

# Report on KIV formalisation of jaundice protocol

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 Procure

## Plan

- KIV in a nutshell (revisited)
- KIV formalisation of Asbru (revisited)
- The jaundice protocol in KIV
- Conclusions

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## KIV in a nutshell (revisited)

- Features:
  - modularity, user interaction, management tools
  - language:
    - algebraic+procedural specifications
    - rich set of programming constructs
      - sequential programs: :=, SKIP, ABORT, VAR, IF, WHILE
      - parallel programs: ||, AWAIT, OR, ATOM
  - ...with programming constructs for Asbru:
    - BREAK (interrupts)
    - ||s (synchronous execution)
    - ||a (any order sequential execution)

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## KIV formalisation of Asbru

- Based on plan-to-program mapping:
  - mapping of plan conditions:
    - FILTER PRECONDITION  $\varphi$  body  $\rightarrow$  AWAIT  $\varphi$ ; body
    - COMPLETE/ABORT CONDITION  $\varphi$  body  $\rightarrow$  BREAK body IF  $\varphi$
    - ACTIVATE MODE manual body  $\rightarrow$  VAR time0=time, dt=[?] AWAIT time0+dt $\leq$ time; body

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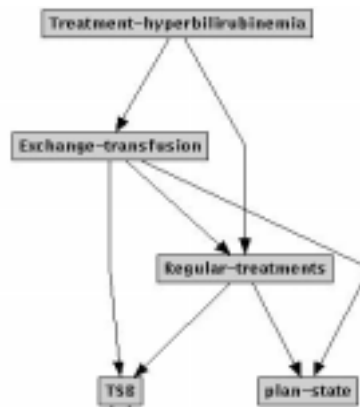
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## KIV formalisation of Asbru (cont.)

- mapping of control structure:
  - DO PARALLEL plan1 plan2... → plan1 ??? plan2...
  - DO ANY-ORDER plan1 plan2... → plan1 ||a plan2...
  - DO UNORDERED plan1 plan2... → plan1 ||s plan2...
- mapping of continuation specification:
  - DO ..., WAIT-FOR planN, ... →  
VAR planN-completed IN  
BREAK ... IF planN-state=completed
- mapping of specific options: *ad hoc* way

## The jaundice protocol in KIV the treatment part

- First version, with big-size modules



## The jaundice protocol in KIV the treatment part (cont.)

### – TSB specification:

- functions&axioms for treatment table, e.g. to derive the appropriate treatment:

```
25 ≤ a ∧ a ≤ 48 ∧ l < 12 →  
get-bilirubin(set-age-level(tsb,a,l))=observation;  
...
```

### – Regular-treatments specification:

- procedures for clinical actions, of automatic activation:

```
Prescribe-observation#(VAR time)  
BEGIN  
  SKIP;  
  VAR time0=time, dt=[?] IN AWAIT time0+dt ≤ time  
END
```

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## The jaundice protocol in KIV the treatment part (cont.)

### or manual activation:

```
Prescribe-observation-manual#(VAR time)  
BEGIN  
  VAR time0=time, dt=[?] IN AWAIT time0+dt ≤ time;  
  SKIP;  
  VAR time0=time, dt=[?] IN AWAIT time0+dt ≤ time  
END
```

- procedures using the previous ones:

```
Observation#(VAR tsb,time,Observation-st)  
BEGIN  
  AWAIT get-bilirubin(tsb)=observation;  
  PBREAK BEGIN  
    Prescribe-observation#(;time);  
    Observation-st:=completed  
  END  
  IF get-bilirubin(tsb) ≠ observation  
END;
```

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## The jaundice protocol in KIV the treatment part (cont.)

- and procedure for Regular-treatments

```

Regular-treatments#(VAR tsb,time,Regular-treatments-st,
                    Phototherapy-intensive-act)

BEGIN
...
  AWAIT get-bilirubin(tsb)#transfusion;
  PBREAK BEGIN
    Feeding-alternatives#(time)
    ||s
    VAR Observation-st=considered IN BEGIN
      PBREAK WHILE true do
        BEGIN
          Phototherapy-intensive#(...) OR ...
          OR Observation#(;tsb,time,Observation-st)
        END
      IF Observation-st=completed
    END
  END
END ...

```

## The jaundice protocol in KIV the treatment part (cont.)

- Next version, with small-size modules



## The jaundice protocol in KIV the diagnosis part

- With small-size modules



## The jaundice protocol in KIV the diagnosis part (cont.)

– algebraic specification: other-diseases

- predicates to be used in IF statements, e.g. to determine if there could be a hemolytic disease:

fam-history  $\vee$  eth-origin  $\vee$  geo-origin  $\vee$  ear-jaundice  $\leftrightarrow$   
 possibility-of-hemolytic-disease(fam-history, eth-origin,  
 geo-origin, ear-jaundice);

## The jaundice protocol in KIV the diagnosis part (cont.)

– procedural specifications:

