Guideline modelling comparison paper

Documentation for PROforma models

Guideline 1: Chronic cough

Modelling requirements:

1. Please model chronic cough, ordering a chest radiograph, treatment.
2. Please model the grade of evidence (re scheduling of CXR).
3. Please model the fact that Chest radiographs do not have to be routinely obtained before beginning treatment. That is, they may or not be obtained, and both options are valid.
4. Please model the criteria (a) presumed PNDS in young non-smokers (b) pregnant women (c) before observing the result of discontinuation of an ACE-I for 4 weeks in patients who developed chronic cough shortly after beginning to take an ACE-I.
5. Please model evaluating sinusitis as the cause of cough, ordering 4-view sinus radiographs, not ordering sinus CT-scan.
6. Please model the criterion that would be used to indicate that the test results are interpreted as normal (re Oesophageal pH monitoring studies).
7. Please model the grade of evidence (re Oesophageal pH monitoring studies).
**PROforma model**

This guideline has been modelled using 27 component tasks (figure 1).

Figure 1: This thumbnail view of the guideline model shows only the hierarchy of tasks within their parent plans and not the scheduling constraints that exist between tasks and govern the order of their execution.
Guideline is not appropriate

Initial assessment: CXR and initial treatment

Scheduling decision: CXR first

Non-specific initial treatment: Order CXR

CXR results: Order CXR

CXR in parallel: Initial treatment of chronic cough

Non-specific initial treatment: Discontinue ACEI

Investigations:
- PNDS investigation
- Sinus radiographs
- Other investigations: Unspecified

GERD investigation: O.pH M. interpretation
- Oesophageal pH monitoring: O.pH M. results

Asthma investigation: Unspecified

Cause

PROforma “Chronic cough” guideline model overview

Ke
- Plan
- Actio
- Enquiri
- Decisio
- Schedulin
PLAN : Chronic cough guideline

This ‘top level’ plan contains 4 tasks:

- An “Initial assessment” enquiry
- An action to inform the user that the patient is ineligible – “Guideline is not appropriate”
- A plan containing subtasks describing the Chest X Ray and initial treatment – “CXR and initial treatment”
- A plan containing subtasks describing subsequent investigations – “Investigations”

Figure 2 : The scheduling constraints between the 4 tasks within the top level plan.

When a guideline is executed, the top-level plan automatically becomes in progress. Of the components within any plan, only those tasks whose scheduling constraints are met (or which have no scheduling constraints) will initially be executed when the plan first becomes in progress. In this case, of the 4 component tasks within the “Chronic cough guideline” plan only the “Initial assessment” task has no scheduling constraints, and this task is thus the first to be executed.
ENQUIRY : “Initial assessment”

The “Initial assessment” enquiry seeks the following eight data items :

- ACE_related (boolean, yes, no)
- Age_group (text, range [“younger”, “older”])
- Cough_duration (integer, weeks)
- Cough_productive (boolean, yes, no)
- Pregnant (boolean, yes, no)
- Presumed_PNDS (boolean, yes, no)
- Sex (text, range [“male”, “female”])
- Smoker (boolean, yes, no)

Requirement 1 – Modelling “chronic cough”

The enquiry has the follow post-condition :

\[
\text{Chronic_cough} = \text{if}( \text{Cough_duration} \geq 3, \text{Yes}, \text{No})
\]

I.E. Upon completion of the task, the value of the data item “Chronic_cough” is set to ‘Yes’ if the reported duration of the cough is greater or equal to 3 weeks, ‘No’ otherwise.

ACTION : “Guideline is not appropriate”

The ‘Chronic cough’ data item is then used to effect branching logic between the next 2 tasks. Once the state of the “Initial assessment” enquiry becomes completed, the scheduling constraints of both the “Guideline is not appropriate” action and the “CXR and initial treatment” plan are met. Execution semantics are such that before any task is executed, its pre-conditions are tested, and if false, the task is discarded. The “Guideline is not appropriate” action has the following pre-condition :

\[
\text{Chronic_cough} = \text{No}
\]

whilst the “CXR and initial treatment” plan has the following as its pre-condition :

\[
\text{Chronic_cough} = \text{Yes}
\]

Thus, if the patient does not have a chronic cough (i.e. the value of ‘cough_duration’ is under 3 weeks), the “Guideline is not appropriate” action executes to inform the user that the patient is ineligible for this guideline. Once this task is completed, no further tasks in the top-level plan can be executed, the top level plan becomes completed and execution finishes.
PLAN: CXR and initial treatment

The plan “CXR and initial treatment” will become in progress once the “Initial assessment” enquiry completes, providing its precondition

Chronic_cough = Yes

is met.

