



Project No. 964220

Intelligent digital tools for screening of brain connectivity and dementia risk estimation in people affected by mild cognitive impairment

Deliverable 1.1

Report map of MCI diagnostics and management

WP 1 – Concept governance and requirements of the AI-Mind Connector and Predictor

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Abbreviations

AAN	American Academy of Neurology
AD	Alzheimer's Disease
AI	Artificial Intelligence
API	Application Programming Interface
CSF	Cerebrospinal Fluid
DPO	Data Protection Officer
EC	European Commission
EU	European Union
H2020	Horizon 2020
MCI	Mild Cognitive Impairment
TSD	Services for Sensitive Data (Tjenester for Sensitiv Data)
UiO	University of Oslo
USIT	University Information Technology Center
WP	Work Package

Partner Short Names

OUS	Oslo University Hospital
AALTO	Aalto University
accelCH	accelopment Schweiz AG
AE	Alzheimer Europe
Brainsymph	BrainSymph AS
DNV	Det Norske Veritas
HUS	Helsinki University Hospital
IRCCS	Scientific Institute for Research, Hospitalization and Healthcare, San Raffaele Roma
Lurtis	Lurtis Rules S.L
Neuroconnect	Neuroconnect Srl
OsloMET	Oslo Metropolitan University
Radboudumc	Radboud University Medical Center
TLU	Tallinn University
UCM	Complutense University of Madrid
UCSC	Università Cattolica del Sacro Cuore

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1 Executive Summary

Deliverable 1.1 is a report mapping the mild cognitive impairment (MCI) diagnostics and management in the European countries participating in the project's clinical study: Finland, Italy, Norway, and Spain.

1.1 Purpose and Scope of the Deliverable

The purpose of this report is to identify the state-of-the-art tools and depict the current clinical practices used for the diagnosis and management of MCI in the four AI-Mind European countries participating in the project's clinical study.

Through a 22-question online survey (Annex I), we collected information on the diagnostics, treatment, and management of MCI, as well as on the clinicians' acceptance and reliance on AI-based diagnostic tools. We analysed the collected data based on scientific literature and guidelines on how MCI is diagnosed, treated, and managed. Additionally, we mapped the healthcare professionals' expectations towards the clinical use of a potential digital AI-based tool for dementia risk-estimation, including issues like their view on reliability, trust, and anticipated patients' acceptance of such technology.

1.2 Outcome overview

In this work, the MCI diagnostics and management in the four countries were pinpointed. State-of-the-art tools used by European healthcare professionals were identified, as well as their needs for early diagnostics of MCI patients and healthcare infrastructure access. In addition, the acceptance and trustworthiness of AI-based medical technology were measured.

The respondents in the four included countries (Finland n=36, Italy n=65, Norway n=49, Spain n=22) identified themselves as female (n=108), male (n=53), and the following specialties were included: general practitioner (n=34), neurology (n=65), geriatrics (n=34), neuropsychology (n=16), nursing (n=16), internal medicine (n=7), psychiatry (n=4), psychology (n=2) and others (n=13). Most professionals (n=151) use MCI as a term in their clinical practice and classify the condition into subtypes (amnesic and non-amnesic, single and multiple domain). Most of the respondents answered that they use clinical impression (n=110) and standardised cognitive testing (n=163) to label the condition as MCI. Reimbursement issues have been raised for standardized test procedures. Further investigation comprises mainly extended cognitive tests, laboratory assessment and MRI. Only few (n=21) use EEG for their examinations. Regarding follow-up consultations, most of the respondents answered they would inform their patient about modifiable risk factors such as diabetes, hypertension and smoking. Furthermore, for respondents that can prescribe medication, a majority (n=106) chooses to use medication for MCI. N=129 clinicians state that labelling the problem is helpful for patients and family members.

Finally, the majority (n=147) of the respondents agree that there is a need for the introduction of an early screening method for dementia risk estimation. They (n=109) also reported to have a high degree of reliance on an AI-based diagnostic tool and would use such technologies (n=133).

2 Introduction

Mild cognitive impairment diagnosis is usually given when the present patient's cognitive impairment does not meet criteria of a dementia diagnosis. The introduction of MCI as a clinical concept was published in 1999 [1], and since then, criteria for MCI diagnosis have changed several times. This evolution has been driven by new observations and research investigations, giving rise to today's selection of new subcategories of MCI.

AI-Mind aims at developing a new medical AI-based technology in the field of dementia prevention. Therefore, understanding current practice will ensure that the future product corresponds to the needs and expectations of the healthcare providers.

2.1 Background

What is Mild Cognitive Impairment?

Mild Cognitive Impairment (MCI) is a condition in which an individual experiences cognitive challenges, without fulfilling the diagnostic criteria for dementia [2,3]. People with MCI are able to perform all daily activities but may present beginning difficulties with their memory and/or performing skills. Affected cognitive areas in people with MCI include skills related to memory, attention, language, visuospatial reasoning, perceptual speed and executive functioning. Usually, the symptoms are identified by the person themselves and/or by a next of kin and are confirmed by a clinical assessment by a healthcare provider [3].

2.1.1 MCI Subtypes

MCI Subtypes are defined by the presence or absence of memory difficulties, and the number of other affected cognitive functions. There are three main subtypes of MCI [3] – see *Figure 1*:

- i. **Amnestic**: only memory is affected.
- ii. **Single non-memory domain**: only one cognitive function, except memory, is affected
- iii. **Multiple cognitive domains**: more cognitive functions are affected.

The MCI subtype aetiologies may be variable: degenerative, vascular, metabolic, traumatic, psychiatric, and possibly others [3].

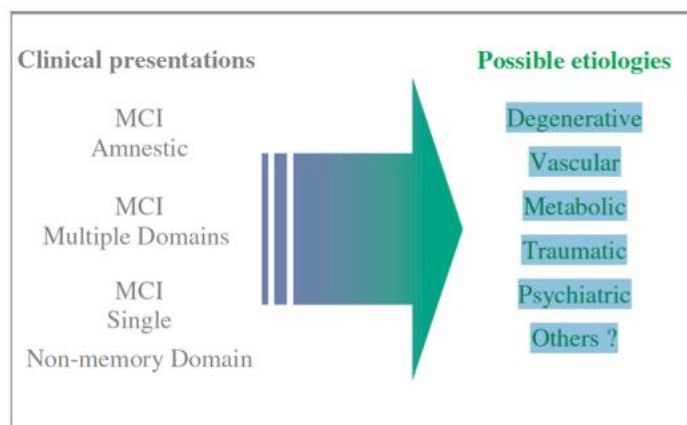


Figure 1: Subtypes of MCI and possible aetiologies (Source: Winblad, et al. 2004)

2.1.2 Epidemiological data

MCI is a common condition in older people. The prevalence of MCI in adults over 65 years is 10-20% [2], and it increases with age (*Figure 2*) and lower educational level [4]. Men are affected more often than women [2]. Research indicates that people with MCI have a higher risk of developing dementia, which may range from 50% to 60% [5]. Compared to age-matched non-MCI people, up to 50% may remain in a stable MCI condition or even recover [3,4].

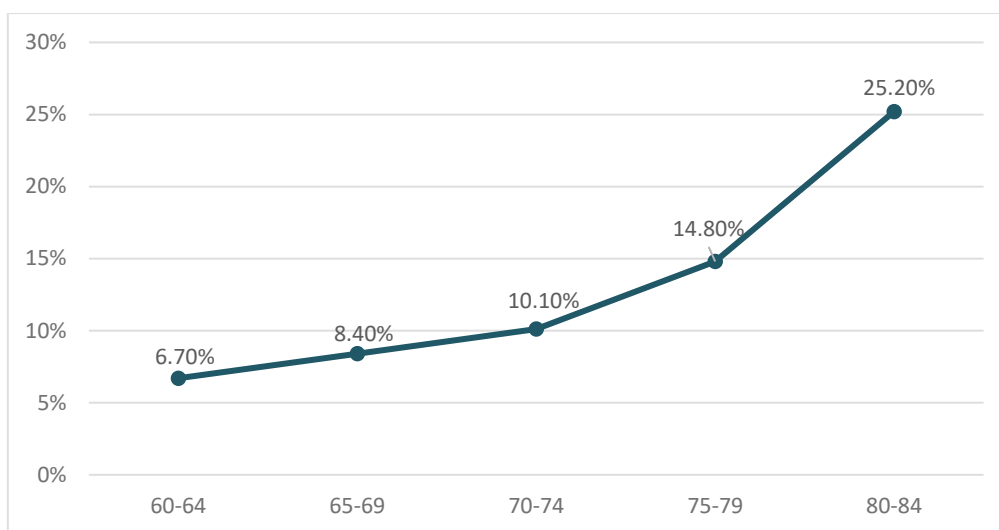


Figure 2: The prevalence of MCI per age group (adapted from Petersen et al. 2018).

