Role-based questionnaire integration for Alzheimer's disease monitoring in a user-centered digital platform

Corina-Elena PETEAN[1,2], Virginia SĂNDULESCU[1,3], Lidia BĂJENARU[1,2], Paul TEODORESCU[1], Cristian ȚÎRLEA[1, 2]

[1] National Institute for Research & Development in Informatics – ICI Bucharest, Romania

corina.petean@ici.ro, virginia.sandulescu@ici.ro, lidia.bajenaru@ici.ro, paul.teodorescu@ici.ro, cristian.tirlea@ici.ro

[2] National University of Science and Technology POLITEHNICA, Bucharest, Romania

corina.petean@ici.ro, lidia.bajenaru@ici.ro, cristian.tirlea@ici.ro

[3] Technical University of Civil Engineering, Bucharest, Romania

virginia.sandulescu@ici.ro

Abstract: Alzheimer's disease (AD) requires early detection and continuous monitoring to enable effective management. Digital health platforms increasingly support this need, yet many lack usability, personalization, or integration across patient, caregiver, and clinician roles. This paper presents the NeuroPredict platform, a modular, role-based digital architecture which includes validated clinical assessment tools specific to AD. In compliance with the user-centered design (UCD) principles, the system provides automated scoring, longitudinal monitoring, and improved usability by adapting access and interaction to the requirements of the patients, caregivers, and clinicians. Internal assessments examined the reliability of differentiated workflows, scoring the algorithm accuracy, and platform stability. When compared to the current approaches that digitize instruments independently, the NeuroPredict platform shows how a role-based approach may enhance interpretability, ensure continuity of care, and facilitate integration into clinical workflows. These findings establish a solid technical basis for digital ecosystems in Alzheimer's disease monitoring which are clinically relevant, extensible, and interoperable, even though the validation with patient cohorts remains a future step.

Keywords: User-Centered Design, Digital Health, Alzheimer's Disease, Role-Based Workflows, Validated Questionnaires.

Integrarea chestionarelor bazată pe roluri pentru monitorizarea bolii Alzheimer într-o platformă digitală centrată pe utilizator

Rezumat: Managementul eficient al bolii Alzheimer (AD) depinde de depistarea precoce și de monitorizarea susținută. Deși platformele de sănătate digitală (e-health) abordează această necesitate, multe prezintă deficiențe în personalizarea experienței de utilizare și în integrarea relației complexe pacient–îngrijitor–clinician. Această lucrare introduce NeuroPredict, o platformă digitală cu arhitectură modulară, proiectată conform principiilor Designului Centrat pe Utilizator (UCD). Platforma integrează chestionare clinice validate specifice afecțiunii AD, oferind funcționalități precum calculul automat al scorurilor și monitorizarea longitudinală. Sistemul optimizează fluxurile de lucru bazate pe roluri, adaptând interacțiunea și accesul la datele clinice pentru fiecare tip de utilizator (pacienți, îngrijitori și medici). Testele inițiale au confirmat fiabilitatea fluxurilor de lucru, precizia calculelor și stabilitatea generală a sistemului. Spre deosebire de demersurile axate pe simpla digitalizare a instrumentelor individuale, NeuroPredict demonstrează modul în care o abordare bazată pe roluri poate îmbunătăți semnificativ interpretabilitatea datelor și continuitatea îngrijirii, facilitând, în același timp, integrarea în ecosistemele clinice. Deși validarea clinică extinsă rămâne un pas viitor, rezultatele obținute stabilesc o bază tehnică solidă pentru dezvoltarea platformelor integrate, scalabile și interoperabile, destinate monitorizării AD.

Cuvinte-cheie: proiectare centrată pe utilizator, sănătate digitală, boala Alzheimer, fluxuri bazate pe roluri, chestionare validate.

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1. Introduction

The most prevalent neurodegenerative disease, Alzheimer's disease (AD), currently affects more than 55 million people worldwide and is expected to affect 139 million by 2050 (WHO, 2021). The progressive decline in memory, reasoning, and autonomy profoundly impacts both patients and caregivers (Scheltens et al., 2021). The conventional medical approaches, which depend on periodic evaluations conducted in person at a facility, often fail to detect subtle early changes or provide the long-term, continuous data needed for an effective management. However, despite these clear opportunities, the adoption of digital tools remains constrained by several significant barriers: poor usability, low digital literacy among the elders, and an insufficient integration with the existing clinical workflows (Wu et al., 2025).

The cutting-edge digital tools, including wearables, cellular applications, and intelligent computing frameworks, deliver easily expandable answers for the integrated decision-support further strengthens these digital care pathways (Băjenaru et al., 2024). In this context, the digital cognitive tools improve the accessibility and engagement offering an accuracy comparable to the traditional assessments, which is especially pertinent in the post-pandemic era as telehealth has become central (Staffaroni et al., 2020; Eost-Telling et al., 2024).

To ensure that the systems are adapted to the skills and requirements of the patients, caregivers, and clinicians, the User-Centered Design (UCD) is essential (ISO, 2019; Farao, Malila, Conrad et al., 2020). It has been demonstrated that the role-based interfaces, which distinguish functionality according to user type, improve task accuracy, reduce cognitive overload, and protect data privacy (Kagwa, Konradsen & Kabir, 2022; Shaik et al., 2025). Many platforms, however, focus on digitizing individual questionnaires without regard to the role differentiation, which leads to poor clinical integration, insufficient personalization, and decreased usability in the actual healthcare settings. Assessing the cognitive and functional status in AD is based on standardized questionnaires. Several validated and often used tools in neurology and geriatrics include the Alzheimer’s Questionnaire (AQ©), Barthel Index (BI), Geriatric Depression Scale – Short Form (GDS-SF), and Quality of Life in Alzheimer’s Disease (QoL-AD) (Malek-Ahmadi, 2015; Cousi et al., 2024). When psychometric validity and interpretability are maintained, their digitization presents potential for automated scoring, remote administration, and longitudinal data collection (Jesus et al., 2024).

