

# HACID - Deliverable

## Requirements for HACID-DSS in medical diagnostics

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<sup>1</sup> The following codes are admitted:

- R: Document, report (excluding the periodic and final reports)
- DEM: Demonstrator, pilot, prototype, plan designs
- DEC: Websites, patents filing, press & media actions, videos, etc.
- DATA: Data sets, microdata, etc.
- DMP: Data management plan
- ETHICS: Deliverables related to ethics issues.
- SECURITY: Deliverables related to security issues
- OTHER: Software, technical diagram, algorithms, models, etc.

<sup>2</sup> The following codes are admitted:

- PU – Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page)
- SEN – Sensitive, limited under the conditions of the Grant Agreement
- Classified R-UE/EU-R – EU RESTRICTED under the Commission Decision No2015/444
- Classified C-UE/EU-C – EU CONFIDENTIAL under the Commission Decision No2015/444
- Classified S-UE/EU-S – EU SECRET under the Commission Decision No2015/444

# Document History

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# 1. Introduction

## 1.1. HACID-DSS

HACID introduces an advanced decision support system (referred to as HACID-DSS) that tackles complex problems by utilizing a hybrid collective intelligence approach, fostering engagement, fairness, and trust. The system is anchored by a knowledge graph architecture, sourced with information from scientific and academic literature, referred to as the Domain Knowledge Graph (DKG), which is specialized in the so-called Case Knowledge Graph (CKG) when a solution for a specific case is sought. The DKG encapsulates broad domain-specific knowledge, while the CKG refines it with case-specific details, utilizing schemas from the DKG. Experts contribute to the CKG, proposing solutions based on their knowledge and the case specifics. The HACID-DSS integrates these proposals with AI-driven analyses to develop a comprehensive, evidence-based solution. This integration embodies hybrid collective intelligence, combining human and machine intelligence. The HACID-DSS ensures a traceable, evidence-supported approach, enhancing decision-making for complex problems.

## 1.2. HACID-DSS Use Case in Medical Diagnostics

A hybrid collective intelligence decision support system such as HACID-DSS is potentially very powerful for the medical diagnostics use case. Such a system can combine the medical expertise of professionals with the advanced capabilities of computers and artificial intelligence. This system can leverage various types of data, from anonymized patient health histories, outcomes of previous similar cases, to extensive medical research, to help inform diagnostic decisions. Medical experts can contribute given their valuable experiential learnings and nuanced understanding of symptoms, while AI contributes quick analysis of large amounts of information and ability to recognize patterns in data that are not immediately obvious.

By merging human insights with technological efficiency, a hybrid collective intelligence approach has the ability to enhance the accuracy of diagnosis, accelerate the decision-making process, and support individualized treatment plans that can be tailored to the needs of the patient. This bridges the gap between traditional medical wisdom, but adds the power of cutting-edge technology that ensures a more informed, comprehensive approach to patient care. The HACID-DSS can not only help improve outcomes for patients, but also streamline the care process, reducing costs and required labor, while building a system that can become more effective as it is used.

## 1.3. The Human Diagnosis Project

The Human Diagnosis Project (Human Dx, or HDx) is a worldwide effort created with and led by the global medical community to build an online system that maps the steps to help any patient and medical professional. By combining collective intelligence with machine learning, Human Dx enables more accurate, affordable, and accessible care for all. Having been established as an

operating entity for over 5 years, Human Dx has built a platform and mobile application product that supports collective intelligence efforts in the medicinal industry and has many insights into how collective intelligence works in medicine. On the Human Dx platform, users can submit medical questions and receive responses from other users. These responses are aggregated and synthesized, providing a collective answer to the posed question. As such, the Human Dx platform is suitable for exploring more granular details on various elements of more collaborative collective intelligence methodologies.

## 2. Approach and Methodology

To explore the use of the HACID-DSS in the medical diagnostics use case, the HACID consortium undertook user and design research activities to better understand the needs of medical practitioners when they make decisions within medical practice.

### Core objectives

1. Understand how a decision support system could be leveraged in real diagnostics support by healthcare practitioners
2. Identify key features from user needs to be investigated for the HACID-DSS prototype
3. Validate HACID's value proposition to "support better decision-making"

Below, we provide an overview of the activities undertaken and the key findings. As a result of the challenges discovered during this research, we proposed several design concepts for how the HACID-DSS could address existing needs amongst clinicians. Selected elements and features of these concepts will be emulated or incorporated into Human Dx for testing and evaluation (see [Section 3](#) and [Section 4](#) below).

### 2.1. User Research

User research activities were structured around three core research questions:

1. What is the decision-making process followed by existing and potential users of a diagnostics DSS?
2. What do users need from a diagnostics DSS to trust and understand its outputs?
3. What is the role of collective intelligence in building confidence in the outputs of a DSS?