Additional MCI risk factors include vascular risk factors (*e.g.* diabetes and hypertension), Apolipoprotein E (APOE) e4 genotype, vitamin D deficiency, sleep-disorders, and prior critical illness (*e.g.* sepsis) [2].

2.1.3 Diagnosis & assessment

The literature identifies four areas of assessment when diagnosing MCI [2,3]:

- Clinical evaluation and medical history - at primary care & specialist's level. These include details about the current condition, the medications taken, onset of the condition and other observations from affected person and/or informant.
- Cognitive and functional assessment - at primary care & specialist's level. A series of neuropsychological tests are being carried out, ideally over time (in a longitudinal manner), to detect the condition and its progress [2,4].
- Neuroimaging – at specialists' level and in research. Neuroimaging is used to decide on specific aetiologies of cognitive decline, to measure the progress, and in some cases to predict the probability of progressing to dementia [3].
- Biomarkers – at specialists' level, mainly in research. The biomarkers are primarily investigated in cerebrospinal fluid (CSF), and some in blood [2].

2.1.4 Treatment

Two main treatment approaches of MCI are usually examined: the specific pharmacological and the secondary, a combination of pharmacological and non-pharmacological intervention.

Specific pharmacological intervention: Today, there are no specific clinical trial class 4-approved medications for MCI patients on the market. All approved medications are indicated for Alzheimer's Disease (AD), such as Acetylcholinesterase inhibitors and memantine. None is

recommended for the treatment of MCI. Nevertheless, clinicians may use them to modulate symptoms. The recently FDA-approved Aducanumab (amyloid beta-directed antibody) medication is now in clinical trial phase 4 and may be the first approved MCI medication in the future.

Combination of non-pharmacological and unspecific pharmacological interventions: These are lifestyle and unspecific pharmacological interventions, treating dementia risk factors. These may delay the onset of dementia [2,6]:

- Medical: Control of vascular risk factors & stroke prevention (blood pressure control, diabetes control, incl. medication for the prevention of these conditions).
- Behavioural: physical activity (e.g., aerobic exercise), mental activity, stop smoking, and alcohol/drug consumption.
- Social: increasing social activities, introducing safety at home actions, use of precaution tools when MCI subjects are participating in daily traffic systems; education of caregivers; strategic long-term planning.

2.1.5 Management

Public management of MCI includes the overall care of affected people and their caregivers, the way the condition is communicated, scheduling procedures of follow-up visits, definition of the cognitive function change assessments, and the definition of subjects' supportive needs [2,3]. Today, most clinicians use a holistic care approach when communicating their findings, explaining the anticipated aetiology of the diagnosis, counseling and educating their patients in a supporting manner [4,7,8]. In order to acknowledge MCI as a unique independent, clinical entity, it will be important to introduce specific evidence-based MCI findings in our already existing national and international dementia guidelines [9]. Consequently in 2018, the revised American Academy of Neurology (AAN) guidelines dedicated a whole section to the management of the MCI condition [4].

2.2 AI in medicine

In recent years, the potential of applying artificial intelligence (AI) technology in healthcare has rapidly advanced and is expected to improve healthcare outcomes. Although AI-based technologies are mainly used in the medical areas of radiology and cancer treatment today, neuroscience is now experiencing a surge of potentially AI-supported diagnoses and treatment opportunities for several disorders [13]. In fact, the idea of AI mimicking the learning processes of the human brain may as well revolutionise clinical neurology [14]. Multiple AI applications are under development, reaching from diagnosis to care delivery products [15]. Nevertheless, there is a substantial lack in the literature of investigating health providers' and users' attitude towards such new technologies.

However, to reach high clinical acceptance, the users need to have trust in such AI based risk estimation and treatment planning technologies. A prerequisite for such trusted use will be the extensive knowledge transfer on how AI works, and which mathematical principles lay behind. Only a few studies have investigated clinicians' attitudes towards AI-based technology [10,11,12].

2.3 Surveys on MCI

As MCI is a relatively recently defined condition [1], researchers still need to investigate how it is diagnosed, treated, and managed throughout the clinical community. This may be achieved by structured surveys, aiming at contributing to the creation of harmonised definitions and guidelines.

We identified two scientific surveys on MCI including: i) respondents from the American Association of Neurology (AAN) in 2010 [16], and ii) respondents from the European Academy of Neurology (EAN) and European Alzheimer's Disease Consortium (EADC) in 2019 [8], both leading to revisions of guidelines.

2.4 Surveys on acceptance of AI-based medical technology

A survey from 2019 on the use of AI among professionals in ophthalmology, dermatology, radiology, and radiation oncology [17] showed that doctors believed that AI would improve their work. Furthermore, they believed that their workforce would be highly impacted by such technology within the next decade. Similar results can be found in the NHS Foundation Trust survey from 2020 [18]. The majority of participants believed that AI will be useful in their work. Likewise, in 2018, a survey on medical students' attitudes showed a high degree of acceptance and belief that AI will revolutionise and improve medicine in the future [19]. In addition, over two-thirds of these students expressed their urgent need to understand AI better.

3 Methodology

The main goal of the task 1.1 is to map the current MCI clinical diagnosing practice in our four participating partner countries (Finland, Italy, Norway and Spain), including procedures of diagnosis, treatment, management, technology assessment and risk estimation tools, and future needs and expectations in the field of MCI. To reach this goal, we designed, distributed and analysed a 22-item online survey, in light of information retrieved from scientific literature.

3.1 Survey

The online prospective survey was approved by the Data Protection Officer (DPO) of Oslo University Hospital. Electronic consent of the respondents was collected at the beginning of the survey, in accordance with the Declaration of Helsinki, following an introductory text with project and survey information.

The methodology for this task was split up into three phases: (1) survey design, (2) distribution and data collection, and (3) analysis.

3.1.1 Design and data management

The survey was designed as an online form, to guarantee a broad target group of respondents in each of the four participating countries. To create the survey, we used the Nettskjema software ("Web Form") developed and operated by the University Information Technology Center (USIT) at the University of Oslo (UiO). Nettskjema sets no responder limitation and is smart phone compatible, making it ideal for large-scale, easily accessible surveys.

The design of individual questions and their classifications was conducted after reviewing the literature on survey design [20] and based on hands-on knowledge on this field. After the questionnaire was reviewed by the AI-Mind's consortium experts, the final survey consisted of 22 multiple choice and open-ended questions (see Annex I).

The data storage and management followed strict standards of data security, and were implemented in the high-security server "Services for Sensitive data" (TSD) via an API solution developed by USIT. No sensitive or identifiable data were collected. More information on the specifications of the solutions used by Nettskjema and TSD can be found here: <https://www.uio.no/english/services/it/research/sensitive-data/>.

3.1.2 Distribution

The survey was distributed in all four countries participating as clinical sites in AI-Mind (Finland, Italy, Norway, Spain), through several predefined distribution channels (Table 1). To ensure efficient distribution, predefined target groups comprising a team of five individuals from each country were defined. The target groups were healthcare professionals working with dementia and/or MCI patients. The response rate was regularly checked to safeguard an even input from all countries. When necessary, additional measures were taken to facilitate distribution and boost the response rate.

Main distribution channels	Description
Emails	Personal emails to clinical sites' specialist networks; mailing lists with recipients relevant to the topic.
Webpage	Publication of objectives and the survey link on country-specific clinical webpages.
Social media	Publication of objectives and the survey link on the social media platforms of the hospitals and patient associations associated with the clinical sites

Table 1: Distribution channels used to reach out the target group of respondents.

3.1.3 Analysis

The multiple-choice questions were analysed using the program IBM SPSS Statistics 27. The responses were investigated with regard to profession, country of origin, years of experience. Codes were built as part of the survey design, and categories followed the different thematic parts of the survey.

4 The content of the survey

The survey's content consisted of four chapters: I. Mild Cognitive Impairment (MCI) as a clinical concept (questions 1-3), II. Clinical practice of cognitive impairment (questions 4-14), III. Future diagnostic tools (questions 15-18), and IV. Experts' background (questions 19-22). The survey is attached in Annex I.

Part I: Mild Cognitive Impairment (MCI) as a clinical concept

This part investigated how the respondents perceive MCI as a clinical concept. We aimed to identify the terms, definitions, subtypes, and clinical guidelines used in everyday clinical practice.

Part II: Clinical practice of cognitive impairment

Here we captured the clinical practices used to diagnose and follow-up people with MCI. We also aimed to: depict the patient journey from the first meeting with a healthcare professional to follow-up visits; to investigate if clinicians are reimbursed for examinations related to cognitive impairment; to identify the nomenclature and tools the clinicians use in their everyday practice; to identify the investigations they plan for their patients, and the interventions introduced (pharmacological and

non-pharmacological treatment). Finally, we wanted to assess the clinicians' attitude towards MCI as a diagnosis and the way they communicate it to their patients.