This study highlights the potential of the scalable, interoperable, and role-based digital assessment in AD monitoring using the NeuroPredict platform, which combines the validated clinical questionnaires with a user-centered, role-based architecture. Through improved usability and longitudinal assessment made achievable by this integration, the people with Alzheimer's disease may gain from early intervention, reduced stress for caregivers, and improved continuity of care. In this study, the related work is outlined (*Section 2*), the platform design and questionnaire integration are described (*Section 3*), the internal evaluations of feasibility and workflow stability are presented (*Section 4*), and the implications and future directions are discussed (*Section 5*).

2. Related work

The management of AD is changing due to digital health solutions that make early detection, remote consultations, and ongoing monitoring accessible (Zheng, Wu & Weng, 2025). Digital platforms have shown promise in improving the coordination and support in the management of Alzheimer’s disease. In this regard, MindMate focuses on cognitive training, reminders, and engagement strategies for the people with Alzheimer’s disease (McGoldrick, Crowford & Evans, 2021), Care4AD demonstrates the potential of the technology-driven solutions to enhance the family–clinician coordination and care management (Mishra et al., 2023), and CogniCare offers educational resources and practical support for caregivers (Kagwa, Konradsen & Kabir, 2022). Dedicated technological tools may mitigate the implementation challenges for the elders exhibiting low levels of digital literacy. A case in point is the KOMP system, whose streamlined, single-button mechanism effectively encourages engagement and social connection within this population segment (Rai et al., 2022).

Large-scale investigations (e.g., the Intuition Study, Butler et al., (2025)) and AI solutions (like Neurotrack, Glenn et al., 2023) verify the possibility of the remote monitoring via smartphones and smartwatches. However, as Piendel, Vališ & Hort, (2023) observe, these tools frequently encounter issues related to interoperability deficits, a lack of rigorous clinical validation, and ongoing discrepancies in user access. Wearable-centric systems show strong remote monitoring pipelines in addition to cognitive apps (Ianculescu, Andrei & Alexandru, 2019).

While the standardized and validated scales continue to be essential to AD monitoring, their conversion to digital formats requires careful adaptation to preserve their reliability. Instruments such as QoL-AD (Logsdon et al., 1999), BI (Wojtusiak, Khan & He, 2021), GDS-SF (Yesavage et al., 1982; Song et al., 2024), and Patient Health Questionnaire-9 (PHQ-9) (Kroenke, Spitzer & Williams, 2001) have been successfully digitized. Digital assisted-living interventions have been associated with improvements in the health-related quality of life (HRQoL) in the elders (Dobre et al., 2023). Other tools such as the Modified Fatigue Impact Scale (MFIS) (Jesus et al., 2024) and the Functional Activities Questionnaire (FAQ) (Lott et al., 2024) extend monitoring to domains such as fatigue and functional decline. Tools such as MFIS and PHQ-9 provide complementary insights on comorbidities and day-to-day functioning, despite not being AD-specific. Most digital platforms include these tools separately and without customization, which makes them less useful. By integrating several validated tools into one role-based ecosystem that is accessible to patients, caregivers, and clinicians, the NeuroPredict platform addresses this gap.

Continuous design, accessibility, and workflow alignment are prioritized in UCD frameworks (ISO, 2019). Usability in Alzheimer's care is enhanced by adaptations such as large fonts, high contrast visuals, multimodal support, and simplified interfaces, as cognitive impairments impact comprehension and navigation (Van Gils et al., 2024; Wu et al., 2025). The necessity of age-appropriate User Experience (UX) is demonstrated by the satisfaction data from the smart assisted-living deployments (Băjenaru, Marinescu & Tomescu, 2022). The participatory design in platforms like MindMate, CogniCare, and KOMP has demonstrated sustained engagement (McGoldrick, Crowford & Evans, 2021). However, few platforms apply UCD to role-based differentiation, tailoring tools for patients, caregivers, and clinicians, which continues to constrain usability and data protection (Kagwa, Konradsen & Kabir, 2022).

3. Materials and methods: integration of questionnaires and platform design

3.1. Overview of the implemented questionnaires

The questionnaires integrated in the NeuroPredict platform were selected to be both clinically relevant and practical to use. In order to identify such questionnaires, in the research phase, the team searched for tools that were already proven to be reliable and accurate in diagnosis. Only instruments with strong psychometric validation, such as the GDS-SF (Sultana et al., 2022) and the AQ© (Malek-Ahmadi & Sabbagh, 2015) were chosen, as they are commonly used and trusted in clinical work. These were selected as priorities due to their frequent application in clinical environments and their capacity to yield consistent and interpretable results. Another consideration was to ensure both comparability with existing datasets and alignment with clinical workflows. Preference was given to questionnaires that are frequently used in the neurology and geriatric practice. The selected instruments also address complementary domains: quality of life or emotional well-being, functional independence, and cognitive status. Because these questionnaires cover several important aspects, through their integration, the platform can record not only clinical symptoms but also a person’s emotional state, well-being, and independence and ability to perform daily basic tasks.