To find the answers to these questions, Nesta performed various activities, such as user interviews and group workshop activities with medical professionals, from different locations (Europe, United States, South America and Asia). Participants worked in primary and secondary care, general medicine, and specialisms. Participants also had different seniority levels, and there was gender balance in the interview sample. An overview of the performed activities is provided in Table 1, along with a description of the participants recruited for each activity. Figure 1 depicts the overall process for the user research activities.

Table 1: An overview of user research activities

Method	Stakeholder group	Research objectives	Participants
Semi-structured interviews	HDx staff	<ul style="list-style-type: none"> <li>• Understand the HDx platform's architecture;</li> <li>• Understand past experiments that the HDx team carried out;</li> <li>• Better understand the use cases and current user base</li> </ul>	3 (technical, medical, and community leads)
Semi-structured interviews	Clinicians	<ul style="list-style-type: none"> <li>• Understand the current clinical decision-making process (challenges and opportunities)</li> </ul>	7 (3 HDx users and 4 non-HDx users)
Collaborative Workshop & survey	Clinicians	<ul style="list-style-type: none"> <li>• Understand what criteria clinicians prioritise for decision-making tools development</li> <li>• Understand the benefits and limitations of current decision-making aids</li> <li>• Feedback on appropriate scenarios of use for HACID and practical considerations for deployment</li> </ul>	6 (non-HDx users)

## 2.2. Design Research

Following user research and its outputs, Nesta led a detailed design research phase. In this phase, the learnings from the user research were incorporated into design opportunity proposals for potential solutions to support the HACID-DSS development. The design opportunities are co-developed with CNR, MPG and Human Dx to identify features and elements that can be implemented into the Human Dx product and that are reflective of the ideas the HACID-DSS would ultimately include.

## 2.3. Collaborative Workshop

As part of the user research activities, Nesta organized a workshop to collect feedback from participants through interviews and group activities. An interactive pair-wise polling exercise engaged the recruited user research participants. In this exercise, each participant is posed a series of questions, presented with comparative options, and must select one of the options that best represents her opinion about the question. After all questions have been answered, a score has been generated for each of the options. Additionally, the workshop engaged users during

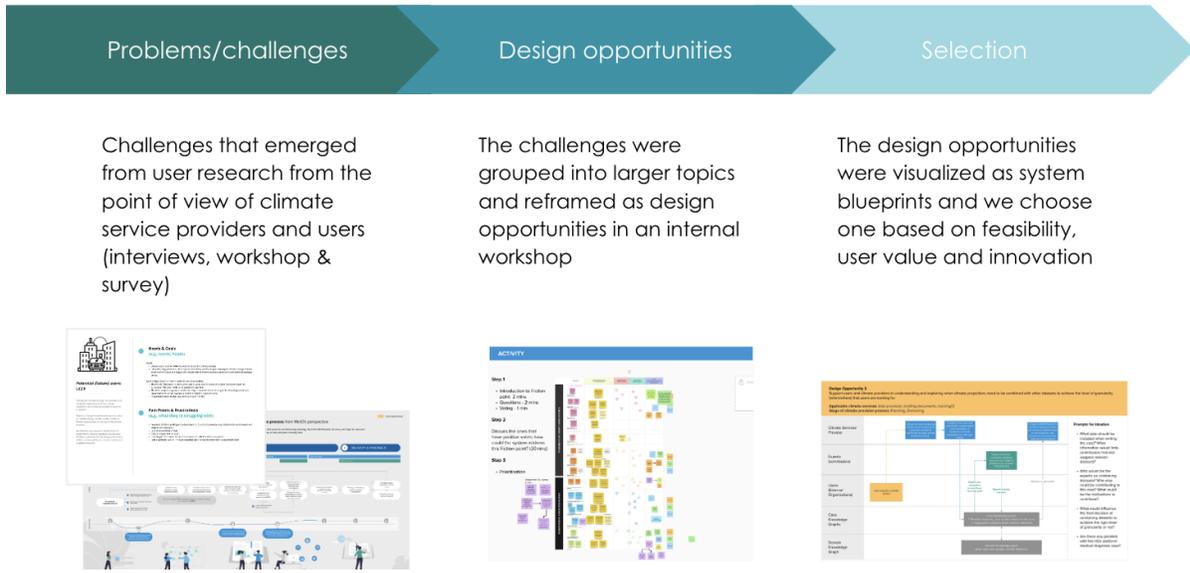


Figure 1: A scheme of the user research process

interactive sessions to provide feedback on how AI tools can support decision-making during medical diagnostics processes. Finally, the participants have been informed about the HACID project and the hybrid collective intelligence approach, and feedback was collected.

