

- Fact: increasing concern in *protocols*
 - descriptions of actions for the management of patients under particular clinical conditions → *protocol-based care*
- Motivation: protocol-based care needs high quality protocols
- Our research: quality improvement of protocols
 - *can formalisation contribute to protocol quality improvement?*

✓ Introduction & motivation

- The Asbru language
- The diabetes & jaundice protocols
- The protocols in Asbru
- Protocol improvement by formalisation
- Conclusion



- Intended to support protocol-based care tasks
- Time-oriented, intention-based, skeletal plan specification language
- Some features:
 - protocols or plans can be executed e.g. in sequence, in parallel, etc
 - conditions can be defined to control plan execution, e.g. applicability or filter conditions
 - intentions can be stated for plans
 - conditions and intentions can have time annotations



- The diabetes protocol of the NHG:
 - management of DMT2
 - diagnosis & treatment
 - low-frequency data, long time-span application, general practitioner/consultation use
 - text + tables, in two versions (cards/booklet)

- The jaundice protocol of the AAP:
 - management of jaundice in healthy newborns
 - diagnosis & treatment
 - low-frequency data, short time-span application, non-specialist/hospital use
 - text + lists + tables + flowcharts



- The diabetes protocol in Asbru:

Hierarchical number	Plan title
1	Diabetes-Mellitus-Type-2
DIAGNOSTIC PLANS	
1.1	Diagnostics
1.1.1	Anamnesis
1.1.1.1	Anamnesis-typical-signs
1.1.1.2	Anamnesis-olderthan-45
1.1.2	Glucose-determination
1.1.3	Risk-inventory
TREATMENT PLANS	
1.2	Policy
1.2.1	Education-DMT2
1.2.2	Treatments-and-Controls
1.2.2.1	Non-insulin-DMT2-treatments
1.2.2.2	Insulin-DMT2-treatments
1.2.2.3	Treatment-of-CV-disease-risk-factors
1.2.2.4	Quarterly-control
1.2.2.5	Annual-control
1.2.3	Policy-for-simultaneous-diseases
1.2.4	Policy-for-hypoglycemic-coma
1.2.5	Consultation-and-referring
...	...



- The jaundice protocol in Asbru:

Hierarchical number	Plan name
1	Hyperbilirubinemia
1.1	Check-for-rapid-TSB-increase
1.2	Check-for-jaundice>2-weeks
1.3	Check-for-jaundice>3-weeks
DIAGNOSTIC PLANS	
1.4	Diagnostics-hyperbilirubinemia
1.4.1	Anamnesis-abnormal-signs
1.4.2	Blood-tests
1.4.2.1	Check-blood-test-mother
1.4.2.2	Perform-blood-test-child
1.4.3	Anamnesis-hemolytic-disease
1.4.3.1	Evaluation-risk-factors-hemolytic-disease
1.4.4	Jaundice-determination
TREATMENT PLANS	
1.5	Treatment hyperbilirubinemia
1.5.1	Regular-treatments
1.5.1.1	Feeding-alternatives
1.5.1.2	Phototherapy-intensive
1.5.1.3	Phototherapy-normal-prescription
1.5.1.4	Phototherapy-normal-recommendation
1.5.1.5	Observation
1.5.2	Exchange-transfusion

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- The jaundice protocol in Asbru (cont.):

PLAN 1.5.1	Regular-treatments	
INTENTIONS	AVOID INTERMEDIATE STATE: bilirubin = transfusion ACHIEVE OVERALL STATE: bilirubin = observation	
CONDITIONS	FILTER:	(bilirubin not transfusion * [..],[0..][..] *now*)
	ABORT:	(bilirubin transfusion * [..],[0..][..] *now*) ...
PLAN-BODY	DO-ALL-TOGETHER { Feeding-alternatives DO-SOME-ANYORDER { <i>Retry aborted children</i> Continuation specification: (Observation) Phototherapy-intensive Phototherapy-normal-prescription Phototherapy-normal-recommended Observation } }	

