

Translating Arden MLMs into GLIF Guidelines – A Case Study of Hyperkalemia Patient Screening

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Background

- Arden Syntax at CPMC
 - More than 200 MLMs
 - No longer executable due to Y2K
 - Need to re-examine the knowledge in MLMs
- GLIF/GLEE at CPMC
 - Representation format for guideline
 - Execution engine to interpret guideline knowledge when applied to specific patient cases
- Translating Arden MLMs into GLIF guidelines

Goal

- Study the feasibility of medical knowledge translation
 - Arden → GLIF as an example
 - Hyperkalemia patient screening as a specific case
- Identify issues arose during the translation process
- Propose potential solutions

```

maintenance:
  title: Screen for hyperkalemia in critical value range ( $\geq 6.0$ );;
  filename: HYPERKALEMIA;;
  version: 1;;
  institution: Columbia-Presbyterian Medical Center;;
  author: Pete Stetson (peter.stetson@dbmi.columbia.edu);;
  specialist: Jai Radhakrishnon, MD, John Crew, MD;;
  date: 2003-09-16;;
  validation: test;;
library:
  purpose: To monitor for patients who have a critically elevated potassium level;;
  explanation: When a potassium lab result is stored, a warning is sent if it is  $> 6.0$ 
    mg/dl. If the patient is in renal failure a lower threshold K+ value is used;;
  keywords: potassium, hyperkalemia;;
knowledge:
  type: data-driven;;
  data:
    ...
    raw_potassiums := read last 3 from {'dam'="PDQRES2"; ;
      '1301','1608','1609','1610','1656','1698','32713','33803','35455','35975',
      '35993','35994'} where they occurred within the past 3 months);
    ...
    ;;
  evoke: k_storage_event;;
logic:
  ...
  creatinine := last (raw_creatinine where it is number);
  ...
  if potassium  $\geq$  cut_off then
    conclude true;
  else
    conclude false;
  endif;
  ...
  ;;
action:
  write "This patient has a critically elevated K+ of " || potassium || " meq/dl on " ||
    time of potassium || " and is at risk for potassium toxicity.";;
end:

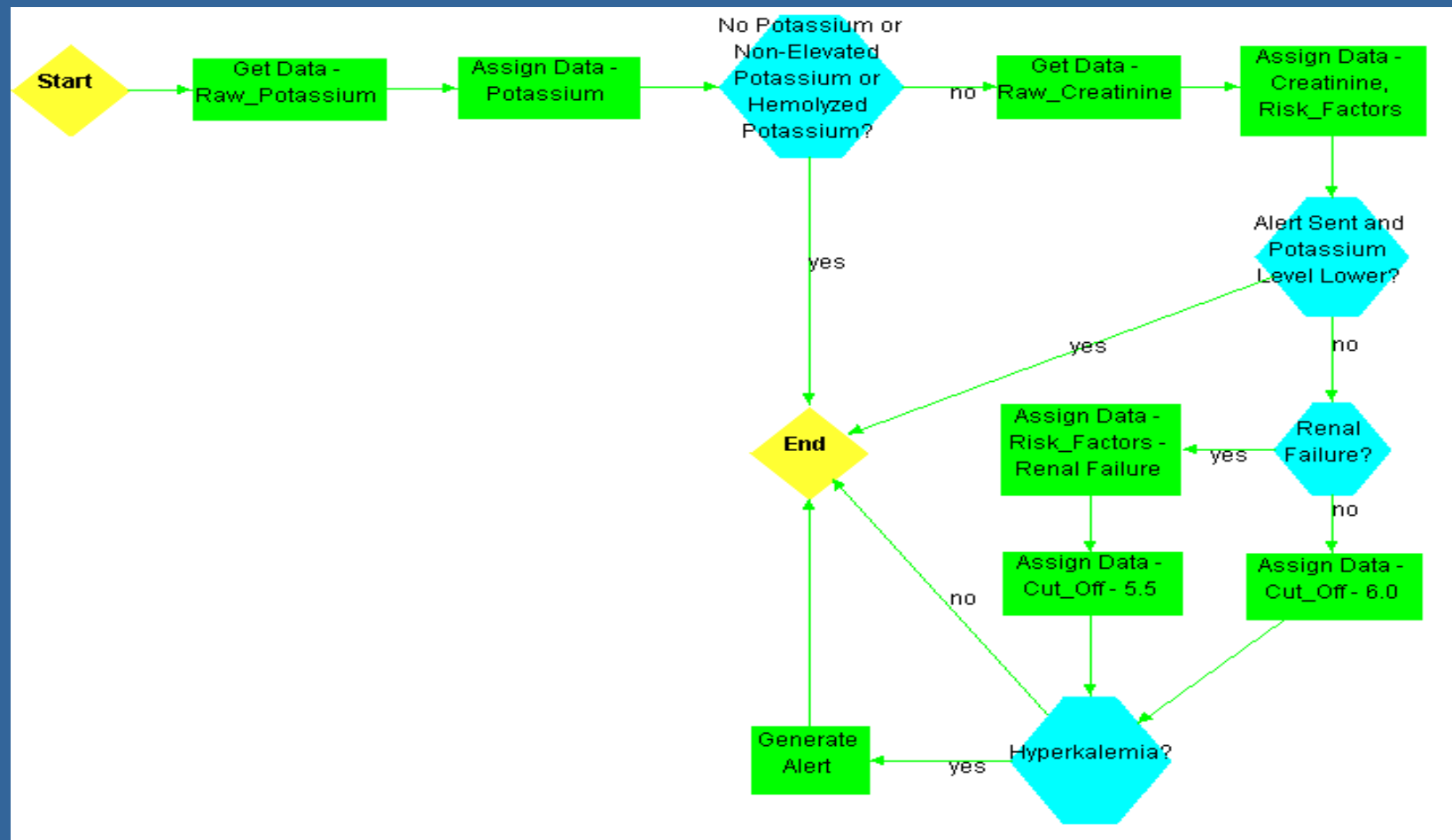
```