Part III: Future diagnostic tools

The third part explored the respondents' attitude towards AI-based technology in medicine. Several opinion-leading clinicians and researchers are trying to find new ways of identifying dementia at earlier stages, to develop means for earlier diagnosis and prevention. Since current methods lack the necessary sensitivity for detecting pre-dementia stages, we wanted to investigate the clinicians' need for dementia risk screening methods. We investigated their available infrastructures (EEGs, digital cognitive tests) connected to the AI-Mind study. Finally, we probed the respondents' attitude towards using a AI-based tool in their daily practice, their beliefs regarding reliability, trust, and the patients' and clinicians' acceptance.

Part IV: Background

In the last part, the survey captured the profile of the respondents: their years of clinical experience, field of specialisation, country of practice, and sex.

5 Results

A total of 173 healthcare professionals from eight specialties (n=65 Neurology, n=34 Geriatrics, n=4 Psychiatry, n=16 Neuropsychology, n=16 Nursing, n=7 Internal Medicine, n=34 General Practitioner, n=2 Psychology, n=13 other) completed the survey. The three larger groups of specialties (Neurologists, Geriatrics, General Practitioners) were specifically selected for highlighting differences among specialties. The respondents identified themselves as 36.5% male (n=63) and 62.4% female (n=108).

The completed survey was well received from all countries (Finland n= 36, Italy n=65, Norway n=49, Spain n=22), while one respondent also was from other country. The respondent's profile (sex, specialty, and years of experience) per country is presented in Figure 3.

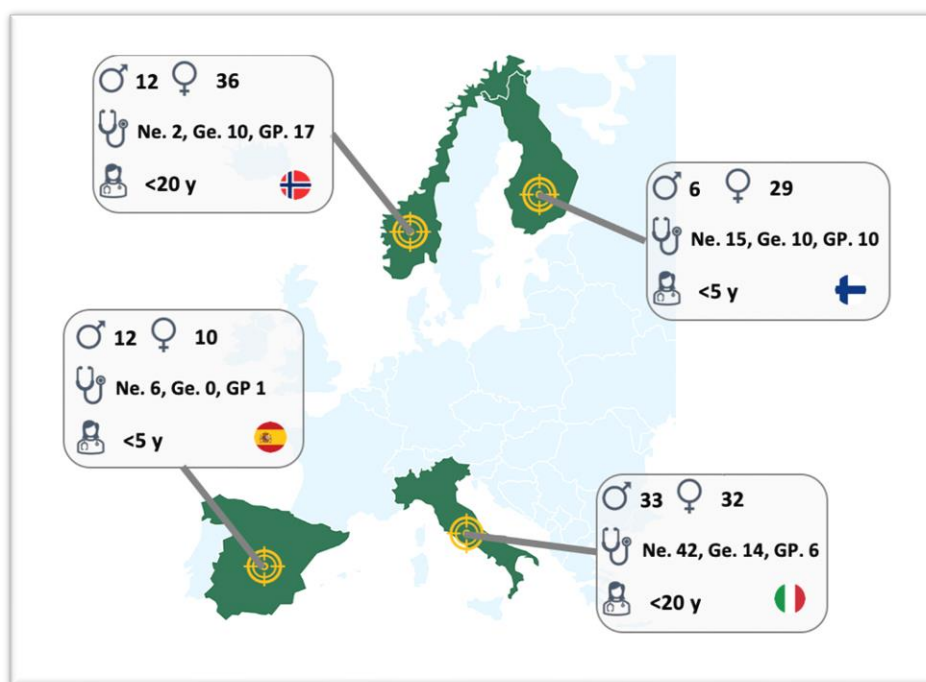


Figure 3: Respondent's profile per country
(sex; Ne= neurologist, Ge=geriatrics, GP=general practitioner; years of experience)

The results per survey part are presented in the chapters below.

5.1 Part I: Definitions & Guidelines

Used definitions and guidelines for mild cognitive impairment had been investigated in this chapter.

5.1.1 Definitions

For light, distinctly non-demented, cognitive decline, the most preferred term used is indeed MCI (n=151, 87,3%). The second most used term was Vascular Cognitive Impairment (n=66, 38,2%), while "Age-Associated Memory Impairment" is hardly used (n=15, (8,7 %) in the four countries.

The respondents using the term MCI, mostly used subtypes of impaired cognitive symptoms (N=102, 68,2%), while a relatively large number of the respondents (N=48, 31,8%) uses no subtypes.

The subtypes used for the classification of impaired cognitive symptoms are presented in *Figure 4*.

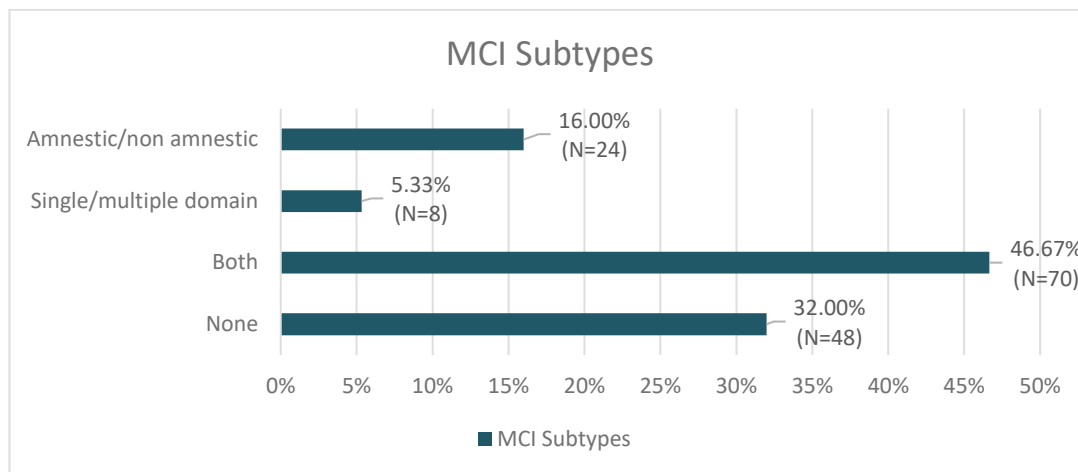


Figure 4: Use of MCI subtypes

Among the three major specialities, it is mainly general practitioners who reported no use of subtyping (n=25, 73.5 %). While both the neurologists and geriatrics preferred the use of subtypes (n=59, 90.8% and n=21, 61.8%) (Table 2).

	Amnestic / non-amnestic	Single / multiple domain	Both	None	Total
Neurologists	13	3	43	6	65
Geriatrics	7	2	12	13	34
General practitioners	1	0	7	25	33

Table 2: MCI subtypes for the 3 most represented specialties.

ICD-10 is the most use manual for diagnosing (n=71). Neurologists principally select NIA-AA and ICD-10 (n=16, n=22, with 24.6% and 33.8%), GPs mostly use ICD-10 (n=20, 58.8%) and geriatrics use ICD-10 (n=19, 55.9%). The trends per country are presented in Table 3.

Country	Nomenclature (%)
Finland 	ICD-10 (88.9%)
Italy 	NIA-AA (43.1%)
Norway 	ICD-10 (67,3%)
Spain 	DSM IV (36.4%)

Table 3: Mostly used nomenclatures per country.

5.1.2 Guidelines

Since there are various guidelines for diagnosing and treating MCI, we wanted to identify which guidelines or if any are used in the four countries. In total, most of the respondents use guidelines (n=141, 81.5%). The clinicians who use guidelines, prefer international over national guidelines (n=75, 53.2% vs. n=60, 42.6%).

When viewing the responses per country, we observe two different trends. Respondents from Finland and Norway mainly use national guidelines (n=19, 76% and n=31, 79.5%), while the Spanish and Italian respondents rely on international (n=11, 68.8% and n=54, 90%).

5.2 Part II: Clinical practices on MCI

5.2.1 Management

In this section, we wished to identify how often our respondents meet people with cognitive impairment at their office, if they identify the potential disease progression themselves or if they refer patients to other specialists. In case of following up themselves, we wished to track the frequency of usually planned follow-up visits, and the reimbursement schemes of clinical activities related to MCI.

Regarding the frequency of seeing regularly newly referred MCI cases, most respondents answered that they meet patient with cognitive decline several times a month (n=79, 45.7%).

Neurologists and geriatrics register often (several times a month) first-time visits from patients with mild cognitive decline (76 % of the neurologists (n=50) and 50% of the geriatrics (n=17); while this is a rather small number of cognitive decline patients is register at the general practitioners (n=6, 17.6%).

The patients of our respondents had been referred to them by another healthcare professional (n=138, 79.8%), but frequently patients took also directly contact with the doctors (n=73, 42.2%). Follow-up visits mostly take place once or twice a year (n=114, 65.9%) or more often (every one to three months; n=41, 23.7%). Only 3.5% of the respondents do not follow-up their patients (n=6).