The addition of validated questionnaires to the digital platforms helps the clinicians notice early signs of neurodegenerative decline, follow patient progress over time, and offer personalized care. Previous studies have shown that reports from patients and caregivers can uncover small signs of deterioration even before they are visible in the clinical evaluations (Glenn et al., 2023). All selected instruments were implemented in the digital form to preserve their psychometric validity, enable automatic scoring, and support longitudinal visualization across multiple domains, such as cognition, quality of life, daily functioning, depression, fatigue, and behavioural symptoms. In this approach to patient-facing tools, we adhered to the principles of UCD, which led to the implementation of features such as simplified navigation, enlarged fonts, high-contrast visuals, and the option for caregiver assistance. These adjustments were made specifically to reduce the cognitive load for the users. The cognitive assessment was conducted through the administration of the AQ© (Malek-Ahmadi & Sabbagh, 2015) in a format completed by the caregivers, ensuring the consistency and reliability in the results. To gain insights into the quality of life and emotional well-being of the participants, we utilized a variety of measures including the QoL-AD (Logsdon et al., 1999; Cousi et al., 2024), GDS-SF, PHQ-9 (Zhen et al., 2020; Song et al., 2024), and the MFIS (Jesus et al., 2024). Each questionnaire was included in a simple digital format to make completion fast and easy for the users. We also measured the functional independence using the BI (Wojtusiak, Khan & He, 2021) and the FAQ. Both were adapted into clear digital layouts with automatic scoring, which helps keep results consistent and easy to interpret.

For clinicians, several specific tools were also included to support an accurate evaluation and decision-making: The Global Assessment of Functioning Scale (GAFS) (Jones et al., 1995) gives a short overview of a person's psychological and social functioning; the Neuropsychiatric Inventory Questionnaire (NPI-Q) (Kaufer et al., 2000) captures the behavioural and psychological symptoms of dementia, along with the emotional strain often felt by the caregivers. Both tools were implemented in validated digital formats. Unlike other platforms that simply digitize each questionnaire on its own, the NeuroPredict platform combines several validated instruments into one connected, role-based system. This makes it easier for patients, caregivers, and clinicians to use the same environment and helps maintain the continuity of care within normal clinical workflows. It also allows for centralized monitoring of the different aspects captured by multiple types of tools.

3.2. Architecture and design principles of the NeuroPredict platform

The NeuroPredict platform was designed as a multi-layer system that follows the structure described by Ianculescu et al. (2025). In its simple form, it collects data from different sources (validated questionnaires, physiological sensors, and cognitive tests) through separate modules. Each module handles a specific type of input before sending the data securely to the cloud, where it can be analyzed using AI methods. The access to the system is organized by the user role so that patients, caregivers, and clinicians only see the parts relevant to their work. This layered setup makes the platform easier to scale, maintain over time, and extend with new medical modules as it develops. For implementation, the Python-based Django framework was selected. Django is both flexible and reliable for building web applications and already offers a clear modular structure, which helps separate the main parts of the platform into logic, data, and interface layers. In the NeuroPredict project, Django's standard structure was followed, and the code was divided into several main components: *settings.[py]* - contains project configuration such as security keys and database connections; *urls[.py]* - defines the routes that connect the different modules of the platform; *views[.py]* - includes the main logic for tasks-questionnaire handling, scoring, and role-based actions; *models[.py]* - defines the database tables (patients), questionnaires, and results using the Object-Relational Mapping (ORM); *templates/* - stores the HyperText Markup Language (HTML) pages that display the interface; *static/* - holds design resources like Cascading Style Sheets (CSS), JavaScript, and images that keep the same look and feel for all user roles (Chen, Ahmed & Lal, 2020). Upon need, each of the before mentioned components were divided in subcomponents so that the complexity of the developed functionalities is easy to manage while still preserving a logical structure in accordance with Django's typical workflow.

This modular setup also supports the platform's multi-role structure, where each type of user has different tasks and permissions. Clinicians can access and manage patient records and medical data as part of their regular clinical work. Caregivers can see relevant patient information, but always under the clinician's approval. Patients have their own view, where they can check personal results and past questionnaire data. This separation keeps the workflow clear and protects sensitive information for every role. While the platform is constructed to support all three roles, the present work focuses on the workflows of patients and clinicians, as they constitute the main workflow for the questionnaire-based evaluation. By supporting a role-based structure, we ensure that the workflows remain clinically relevant, user-friendly, and compliant with the data protection standards.

3.2.1. Modular design for clinical questionnaire integration

A separate module was developed to manage the back-end section related to questionnaires. Each clinical questionnaire was built using the same template, so the system stays flexible and easy to maintain over time. Every questionnaire includes its own information, such as title, description, items, scoring logic, and interpretation rules, all stored in the database. This way, new instruments can be added, updated, or replaced without changing the main code of the application. Each questionnaire, no matter how they are structured or scored, goes through the same standardized processing pipeline. Django's reusable templates were used to display each questionnaire dynamically and connect it to a single scoring workflow. This approach helps keep data handling consistent across user roles. Because the questionnaire definitions are stored separately from the core code, the platform remains stable, easy to expand, and fully aligned with the clinical requirements.

3.2.2. Role-specific questionnaire workflow

The NeuroPredict platform was designed with separate interaction flows for patients and clinicians, so that each user sees only what fits his role and level of responsibility. For patients, the process was made as simple and clear as possible. Each question includes short, direct instructions, and the navigation is kept linear to reduce confusion and make self-reporting easier. After completing a questionnaire, the system automatically saves and processes the answers, storing the results (responses and score) securely for later review. Clinicians can view questionnaires grouped by condition, check their full content, assign them to patients, and add short notes or deadlines if needed. They can also complete the forms together with their patients during the consultations. The platform then provides detailed score interpretations, individual item responses, and longitudinal summaries to help the clinicians follow the progress and make informed decisions. Both the patient and clinician workflows connect to the same backend pipeline, which checks data accuracy, calculates scores, and links results to the right interpretation. This setup follows the UCD principles by keeping the process simple and well-guided for patients, while giving clinicians control and analytical detail when reviewing results. Figure 1 shows how these two workflows complement each other and connect within the shared data layer.