Guiding Principles for Translation

- Top level
 - MLM instance → GLIF guideline instance
- Knowledge role mapping
 - Slots of MLM → slots of GLIF classes
- Procedure code translation
 - Logic slot of MLM → GLIF guideline steps

MLM Slots and Statements	GLIF Entities
MLM (1)	Guideline (1)
maintenance.title (1)	Guideline.maintenance_info.title (1)
maintenance.filename (1)	
maintenance.version (1)	Guideline.maintenance_info.encoded_guideline_version (1)
maintenance.institution (1)	Guideline.maintenance_info.developing_institution (1)
maintenance.author (1)	Guideline.maintenance_info.author (1)
maintenance.specialist (1)	Guideline.maintenance_info.author (1)
maintenance.date (1)	Guideline.maintenance_info.authoring_date (1)
maintenance.validation (1)	Guideline.maintenance_info.representation_status (1)
library.purpose (1)	Guideline.didactics.items.material (1)
library.explanation (1)	Guideline.didactics.items.material (1)
library.keywords (1)	Guideline.didactics.items.material (1)
knowledge.type (1)	
knowledge.data (1)	Event (1)
knowledge.data (4)	Variable_Data_Item (4)
knowledge.data (4)	(leave to local system)
knowledge.evoke (1)	Triggering_Event (1)
knowledge.logic.assignment_statement (6)	Action_Step (7), Variable_Data_Item (5)
knowledge.logic.if_then_statement (5)	Case_Step (4), Three_Valued_Criterion (8)
	Patient_State_Step (2)
knowledge.action (1)	Action_Step (1), Literal_Data_Item (1)

Translated GLIF Algorithm



Validity Testing

- Use GLEE as a tool
 - Simulate the application of the translated knowledge to specific patient cases
- Domain expert created 5 simulated cases
 - Represent typical patients
 - Cover all possible execution paths
- For each of the 5 cases, the actual result matched with the expectation (the gold standard developed by the domain expert who created the cases)

Problems Identified

- Mix-up of general medical knowledge and local policy in MLM
 - Need to use different approaches
- Flow control
 - Procedure translation
 - Insertion of patient state step implied
- Data definition
 - The curly braces problem
- Event-driven execution
 - Batch-mode processing to improve performance

Potential Solution

- Manual translation
 - Labor-intensive, error-prone, difficult to generalize
- Potential solution: automatic translation
 - Direct translation could be difficult (overlapping of different models)
 - Development of an intermediate layer as the target of translation
 - Formalize individual models (procedures, etc.)
 - The guiding principles as the starting point of a set of mapping rules that facilitate the translation

Conclusion

- Feasible to translate the medical knowledge embedded in the Arden MLMs into the GLIF format
- Significant efforts are necessary to handle the problems in the translation
- Automatic translation could be a more generalizable approach for future work

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All positive comments are attributed to the presenter. All negative comments are the author's responsibility.