Reimbursement for clinical activities were categorised in clinical investigation (n=18, 10.4%), standardised cognitive testing (n=17, 9.8%) or both (n=61, 35.3%) and are partly covered. A part of respondents reported that they receive no reimbursement at all (n=60, 35.2%). Table 4 presents what the responders think the reimbursement of their clinical activities are in their country.

	Finland 	Italy 	Norway 	Spain 
Clinical Investigation	22.2%	38,9%	27,8%	11,1%
Cognitive Testing	17.6%	17,6%	47,1%	17,6%
Both	18.0%	49,2%	27,9%	4,9%
None	22.6%	35,5%	22,6%	19,4%

Table 4: Reimbursement of clinical activities per country.

5.2.2 Diagnosis, Examinations, Treatment, Communication

In this section we present how clinicians identify cognitive impairment, how they confirm their clinical impression through follow-up examinations and tests, and how they communicate results and offer treatment to the patients.

The most common way to identify MCI in our respondent population is based on both clinical impression (n=110, 63.6%) and the use of standardised cognitive testing (n=163, 94.2%). A relatively small number of the respondents replied that they refer their patients directly to a specialist for identifying cognitive impairment (n=50, 28.9%). *Figure 5* presents the preferred diagnostic tools for the three most represented specialities.

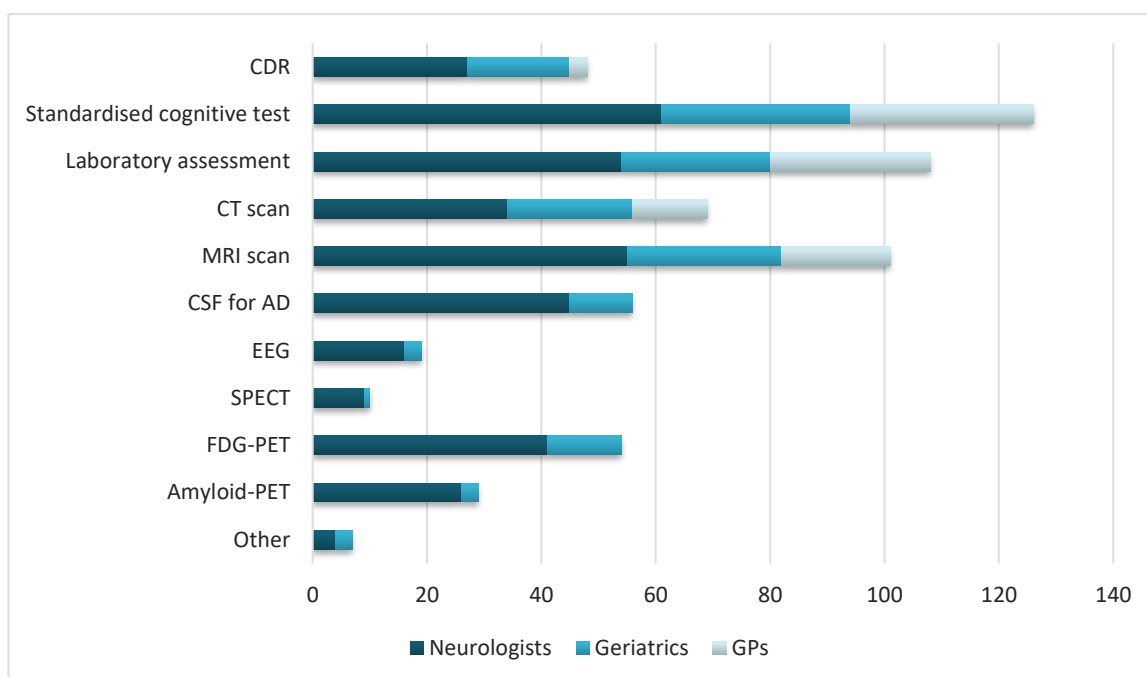


Figure 5: Preferred diagnostic investigations for three mostly represented specialities.

The use of diagnostic tools per country is presented in *Figure 6*.

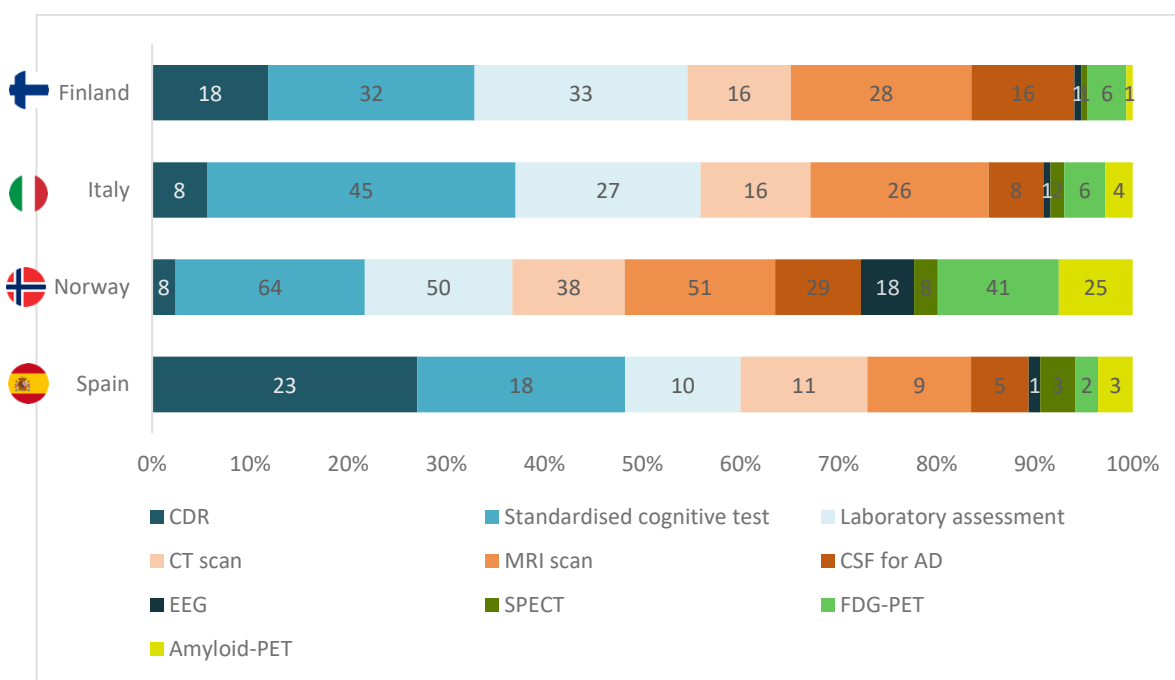


Figure 6: Preferred diagnostic tools per country.

When a patient has mild cognitive impairment, the clinicians mostly investigate vascular-related conditions: hypertension (n=123, 71,1%), pre-hypertension (n=43, 24.9 %) diabetes (n=118, 68.2%), pre-diabetes (n=50, 28.9 %), smoking (n=103, 59.5%). Other important conditions related to mental health like depression (n=162, 93.6%), mental examination (n=90, 52.0 %), and alcohol use (n=129, 74.6%) are systematically investigated.

For respondents that can prescribe medications (n=144, see table 5), we observed that most do prescribe medications for MCI in contrast to those who do not (n=106, 74 % vs. n=38, 26 %). From the prescribed medications the mostly used are the cholinesterase inhibitors and antidepressants (n=71, 64.0% and n=72, 64.9%), followed by memantine (n=41, 36.9%) and Nootropic (n=40, 36.0%). Figure 7 presents the selected pharmacological treatments.

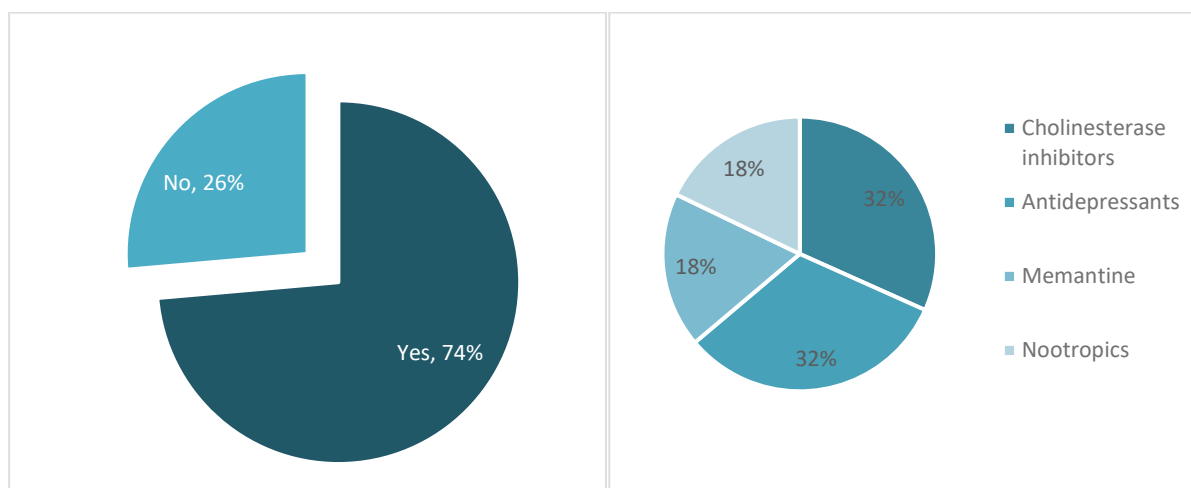


Figure 7: Pharmacological treatment of MCI.

