

APPLE-MH-2: Decision Support in Mental Health Care: End of Project Report

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1. Introduction

This document is the end-of-project report for APPLE-MH Phase 2, which extends the work of APPLE-MH Phase 1 (detailed in <https://openclinical.net/index.php?id=723>). The focus of APPLE-MH is the modelling of shared decisions in Mental Health. The longer term goal of the project is to develop the models into a practical service implementation in which distributed processes work together to enable collaborative decision-making, leading to semi-automated plan updating and rapid learning. A rapid learning framework is a long-term challenge and requires the logic-based foundations of *PROforma* to be extended to incorporate data analytics and machine learning techniques (see [Fox, 2016] and <https://www.youtube.com/watchv=9wWG88B8e60&t=77s>).

Phase 1 delivered several decision support prototypes which demonstrate distributed and shared decision-making in Mental Health based on published NICE clinical guidelines. Documents for Phase 1 are published on OpenClinical (<https://openclinical.net/>) together with our demonstrations of clinician facing, patient facing and joint decision-making tools, known as pathway models. Two of the most important deliverables from Phase 1 were *clinical-view* (providing clinical services), and *patient-view* (providing patient services). In addition to these specific models, the project also suggested potential for re-usable patterns in workflows. These include a generic pattern for *active monitoring* and *collaborative decision-making*, which we hope to validate in other mental health applications, and in patient-centred multidisciplinary care more widely.

The goal of APPLE-MH-2 was to extend the *clinical view* prototype to include multi-disciplinary teams (MDTs) in mental health. In Phase 1, *clinical view* focused on the early stages of a patient in the mental health system, particularly Primary Care. In Phase 2, *clinical-view* has been extended to include decision support for both Primary Care and for a multi-disciplinary team. This resulted in two prototypes *PTSD-Depression* and *MDT-Distributed*, which are available at <https://labs.openclinical.net/newmind/>.

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2. Multi-Disciplinary Teams in Mental Health - Background

A Community Mental Health Team (CMHT) works with Primary Care and other services in the local community. CMHTs include multi-disciplinary teams (MDTs) which are made up of different professionals. These include social workers, community psychiatric nurses (CPNs), psychologists, psychiatrists, team managers and occupational therapists.

To reduce risk and enhance multi-disciplinary collaboration, referrals for specialist treatment are handled centrally by the CMHT. Even if a patient is referred by their GP to a named specialist (such as a psychiatrist), the CMHT is automatically involved in the referral decision.

The majority of referrals handled by a CMHT originate from Primary Care but sometimes other agencies may refer patients (e.g. Crisis Resolution Teams, Inpatient services or Probation services).

A central component of a multi-disciplinary team is the MDT meeting, which takes place regularly (typically weekly). Mental Health MDT meetings usually do not make diagnoses or detailed treatment decisions. Instead they make decisions about care management on a high-level, particularly involving risk assessment and resource allocation. Typically an outcome for a patient under discussion might be "to see psychiatrist to review diagnosis/medication" or "request psychologist to assess for suitable therapy to address trauma history". A typical MDT meeting will last 1 - 2 hours and review 15 - 30 patients. (However, this is widely variable [Nic a Bhaire, 2015]).

3. Use Cases

Use cases for APPLE-MH-2 are as follows:

1. To provide decision support during a Primary Care consultation to recognise complex mental health conditions and make referrals to an MDT if necessary.
2. To provide decision support during an MDT meeting to help decide what action should be taken for each patient under discussion.

In both cases, the relevant patient information is displayed for each patient under consideration. These details include (a) a summary of the patient's data (where data category would be expandable to show more detail as required) and (b) decisions that are applicable to the patient. These are elaborated below.

(a) Patient data

During a Primary Care consultation, the patient data includes answers to relevant questions, symptom questionnaires such as PHQ9 (which may have been already filled in online), and patient medical history.

During an MDT meeting, the details of each patient is displayed to the meeting participants. This data will typically include a summary of the patient's mental health condition, along with relevant circumstances, history, and stage in the mental health care system (e.g. newly referred from Primary Care, undergoing treatment, waiting for treatment (with waiting time), finished treatment etc.).