REQUIREMENT 3: Please model the fact that Chest radiographs do not have to be routinely obtained before beginning treatment. That is, they may or not be obtained, and both options are valid.

This plan contains 2 further plans which themselves contain tasks describing the ordering of the Chest X Ray and initial treatment of patients with a chronic cough. The ‘CXR first’ plan describes a Chest X Ray being ordered, and the result received, before any treatment is commenced. The ‘CXR in parallel’ plan describes these actions taking place potentially in parallel.

These 2 plans have mutually exclusive pre-conditions which refer to the result of the “Scheduling decision” decision task. Scheduling constraints within the “CXR and initial treatment” plan are arranged such that this decision must be completed before either of the 2 sub-plans can be commenced.

Figure 3: The scheduling constraints between the 3 tasks within the “CXR and initial treatment” plan.
DECISION : “Scheduling decision”

REQUIREMENT 4 : Please model the criteria (a) presumed PNDS in young non-smokers (b) pregnant women (c) before observing the result of discontinuation of an ACE-I for 4 weeks in patients who developed chronic cough shortly after beginning to take an ACE-I.

This decision task evaluates whether it is appropriate to obtain a chest radiograph before beginning treatment, or whether treatment can commence in parallel with the ordering of the chest radiograph.

The decision has 2 candidates : “CXR_in_parallel” and “CXR_first”

3 arguments are described for the candidate “CXR_in_parallel” :

Age_group = Younger and Smoker = No and Presumed_PNDS = Yes
Pregnant = Yes and Female = Yes
ACE_related = Yes

The argumentation model for this decision is set to “Symbolic”, which allows 4 levels of support to be associated with each argument – ‘For’, ‘Against’, ‘Confirming’ and ‘Excluding’. Each of the arguments associated with the “CXR_in_parallel” is given the support level ‘for’.

There is only 1 argument related to the “CXR_first” candidate :

netsupport( Scheduling_decision, CXR_in_parallel ) < 1

The decision’s ‘choice mode’ is set to ‘single’, meaning only one candidate can be selected. The decision is set to execute “manually” (as opposed to “automatically”), meaning that user confirmation is required to confirm the selected candidate.

REQUIREMENT 2 : Please model the grade of evidence (re : scheduling of the CXR)

PROforma does not support an explicit “machine interpretable” field for representing the grade of evidence associated with recommendations, since it is unclear what the appropriate “machine interpretation” / semantics of such a grade would be. In this case, the grade of evidence associated with the recommendation that the CXR need not be ordered before commencing treatment in certain groups of patient is represented as free text within the description field of the “Scheduling decision” task as follows:

Chest Radiographs should be ordered before any treatment is prescribed in nearly all patients with chronic cough (Grade II-2).

This string can be presented to the user at the appropriate point during guideline execution.
PLAN : CXR_first

This plan has the precondition "result_of( Scheduling_decision ) = CXR_first"; the plan will be discarded if that pre-condition is not met when tested at the start of the task’s execution.

The plan contains three tasks:

**ACTION : Order CXR**
This task advises the user to order a CXR

**ENQUIRY : CXR report**
This task asks the user for the data item ‘CXR_result’ (range ['normal', 'other'])

**ACTION : Non-specific initial treatment**
This task advises the unspecified initial treatment

Scheduling constraints are used to ensure that the “non specific initial treatment” action cannot commence until the “CXR report” enquiry has completed

Figure 4 : The scheduling constraints between the 3 tasks within the “CXR first” plan.
PLAN : CXR_in_parallel

This plan has the precondition "result_of( Scheduling_decision ) = CXR_in_parallel"; the plan will be discarded if that pre-condition is not met when tested at the start of the task’s execution.

The plans contains three tasks:

ACTION : Order CXR
This task advises the user to order a CXR

ENQUIRY : CXR report
This task asks the user for the data item ‘CXR_result’ (range [‘normal’, ‘other’]

PLAN : Initial treatment of chronic cough
Containing the 2 tasks:
ACTION : Discontinue ACEI
ACTION : Non specific initial treatment
These tasks have no scheduling constraints and thus execute in parallel as soon as the plan becomes in progress.

REQUIREMENT 4c : “Chest radiographs do not have to be routinely obtained… before observing the result of discontinuing an ACE-I for 4 weeks …”

In this plan, the action “Discontinue ACEI”, contained within the plan “Initial treatment of chronic cough”, will be executed at the same time as the action “Order CXR” since neither it nor its parent plan has any scheduling constraints

Figure 5 : There is no scheduling constraint on the “Initial treatment of chronic cough” plan, nor on its two component actions.
PLAN : Investigations

Figure 6: The 4 plans contained within the “Investigations” plan, and the decision which controls which plans are to be executed.