	Yes	No	Total
Neurologists	55	10	65
Geriatrics	24	10	34
Psychiatry	2	2	4
Internal medicine	4	3	7
General practitioners	21	13	34
Total	106	38	144

Table 5: Use of prescription for MCI

Finally, the diagnosis is communicated to the patient as “memory problems or difficulties” (n=130, 75.1%), or as “mild cognitive impairment” (n=111, 64.2%), or as “possible early dementia” or “early AD” (n=60, 34.7% and n=51, 29.5%) in total.

The personal view of the responders is that “Labelling the problem is helpful for patients and family members” (n=129, 74.6%) and that they would “Inform the patient about modifiable risk factors” (n=138, 79.8%).

5.3 Part III - Acceptance of future diagnostic tools

In this part, we investigated the attitude of the clinicians towards future AI-based digitalised diagnostic tools, their needs, their access to EEG and digital cognitive testing infrastructure, and the acceptance of tool like those under development in AI-Mind.

A large proportion of respondents (85.0%; n = 147) agree that there is a need for early screening method for dementia. For the three major specialities, almost all Geriatrics agreed on this need (94.1%), as well as 92.3% of the Neurologists and a big part of the GPs (61.8%).

Those who responded positively, also replied that they would support the use of digitalised cognitive tests (n=130, 88.4%). The results from all countries indicate a high acceptance for the use of digital cognitive tests, ranging from in 79.6% in Norway to 89.2% in Italy.

Regarding the access to EEG, we identified differences among the four countries, ranging from low access for the Norwegian respondents (n=13, 26.5%) to higher access in Italy (n=48, 73.8%). In Finland and Spain, the access to EEG equipment is also relatively high (n=21, 58.3% and n=16, 72.7%).

More than half (n = 109, 63.0 %) of respondents would rely on AI-based diagnostic tool for their work if available; *Figure 8* presents the results at a country level. Most respondents were positive to use supportive AI tools in their field of practice (n=133, 76.9%, agreed or strongly agreed). *Figure 9* presents the reliance on AI-based diagnostic tools per country.

Finally, a larger part of respondents stated that their patients would feel comfortable with AI-guided diagnosis (n=65, 37.6%, by responding “agree” or “strongly agree”), compared to those answering “disagree” or “strongly disagree” (n=26, 15%). But many neither agreed nor disagreed with this statement (n=82, 47.4%).

The following *Figures (8-13)* present an overview of the: use, reliance, and the patients' potential comfort with an AI-based diagnosis, according to the clinicians' view, per country and for the most represented specialties.

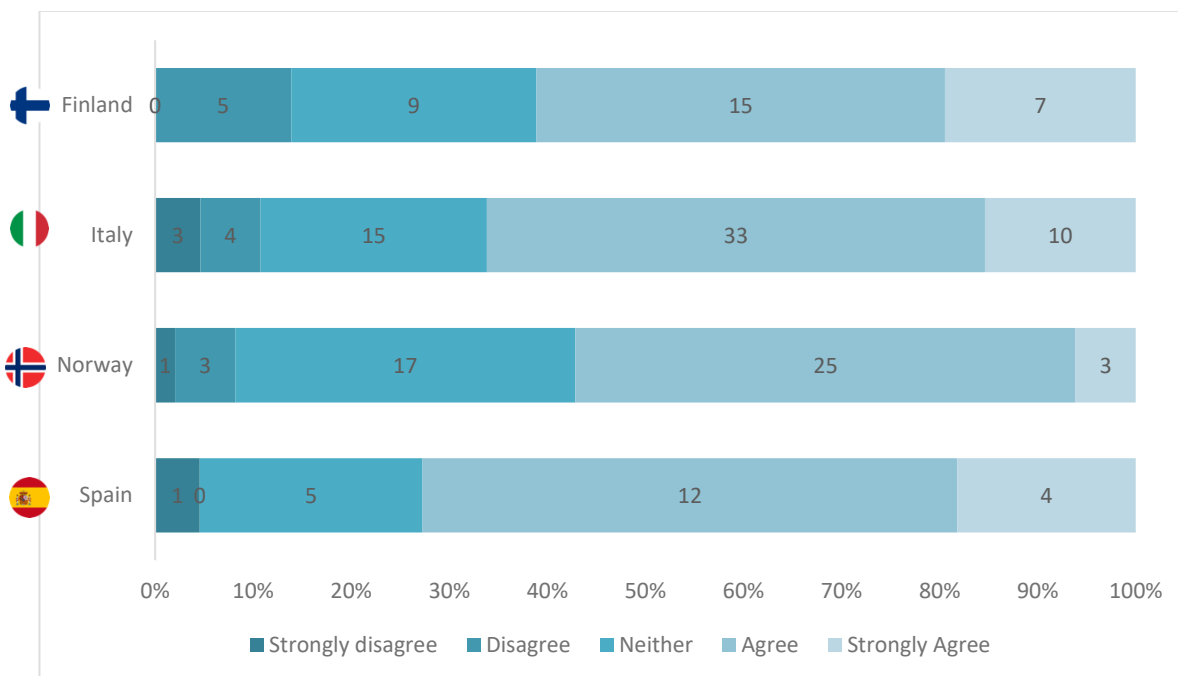


Figure 8: Per country reliance on an AI-based diagnostics tool to help diagnose cognitive impairment.

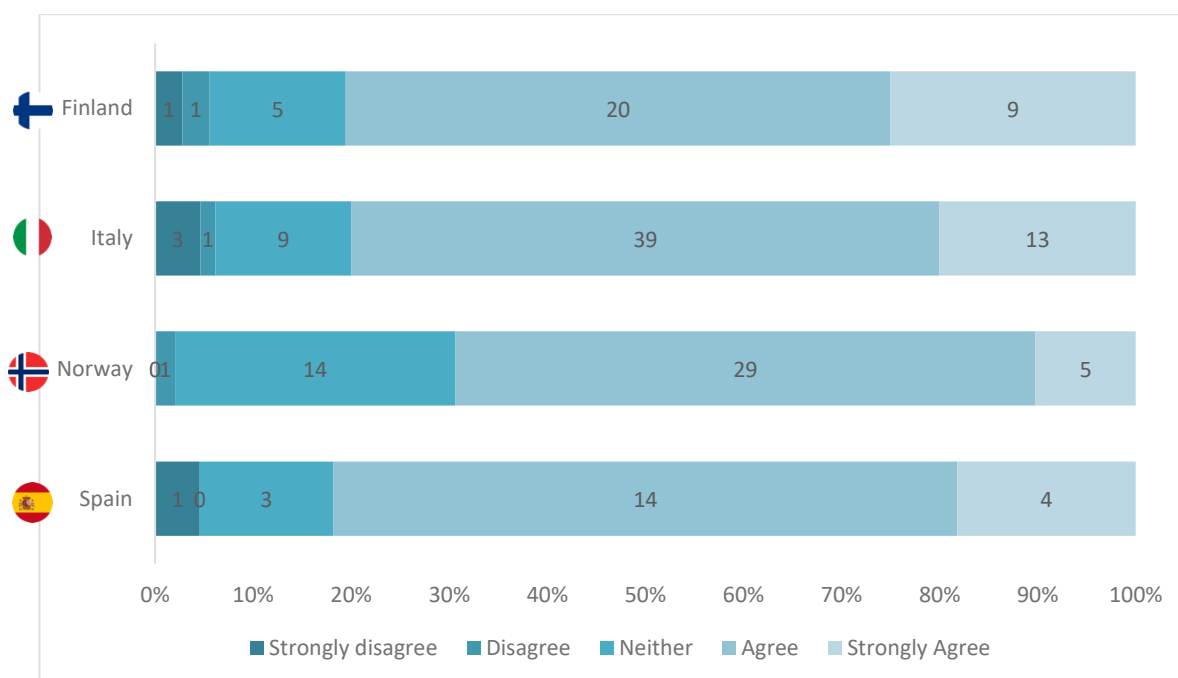


Figure 9: Per country attitude towards the use of an AI-based supportive diagnostic tool.

