Solution Report Case 2: Chronic kidney disease (CKD) + Hypertension (HTN) + Atrial fibrillation (AFib)

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Part 1: Architecture and use

Architecture
Common to all cases

The UJI approach to the management of comorbidities in CIGs uses solely the editing and enacting facilities of the CIG language, in our case PROforma (and its Composer tool). Consequently, no architecture is proposed. Instead, the management of comorbidities is handled by developing specific PROforma fragments that should be considered when jointly using the CIGs of the comorbid conditions. We refer to these fragments as comorbidity management models (CMMs). Note that, for the combined use of the CIGs of the comorbid conditions, a series of adaptations might be required.

CIG representation
Common to all cases

We have represented the CIG in PROforma, using the Composer tool to edit the models. We have designed a CMM to solve the specific scenarios/patient cases proposed (e.g. 76-year old female with TIA and DU in case 1). Note that we have only considered the interactions of the provided scenarios. Moreover, the CMM assumes that all the comorbidities indicated are present. In case additional scenarios are required, the new situations should be modelled as a new CMM to be considered together with the existing one(s).

For a complete solution, it would be necessary to model the CIGs involved and build a final model with such CIGs and the CMMs. This approach is labor intensive since it is necessary to model each possible interaction as a CMM. On the positive side, the interactions will be fully described in the CMM, resulting in self-contained and self-explanatory models.

The descriptions below refer to the elements of the PROforma CIG language. ****TODO add paragraph or reference****.

We have followed the following naming conventions. Each time a drug/treatment is prescribed we use a task (usually a plan or an action) with a name beginning with the word "start" followed by the name of the drug/treatment. Each time a drug/treatment needs to be stopped, we have explicitly represented it with a task whose name begins with the word "stop" followed by the name of the drug/treatment. Moreover, if the drug/treatment must be resumed after a period of time, or when the problem is solved, we have also modelled it with a task whose name starts with the word "resume" followed by the name of the drug/treatment. This naming convention helps to realize that there is an action for interaction management and also how it has been solved. In addition, we have associated tasks and data to appropriate SNOMED CT ontology terms.

Apart from that, decisions by the clinician or the patient have been modelled as enquiry tasks. For example, the decision to prescribe or not aspirin will be modelled with a task enquiry_add_aspirin, requesting an answer yes or no from the clinician.

Task preconditions and wait conditions have been fundamental to solve the interactions of the proposed scenarios.

CIG representation
Specific to CASE 2

CASE 2

Here we describe the PROforma CMM to solve the interactions of the Case 2 scenario, a patient with Chronic Kidney Disease (CKD), treated for Hypertension and a new problem appears to be treated, atrial fibrillation (AFib). The top level plan in PROforma is shown in Figure 1. The enquiry enquiry_AFib has two scheduling constraints. The plan Management_of_AFib has as precondition AFib_diagnosis="yes".
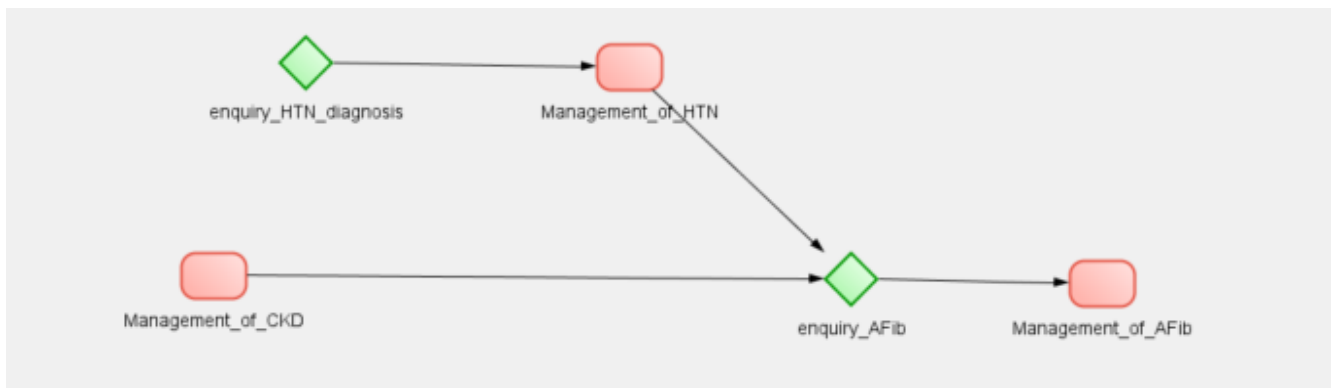