3.2.3. Questionnaire module implementation

The questionnaire module in the NeuroPredict platform was created to deliver and score validated clinical instruments through one unified workflow. The main goal was to keep a clinical accuracy while making the process automatic, secure, and easy to track over time. The module uses Django's layered structure, combining the questionnaires are stored in the database using the structured Structured Query Language (SQL) scripts instead of the hard-coded logic. This design makes it simple to add, update, or remove instruments without changing the source code. Each questionnaire includes: (a) **metadata** – such as the name, description, instructions, and the roles it applies to; (b) **questions and responses** – with numerical or categorical values linked to specific scores; (c) **score interpretations** – that map score ranges to clinical meanings (for example, normal, mild, or dementia-level impairment); and (d) **completed records** – storing answers together with patient identifiers, timestamps, and item-level data for later review. By separating questionnaire definitions from patient data, the module stays easy to maintain and extend, while ensuring consistency and reliability for future validation.

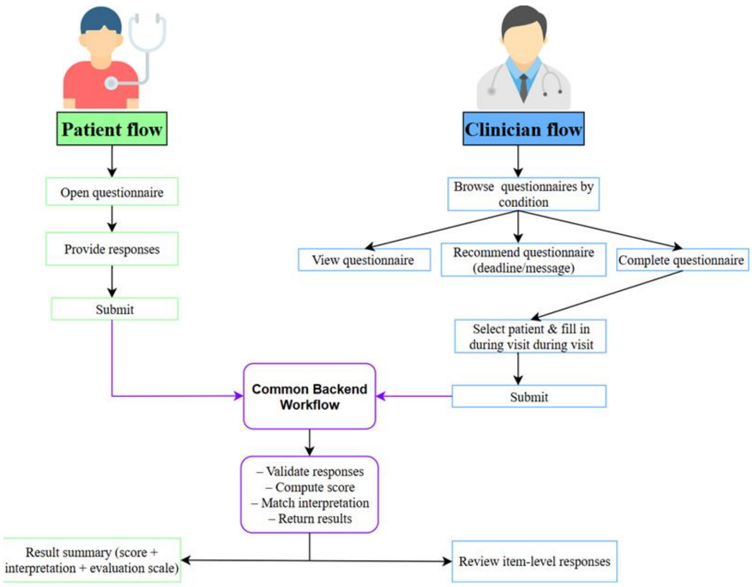

Figure 1. Interaction flows for patients and clinicians in the NeuroPredict questionnaire module (own research)

3.2.4. Data validation, security, and module extensibility

The questionnaire module includes several checks that help keep data accurate, secure, and easy to expand in the future. The validation rules make sure that all the required fields are filled in and that the information follows the correct format. When something is missing or entered incorrectly, the system shows clear error messages to help the user fix them.

The access control is managed through specific permissions based on user roles. The patients can complete the questionnaires and see their own results, while the clinicians can recommend, administer, and review them. Each record is saved with a timestamp and the user's role, which keeps a full history for audits and later verification. Because the module is built on a data-driven structure, new questionnaires can be added through the same SQL-based setup and automatic scoring process. This makes the platform easy to maintain and scale over time.

4. Results

Before the application of the questionnaire module in clinical procedures, an internal testing was carried out in order to verify its technological reliability and overall stability. The evaluation was conducted in a secure environment and by the developers in order to assess some key points:

1. *Proper Scoring* - ensuring that all the scoring algorithms were in alignment with the clinical definitions.
2. *SQL consistency* - confirming the questionnaire definitions are properly filled and rendered from the Django templates with no errors.
3. *Workflow stability* - testing role-based interactions (e.g., patient completion and recommendation by clinician) in order to run each path reliably.
4. Database - confirming that the total scores, interpretations, and item-level information were properly stored in the database.

This stage was intended as a practical verification of the system functionality rather than a formal performance evaluation. The team verified that the questionnaires were rendered correctly, the scoring algorithms produced accurate results, and the stored data remained consistent across different user roles. The results confirmed the correct operation of the implemented functionalities and the technical readiness of the module for the future pilot deployment with real users, while the quantitative performance testing and the clinical validation would remain part of the next development stages.

4.1. Implementing functions with Alzheimer's disease specific questionnaires

In order to demonstrate the operations of the module in practice, two Alzheimer-specific tools were embedded as baseline comparisons: the AQ© and the QoL-AD. The AQ© represents a weighted dichotomous screening questionnaire with 21 informant-reporting questions and was selected owing to its relative complexity. The QoL-AD, in contrast, obtains the patient's own perception of the quality of life with 13 Likert-scale questions in the domains of psychology, physical health, and social functions. Both surveys were embedded in the NeuroPredict platform in the electronic format with automatic scoring, longitudinal visualizations, and differential access according to the role of the user. Together, they demonstrate the system's capabilities for combining clinician-initiated assessments with patient-reporting and producing supplementary insights into the cognitive and functional status in AD.