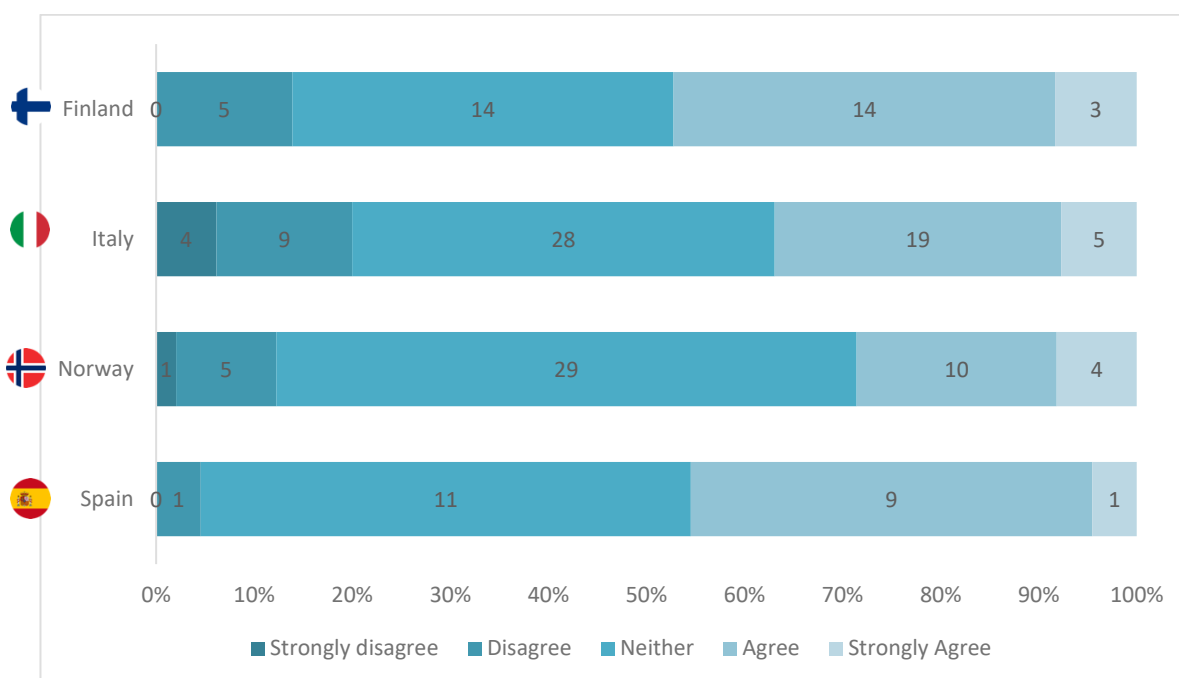


Figure 10: Per country patient comfort with AI-guided diagnosis, according to the clinicians.

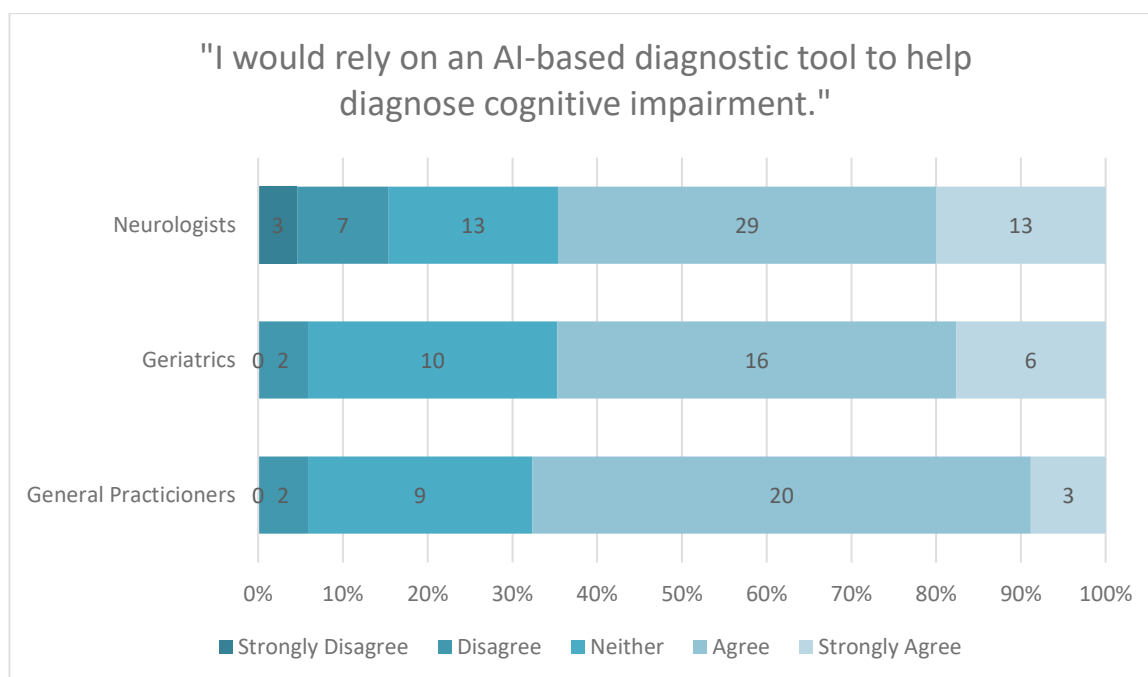


Figure 11: Reliance on an AI-based diagnostics tool for the diagnosis of cognitive impairment by the 3 most represented specialties.

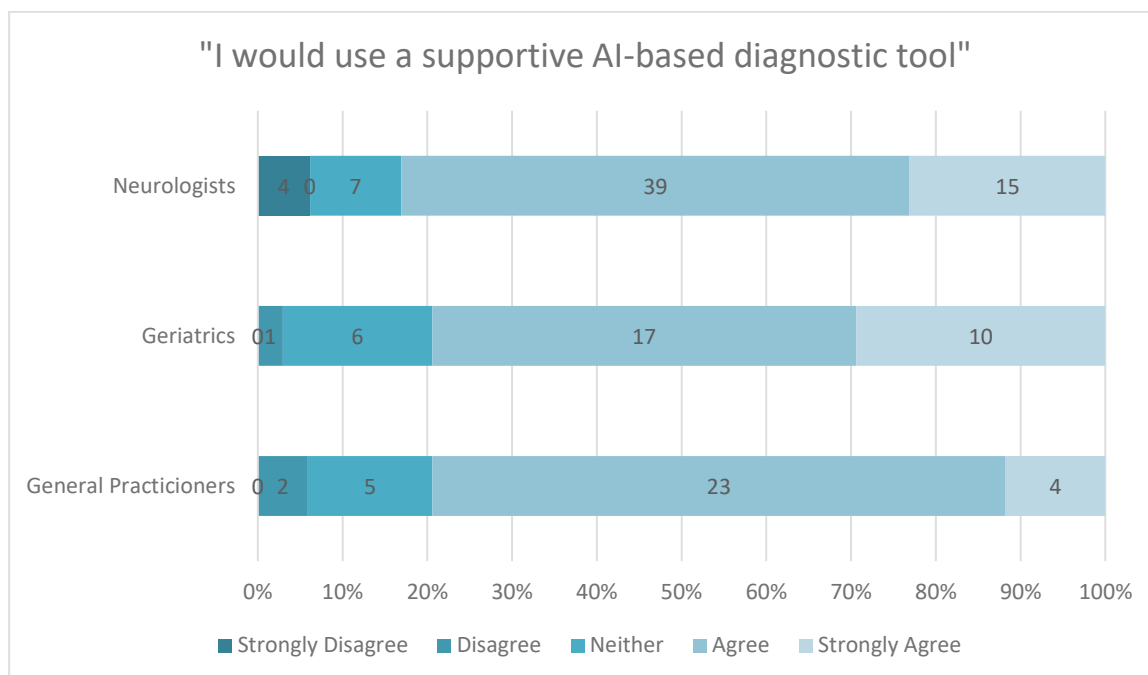


Figure 12: Use of a supportive AI-based diagnostic tool by the 3 most represented specialties.