### 2.4. Limitations

The sample size for the user research conducted with clinicians was relatively small (13 participants). This was due to recruitment challenges. Clinicians are a hard-to-reach stakeholder group with constrained schedules. Despite efforts and diversifying our recruitment strategies, the sample size remained relatively small. This limited scope may not fully capture the diverse perspectives within the clinician community. Moving forward, we intend to mitigate these limitations by maintaining ongoing engagement with stakeholders throughout the HACID process and our Participatory AI approach. We will continue to gather user input, refine our understanding, and ensure the development of solutions aligns with clinicians' evolving needs and preferences.

## 3. Design Outputs

The results of the user research and design activities described in the previous section are:

- A set of personas that identify different users and stakeholders involved in the kind of decision-making process targeted by HACID-DSS.
- Mockups of two design concepts, i.e., possible implementations of the HACID-DSS that could support clinicians in their decision-making process.

The design mockups were informed by findings from the user research that revealed relevant opportunities that would be a good fit for HACID technology, as well as constraints that a HACID-DSS would need to satisfy.

The final outcome of the design research activities is an emerging set of design principles in relation to the implementation of AI in healthcare. These principles are based on priorities expressed by clinicians and will be further refined through ongoing participatory interventions during the next stages of development, testing and evaluation.

### 3.1. User needs and the clinical decision-making process

As a result of the user interviews, Nesta developed “personas” of different kinds of user stakeholders that may be involved in the decision-making process. A persona is a fictional representation of an ideal user that shares traits and characteristics of real users. Here, personas are completed with a user journey, which represents a typical path the user would take through the diagnostics process. User journeys are useful to identify the different ways to enable the user to achieve their goal as quickly and easily as possible. Personas were created based on seven user interviews (gender-balanced, covering all levels of seniority). Two types of personas were identified:

1. General practitioner in primary care
2. Specialist in secondary care

Each persona has a potentially different use for HACID-DSS. Creating personas and considering what general challenges and opportunities are for that persona encourages taking those factors into account when developing the HACID-DSS. This aim ultimately maximizes the chance for adoption and usefulness of the technology.

#### 3.1.1. General practitioner

The general practitioner is more likely to encounter situations that involve breadth of context (see Figure 2). They may be presented with a lot of information, or not enough, and have to make decisions potentially without the whole picture. For this kind of user, finding ways to improve speed to decision with confidence and access to specific information are key highlights.

Overall, primary care clinicians are under a lot of pressure to diagnose and treat patients with significant time constraints and very little support. The main decision-making aid used by these clinicians is asking a colleague or a specialist, followed by *Uptodate* and *ChatGPT*. Other decision-making aids mentioned include *Five Minute Consult*, a *Google* search, *Elicit.org*, *Facebook* groups.

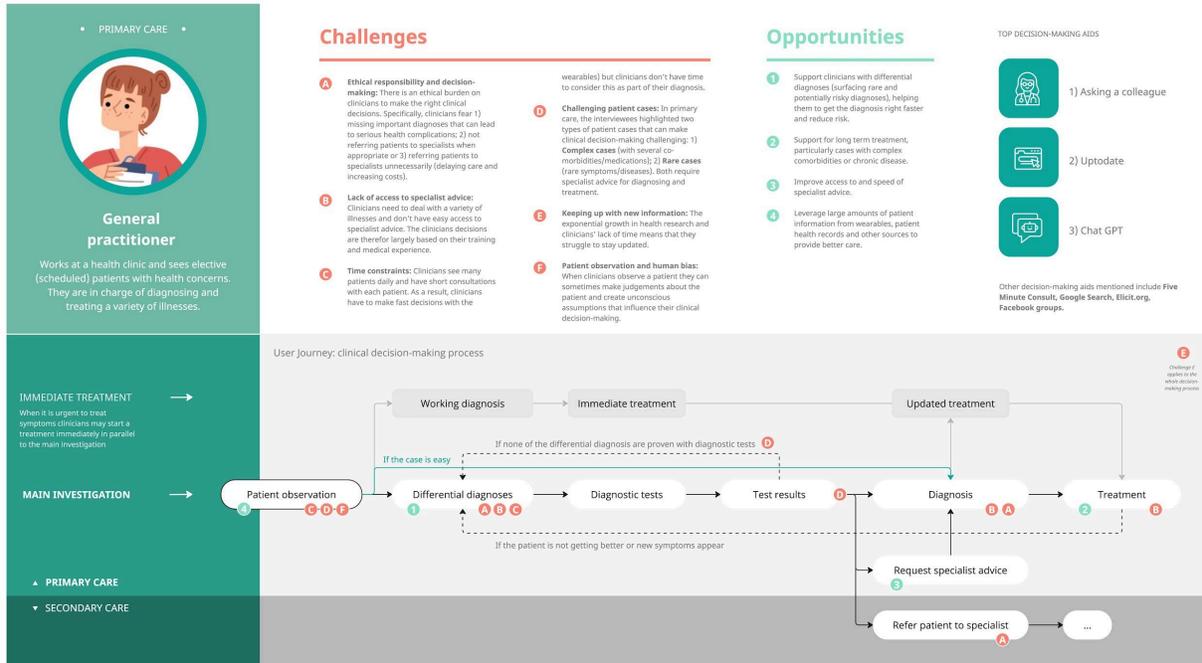


Figure 2: The “General Practitioner” persona, with full specified opportunities and challenges related to interaction with a diagnostics DSS. The user journey is also described. A high-resolution image is provided as supplementary material to this deliverable.

