB, JPK. Formal Analysis: SB, JPK. Investigation / Data Collection: SB, JPK. Resources: Region Västra Götaland; University of Gothenburg. Data Curation: SB, JPK. Writing – Original Draft: SB. Writing – Review & Editing: SB, JPK. Visualisation: SB. Supervision: JPK. Project Administration: SB. Funding Acquisition: JPK.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was funded by FORTE [grant number: 2024-01840] and FORTE [grant number: 2025-02068].

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The empirical development materials generated and analysed during the current study, including workshop notes, prototype feedback, requirement documents and workflow models, are not publicly available because they contain contextual and organisational information from participating care organisations. De-identified materials may be made available from the corresponding author upon reasonable request and subject to ethical, legal and organisational approval.

References

1. World Health Organization. *Decade of healthy ageing: baseline report*: World Health Organization, 2020.
2. Henni SH, Skudutyte-Rysstad R, Ansteinsson V, et al. Oral health and oral health-related quality of life among older adults receiving home health care services: a scoping review. *Gerodontology* 2023; 40: 161–171. https://doi.org/10.1111/ger.12649

3. Patel R and Gallagher JE. Healthy ageing and oral health: priority, policy and public health. *BDJ Open* 2024; 10: 79. https://doi.org/10.1038/s41405-024-00262-z
4. Aida J, Takeuchi K, Furuta M, et al. Burden of oral diseases and access to oral care in an ageing society. *Int Dent J* 2022; 72: S5–S11. https://doi.org/10.1016/j.identj.2022.06.012
5. Chan AKY, Tsang YC, Jiang CM, et al. Integration of oral health into general health services for older adults. *Geriatrics (Basel)* 2023; 8: 20. https://doi.org/10.3390/geriatrics8010020
6. Mitchell G, Stark P, Wilson CB, et al. "Whose role is it anyway?" Experiences of community nurses in the delivery and support of oral health care for older people living at home: a grounded theory study. *BMC Nurs* 2023; 22: 359. https://doi.org/10.1186/s12912-023-01533-0
7. Persson J, Johansson I, Torgé CJ, et al. Oral care cards as a support in daily oral care of frail older adults: experiences and perceptions of professionals in nursing and dental care—a qualitative study. *Int J Environ Res Public Health* 2022; 19: 9380. https://doi.org/10.3390/ijerph19159380
8. Björns S, Velic M and Persson Kylén J. Oral care cards as a support in the daily life of frail older adults: experiences and perceptions of leaders in municipal and dental care settings. *Gerodontology* 2026. https://doi.org/10.1111/ger.70074
9. van Dongen JJJ, Lenzen SA, van Bokhoven MA, et al. Interprofessional collaboration regarding patients' care plans in primary care: a focus group study into influential factors. *BMC Fam Pract* 2016; 17: 58. https://doi.org/10.1186/s12875-016-0456-5
10. Greenhalgh T, Wherton J, Papoutsi C, et al. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread and sustainability of health and care technologies. *J Med Internet Res* 2017; 19: e367. https://doi.org/10.2196/jmir.8775
11. Sveriges Kommuner och Regioner. *Regionernas särskilda tandvårdsstöd 2022*: Sveriges Kommuner och Regioner, 2023.
12. Persson Kylén J, Björns S, Hägglin C, et al. Decisional needs for older adults, home health care nurses and dental hygienists during team-based oral health assessments in ordinary home settings—a qualitative study. *BMC Geriatr* 2024; 24: 779. https://doi.org/10.1186/s12877-024-05367-6
13. Socialstyrelsen. *God och nära vård [Internet]*: Socialstyrelsen. [cited 2026 May 12]. Available from. https://www.socialstyrelsen.se/kunskapsstod-och-regler/omraden/god-och-nara-vard/
14. World Health Organization. *Global strategy and action plan on oral health 2023–2030*. : World Health Organization, 2024.
15. World Health Organization, International Telecommunication Union. *Digital health platform handbook: building a digital information infrastructure (infostructure) for health*: World Health Organization and International Telecommunication Union, 2020.
16. Poudel P, Paudel G, Acharya R, et al. Oral health and healthy ageing: a scoping review. *BMC Geriatr* 2024; 24: 33. https://doi.org/10.1186/s12877-023-04613-7
17. Hoste N, Baele E, De Vleeschauwer A, et al. Interprofessional collaboration on oral health for frail home-dwelling older people: a focus group study on needs and barriers experienced by general practitioners and community pharmacists. *BMC Prim Care* 2025; 26: 253. https://doi.org/10.1186/s12875-025-02955-2
18. de Jong MHS, Jerković-Ćosić K, van der Veen MH, et al. Improving oral health care for frail, community-dwelling older people: exploring barriers and facilitators for interprofessional collaboration. *Int Dent J* 2026; 76: 109346. https://doi.org/10.1016/j.identj.2025.109346
19. Persson Kylén J, Björns S, Hägglin C, et al. Evaluation of collaborative oral health care planning between older adults and personnel from public dental care and municipal care organizations: a study protocol for a cluster-randomized controlled study in Sweden. *Trials* 2025; 26: 57. https://doi.org/10.1186/s13063-025-08753-6
20. Skivington K, Matthews L, Simpson SA, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ* 2021; 374: n2061. https://doi.org/10.1136/bmj.n2061
21. Duncan E, O'Cathain A, Rousseau N, et al. Guidance for reporting intervention development studies in health research (GUIDED): an evidence-based consensus study. *BMJ Open* 2020; 10: e033516. https://doi.org/10.1136/bmjopen-2019-033516
22. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014; 348: g1687. https://doi.org/10.1136/bmj.g1687
23. Slattery P, Saeri AK and Bragge P. Research co-design in health: a rapid overview of reviews. *Health Res Policy Syst* 2020; 18: 17. https://doi.org/10.1186/s12961-020-0528-9
24. Kothari A, McCutcheon C and Graham ID. Defining integrated knowledge translation and moving forward: a response to recent commentaries. *Int J Health Policy Manag* 2017; 6: 299–300. https://doi.org/10.15171/ijhpm.2017.15
25. Persson Kylén J. Oral Health Care Planning: A conceptual model based on collaboration and person-centred care (PhD dissertation, University West). Retrieved from. https://urn.kb.se/resolve?urn=urn:nbn:se:hv:diva-23299 (2025).
26. Andersson P, Rahm Hallberg I and Renvert S. Inter-rater reliability of an oral assessment guide for elderly patients residing in a rehabilitation ward. *Spec Care Dentist* 2002; 22(5): 181–186. https://doi.org/10.1111/j.1754-4505.2002.tb00268.x
27. Johansson I, Jansson H and Lindmark U. Oral health status of older adults in Sweden receiving elder care: findings from nursing assessments. *Nurs Res* 2016; 65: 215–223. https://doi.org/10.1097/NNR.0000000000000154