(b) Decisions

There are two types of decisions that can be supported: (1) recognition of a condition, and (2) treatment actions (such as referral, prescription etc.). For both types of decision, possible options are listed with reasons in favour and reasons against each one. Typically one option is recommended by the system. The user then selects an option which may or may not be the recommended one. For example, if the options are applicable actions, they are listed in order of the advisability of each action, with the most advisable action(s) at the top and the least advisable at the bottom (with reasons given). If an action is agreed at an MDT meeting, it can be selected from the list. The patient data is then automatically updated to reflect this.

The expertise available in an MDT is particularly relevant for patients with complex or multiple conditions. In consultation with the domain expert (LW), we extended the original depression scenario used in APPLE-MH Phase 1 to include PTSD combined with depression. The data model was extended to include PTSD symptoms and relevant life events.

4. Method: OpenClinical and the *PROforma* Language

APPLE-MH prototypes are developed using the *PROforma* language [Sutton and Fox, 2003], which was developed for modelling decision-making and planning, particularly but not exclusively in clinical practice. *PROforma* is an executable specification language that supports evidence-based decision-making and management of clinical care pathways. It is based on a theory of high level cognition which resulted from many years of study of clinical practice and medical expertise [Fox and Das, 2000]. Its most distinctive feature is that it supports an intuitive ontology of plans and decisions using logical concepts from AI planning and a decision model based on formal argumentation. The decision model can be contrasted with traditional quantitative models, though it can also accommodate such quantitative decision procedures where the required data are available.

Using a technology stack provided by the OpenClinical.net knowledge sharing platform, a *PROforma* model (called a "publet") can be published and used in clinical decision support systems (CDS). Authoring platforms such as Tallis, Arezzo and OPS are used to develop and demonstrate publets for research and knowledge-sharing purposes. (Details of these tools are available on the OpenClinical website). Prototypes developed by the APPLE-MH project are OpenClinical publets.

5. Results and Deliverables

For this short project, the main deliverables were the prototype decision support publets and the associated documentation. These are available at <https://labs.openclinical.net/newmind/>. A short user guide is [here](#) and a detailed CREDO specification document is [here](#). A journal paper is also in preparation.

The work involved the following stages:

1. Defining distributed services.
2. Requirements gathering for MDT meetings.
3. Prototype development and informal evaluation.

These are summarised below.

5.1 Defining Distributed Services - Primary Care and CMHT

Decision support takes place in an environment in which multiple agencies and professionals work together. We defined an environment in which the following services are available: Primary Care and CMHT (which includes an MDT). Patients are often referred to an MDT from Primary Care. Both these components together make up the distributed service system and replaces the Phase 1 *clinical-view*. The new publet *MDT-distributed* is available at <https://labs.openclinical.net/newmind/>.

Although the Primary Care component is shown connected to the CMHT component, the detailed decision support which populates Primary Care is defined separately in *PTSD-Depression* (available at the same web location). This is currently a publet for PTSD with depression which follows the NICE Guidelines at <https://www.nice.org.uk/guidance/ng116/chapter/Recommendations> (particularly section 1.7).

With further development of the OPS platform, the goal is to import different Primary Care publets for specific conditions together with preloaded patient data.

5.2 MDT Meetings - requirements gathering

Through consultation with our domain expert (LW), we determined that an MDT meeting should be considered as having two components: (a) **meeting screening** (before the meeting) and (b) **meeting actions** (during the meeting). The requirements for both are below.

(a) Meeting screening

Before the main MDT meeting, a screening stage can take place to identify decisions that can be made quickly, without the need to take time at an MDT meeting. Some actions may be permitted at the screening stage for patients whose needs are straightforward and do not require an MDT discussion. Permitted screening actions should be configurable. For example, key worker allocation is common during screening. Referrals for assessment may also be possible.