### 3.1.2. Specialist

Specialists are more likely to be presented with difficult situations where the context is highly constrained to a particular domain (see Figure 3). Like the general practitioner, the time needed to make a decision is key, although specialists may encounter complicated scenarios that can make it difficult to provide an answer with good confidence.

Overall, secondary care struggles with co-morbidities and pre-existing conditions that fall outside their specialism. They need access to other specialists to make clinical decisions. The main decision-making aid used by these clinicians is asking a senior colleague, followed by risk calculators (e.g., *mdcalc*) and *Google Scholar* and *Google search*. Other decision-making aids mentioned include *Open Athens*, *Uptodate* and *Butterfly*.

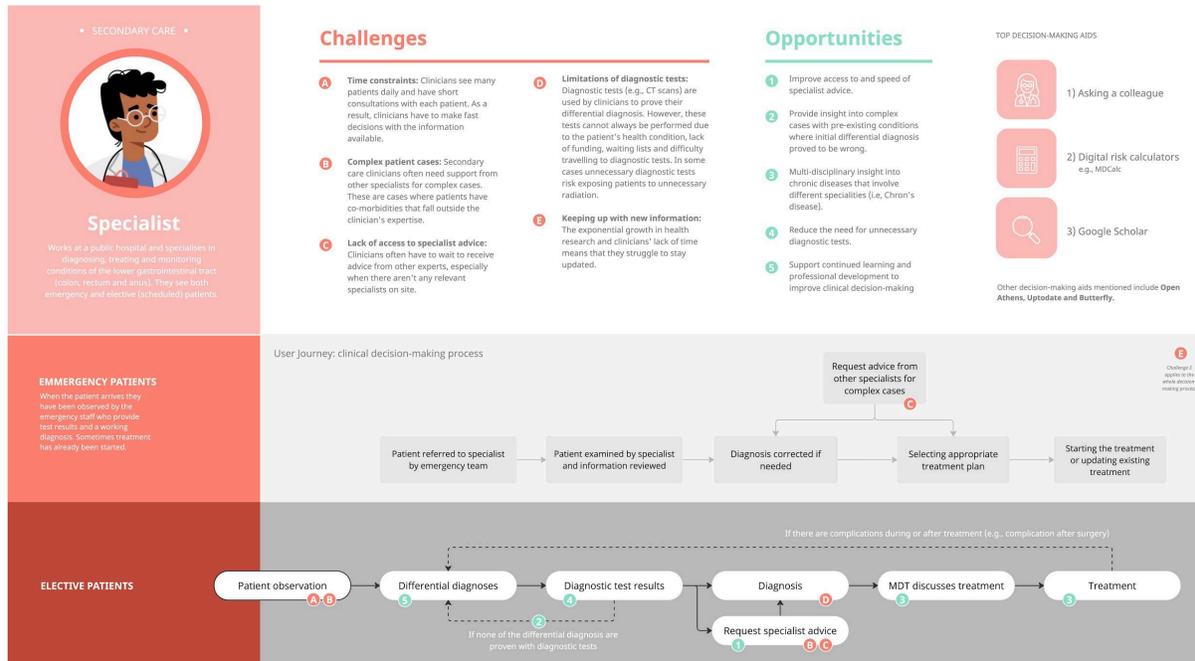


Figure 3: The “Specialist” persona, with full specified opportunities and challenges related to interaction with a diagnostics DSS. The user journey is also described. A high-resolution image is provided as supplementary material to this deliverable.

### 3.2. User values and priorities for clinical decision-making tools

During the workshop activities, the participants provided insights on what they look for in a useful decision-making tool that can help their clinical work. Through the interactive pairwise polling activities (see Figure 4), we could surface what are the most important criteria for the adoption of a decision-making tool in a clinical setting:

1. The clinical decision-making support tool provides error probability/confidence rating for recommendations (error/confidence) - 97 votes
2. It is able to provide the right answer (Accuracy) - 82 votes
3. There is accountability for errors (accountability/liability) - 80 votes

Conversely, the least important criteria are:

1. The tool tells me something that I didn't know (Novel idea/new information) - 12 votes
2. I understand exactly how it works (Explainability) - 16 votes