4.2. Patient view

In the patient interface, the platform allows for a specified area with all the clinician-recommended questionnaires in succession so that ease and clarity can be offered. The patient can access to general and disease-specific tools such as the AQ©, QoL-AD, and short descriptions for guidance. When a patient selects the QoL-AD (Figure 2), the interface displays clear completion instructions and each item is presented with clear response options on a four-point Likert scale. Once all items are answered, the system automatically computes and displays the score along with an interpretation (Figure 3).

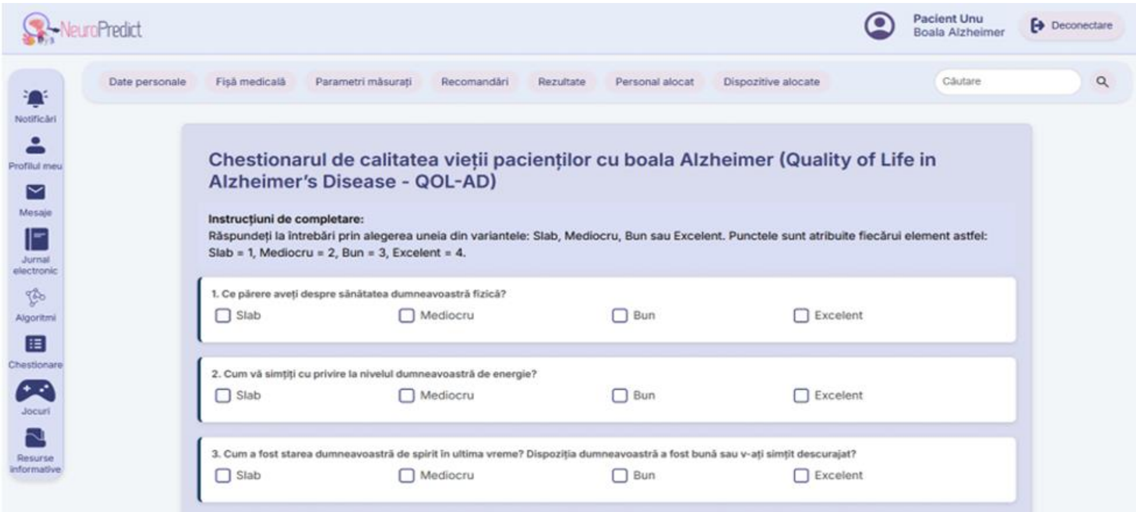

Figure 2. Patient interface for completing the QoL-AD questionnaire, with clear instructions and four-point Likert response options (own research)

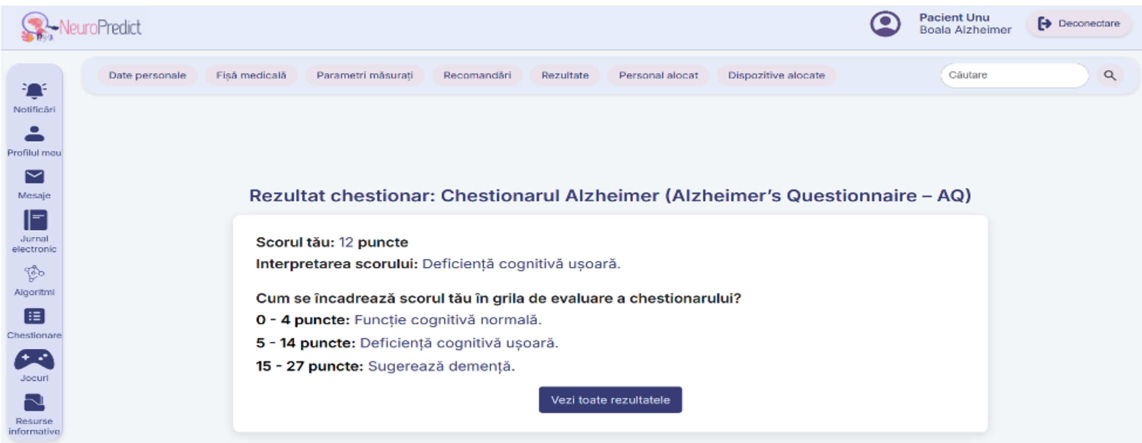

Figure 3. Automatically generated patient results for the AQ© questionnaire (own research)

In addition to the individual results, the patient can also review a longitudinal record of the previously completed questionnaires. As illustrated in Figure 4, this summary table includes the questionnaire name, the date and time of completion, the person who completed it (patient or clinician), the recommended clinician if applicable, the resulting score, and its interpretation. This view supports the patient awareness and enables the continuous tracking of the quality-of-life indicators over time.