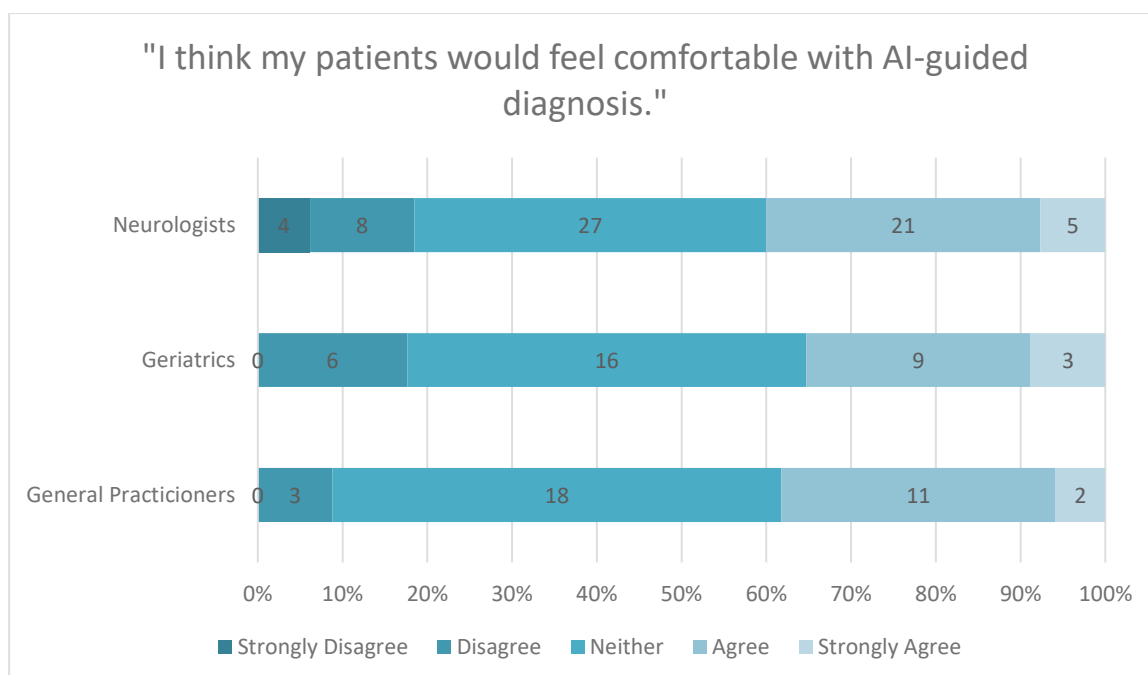


Figure 13: Patients' comfort with AI-guided diagnosis, as estimated by the clinicians.

When looking at the attitude towards AI-based technology based on the years of experience, the results show that the majority of respondents is positive. From professionals with over 20 years of experience - years of practice as a specialist - a large portion (n=19, 76.0 %) would rely on AI-based technology (replied "agree" or "strongly agree"). A bit more than half of those with under 5 years of experience would rely on such technologies (n=27, 62.8 %). The same group (<5 years of experience) reported that they would use such tools (n=35, 81.4%) (replied "agree" or "strongly agree"). The same was found for the most experienced respondents (>20 years of experience) (n=25, 72.9%).

6 Analysis & Conclusions

This survey was conducted to investigate the clinical practice for MCI in four European countries in different fields of specialisation. The need for the survey on clinical practice was based on the wide range of guidelines and disease understanding on MCI, and the fact that this is a condition herald to increase in prevalence in the future. In addition, we wanted to investigate the attitude these professionals had toward use of new diagnostic tools and especially AI-based technology. Since AI-Mind aims at developing an AI-based technology for dementia risk assessment of people with MCI, understanding the current practices will ensure that the future product corresponds to the needs and expectations of the healthcare professionals.

The use of AI in dementia diagnostics and treatment is a growing field of interest for both healthcare providers and policy makers. Each profession selected to respond in this survey may in the future use AI tools as part of their routine practice. We already know that different tools are being developed specifically for these specialties, such as in the AI-Mind project. To our knowledge, this survey is one of the first of its kind to investigate specifically the field of MCI with a combined focus on new era of diagnostic tools.

For the analysis of results two main variables were used: the country of practice and the specialty of respondents. In some specific cases, the responses were viewed through other elements of the respondents' background, like the years of experience.

From this survey, we see that the term MCI was mostly used at both country and specialization levels. From those using MCI subtypes we see that many used both subtypes for MCI, correlating to the guidelines [3]. But an interestingly large number of respondents using MCI do not use any subtyping. When it comes to the used nomenclature, we see that there is a variation between the Nordic countries and Spain and Italy. With Norway and Finland using the ICD-10, while Spain and Italy use DSM-VI and NIA-AA. The northern countries use national guidelines, while the Southern countries rely on international guidelines. The differences in the use of subtypes, guidelines and nomenclature, imply a variation of clinical practices in Europe.

Most of the respondents see frequently new patients with MCI. The follow-up visit mainly takes place once or twice a year. In most of the cases professionals get reimbursement for different clinical activities related to the condition, but a considerable part seems not to get reimbursement. This is a surprisingly large number for a European country healthcare system and may be due to different perception of reimbursement schemes among the respondents. There was also a variability in the patterns of diagnosing, treating and following up, which may be due to the fact that the decision-making is based on either local guidelines or on international guidelines. This could also be influenced by the background of the clinicians.

In a primary care setting, standard tests (like standard cognitive testing and laboratory assessment) are performed, while at specialists' level the investigations are involving specific advanced examinations, like SPECT, PET, etc. At a country level, we see that CDR, MRI, simple standard cognitive testing, and laboratory assessments are quite equally distributed among countries.

Regarding pharmacological treatment, we could document that most of the respondents use medications, mainly cholinesterase inhibitors and antidepressants, with a near equal distribution for the different drugs. When communicating the condition to the patient, the mainly used terms are: "memory problems and difficulties" or "MCI", but also a significant number that names it as "early AD" or "dementia". Labelling the problem is helpful for both the family and patient. This indicates that clinicians find important to inform patients and their families, provide the appropriate

medication, and motivate them to actively adapt their lifestyle, in a way that may delay the cognitive decline.

Most of the respondents agreed on the need of early dementia identification through a screening tool. They also support the implementation of digital cognitive testing, indicating a high acceptance for such new digital tools. Most importantly, we identify a large portion of positive respondents' attitude towards the reliance and use of AI-based diagnostic technologies. This is also reflected in previous surveys in other fields of medicine, indicating an overall acceptance of AI in medicine. Our findings also imply that this attitude is similar across countries and specialties. Nevertheless, the portion of strong disagreement and disagreement might have a high influential impact on the acceptance of AI-based tools and should be proactively addressed by the AI-Mind project. Furthermore, the reported EEG access and use was relatively low and not sufficiently described. AI-Mind should actively work to broaden the general access and awareness of EEG infrastructure during the project period. Finally, despite the highly positive acceptance of AI-based tools from the clinicians, our findings show that they were less confident about their patients' attitude towards such technologies. This may imply a discrepancy in attitude between the end-users and receivers of future AI-supported healthcare.

The need for national and international guidelines on MCI has been already discussed among researchers, e.g. in [9]. In our survey, we identified differences in clinical practices for diagnosis and treatment of MCI, which may result in a variation of provided healthcare services. Further research is needed on the consequences this may have, to establish harmonised procedures and to ensure that all patients have equal healthcare opportunities. In a future European healthcare system such equity can be achieved through the use of AI. The successful implementation of AI in healthcare will depend on a detailed understanding of clinician and patient expectations, therefore further investigations are needed.

The survey identified needs for further awareness on the potential use of AI-based tools in medicine through e.g., educational workshops for professionals and facilitating knowledge transfer when introducing AI-based supportive tools by the AI-Mind project.

The limitations of this survey are to be considered. Volunteer response bias indicates that the results may not be widely representative of the views of clinicians in Norway, Finland, Spain and Italy. Moreover, the survey may not be generalizable beyond these countries, even though it is worth noticing the responses are from both northern and southern Europe. As the response rates from the different specialties were in general low and cannot ascertain whether the views of respondents are representative for the group. Finally, the survey design imposes limitations on the scope of response options and thus the survey findings should not be regarded as a comprehensive account of the perceptions of respondents. This limitation was mitigated by the inclusion of open-ended questions.

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8 Annex I – Survey

6/18/2021

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AI-Mind: Survey on mild cognitive impairment in clinical practice copy

Page 1

Mandatory fields are marked with this star *



Dear participant

The Research and Innovation Action (RIA) No. 964220 in the H2020-SC1-BHC-06-2020 is financing a 14 million Euro action to develop Intelligent digital tools for screening of brain connectivity and dementia risk estimation in people affected by mild cognitive impairment.

We would like to invite you to help us map the current diagnostic procedures for classifying mild cognitive symptoms.

The purpose of this survey is to capture information related to existing clinical guidelines, reimbursement schemes and challenges, as well as to identify the state-of-the-art tools used in selected European hospitals for screening, diagnosing, monitoring and collecting information on met and unmet needs for early diagnosis of MCI patients.

Why are you being asked to participate?

As a healthcare professional, we kindly ask you to fill out this short questionnaire, according to your recently used procedures and opinions.

About the method

The collected answers will be administrated in an electronic data collection tool (Nettskjema) provided by the University of Oslo. The survey is anonymous. Your information cannot be traced back to you. There are no risks or other obligations associated with your participation in the survey. The online survey will take less than 10 minutes.

Your personal privacy

It is voluntary to participate in the survey. Your response won't be registered until you choose to submit your answers. We do not collect any sensitive personal information. We will process your data in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

For more information about our project, please visit our website

www.ai-mind.eu

or contact us at

contact@ai-mind.eu

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Page 2

Mandatory fields are marked with this star *

Before you start the questions, please confirm that you have read through the introduction and agree to participate in the survey. *

- ☐ I agree to participate in the survey and that my responses can be used for the purposes described on the previous page.