## What would you prioritise when developing a clinical decision-making support tool?

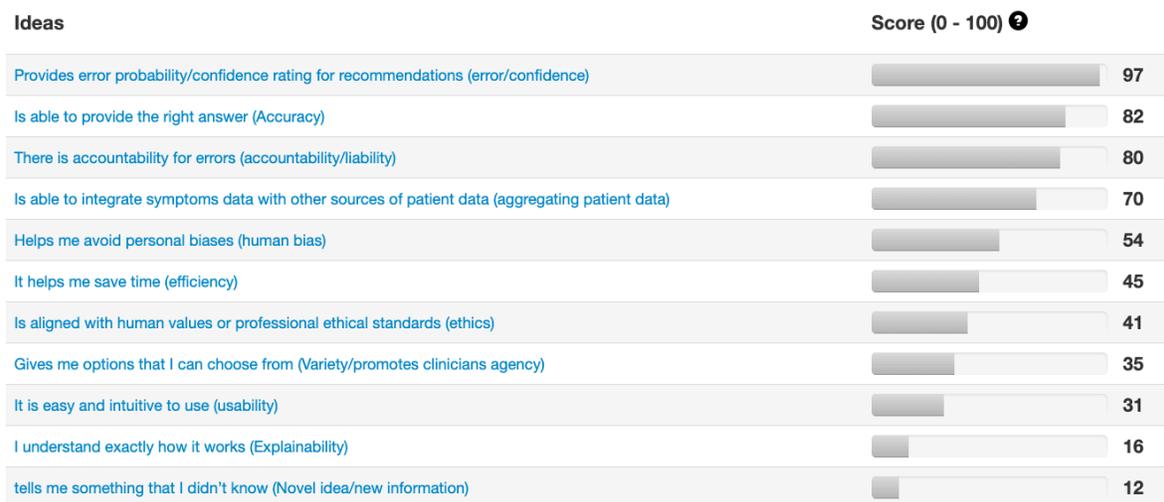


Figure 4. Results of the interactive pairwise poll with ranking of the different criteria for choosing a diagnostic DSS.

These insights (both positive and negative), coupled with the direct interaction with the user stakeholders resulting from the workshop, have informed the process that led to the proposal of two design opportunities for the use of diagnostics DSS, one for each persona, as a result of the prioritization among multiple alternatives. These design opportunities are then evaluated for integration in the Human Dx platform with the support of the HACID consortium, as described in [Section 4](#).

### 3.4. Design Principles

The design principles described in Figure 5 are intended as guidelines to inform the design of the HACID-DSS for the medical use case.. They are based on the most highly-ranking statements from the pairwise prioritization activity described in [Section 3.2](#):

- Trustworthiness
- Awareness of the patient
- Helpful in avoiding human bias
- Time efficient

Due to the limited sample size involved in the workshop, we interpret these as emerging design principles that will be further tested and iterated throughout the project.



# Emerging Design principles

## The system must be trustworthy:

- It should provide explanations for recommendations & related sources (explainability)
- It should provide error probability/confidence rating for recommendations (error/confidence)
- There should be accountability for errors (accountability/liability)
- It should be able to provide the right answer (accuracy)

## The system must be patient-aware:

- It should be able to integrate symptoms data with other sources of patient data

## The system should help avoid human bias:

- It should help clinicians avoid personal biases

## The system should be time-efficient:

- It should help clinicians save time (efficiency)

Figure 5. Design principles emerging from the workshop activities.

## 3.5. Opportunities

The user research and design activities have been followed by a brainstorming phase and the sketch of two design concepts that illustrate opportunities to integrate a HACID-DSS approach into clinical decision-making. These additional functionalities could be integrated in the Human Dx platform to test the viability of combining crowdsourcing and AI for better diagnostic decisions in real time clinical practice.

### 3.5.1. Opportunity 1 - Cliniflow

*Cliniflow* describes a real-time decision support system for clinicians that surfaces relevant research and provides an option to crowdsource information from other clinicians, all integrated within the clinician's workflow.

#### 3.5.1.1. Description

*Cliniflow* surfaces relevant search results and provides an option to "crowd-verify" information. It tackles the challenges of:

1. Lack of access to specialist advice
2. Complex patient cases that require different specialties to diagnose
3. Keeping up with new medical research

*Cliniflow* is conceived as a plug-in which is fully integrated into the clinician's workflow. It surfaces relevant content as the clinician searches online or types a patient case. Examples of such surfaced information could be:

- Well-known interaction between medicaments, symptoms and diseases
- Common or rare comorbidities

- Relevant research articles and guidelines

This seamless interaction is important because clinicians are extremely time-poor. The concept takes a two-step approach to supporting the clinician diagnosing a patient:

1. AI-suggested differential diagnoses based on a patient case
2. Diagnoses from step 1 can be sent for crowd verification

The first step allows clinicians to have an immediate response during a consultation through the AI suggested diagnosis. This AI suggestion can help the clinician make a decision on what diagnostic tests to order based on the differential diagnosis considered.

The second step, crowd-verification, allows the clinician to get advice from other specialties which is particularly important for complex cases. It also improves trustworthiness of the AI-suggested diagnoses.

