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BMJ Open eHealth tools to assess neurological function: a systematic review protocol for a mapping exercise

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ABSTRACT

Introduction Population-based epidemiological studies investigating risk/protective factors are outlining prevention strategies for neurological conditions that often do not have effective treatment. However, ascertaining neurological outcomes can be a time consuming and expensive process, often requiring specialised personnel and/or equipment. Thus, collecting neurological data on a large scale has been an ongoing challenge for clinicians and researchers alike. The development of new technology and the emergence of several opportunities to adapt it to the health research and practice (eHealth) can be a promising solution to this problem. Several neurological eHealth tools have been developed, with many others being currently planned.

Methods and analysis We propose a systematic review mapping the available eHealth tools for assessing the different aspects of neurological function. The search aims at identifying studies published in peer-reviewed journals, which focused on the development or implementation of eHealth for assessing neurological signs or symptoms. Four engine databases are being considered (PubMed, EBSCOhost, Web of Science and Scopus), and data extraction will follow a process aimed at classifying them by their characteristics and purposes.

Ethics and dissemination This mapping exercise will be made available to researchers in order to aid them in successfully ascertaining neurological outcomes in large population-based epidemiological studies. Given the nature of this study, no ethical clearance was needed to conduct the review.

INTRODUCTION

Since the use of portable electronic devices has become widely available, information technology has achieved a progressively more prominent role in the medical field. The tools derived are collectively referred to as eHealth: health services that bridge the concepts of medical informatics and public health and can be found on different platforms, for example, a smartphone application, a web-based tool or a device.¹ eHealth showed to have a number of advantages for healthcare, improving assessment and intervention, closing physical distance between patient

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This protocol outlines a systematic review aimed at mapping all mobile tools and application developed to assess neurological function.
- ⇒ The wide timeframe planned and the inclusion of four search engines will allow a comprehensive and exhaustive mapping.
- ⇒ The planned classification by type of tool (eg, app or hardware) and by type of neurological function assessed will provide an easy-to-navigate guide for the researcher.
- ⇒ Language and non-validation barriers of the captured eHealth neurological tools to be used may be the main limitation of this study.

and clinician and contributing to research.^{1 2} The development and use of eHealth tools gained even more relevance during the recent COVID-19 pandemic, when access to in-person contacts has become limited.³ eHealth devices may involve the presence of a skilled health worker (in person or via video-conferencing) or be available as a fully computerised/automatised tool or device, for example, eHealth services that screen for diseases or offer specialised therapy, as seen for example in mental health.⁴

The majority of the application of eHealth tools are in the field of diagnostic or disease management.⁵ Nonetheless, some are also extremely relevant for research purposes, too. In particular, eHealth that can measure clinical data outside the hospital setting and without necessarily relying on highly specialised healthcare personnel are of particular interest for epidemiological studies. Population-based epidemiological studies often require the measurement of clinical and personal characteristics on large cohorts of participants, and eHealth tools can contribute extending data collection in hard-to-reach populations or low-income settings with scarce resources available.⁶

Neurological diseases are condition affecting the central or peripheral nervous system; the most common are Alzheimer's disease, Parkinson's disease, epilepsy and stroke.⁷ They can vary in nature and aetiology, but many of them have in common an overall poorly defined profile risk and a very severe prognosis. Prevention for most neurological diseases is, therefore, key. Among the many applications available to be used for data collection, those investigating possible neurological symptoms, such as cognition, motor function and coordination, are of particular interest due to the fact that clinical assessment of neurological disorders (ie, those that affect the nervous system, such as Parkinson's disease and Alzheimer's disease) often requires highly specialised equipment and trained personnel (ie, a CT scan and other devices, a neurologist).⁸ Large population-based studies may be key to study the association between those risk factors and outcome data.^{9 10}