Figure 1: Top-level plan for the management of CKD+Hypertension<+AF

There is a plan for the management of Chronic Kidney Disease (CKD), whose content is shown in Figure 2. The plan enquiries the value of Estimated Glomerular Filtration Rate (eGFR). Next, a decision determines whether there is CKD depending on the value of eGFR (a value below 60 in eGFR implies CKD is present). The treatment follows the recommendations of the guideline. The 3 tasks whose name starts with the word "enquiry" have as precondition CKD_diagnosis="yes". The actions with the appropriate treatment have also preconditions considering the values asked in the corresponding enquiries.
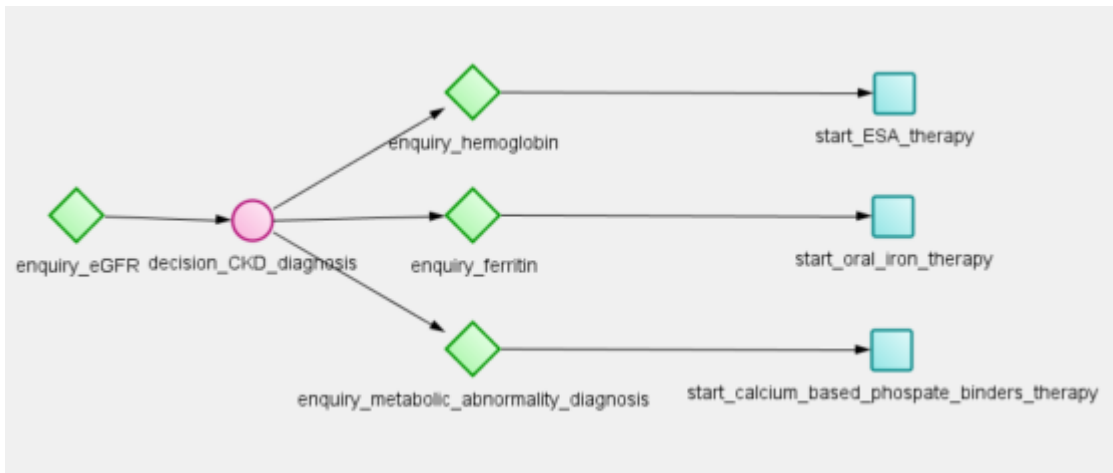
Figure 2: Content of the plan Management_of_CKD