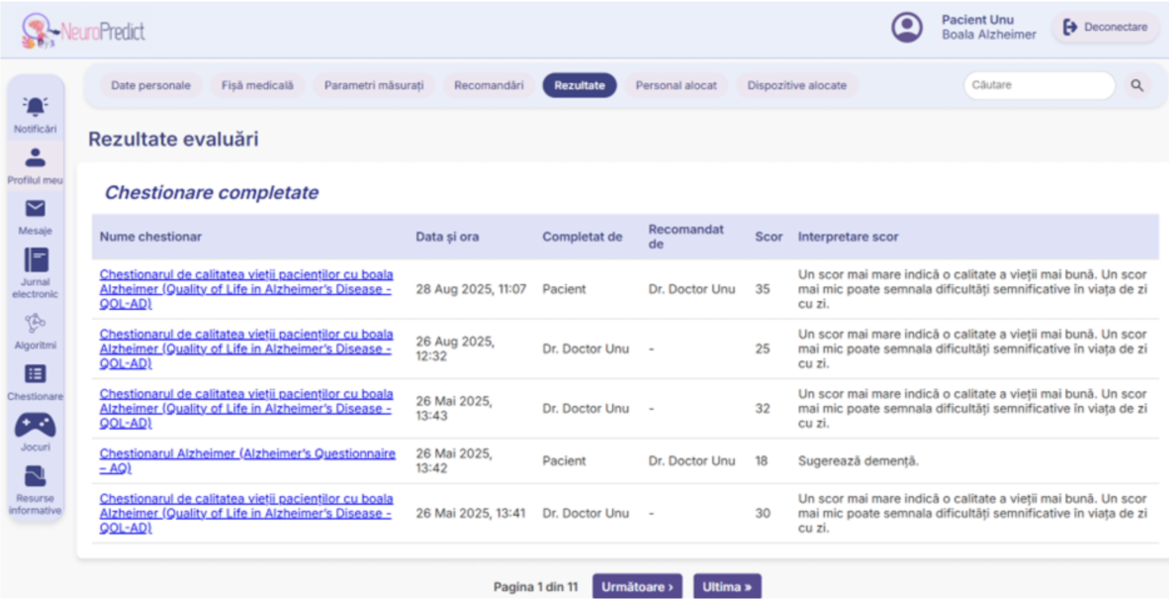

Figure 4. Longitudinal view of the completed questionnaires in the patient account, including scores, interpretations, and completion details (own research)

4.3. Clinician perspective

From a clinician's perspective, the NeuroPredict platform offers an enhanced functionality that is specifically designed for medical workflows. In Figure 5, the clinicians can access the disease-specific questionnaires and view three main activities for all instruments: View, Recommend, and Complete.

- **View -** allows the clinicians simply to view and read the entire content of a questionnaire without answering it. This facility can be used regularly in the process of re-acquainting oneself with the questions or prior to conducting a patient interview.
- **Recommend -** allows the clinician to refer the patient to a particular questionnaire and, if desired, append a short and personal note or observation with a deadline for completion (see Figure 6).
- **Complete -** allows the clinician to fill in the questionnaire on behalf of or together with the patient during a consultation. The clinician accesses a similar interface to record patient responses.

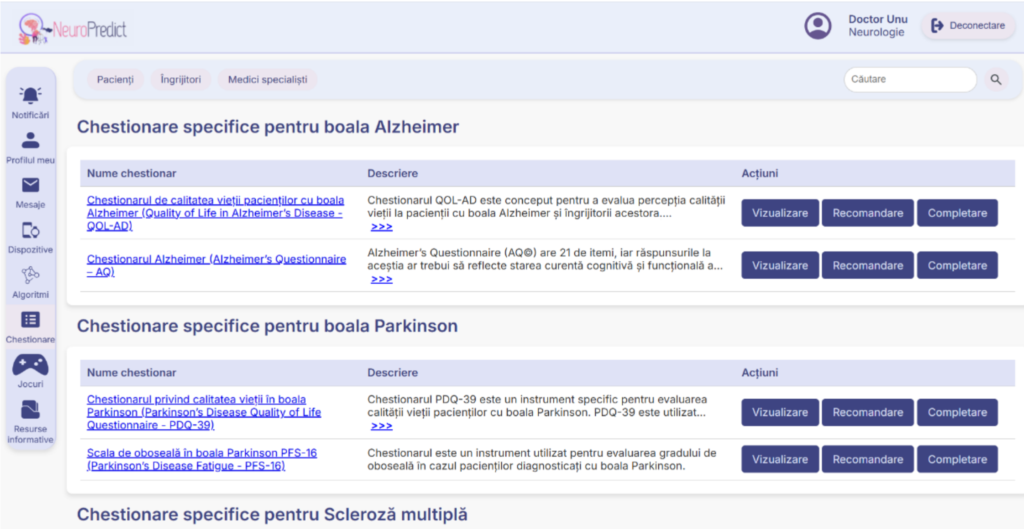

Figure 5. Clinician interface displaying disease-specific questionnaires, with three main actions: View, Recommend, and Complete (own research)

Figure 6. Clinician interface for recommending questionnaires, including patient selection, optional messaging, and deadline setting (own research)

When submitted, the overall score is automatically determined and an interpretation is provided and kept in the patient's file together with the clinician identifier and completion data. This process enables both self-administered and clinician-administered assessments, with exact tracking of the results and clinical decision-making alignment. Collectively, these workflows demonstrate not just the platform flexibility for Alzheimer-specific assessments, but also its potential for extension to other instruments and for longitudinal outcome measurement, thereby facilitating monitoring and evidence-based decision-making in clinical practice.

5. Discussion

5.1. Interpretation of findings

The results demonstrate that the role-based integration of the clinical questionnaires within a digital health platform is both feasible and technically sound. With distinction in access and engagement between patients, caregivers, and clinicians, the NeuroPredict platform applies the UCD principles in a way that meets the distinct requirements of AD monitoring. For patients, the simplified interface helps reduce the cognitive effort through clear instructions and intuitive navigation. Clinicians, on the other hand, benefit from advanced functions such as questionnaire assignment, proxy completion, and instant score interpretation, which together streamline the assessment workflow.

Including the Alzheimer-specific instruments further show how the framework can adapt to different types of clinical measures, from the complex diagnostic questionnaires with weighted binary scoring to the patient-reported outcomes based on the Likert scales. This demonstrates the system's capacity to manage diverse assessment formats within a single standardized process.

Overall, these findings indicate that the platform effectively connects the technical implementation with a real clinical usability. Beyond confirming its functional correctness, it establishes a foundation for the longitudinal follow-up, structured decision support, and scalable, role-based tools that promote the patient-centered management of AD.