A systematic map of all available eHealth tools to assess neurological sign and symptoms for research purpose will enhance the visibility of this wealth of resources available, potentially fostering collaborations among researchers, and boosting the use of these tools, by also discouraging duplications. A direct comparison of available tools, moreover, will help investigators to navigate through the detailed properties of the existing tools assessing if they meet the requirements to be used in real-life contexts facilitating the choice of the most adequate, depending on needs. This protocol outlines the methods to be used for such a mapping exercise. The systematic review aim is to provide a comprehensive map of eHealth tools that assess neurological signs and symptoms, categorising them by device type (ie, software or hardware) and by symptom/sign assessment (ie, disorder or impairment). To our knowledge, no previous systematic review has yet been conducted with this aim.

METHOD AND ANALYSIS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was used to develop the protocol for this systematic review (online supplemental material).¹¹ The protocol was submitted

to the PROSPERO Database (ID: 314489). A step-to-step description of the planned methodology and analysis is provided below.

Patient and public involvement

Patients and public were not involved in the development of this protocol.

Search strategy

The search terms were identified in order to capture all papers including research on eHealth devices, on measurement, assessment or screening of neurological symptoms/signs, excluding intervention and rehabilitation tools. The search terms referring to the neurological symptoms/signs were based on a conventional neurological examination.¹² Each field was expanded with a number of synonyms using the OR Boolean connector, and then the fields were merged using the AND Boolean connector. There was also a NOT Boolean connector that excluded intervention and rehabilitation terms. A full list of terms by field is reported in [table 1](#).

Searches will be conducted in four electronic databases: PubMed, Web of Science, EBSCO Host and Scopus. The searches will be run from the year 2008 to date; the start date was chosen as the year in which the first smartphone was released. Therefore, by selecting this time window, it is expected that the captured tools will be up to date with contemporary technology and that both smartphone applications or web-based platforms will be able to run optimally with current software.

Selection process

The Zotero software will be used to store references and relevant information on each publication. Reference lists coming from each search engine will be combined, and duplicates will be removed. For initial eligibility purposes, titles and abstracts will be reviewed. Subsequently, two reviewers will independently assess the inclusion/exclusion criteria of identified papers. When the two reviewers disagree on the inclusion or exclusion of a given study, a third reviewer will give their input, solving the disagreement.

Table 1 Search term combination through Boolean connectors

Electronic tool		Assessment		Symptom		Neuro		Rehabilitation
mobile app*	AND	screen*	AND	symptom*	AND	neuro*	NOT	interv*
app		assess*		signs		brain		improv*
electronic app*		measure*		outcome		speech		care*
device				disease*		tremor		treat*
ehealth				disorder*		cognitive		rehab*
mhealth wearable						gait		
						motor		
						cranial		
						coordination		
						sensation		

Terms in each field (column) were connected with a Boolean OR, before merging the four fields.

Eligibility

The inclusion and exclusion criteria (as well as data extractions) is structured according to an adapted version of the population, intervention, control and outcome criteria.

Inclusion criteria

Participants

- ▶ Human participants of all ages and sexes.

Interventions

- ▶ Electronic tools or eHealth devices (allowing the assessment of one or more neurological signs or symptoms).
- ▶ Both tools in the form of a software (eg, mobile application) or hardware (eg, wearable device) to be included.

Context/setting

- ▶ Only studies conducted outside a hospital or formal clinical setting.

Outcomes

- ▶ Studies containing at least one assessment of a neurological symptom, a sign or a function (eg, cognitive function and motor function).

Types of studies

- ▶ All study designs describing development, implementation or use of portable electronic tools.

Types of publication

- ▶ Empirical research written in English, so it can be accessed by any English speaker and published in peer-reviewed journals.

Exclusion criteria

Participants

- ▶ Any animal study.

Interventions

- ▶ Any study that applies artificial intelligence or any other software in order to make a diagnosis to replace clinical evaluation.