On the other hand, the patient is also treated for Hypertension if needed. The plan to control blood pressure is shown in Figure 3. Depending on the age of the patient, ACE inhibitors or calcium channel blockers (CCM) are recommended. If hypertension is not controlled, combines ACE inhibitors with diuretics for all ages (plan step2_treatment). Lastly, if hypertension is not controlled still, CCB is added to the treatment.
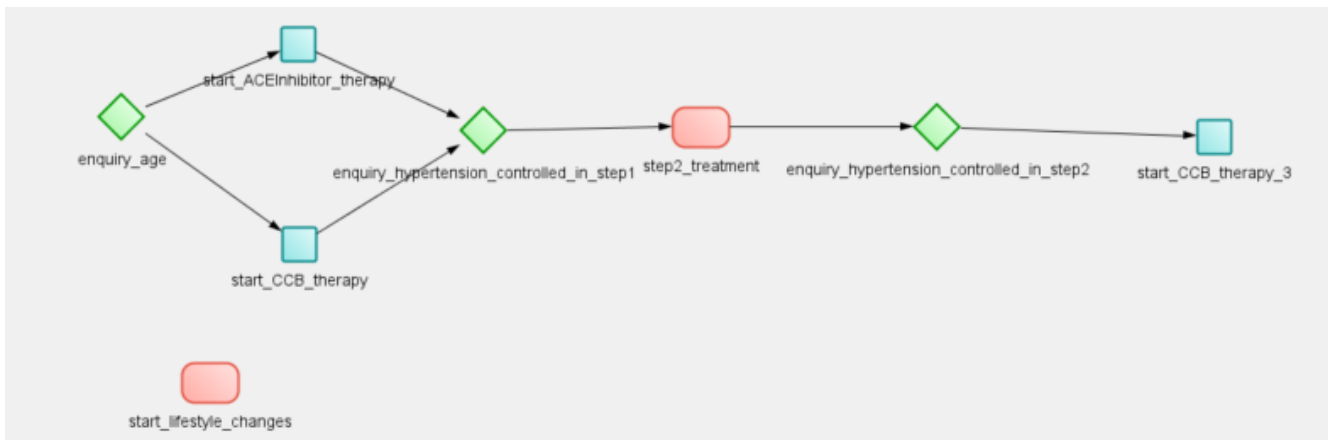

Figure 3: Content of the plan Management_of_hypertension

If a patient with CKD and hypertension is now diagnosed with AF, the goal is to control flow rate by means of the recommended therapy: anticoagulants, channel blockers and beta blockers (Figure 4). In all the cases, the plans consider the possible interactions of these therapies with the previous diagnoses and their treatments. These interactions are implemented by means of preconditions in the tasks. For example, if the patient is having ESA therapy for CKD, there is an action that explicitly indicates stopping the therapy and another action to use warfarin instead (see Figures 5 and 6 with the preconditions of the task stop_ESA_therapy). In the case of channel beta blockers, the adequate

drug is indicated considering whether the patient is diagnosed with CKD or not. Again we use the precondition, in this case it checks the value of CKD_diagnosis.

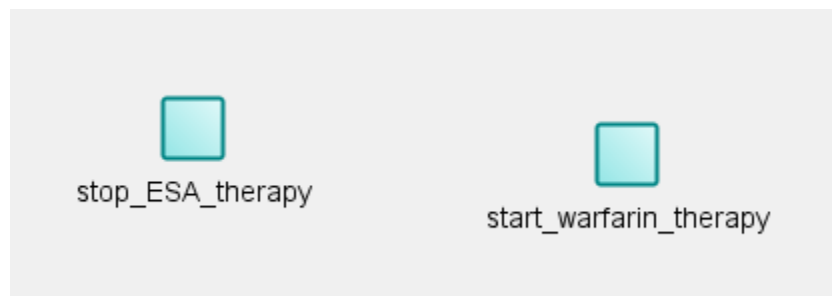Figure 4: Content of the plan Management_of_AF

Figure 5: Content of the plan anticoagulant_therapy

Figure 6: Properties table of the task stop_ESA_therapy in patients with AF

Finally, beta blockers are recommended only if the patient is not on treatment with ACE inhibitors or CCB. This has also been modelled with a precondition in the corresponding action: not(is_completed(start_CCB_therapy)) or not(is_completed(start_CCB_therapy_3)) or not(is_completed(start_ACEInhibitor_therapy)) or not(is_completed(start_ACEInhibitor_therapy_2))

Domain knowledge representation
Common to all cases

As mentioned above, we have associated tasks and data to appropriate SNOMED CT ontology terms when possible.

Mode of use
Common to all cases
The system could be used to develop a PROforma-based DSS system. It could be used for simulation but also at the moment of the patient encounter.

Strengths of the approach
Common to all cases
Does the approach have very good support for particular features? Which? Please justify. What is the singular point of strength of your approach?

- Explainability: Interactions are fully described in the CMM, resulting in self-contained and self-explanatory models
- Ontology binding
- Support for both automated decisions and for decisions by the clinician or the patient

Part 3: Implementation of the Case Studies

N/A.