 Page break

Page 3

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Mild Cognitive Impairment (MCI) as a clinical concept

1. Which of the following terms do you use as a clinical diagnosis? *

select all that apply

- ☐ Cognitive Impairment, No Dementia (CIND)
- ☐ Age-Associated Memory Impairment (AAMI)
- ☐ Mild Cognitive Impairment (MCI)
- ☐ Vascular Cognitive Impairment (VCI)
- ☐ Other
- ☐ I don't know

1a. Please specify, if needed

-  This element is only shown when the option "Other" is selected in the question "1. Which of the following terms do you use as a clinical diagnosis?"

2. Which subtypes do you use for classifying the impaired cognitive symptoms? *

(select one)

- ☐ Amnestic vs. non-amnestic
- ☐ Single vs. multiple domain

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- ☐ Both of the above
- ☐ I do not use subtypes
- ☐ Other

2a. Please specify, if needed

-  This element is only shown when the option "Other" is selected in the question "2. Which subtypes do you use for classifying the impaired cognitive symptoms?"

3. Do you use standardised clinical guidelines? *

select one

- ☐ Yes
- ☐ No

3a. If yes, which clinical guidelines do you use? *

-  This element is only shown when the option "Yes" is selected in the question "3. Do you use standardised clinical guidelines?"

(select one)

- ☐ Local
- ☐ International
- ☐ National
- ☐ Others

3b. Please specify which guidelines *

-  This element is only shown when the option "Yes" is selected in the question "3. Do you use standardised clinical guidelines?"

3c. If no, please indicate why if needed

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-  This element is only shown when the option "No" is selected in the question "3. Do you use standardised clinical guidelines?"

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Page 4

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Clinical practice of cognitive impairment.

4. How do you identify mild cognitive symptoms? *

select all that apply

- ☐ Clinical impression
- ☐ Standardised cognitive testing
- ☐ Referral to specialist
- ☐ Other
- ☐ I don't know

4a. If other, please specify if needed

-  This element is only shown when the option "Other" is selected in the question "4. How do you identify mild cognitive symptoms?"

5. On average, how often do patients with mild cognitive symptoms visit for the first time your office/clinic? *

select one

- ☐ Often (several times per month)
- ☐ Sometimes (once or twice a month)
- ☐ Rarely (less than once a month)

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- ☐ Never
- ☐ I don't know

6. How are these patients referred to your office/clinic? *

select all that apply

- ☐ Patient contacts me directly
- ☐ Referred by other healthcare professional
- ☐ Referred by next of kin
- ☐ Other
- ☐ I don't know

6a. If other, please specify *

-  This element is only shown when the option "Other" is selected in the question "6. How are these patients referred to your office/clinic?"

7. On average, how often do you follow-up a patient with a given MCI diagnosis? *

select one

- ☐ Often (every one to three months)
- ☐ Sometimes (once or twice a year)
- ☐ Rarely (less than once a year)
- ☐ I do not follow-up
- ☐ I don't know

7a. In case you do not follow up, which of the following specialties will be responsible for the follow-up? *

-  This element is only shown when the option "I do not follow-up" is selected in the question "7. On average, how often do you follow-up a patient with a given MCI diagnosis?"

select all that apply

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- ☐ Neurology
- ☐ Geriatrics
- ☐ Psychiatry
- ☐ Neuropsychology
- ☐ Nursing
- ☐ Internal Medicine
- ☐ General Practitioner
- ☐ Other
- ☐ I don't know

7a-1. if other, please specify *

-  This element is only shown when the option "Other" is selected in the question "7a. In case you do not follow up, which of the following specialties will be responsible for the follow-up?"

8. Which nomenclature are you using for cognitive impairment? *

select one

- ☐ ICD-10
- ☐ ICD-11
- ☐ DSM IV
- ☐ DSM V
- ☐ NIA-AA (2011)
- ☐ IWG (2014)
- ☐ None
- ☐ Other
- ☐ I don't know

8a If other, please specify *

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-  This element is only shown when the option "Other" is selected in the question "8. Which nomenclature are you using for cognitive impairment?"

9. Which of the following do you receive reimbursement for? *

select one

- ☐ Clinical investigation (physical exam, survey, laboratory, medical imaging)
- ☐ Use of standardised cognitive testing
- ☐ Both
- ☐ None
- ☐ I don't know

10. Which of the following diagnostic investigations do you use to diagnose patients with mild cognitive symptoms? *

select all that apply

- ☐ CDR dementia staging instrument
- ☐ Standardised cognitive testing
- ☐ Laboratory assessment (routine blood screening)
- ☐ CT scan
- ☐ MRI scan
- ☐ Cerebrospinal fluid for AD biomarkers
- ☐ EEG
- ☐ SPECT perfusion scan
- ☐ FDG-PET scan
- ☐ Amyloid-PET scan
- ☐ Others
- ☐ None

10a. If others, please specify *

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This element is only shown when the option "Others" is selected in the question "10. Which of the following diagnostic investigations do you use to diagnose patients with mild cognitive symptoms?"

11. Which terms are you using to communicate the patient's difficulties to the patients and their families? *

select all that apply

- ☐ Memory problems or difficulties
- ☐ Mild cognitive impairment
- ☐ Possible early Alzheimer's disease (AD)
- ☐ Possible early dementia
- ☐ Expressing uncertainty to patient and family at that time-point
- ☐ Other
- ☐ I don't know

11a. If other, please specify *



This element is only shown when the option "Other" is selected in the question "11. Which terms are you using to communicate the patient's difficulties to the patients and their families?"

12. When a patient has mild cognitive symptoms, which of the following topics do you investigate further? *

select all that apply

- ☐ Diet and nutrition
- ☐ Mental exercise
- ☐ Physical exercise
- ☐ Alcohol use
- ☐ Medication
- ☐ Pre-Hypertension (systolic BP >120 mmHg)

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- ☐ Hypertension (BP > 140/90 mmHg)
- ☐ Pre Diabetes (HbA1C: 5.7% - 6.4% or 39mmol/mol - 46mmol/mol)
- ☐ Diabetes (HbA1C: > 6.5% or > 48mmol/mol)
- ☐ Obesity
- ☐ Hearing loss
- ☐ Smoking
- ☐ Depression
- ☐ Social isolation
- ☐ Air pollution
- ☐ History of head injury
- ☐ Other
- ☐ None

12a. If other, please specify *



This element is only shown when the option "Other" is selected in the question
 "12. When a patient has mild cognitive symptoms, which of the following topics
 do you investigate further?"

13. If you prescribe medications for your patients with mild cognitive symptoms, which of the following do you use? *

select all that apply

- ☐ Cholinesterase inhibitors
- ☐ Memantine
- ☐ Nootropic
- ☐ Antidepressant
- ☐ Other
- ☐ None

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13a. If other, please specify



This element is only shown when the option "Other" is selected in the question "13. If you prescribe medications for your patients with mild cognitive symptoms, which of the following do you use?"

14. With which of the following statements do you agree?

select all that apply

- ☐ Labelling the problem is helpful for patients and family members
- ☐ Because there is no direct treatment for dementia, it does not help to diagnose MCI
- ☐ MCI is difficult to be reliably diagnosed
- ☐ Diagnosing MCI causes unnecessary worry
- ☐ A diagnosis is useful so the patient can be more involved
- ☐ I will Inform the patient about modifiable risk factors
- ☐ Certain medications can be useful for treating some patients with MCI
- ☐ None of the above

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Page 5

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Future diagnostic tools

15. Is there a need for an early screening method for dementia risk? *

select one

- ☐ Yes
- ☐ No
- ☐ I do not know

16. Do you have access to EEG technology? *

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select one

- ☐ Yes
- ☐ No
- ☐ I do not know

17. Would you support the implementation of digitalised cognitive tests? (eg. by the use of a tablet) *

select one

- ☐ Yes
- ☐ No
- ☐ I do not know

18. To what extent do you agree or disagree with the following statements?
 (please select one answer per row)

I would rely on an AI-based diagnostic tool to help diagnose cognitive impairment. *

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Strongly agree

I would use a supportive AI-based diagnostic tool. *

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neither agree nor disagree

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- ☐ Agree
- ☐ Strongly agree

I think my patients would feel comfortable with AI-guided diagnosis. *

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Strongly agree

 Page break

Page 6

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Background

19. In which country do you work? *

select one

- ☐ Finland
- ☐ Norway
- ☐ Spain
- ☐ Italy
- ☐ Other European countries
- ☐ Non-European country

20. How do you identify yourself? *

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select one

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to specify

21. What is your medical specialty? *

select all that apply

- ☐ Neurology
- ☐ Geriatrics
- ☐ Psychiatry
- ☐ Neuropsychology
- ☐ Nursing
- ☐ Internal Medicine
- ☐ General Practitioner
- ☐ Psychology
- ☐ Other
- ☐ I do not have a specialty

21a. If other, please specify *

-  This element is only shown when the option "Other" is selected in the question "21. What is your medical specialty?"

22. How many years have you worked in the field (after completion of your specialization/studies)? *

select one

- ☐ < 5 years
- ☐ 5-10 years

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