- Anamnesis-abnormal-signs procedure:

```

PLAN Anamnesis-abnormal-signs
  Anamnesis-abnormal-signs-time, pathologic-reason,
  Anamnesis-abnormal-signs-st)
  CONDITIONS
  BEGIN
    abort-conditions: pathologic-reason=true
  PBREAK
  PLAN BODY
  VAR let=[?], apn=[?], tac=[?],... exc-weight-loss=[?] IN
  do sequentially, wait-for all
  BEGIN
    let=[?] || a apn=[?] || a ... || a exc-weight-loss=[?];
    VAR time0=time, dt=[?] IN AWAIT time0+dt≤time;
    pathologic-reason:=possibility-of-other-diseases(let,
    ask lethargy
    ask apna
    if (lethargy=true or apna=true or as)
    then possibility-of-other-diseases:=true
  IF pathologic-reason:=false;
  IF pathologic-reason = true
  IF (possibility-of-other-diseases=true)
  THEN Anamnesis-abnormal-signs-st:=aborted
  then pathologic-reason:=true
  END
  END
  END
  
```

## The jaundice protocol in KIV the diagnosis part (cont.)

- Blood-tests procedure:

```

PLAN Blood-tests
  Blood-tests-time, pathologic-reason, Blood-tests-st)
  PLAN BODY
  BEGIN
    do sequentially, wait-for-optional-subplans=yes, wait-for one
    VAR Check-blood-test-mother-st=considered,
    Check-blood-test-mother
    Perform-blood-test-child-st=considered IN
    Perform-blood-test-child
  BEGIN
    PLAN Check-blood-test-mother
    CONDITIONS
    filter-preconditions: known(blo-mother) and known(rhe-mother)
    ant-mother-time, Check-blood-test-mother-st);
    and known(ant-mother)
    Perform-blood-test-child#(; time, pathologic-reason,
    ... Perform-blood-test-child-st)
    PLAN Perform-blood-test-child
    END
    CONDITIONS
    IF Check-blood-test-mother-st≠completed
    filter-preconditions: not(known(blo-mother) and known(rhe-mother)
    Perform-blood-test-child-st=aborted,
    ... and known(ant-mother)) or ...
  END...
  END
  
```

## The jaundice protocol in KIV the diagnosis part (cont.)

- Jaundice-determination procedure:

```

Jaundice-determination-PLAN Anamnesis-abnormal-signs,
PLAN BODY jaundice-clinically-significant)
BEGIN
do sequentially, wait-for all
  Blanching-skin-with-digital-pressure-test-manual#(; time)
  OR Icterometer-test-manual#(; time)
  OR Transcutaneous-jaundice-meter-test-manual#(; time)
  OR Determine-extent-cephalocaudal-progression-manual#(; time);
  jaundice-clinically-significant-true;
  VAR time0=time, determine-extent-cephalocaudal-progression
  ask jaundice-clinically-significant
END;
```

## The jaundice protocol in KIV the diagnosis part (cont.)

- ...and Diagnosis-hyperbilirubinemia procedure:

```

Diagnosis-hyperbilirubinemia-PLAN Anamnesis-abnormal-signs, blo-mother, rhe-mother,
PLAN BODY pathologic-reason, time, jaundice-clinically-significant, pathologic-reason
BEGIN
do sequentially, wait-for all
  VAR Anamnesis-abnormal-signs-st=considered, Blood-tests-st=considered,
  pathologic-reason=false
  BEGIN
    Anamnesis-abnormal-signs
    PBREAK
    BEGIN
      Blood-tests
      BEGIN
        Anamnesis-hemolytic-disease
        Jaundice-determination
        Anamnesis-abnormal-signs#(; time, pathologic-reason, Anamnesis-a
        Blood-tests#(; blo-mother, rhe-mother, ant-mother, time, pathologi
        Blood-tests-st);
        Anamnesis-hemolytic-disease#(; time, pathologic-reason, Anamnesi
        Jaundice-determination#(; time, jaundice-clinically-significant
      END
    IF Anamnesis-abnormal-signs-st=aborted v Blood-tests-st=aborted
    v Anamnesis-hemolytic-disease-st=aborted
  END
END
```

## The jaundice protocol in KIV the top-level plan

– procedural specification:

- Hyperbilirubinemia procedure:

```

PLAN Hyperbilirubinemia
Hyperbilirubinemia#(var age,tsb,direct-serum-bilirubin,total-urine-bili
CONDITIONS other,rhe-mother,ant-mother,tsb,time)
BEGIN
  abort-conditions: possibility-of-hemolytic-disease=true
  VAR var-possibility-of-hemolytic-disease=[?],var-possibility-of-chole
PLAN BODY
  Diagnostics+Treatment-hyperbilirubinemia-state=[?] IN
  do unordered, wait-for Diagnostics+Treatment-hyperbilirubinemia
  PBREAK Check-for-rapid-TSB-increase
  BEGIN Check-for-jaundice>2-weeks
    Check-for-rapid-TSB-increase#(; age,tsb,direct-serum-bilirubin
    ||s Check-for-jaundice>3-weeks
    ||s Check-for-jaundice-after-2-weeks#(; tsb,direct-serum-bilir
    ||s Diagnostics+Treatment-hyperbilirubinemia; time,var-possibility-c
    ||s Diagnostics+Treatment-hyperbilirubinemia#(; term,age,blo-m
  END
  IF Diagnostics+Treatment-hyperbilirubinemia-state=completed
  v var-possibility-of-hemolytic-disease=true
END
END

```

## Conclusions

- Current state:
  - formalisation of jaundice is complete but not stable
    - open questions in translation of difficult plans
    - still no proper translation for parallel plans
- Conclusion:
  - translation of intermediate Asbru models into KIV is harder than expected
  - Asbru plans are difficult to recognise in KIV

## Conclusions (cont.)

- Next steps
  - study (somehow) general translation rules
  - extend KIV with more Asbru constructs