28. Grönbeck LI, Andersson P, Dahlin-Ivanoff S, et al. Development of an instrument to assess oral hygiene ability in older adults: the Oral Hygiene Ability Instrument. *Gerodontology* 2020; 37: 19–27. https://doi.org/10.1111/ger.12440
29. Grönbeck LI, Andersson P, Dahlin-Ivanoff S, et al. Evaluation of the Oral Hygiene Ability Instrument (OHAI): test of reliability. *Int J Dent Hyg* 2024; 22: 806–816. https://doi.org/10.1111/idh.12797
30. Grönbeck LI, Andersson P, Dahlin-Ivanoff S, et al. Validity of the Oral Hygiene Ability Instrument. *Gerodontology* 2025; 42: 285–294. https://doi.org/10.1111/ger.12813
31. Socialstyrelsen. *Nationella riktlinjer för tandvård: stöd för styrning och ledning 2022*: Socialstyrelsen, 2022.
32. Persson J, Svensson A, Lindén IG, et al. Aspects of expansive learning in the context of healthy ageing: a formative intervention between dental care and municipal healthcare. *Int J Environ Res Public Health* 2022; 19: 1089. https://doi.org/10.3390/ijerph19031089
33. Javadi SKHS, Jamieson L, Nouri A, et al. Exploring digital health technologies for enhancing oral health: a scoping review of interventions for older adults. *Gerodontology* 2025; 0: 1–24. https://doi.org/10.1111/ger.70033
34. Proctor E, Silmere H, Raghavan R, et al. Outcomes for implementation research: conceptual distinctions, measurement challenges and research agenda. *Adm Policy Ment Health* 2011; 38: 65–76. https://doi.org/10.1007/s10488-010-0319-7
35. Persson Kylén J, Stacey D, Wårdh I, et al. Shared decision-making theories, conceptual models and frameworks within oral healthcare: a theory analysis. *Int J Dent Hyg* 2026. https://doi.org/10.1111/idh.70074
36. Ben-Omran MO, Livinski AA, Kopycka-Kedzierawski DT, et al. The use of teledentistry in facilitating oral health for older adults: a scoping review. *J Am Dent Assoc* 2021; 152: 998–1011.e17. https://doi.org/10.1016/j.adaj.2021.06.005
37. Haji Seyed Javadi SK, Jamieson L, Fazli M, et al. Intra-oral camera utilisation: a multi-perspective study on applications, challenges and future directions. *Br Dent J* 2026. https://doi.org/10.1038/s41415-025-9110-8