(b) Meeting actions

The following are key actions that take place during an MDT meeting:

1. Referral decisions – determine if a patient meets criteria for an assessment. If so, refer to a specialist; if not, send the patient back to their original referrer with advice. If criteria are satisfied but resources are insufficient, referral may be delayed if the patient is not high-risk.
2. Allocation decisions – for patients who have already been assessed, determine if they meet the criteria for allocation. If so, allocate the patient to a key worker (care coordinator); if not, send the patient back to their original referrer with advice. If criteria are satisfied but resources are insufficient, allocation may be delayed if the patient is not high-risk.
3. General discussions about patients of concern.

Regarding delay, it is also important to ensure that waiting times are within targets, and to keep track of elapsed time as the patient goes through the different stages.³

5.3 Development of Publets

The prototype development took place incrementally with frequent iterations and feedback from LW.

We have used the L1-L4 hierarchy of levels defined in [Boxwalla et al, 2011] for Clinical Decision Support systems (CDS). We have interpreted these levels as follows:

- L1: “Unstructured” – narrative text (e.g. policy guidelines). These are based on population health and evidence. For APPLE-MH2, they are the NICE guidelines for depression and PTSD.
- L2: “Semi-structured” – organised text. This defines the functionality of services and indicates the main decisions and actions. The focus is on an individual patient being treated, and not on population health. The MDT requirements in 5.2 are defined on this level, along with Use Cases (Section 3) and the CREDO service specification [here](#).

³ This feature is not yet supported by the prototype and would need further development of the OPS platform.

- L3: “Structured” – this is a computable and precise specification of L2, and may be executable for demonstration or research purposes (but not for real-life clinical use). It is shareable across different clinical settings and implementations (e.g. *PROforma*, Arden Syntax MLMs). APPLE-MH prototypes are defined on L3.

L4: “Executable” – this is the knowledge representation that is to be implemented in a particular CDS system. It includes the content of L3 along with details that are specific to the CDS software and organisation. Usually the author is the CDS implementer. The L4 version can be in the same language as the L3 version if the local CDS tool can interpret it.

APPLE-MH prototypes are defined on L3, although we aim for them to be integrated into products by clinical users (where they would be translated to L4). L2 (structured text) includes requirements (5.2) and the more detailed specification in the CREDO service document. Use cases (Section 3) are also considered to be on L2.

The first use case was translated into the *PTSD-Depression* prototype. This populates the Primary Care component and includes two main decisions:

- determine if PTSD is present;
- determine if severe depression is present (in which case it should be treated first according to NICE).

The second use case was translated into the *MDT-distributed* prototype. The CMHT component includes two *PROforma* plans: *meeting-screening* and *MDT-meeting*. Each of these components implement the decisions in 5.2(a) and (b) respectively.

5.4 Summary of data model

To recognise depression or PTSD, the Primary Care component initially asks for the following data:

- relevant questions (medical history, prescriptions, social circumstances etc).
- trauma signs and symptoms (listed in NICE guidelines)
- trauma-relevant life events
- PHQ-9 symptoms for depression

Once the required decisions have been made, the following data is updated:

- condition(s) recognised (not a final diagnosis but main symptoms are present)
- medication updates (if any)
- referral details, if any (e.g. name of practitioner, urgency etc.) If there is a referral, the patient is usually transferred to the CMHT where referrals are managed centrally.

The MDT meeting in the CMHT usually makes resource management decisions, and does not make detailed diagnoses or treatment plans. The current prototypes use the following data definitions:

- configurable list of actions permitted during screening (e.g. key worker allocation, assessment referral)
- resource status: how good is the availability of different resources? (e.g. key worker availability)
- summary of patient status (currently this is indicated as mild, severe, complex, or unknown).
- what decisions, if any, were made during the screening stage? (e.g. allocated from screening, referred from screening)
- were concerns raised about this patient (for discussion at meeting)
- what actions were taken at the meeting? (e.g. key worker allocation, delay, send back to referrer).

A full list is included in the CREDO service specification.