Crowd-verification explores a light-touch model of crowdsourcing. It allows contributing clinicians to have a fast way to provide input: they are presented with diagnoses and can simply agree or disagree. If they believe there are diagnoses missing they can also add or suggest a new diagnosis.

### 3.5.1.2. Mockups

PATIENT HEALTH RECORD

## Patient Consultation

He has a negative **smoking/vaping history**, no illicit drug use. on examination, the pain was localised to the anterior axillary line, over the 9th rib on the right chest, it was tender, and radiated to his right shoulder, **was exacerbated with deep breathing.**

The only significant lab abnormality was a CRP of 200. Chest x ray was done, it showed opacification in the lower lobe and CP angle was acute. HRCT chest showed a pleural lesion at the same area. VATS guided biopsy was done, histopath of **pleural tissue showed fibrosis, acanthosis and chronic inflammation**, lung parenchyma was benign, fungal immunohistochemical stains were negative. TB work up was also done last month and it came out negative.

ASSOCIATED DIFFERENTIALS (AI)

- Cold
- Sleep Apnea
- Hay fever

Submit for crowd verification

LATEST RESEARCH

Sleep Apnea

Researchers are learning more about the differences in sleep apnea between men and women. For example, they've discovered that women have fewer breathing pauses than men during the early non-REM stage of sleep, but as they get into deeper REM sleep, their breathing stops just as many times as men's.

LATEST RESEARCH

Deep breathing

USEFUL FEATURES: SUPPORT FOR CLINICIANS

- 1 Plug-in that surfaces suggested diagnoses (AI) that can be submitted to be verified by other clinicians
- 2 It also summarises relevant research as you search/type

Mock-up

**CONTRIBUTING: SOLVING CASES**

- 1
Search cases by topic or key words
- 2
See patient cases and solve them by agreeing or disagreeing with AI generated differentials and suggesting new ones

Mock-up

**REWARD: DOWNLOADING EVIDENCE FOR CPD**

- 1
Access your profile, your user title and usage data.
- 2
Download your 'Continuous Professional Development' logged learning activity since 1401.
- 3
Find the results of cases that you sent for crowd verification.

Mock-up

### 3.5.1.3. Value Proposition

*Cliniflow* provides additional value to users because it acts as a continuous learning and support tool, by surfacing the latest research and suggesting diagnoses. Beyond this functionality, clinicians are rewarded for helping others through the crowd-verification system, as the tool is connected to their Continuous Professional Development (CPD) efforts. Interactions with the system are logged and can be downloaded as evidence of their learning for audits and career progression discussions.

Main benefits for users:

- Provide support and additional information during the diagnostic process: the DSS engages automatically during the clinical decision-making activities, allowing for a fast information loop
- Access to other specialists: the crowd verification process provides additional checks on the AI-surfaced information by connecting pieces of information to the relevant specialists in the community
- Continuous learning and awareness of latest research: the AI-surfaced references are gathered from a constantly updated cross-disciplinary pool of research articles and clinical resources
- Logged hours and evidence for CPD: these allow both the certification of the efforts of the participants, as well as the provision of feedback and quantification of their learning progress

#### 3.5.1.4. Open Questions

The implementation and use of Cliniflow in a real-life setting could shed light on a series of open questions that the user research and design activities have identified. These open issues can be classified in two broad groups: either related to the suggestion provided by the AI, or to their verification to the crowd.

With respect to the AI-driven suggestion of additional clinical information:

- **Research summaries:** What information would clinicians find relevant? How and when should that information be surfaced?
- **Suggested diagnoses:** Is it possible to provide confidence/probabilities about the accuracy of the suggested diagnoses? How would this influence the trust and usage of the overall system? How is accountability factored in?
- **Plug-in format:** What are the privacy and security considerations of using a “plug-in” which acts on information typed by clinicians across different platforms? Is personal information a concern?

With respect to crowd-verification:

- **AI-aided crowdsourcing:** What are the consequences of providing clinicians with AI-suggested diagnoses as a starting point for their contribution? Does it make it easier or harder to contribute? Does it impact the accuracy of contributions? How does it impact the trust of clinicians in the “crowd”?
- **Participation:** What UI features will incentivize regular participation in crowd-verification?
- **Participation:** How might we guarantee that crowd-verification is completed within a reasonable time frame (for example, within 48 hours)?
- **Incentive:** Is CPD perceived as an appropriate and worthwhile benefit?

#### 3.5.2. Opportunity 2 - Virtual Multi-Disciplinary Team Collaboration

This second concept describes a decision support system that aids clinicians in choosing treatment plans for real complex cases (such as those that involve comorbidities or existing

medications). This tool also offers a training function for contributing clinicians to practice developing treatment plans for complex cases and learning about the risks or interdependencies of each treatment through virtual deliberation with other experts.