5.2. Comparison with related work

As outlined in Section 2, several digital platforms for cognitive assessment and AD monitoring have already demonstrated the feasibility of digitizing traditional tests, providing standardized administration, automated scoring, and in some cases remote delivery. These advances reduce the clinician's workload and expand the opportunities for data collection. Yet, most current solutions address all users in the same way, providing nearly identical interfaces for patients and clinicians while seldom incorporating the caregiver participation. Such an approach often reduces the usability and neglects the importance of the proxy input when the patients are unable to complete assessments on their own.

The NeuroPredict platform addresses this gap by making the role differentiation a core aspect of its design. The interface remains simple and guided for patients, supports proxy completion when needed, and gives clinicians an extended control for managing, reviewing, and interpreting results. Through the inclusion of the validated Alzheimer-specific questionnaires within this framework, the NeuroPredict platform moves beyond the basic test digitization and embodies a genuinely user-centered, role-based system aligned with the real clinical practice.

5.3. Clinical implications

The integration of the role-specific questionnaires is likely to influence the clinical practice in several meaningful ways. For clinicians, the system offers greater control and transparency by recording each completed instrument together with unique identifiers, timestamps, and detailed score interpretations. This structure simplifies the review and auditing processes and can support more informed clinical decisions based on standardized data. Patients benefit from an interface intentionally designed to be simple and intuitive, which helps reduce their cognitive effort during completion. At the same time, caregivers can participate more actively by providing proxy input or completing caregiver-oriented scales when the patients are unable to do so themselves. These collaborative features mirror the dynamics of the real clinical settings more closely than any conventional digital forms.

Another important advantage is the longitudinal perspective: all completed questionnaires are stored in patient records along with temporal markers, allowing clinicians to follow the disease progression and compare the outcomes across multiple assessments. This structured, longitudinal evidence has the potential to inform timely interventions and strengthen the basis for clinical decisions.

Although the present article is focused on the questionnaire module, the broader NeuroPredict platform is designed to support patient monitoring through multiple complementary modalities, including the physiological parameter tracking, serious games for cognitive stimulation, and AI-driven algorithms for digital test analysis. In this way, the questionnaire module is envisioned not to stand in isolation but contribute to a comprehensive digital ecosystem aimed at improving early detection, continuous monitoring, and personalized management of AD.

5.4. Limitations and future work

While the NeuroPredict platform demonstrates the feasibility of the role-based questionnaire integration, several limitations and corresponding directions for future work must be acknowledged. First, validation to date has been restricted to internal testing in controlled environments. In addition, although user-centered principles guided certain interface adaptations (e.g., larger fonts, pictograms), no usability testing with end-users or expert UX evaluations have been conducted so far. Pilot studies with patients and healthcare professionals remain required to assess the usability and clinical impact. The system's actual implementation is a further limitation. Engaging with the platform may be challenging for the elders who lack access to appropriate devices and reliable internet connections, or who have inadequate digital abilities. These challenges could restrict the scalability, indicating the necessity of user education, design improvements, or even an offline mode to guarantee accessibility in a variety of contexts. At this point, scoring and interpretation are based on predefined guidelines that do not yet dynamically adjust to unique traits. Therefore, future work will focus on developing and improving the NeuroPredict framework as a whole as well as the questionnaire module. To evaluate usability, acceptance, and clinical impact under real conditions, the next step should include the pilot validation with patients, carers, and clinicians.

The platform may also be complemented by interactive cognitive tasks and advanced reporting dashboards. Such features could provide richer feedback, normative comparisons, and longitudinal charts that support discussions of symptom progression and clinical decision-making. Beyond the questionnaires, the AI-driven modules will extend the multimodal framework, including analysis of Clock Drawing Tests, speech and voice features, and gait monitoring. This will position the questionnaires as one component within a comprehensive ecosystem for neurodegenerative disease monitoring. Finally, the potential for interoperability with standardized Electronic Health Record systems (e.g., HL7/FHIR) will be explored to enable the integration into the existing clinical workflows and the secure exchange of structured data. Together, these directions will consolidate the NeuroPredict platform as a clinically validated, extensible, and interoperable digital ecosystem, with the questionnaire module serving as a foundational component.

6. Conclusions

This study highlights the technical potential of incorporating clinically validated questionnaires into a role-based digital architecture for Alzheimer's disease monitoring. Beyond the essential digitization of individual questions, the main achievement lies in demonstrating how different processes for patients, professionals, and caregivers can be integrated into a single digital framework. The reliability and stability of the module were verified through internal tests, demonstrating a solid technological basis for role-specific interaction, automatic scoring and longitudinal tracking. Although it is recognized that the validation with end users and clinicians remain an essential next step, these results demonstrate the potential of reducing the patient burden and support a more structured clinical decision-making. Going forward, the framework creates a basis for the interoperability with the EHR systems and multimodal extensions such as speech, drawing, and gait analysis. To ensure that the NeuroPredict platform develops from a technical prototype into a clinically useful tool for the management of the neurodegenerative diseases, it will be important to conduct additional clinical trials to validate its usability, acceptability, and clinical relevance.

Author contributions

Conceptualization: L.B. and V.S.; Methodology: L.B., V.S. and C.P.; Software: V.S., C.P. and C.T.; Validation: L.B., P.T. and C.T.; Data curation: C.P., P.T. and C.T.; Writing—original draft preparation: L.B., C.P., P.T., C.T. and V.S.; Writing—review and editing: L.B., C.P, V.S., P.T. and C.T. All authors have read and agreed to the published version of the manuscript.