6. Discussion and Future Work

Subject to funding, the next phase of APPLE-MH will involve further development of the prototypes. This is expected to include the following:

- Closer integration and data sharing between *PTSD-depression* and *MDT-distributed*: this would populate the CMHT component with more detailed patient data. Currently the CMHT data is summarised. In the enhanced version, the patient who is referred from Primary Care will have all of their data in the CMHT automatically. This will allow the argumentation in MDT decisions to be more detailed (e.g. taking into account particular symptoms or home circumstances).
- Usability enhancements, including tracking of changes to different kinds of data (such as resource data and individual patient data). In particular, a configurable dashboard is required to show the acceptable waiting times for different conditions or levels of risk, along with the capability to keep track of elapsed time for each patient.
- Pablets for assessment specialists and key workers: data sharing between Primary Care and CMHT allows detailed decision support services to be specified for assessment specialists and keyworkers. Such services would take into account specific patient symptoms and limitations, as well as circumstances.
- Integration with patient-view from Phase 1, along with the active monitoring and shared-decision prototypes developed in that phase.

6.1 Wider Consultation and evaluation

A wider consultation study is envisaged, where LW can invite professional colleagues to access the APPLE-MH prototypes and to run them with simulated cases. A questionnaire can then be used to evaluate features such as usefulness, efficiency, usability, and reliability.

A retrospective evaluation is feasible using past patient notes. OpenClinical has already carried out such a study for kidney transplantation [Knight et al. 2018]. (Ethics permission needs to be considered carefully as the rules about aggregated data may have changed).

References

- Boxwala AA., Rocha BH, Maviglia S, Kashyap V, Meltzer S, Kim J, ... Middleton B. A multi-layered framework for disseminating knowledge for computer-based decision support. *Journal of the American Medical Informatics Association : JAMIA*, 18 Suppl 1(Suppl 1), i132-i139. doi:10.1136/amiajnl-2011-000334 2011
- Fox J and Das S *Artificial Intelligence in Hazardous Applications*. AAAI and MIT press, 2000
- Fox J, Beveridge M, Glasspool D "Understanding intelligent agents: analysis and synthesis" *AI Communications* , Volume 16 (3) - Jan 1, 2003
- Fox J et al "OpenClinical.net: a platform for creating and sharing knowledge and promoting best practice in healthcare" *Computers in Industry*, 2013, short description at <https://www.mpls.ox.ac.uk/mplsinsights/supporting-doctors-better-decisions> and web site <https://tallis.openclinical.net/>
- Fox J "Cognitive systems at the point of care: the CREDO program" *Journal of Biomed Informatics*, 68, pp 83-95, 2017
- Henderson H, Flood C, Leese M, Thornicroft G, Sutherby K, Szmuckler G. Effect of joint crisis plans on use of compulsory treatment in psychiatry: single blind randomised controlled trial. *BMJ*; 329:136. 2004
- Knight SR, Cao KN, South M, Hayward N, Hunter JP, Fox J. "Development of a Clinical Decision Support System for Living Kidney Donor Assessment Based on National Guidelines". *Transplantation* 102(10):e447-e453. Published online Jul 2018. <https://www.ncbi.nlm.nih.gov/pubmed/30028418>
- Nic a Bhaird C. Multidisciplinary team meetings in community mental health care: a mixed-methods investigation of their functions and organisation. PhD thesis available at: <https://discovery.ucl.ac.uk/id/eprint/1471491/10/Caoimhe%20Nic%20a%20Bhaird%20Thesis%2030.9.15.pdf.%20REDACTED.pdf>

PHQ 9 health questionnaire <https://www.mdcalc.com/phq-9-patient-health-questionnaire-9>

Richards DA, Lankshear AJ, Fletcher J, Rogers A, Barkham M, Bower P, Gask L, Gilbody S, Lovell K. Developing a UK protocol for collaborative care: a qualitative study. *Gen Hosp Psychiatry* 2006;28(4): 296-305.

Sutton D. and Fox J., "The syntax and semantics of the PROforma guideline modelling language", *J Am Med Inf*, 2003. Summary of PROforma concepts at: http://archive.cossac.org/tallis/Basic_proforma_concepts01.htm