While in Cliniflow the AI is proactive (adds clinical information) and the crowd is reactive (validates the correctness of the AI-provided information), in the Virtual Multi-Disciplinary Team Collaboration the roles are inverted: the crowd is proactive (discusses and provides a differential diagnose) and the AI is reactive (aggregates the crowd-provided information).

### 3.5.2.1. Description

Patient cases are getting increasingly complex and patient management is becoming a multidisciplinary effort. However, accessing other specialties is non-trivial and can take a long time. This tool allows users to request support from clinicians across the world for additional insights and possible treatment plans. Groups of clinicians who solve cases by providing treatment plans can also use this tool as a learning aid. The Multi-Disciplinary Team (MDT) is tasked with providing an “answer” for the patient case. Note that this design opportunity focuses on treatment plans instead of diagnoses, as this was identified as an interesting aspect during the user research. Indeed, within current medical practice stable MDTs are typically formed for treatment plans for complex chronic diseases with several (potential) comorbidities. Within HACID, however, we will limit our investigation to diagnostics, in line with the goal of the project and the mission of Human Dx (see also [Section 4](#)).

This team is created virtually, and all users provide their treatment options. Different experts are selected, ensuring that members are in a medical speciality or position that is relevant to the patient case, and that the team is diverse in specialties and covers all the necessary specialties (possibly with some redundancy). An example of an MDT might be one composed of 1 nutritionist, 1 psychologist, 1 nurse, 1 cardiologist, and 1 gastroenterologist. The treatment plans provided by the members of the MDT are discussed within the platform and each specialist can revise the proposed treatment. Finally, all proposals are combined and summarized into a single treatment plan.

### 3.5.2.2. Mockups

**GETTING SUPPORT: CLINICIAN ASKS FOR HELP TO TREAT A COMPLEX CASE**

- 1 The clinician inputs a complex patient case with all the relevant information available
- 2 They choose what specialties are relevant to the case and should be included in the MDT. They also set the timeline for getting a response.
- 3 The clinician sees the final Virtual MDT response 3 days later. They can also see the ranked treatment plans from all contributors.
- 4 They can then select the right treatment and provide updates to solvers on how well the patient is responding to the treatment

Mock-up

**CONTRIBUTING: LEARNING HOW TO TREAT COMPLEX CASES**

- 1 Contributor reads a real ('insight') or 'training' patient case and suggests a treatment plan.
- 2 They are added to a virtual MDT and have time to see their colleagues' treatment plans and agree on the best one (deliberation)
- 3 Finally, they see a ranking of the most commonly suggested treatment plans by teams. Later they will get a notification to learn if their teams' treatment was selected by the clinician.

Mock-up

🔄 interactive learning

### 3.5.2.3. Value Proposition

In contrast with the previously described Cliniflow, the value provided by the Virtual Multi-Disciplinary Teams is more focused on the unique dialog that emerges when different specialists contribute with their own experience to the discussion of a clinical case.

Benefits for users:

- Quickly gathering input from other experts on possible diagnoses: without the Virtual MDT Collaboration, contacting single experts to explain a case which could take a long time
- Learning about potential risks of misdiagnoses through MDT discussion: the system could nudge the MDT discussions to remember to take into account possible drawbacks of certain suggested diagnoses
- Logged hours and evidence for CPD (as in Cliniflow)

#### 3.5.2.4. Open Questions

Similarly to Cliniflow, the implementation and use of Virtual MDT Collaborations could provide data on various open questions highlighted by the user research and design activities.

Regarding the responses provided by the MDT:

- **Trust:** Would virtual MDT improve or deteriorate trust in the “crowd”, compared to single experts? How accurate would the MDT result have to be for clinicians to trust it?
- **Accountability:** How would clinicians feel about accountability for responses provided by a MDT, compared to single experts?

Regarding the process leading to the decisions:

- **Deliberation:** How would the system select MDTs? Would every contributor be added to a MDT? What if someone responds to the case right before it is about to close and there is no time for deliberation?
- **Dealing with complex cases:** Are clinicians willing to participate in virtual MDTs? Could interacting with other experts to deliberate on treatment plans help clinicians better deal with complex cases that fall outside their expertise? How would accuracy change following MDT deliberation with respect to crowdsourcing independent opinions?