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- The diabetes protocol:
 - originally: 4 pages (cards)
 - in Asbru: 56 plans (>100K in XML Asbru)
- The jaundice protocol:
 - originally: 8 pages
 - in Asbru: 40 plans (66K in XML Asbru)



- Formalisation in Asbru revealed numerous anomalies
 - issues leading to misinterpretations/ preventing an adequate transcription → indications for protocol improvement
- Types of anomalies:
 - ambiguity
 - incompleteness
 - inconsistency
 - redundancy



– Ambiguity anomalies

- ambiguous text
 - ambiguous terms, e.g. indistinct use of terms “*jaundiced*” and “*clinically jaundiced*”
- potential wrong interpretations

– Incompleteness anomalies: missing information or insufficient information

- missing term definitions, e.g. “*jaundiced*” and “*clinically jaundiced*”
- missing abstract term definitions, e.g. “*rapidly rising TSB levels*”



– Incompleteness anomalies (cont.)

- missing information on data utilisation, e.g.
 - tests are requested but the results are not used, e.g. *child blood typing* in jaundice; *creatinin test* in diabetes
 - data are requested but the values are not used, e.g. questions about *alcohol consumption* and *physical exercise habits* in diabetes
- missing information on data management, e.g. *weight* and *blood pressure* are periodically requested in diabetes controls without indications on their storage mode



– Incompleteness anomalies (cont.)

- missing information on decision making, e.g. alternative insulin treatments are described in diabetes without specifying how to decide the one to be applied
 - insufficient information on decision making, e.g. a procedure is suggested in jaundice without further details:
 - *“Determination of the rate of rise of TSB and the infant's age may help determine how often to monitor bilirubin levels and whether to begin phototherapy.”*
- potential wrong interpretations



– Inconsistency anomalies: elements resulting in different decisions given the same data

- inconsistent recommendations, e.g. in jaundice, recommendations for *child blood typing* and *Coombs test* in text different from the ones in flowcharts
 - recommendations in conflict with the applicability of protocol, e.g. recommendations in text for children jaundiced in their first 24h, who are considered non healthy in flowcharts
- serious problems!



– Redundancy anomalies: elements that can be removed without loss

- repeated information requests, e.g. *weight* is requested twice in diabetes annual control
- unnecessary inconveniences for the patient
- efficiency loss in care process

– Anomalies in diabetes protocol:

	Ambiguity		Incompleteness				Inconsistency		Redundancy
	text	terms	missing info. on defs.	missing info. on data	missing info. on decisions	insufficient info. on decisions	recom. out of scope	inconsistent recom.	repeated data requests
Diabetes	1	3	6	24	1	7	0	0	2
Jaundice	1	0	3	4	0	3	2	4	0

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• Discussion:

– Anomalies and diabetes & jaundice protocols:

- incompleteness is the most common anomaly → intentional gaps corresponding to background knowledge/points where there is no agreement?
- inconsistency only occurs in jaundice → careless use of alternative notations?

– Anomalies are not errors but signs of possible errors, e.g.

- repeated questions may point to a duplication error or to an error in one of the questions, e.g. *weight-gain* instead of *weight*

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- Discussion (cont.):
 - Anomalies must be analysed and removed:
 - (unquestionably) ambiguity, inconsistency and redundancy must be removed
 - incompleteness should be removed by
 - making background knowledge explicit
 - making points where there is no agreement explicit
 - and it should be done
 - to widen the potential target group/applications of the protocol
 - to develop computerised support for the protocol



- Formalisation in Asbru:
 - gives us useful directions for protocol improvement (*it does contribute to protocol quality improvement*)
 - even in the case of high quality protocols
- ...but:
 - requires a big effort
- Future work (EU Procure project):
 - going further with protocol formalisation,
 - to assess the applicability of protocol formalisation/verification and
 - with the collaboration of medical partners