Context/setting

- ▶ Any study carried out in a clinical setting using non-portable tools (eg, neuroimaging, neurostimulation, modulation and feedback), lab procedures (eg, biomarkers) or requiring a specialised medical personnel.

Types of studies

- ▶ Studies not providing original research.
When more than one paper is identified reporting data on one tool, the information about the eHealth tool will be collected from all available sources. If more than one population-based application is reported, only the one with the largest sample size will be summarised in tables.

Data extraction

Data extraction will be structured according to the following categories:

- ▶ General characteristics of the paper: authors, year of publication and country.
- ▶ Type of study: development, implementation or use of electronic tools.
- ▶ Study design, date of study and its length.
- ▶ eHealth tool: name, characteristics (eg, hardware vs software), length of assessment, special features, internet connection requirement, self-assessment versus operator-mediated assessment, validated versus non-validated in a population, potential for bias (eg, training effect), type of output variable (eg, score, measurement on a continuous scale) and availability (eg, cost, platform).
- ▶ Participants: sample size, mean age and gender distribution, any relevant characteristics of the population (eg, migrants, indigenous, etc).
- ▶ Context: setting of the research.
- ▶ Outcome: sign/symptom assessed.

Quality assessment

Included papers will be appraised in terms of their quality by using the Newcastle Ottawa scale¹³ appropriately adapted to specific study design, where applicable. However, studies will not be excluded from the mapping exercise depending on their assessed quality, unless this is judged to be so low to impair the validity itself of the described tool.

Data synthesis

For the purpose of this review, a narrative descriptive approach will be adopted by the authors to synthesise the data found. The basic information will be tabulated in a series of tables and infographics aimed at providing relevant information at glance. These tables will contain information pertaining to the characteristics of the study (eg, how it was conducted, how was the study design, what were the characteristics of participants...) and the characteristics of the tools (eg, length of assessment, if it is validated, comparison measures, platform availability...). The information will be extensively covered in tables regarding the properties of the study and those of the tool, with several columns in each table specifying a given property, such as the platform in which the tool can be found. In addition, more detailed information will be summarised in an adequate narrative synthesis displaying the different electronic tools and linking them to their purposes: this will be performed via a coding of the results, which in turn will offer valuable information that will allow for the grouping of the tools in subcategories. In case too many papers are found in the primary search, the data synthesis will be split into two major meaningful categories (eg, hardware vs software, by neurological function...) and reported accordingly.

There are some limitations that arise from this study. One potential limitation is the fact that the eHealth tools



that will be described may be limited to a specific context, language, population or country. However, by capturing all existing neurological research tools and detailing their country of development, in addition to their language, we assure that the reader has a range of multiple tools to select from, choosing the one that best suits the intended purpose. Another potential limitation is that, by adding a 'NOT' connector to the search terms, perhaps some of the neurological eHealth that aims at rehabilitation/therapy symptom/sign collection may not be captured by the search.

Data reporting

All sections of the systematic review will be reported following the PRISMA guidelines.¹⁴

ETHICS AND DISSEMINATION

This systematic review aims at mapping information already available in the public domain in scientific journal; therefore, no further ethical approval will be sought.

The rationale, methods, results and discussion of this systematic review will be written for publication and submitted to a peer-reviewed journal for dissemination in the scientific community. Furthermore, results will be presented in scientific conference and, where relevant, infographic and other user friendly summary of the main results of the paper disseminated to potentially interested audience through formal and informal channels (ie, social media).

Twitter Valentina Gallo @drvgallo

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Contributors The review was conceptualised and the protocol drafted by VRF and VG, as part of VRF's PhD research. Feedback and suggestions were given by the remaining authors. EM was involved throughout the writing process and preparations for conducting the review: giving insight on the inclusion and exclusion criteria and selecting the search engines and terms. HS and LB were involved in the writing and structuring of the protocol, given their prior experience in successfully conducting systematic reviews, as well as their expertise on the topic (health/eHealth).

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

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