## 4. Human Dx Implementation and Roadmap

### 4.1. Challenges and objectives

Human Dx is an established entity with a platform, mobile application product, and user base. Any modification or integration of external technologies into the Human Dx platform, as well as any procedure for the exchange of data among the HACID participants, must be designed and carried out while keeping in mind various practical considerations and constraints, including the following:

- The Human Dx platform is an established private business, actively used by a large number of users, some of which make use of the platform for professional interactions, in addition to training
  - User-facing and product-changing integrations can thus be carried out only if approved by the board and found to conform to the Human Dx mission, business direction, established design practices and to the needs of the Human Dx users

- The Human Dx mobile application maintains compatibility with a very diverse set of smartphones and operating systems
  - Modifications to the mobile application require an extensive testing procedure to ensure the aimed level of device compatibility
- User interface changes and new user-facing features are delivered to the Human Dx users through updates to the mobile application
  - Pushing an application update requires approval from app stores like Apple Store or Google Play store, which may result in delays in feature introductions
- Old versions of the Human Dx mobile application are still supported for a number of years
  - Any modification to the mobile application must be done in a way that ensures both backward and forward compatibility with the rest of the platform

Despite the aforementioned challenges, the Human Dx platform can still serve as an experimentation platform for testing or validating various ideas. The objective is to formulate hypotheses for high-value features of the proposed HACID-DSS in medical diagnostics, develop experiments to test these hypotheses within the framework of the Human Dx platform, and validate by implementing features and collecting supporting data within Human Dx.

## 4.2. Cliniflow

For the proposed opportunity *Cliniflow* described in [Section 3.5.1](#), Human Dx will aim to implement the outlined two-step approach:

1. AI-suggested differential diagnoses based on a patient case
2. Diagnoses from step 1 sent out for crowd-verification

The proposed experiments will help answer a few open questions about this design opportunity, mainly related to the expected accuracy of an AI-aided crowdsourcing process, as well as the associated trustworthiness.

### 4.2.1. Support for a System Quick Response

Human Dx can add a feature that provides a system response on a user case after a case is submitted. This response can be in the form of suggested answers, or a system-provided answer given the system's best-determined result. *Cliniflow* proposes that a decision support system focus on differential diagnosis, which has high relevance given the HACID-DSS use case in medical diagnostics, but it may also provide additional information to other aspects of the case, not limited to differential diagnoses. The implementation within the Human Dx platform can explore both directions.

### 4.2.2. Verification of System Responses Using the Crowd

For the second step in the *Cliniflow* approach, Human Dx will also incorporate a feature that enables a user who has submitted a case to request input from other users on the Human Dx platform. The input mechanism may take different forms, ranging from structured to unstructured

feedback on the response. This user feedback may be publicly reviewable and not constrained only to be viewed by the submitter. The time at which the feedback becomes public is an important factor: participants could be influenced if they are exposed to the feedback of others users before they have provided their opinion.

### 4.3. Virtual Multi-Disciplinary Team Collaboration

Two elements described in [Section 3.5.2](#) for the Virtual Multi-Disciplinary Team Collaboration that Human Dx has targeted are:

1. Single platform for open-ended user deliberation
2. Optional aggregation of multiple responses in a single set of differential diagnoses in case no consensus can be formed

While the design opportunity focused on decision-making about the treatment, within HACID we will limit experimentation about providing diagnoses, because this is in line with the project scope and the Human Dx mission. Nevertheless, this activity will help answer open questions about the advantages of open deliberation within MDTs, as well as on the way in which MDTs should be formed.

#### 4.3.1. Engagement Modalities for User-Driven Collaboration

A key highlight of the Virtual MDT Collaboration approach is improved exchange of ideas with experts that may not be in the immediate professional network of the user. Human Dx is a platform with international users, so it is well-positioned to provide a streamlined experience for user collaboration across geographical borders and time-zones.

When users submit cases to Human Dx, they will be given the option to invite other users of the platform to discuss the case. Alternatively, the system may create MDTs with the appropriate specialties and fill these roles using specialists that are currently logged into the platform. Cases will have a chat-based system that enables users to send messages to other users that have been added to the case. The members collaborating on the case can use the chat to engage with other users on the case in standard chat-application-like manners, and revise their differential diagnoses following the interaction with other users.

#### 4.3.2. Aggregation of Multiple Responses

Because there will be multiple participants within an MDT involved in a case, there will likely be different suggestions by each of the participants, unless participants within the same MDT manage to reach consensus. Human Dx will include a feature that aims to aggregate or synthesize these multiple responses to provide the case owner a more comprehensive view of all the responses.

## 4.4. Roadmap

Subject to the challenges and constraints described in [Section 4.1](#), Cliniflow and the Virtual MDT Collaboration will be integrated and implemented in the Human Dx platform according to the following roadmap (PM = Project Month).

### 4.4.1. Cliniflow

- PM 20 to 23: Development of Cliniflow
- PM 23: Alpha version presented to the HACID members
- PM 23-26: Refinement using feedback from HACID members
- PM 26: Beta version presented to internal testers
- PM 27: Experiments with Ciniflow are performed with the Human Dx users base

### 4.4.2. Virtual Multi-Disciplinary Team Collaboration:

- PM 25 to 29: Development of Virtual MDT Collaboration (partially overlapping with Cliniflow)
- PM 29: Alpha version presented to HACID members
- PM 29-32: Further development based on feedback from HACID members
- PM 32: Beta version presented to internal testers
- PM 33: Experiments with the Virtual MDT Collaboration are performed with the Human Dx user base