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Corina-Elena PETEAN is a software developer at the National Institute for Research & Development in Informatics – ICI Bucharest and a Master's student in the "Medical Informatics Systems" program at the Faculty of Automatic Control and Computers, National University of Science and Technology Politehnica Bucharest (UNSTPB). Her research interests include the development of medical applications, biomedical image processing and analysis, artificial intelligence in healthcare, as well as telemedicine and digital patient monitoring solutions.

Corina-Elena PETEAN este programator la Institutul Național de Cercetare-Dezvoltare în Informatică – ICI București și student-masterand în cadrul programului „Sisteme Informatice în Medicină" din cadrul Facultății de Automatică și Calculatoare, Universitatea Națională de Știință și Tehnologie Politehnica București (UNSTPB). Domeniile sale de cercetare includ dezvoltarea de aplicații medicale, prelucrarea și analiza imaginilor biomedicale, aplicarea inteligenței artificiale în sănătate, precum și soluții de telemedicină și monitorizare digitală a pacienților.

Virginia SĂNDULESCU, Eng. Ph.D., has over 15 years of experience in research and development in ICT and academia, as Scientific Resercher National Institute for Research & Development in Informatics – ICI Bucharest and Lecturer at the Technical University of Civil Engineering Bucharest - TUCEB. Her research areas include computer networks, operating systems and interoperability. She specialized in designing solutions that integrate full-stack development, IoT technologies, and artificial intelligence, applied to smart environments, affective computing, and healthcare.

Virginia SĂNDULESCU, Dr. ing., are peste 15 ani de experiență în cercetare-dezvoltare în IT&C și în mediul academic, în calitate de cercetător științific la Institutul Național de Cercetare-Dezvoltare în Informatică - ICI București și conferențiar la Universitatea Tehnică de Construcții din București. Domeniile sale de interes includ rețelele de calculatoare, sistemele de operare și aspecte legate de interoperabilitate. Este specializată în proiectarea de soluții care integrează dezvoltarea full-stack, tehnologiile IoT și inteligența artificială pentru aplicații în medii inteligente, computație afectivă și sănătate.

Lidia BĂJENARU, Eng. Ph.D., is a Senior Researcher I at the National Institute for Research & Development in Informatics – ICI Bucharest and a Senior Researcher II at the National University of Science and Technology Politehnica Bucharest (UNSTPB). She holds a B.S. in Computer Engineering from the “Gheorghe Asachi” Technical University of Iași and a Ph.D. in Economic Informatics from the Bucharest University of Economic Studies. She has coordinated and contributed to more than 40 national and international projects. The Internet of Things, e-health, e-learning, data analytics, AI, semantic technologies, and data management are some of her areas of interest. She is the author of more than 120 scientific publications and a member of several professional associations and scientific committees.

Lidia BĂJENARU este cercetător științific gradul I la Institutul Național de Cercetare-Dezvoltare în Informatică - ICI București și cercetător științific gradul II la Universitatea Națională de Știință și Tehnologie POLITEHNICA București (UNSTPB). A absolvit Facultatea de Automatică și Calculatoare din cadrul Universității Tehnice „Gheorghe Asachi” din Iași și a obținut titlul de doctor în informatică economică la Academia de Studii Economice din București. A coordonat și susținut peste 40 de proiecte naționale și internaționale. Este autoarea a peste 120 de publicații științifice și membru al mai multor asociații profesionale și comitete științifice. Domeniile sale de interes includ Internetul lucrurilor, e-sănătatea, e-learning-ul, analiza datelor, inteligența artificială, tehnologiile semantice și managementul datelor.

Paul TEODORESCU is an engineer by profession, with over 11 years of experience working in Canada, in the IT field, specializing in databases, PL/SQL, Big data and Data warehousing. He currently works as a Scientific Researcher at the National Institute for Research and Development in Informatics – ICI Bucharest, where he is involved in projects involving Artificial Intelligence (AI), Natural Language Processing (NLP) and Geographical Information Systems (GIS) projects.

Paul TEODORESCU este inginer de profesie, cu 11 ani de experință în Canada în domeniul

IT, specializat în baze de date, PL/SQL și gestionarea datelor de mari dimensiuni, inclusiv sisteme de tip data warehousing. În prezent lucrează ca cercetător științific la Institutul Național de Cercetare-Dezvoltare în Informatică – ICI București, fiind implicat în proiecte de Inteligență Artificială (IA), Procesarea Limbajului Natural (NLP) și Sisteme Informaționale Geografice (GIS).

Cristian ȚÎRLEA is a graduate of the Faculty of Electrical Engineering at the National University of Science and Technology Politehnica Bucharest (UNSTPB). His experience in IT is focused on R&D with an interest in databases, especially on PL/SQL and Oracle database development, data storage and natural language processing (NLP). He currently works as a Researcher Assistant at the National Institute for Research and Development in Informatics – ICI Bucharest, being involved in complex projects in the field of machine learning and data analysis, building out real world data driven technology solutions.

Cristian ȚÎRLEA este absolvent al Facultății de Inginerie Electrică, Universitatea Națională de Știință și Tehnologie POLITEHNICA București. Experiență sa în IT este axată pe cercetare și dezvoltare, cu interes pentru baze de date, în special PL/SQL și Oracle, stocarea datelor și procesarea limbajului natural (NLP). În prezent, este asistent de cercetare la Institutul Național de Cercetare-Dezvoltare în Informatică – ICI București, fiind implicat în proiecte complexe în domeniul învățării automate și analizei datelor, dezvoltând soluții tehnologice bazate pe date reale.