DECISION : Cause

This decision task assesses what the likely cause of the cough is, in the light of the Chest X-Ray result. The only information given in the guideline summary is the phrase:

“When the Chest X-Ray is normal, PNDS, Asthma, and GERD are the likely causes of chronic cough”

The decision thus has 4 candidates — “PNDS”, “Asthma”, “GERD” and “Other”. The argument “CXR_result = normal” is an argument “for” each of the first 3 candidates, whilst the argument “CXR_result = other” is an argument “for” the final candidate.

The decision’s “Choice mode” slot is set to multiple, so multiple candidates can be selected.
PLAN : PNDS evaluation

This plan has a scheduling constraint such that it only executes after the “Cause” decision has completed, and a precondition:

Result_of(Cause) includes ‘PNDS’

Thus this plan will only execute if PNDS is one of the proposed causes of the cough.

The plan contains the action, “Sinus Radiographs”.

ACTION : Sinus Radiographs

REQUIREMENT 5: Please model evaluating sinusitis as the cause of cough, ordering 4-view sinus radiographs, not ordering sinus CT-scan.

The “Sinus radiographs” action has the following 2 free text slots:

Procedure: “4 view sinus radiographs”
Caption: “Sinusitis may be the cause of PNDS 30% of the time (60% if the cough is productive). Sinus CT scans are not routinely recommended to evaluate for sinusitis as the cause of cough.”

Thus the negative recommendation about Sinus CT scans is conveyed to the user as a text message given when the “Sinus radiographs” action is executed.

PLAN : Asthma evaluation

This plan has a scheduling constraint such that it only executes after the “Cause” decision has completed, and a precondition:

Result_of(Cause) includes ‘Asthma’

Thus this plan will only execute if Asthma is one of the proposed causes of the cough.

The plan contains the action, “Unspecified”.

ACTION : Unspecified

No specific investigations for evaluating asthma as the cause of chronic cough are given in the guideline fragment used in this case study.
PLAN: Other investigations

This plan has a scheduling constraint such that it only executes after the “Cause” decision has completed, and a precondition:

Result_of(Cause) includes ‘Other’

Thus this plan will only execute if ‘other’ is one of the proposed causes of the cough.

The plan contains the action, “Unspecified”.

ACTION: Unspecified

No specific investigations for evaluating other causes of chronic cough are given in the guideline fragment used in this case study.

PLAN: GERD evaluation

This plan has a scheduling constraint such that it only executes after the “Cause” decision has completed, and a precondition:

Result_of(Cause) includes ‘GERD’

Thus this plan will only execute if ‘GERD’ is one of the proposed causes of the cough.

Figure 7: The 3 component tasks of the “GERD Evaluation” plan, and their scheduling constraints
**ACTION : Oesophageal pH monitoring**

This action has 2 slots :

- **Procedure** : “24 hour Oesophageal pH monitoring”
- **Context** : “24 hour Oesophageal pH monitoring is the most diagnostically useful test for evaluating GERD as the cause of cough.”

**ENQUIRY : Oesophageal pH monitoring results**

This enquiry seeks 2 data items :

- Conventional_indices (text, range [“within normal range”, “outside normal range”])
- Suspicious_coughs (boolean, Yes, No)

**DECISION : Oesophageal pH monitoring interpretation**

**REQUIREMENT 6 : Please model the criterion that would be used to indicate that the test results are interpreted as normal (re Oesophageal pH monitoring studies).**

This decision (choice mode – “single”, support mode “symbolic”) has the follow 2 candidates :

1. **Candidate : “Normal”**
   - **Argument** :
     - “For, Conventional_indices = ‘Within normal range’ and Suspicious_coughs = No”

2. **Candidate : “Abnormal”**
   - **Arguments** :
     - “For, Conventional_indices = ‘Outside normal range’”
     - “For, Suspicious_coughs = Yes”

**REQUIREMENT 7 : Please model the grade of evidence (re Oesophageal pH monitoring studies).**

As discussed earlier, modelling of grades of evidence is not explicitly supported in PROforma. The task has the description field as follows :

“Conventional indices used by gastroenterologists to assess for esophagitis may be misleading normal. Until further studies provide better guidelines, the test should be read as normal when conventional indices are within the normal range and no suspicious reflux-induced coughs appear during the monitoring session (Grade II-2)