Supporting Protocol-Based Care in Medicine via Multiple Coordinated Views

Wolfgang Aigner & Silvia Miksch
{aigner, silvia}@asgaard.tuwien.ac.at

Institute of Software Technology & Interactive Systems 
Vienna University of Technology
Motivation

What is the problem?
computer supported protocol-based care doesn’t communicate its information to domain experts (very well)

Why is it important?
domain experts = physicians & medical staff = those for whom the technology was created for; to support the complex and demanding task of treating patients

Our solution
multiple simultaneous coordinated views
use visual representations familiar to domain experts
Contents

What is protocol-based care?
Data characteristics & Users’ tasks
Our solution: CareVis
  Views
  View coupling
Design method
Summary & Future work
What is Protocol-Based Care?

treatment along clinical protocols (treatment plans)

reusable definitions of a particular care process

**prose text; tables; figures; flow-chart algorithms**

computer support

computerized guidelines & protocols

**modeling; selection; execution; data abstraction**

plan representation language **Asbru**
What is Protocol-Based Care?

**Management of Hyperbilirubinemia in the Healthy Term Newborn**

**Practice Guideline**

**Pediatrics**

Volume 94, Number 4

October, 1994

**American Academy of Pediatrics**

Provisional Committee for Quality Improvement

Each year approximately 60% of the 4 million various forms of evaluation and treatment. For controversy as the possible adverse consequences of potentially detrimental neurologic effects from particularly with regard to the management of 16) Although most data are based on infants of weeks of gestation.

Under certain circumstances, bilirubin may be even in healthy term newborns. Most studies of specific level of total serum bilirubin (TSB) due serious neurologic abnormality (including hearing impairment) [2-9]. Other studies have described outcomes associated with TSB levels, particularly when used in conjunction with albumin binding capacity concentration and those that affect the binding of bilirubin by the albumin, and the vulnerability of brain cells to the toxic effects of what bilirubin concentration or under what circumstances significant risk of brain damage occurs. Although currently data indicates that risk for kernicterus is not clear, the following practice parameter may not apply.

Factors influencing bilirubin toxicity to the brain cells of newborn infants are complex and include those that affect the serum albumin concentration and those that affect the binding of bilirubin into the brain, and the vulnerability of brain cells to the toxic effects of what bilirubin concentration or under what circumstances significant risk of brain damage occurs. Although currently data indicates that risk for kernicterus is not clear, the following practice parameter may not apply.

There are no simple solutions to the management of jaundiced neonates. Continuing evaluation of serum bilirubin levels and brain damage as well as differences in patient populations contributes to variations in the management of hyperbilirubinemia. Early postpartum discharge complicated the management of jaundiced newborns, because it places additional responsibilities upon patients.

Some conditions significantly increase the risk of hyperbilirubinemia, including history of a previous hyperbilirubinemia, decreasing gestational age, breast-feeding, and large weight loss after birth. However, gestation and above are considered "term," infants 37 to 38 weeks of gestation may be premature infants, and there is a strong correlation between decreasing gestational age and risk for hyperbilirubinemia. Infants born at 37 weeks gestation are much more likely to develop a serum bilirubin level of birth.
What is Protocol-Based Care?

treatment along clinical protocols (treatment plans)
  reusable definitions of a particular care process
  prose text; tables; figures; flow-chart algorithms

computer support
  computerized guidelines & protocols
  modeling; selection; execution; data abstraction
  plan representation language Asbru
What is Protocol-Based Care?

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plan-library SYSTEM "asbru_7_3.dtd">
<plan-library>
  <domain-defs>
    <domain name="controlled_ventilation_domain">
      ...
    </domain>
  </domain-defs>
  <plans>
    <plan-group>
      <plan name="ventilation_plan">
        <intentions>
          ...
        </intentions>
        <conditions>
          <complete-condition>
            <constraint-combination type="and">
              <parameter-proposition parameter-name="FiO2">
                <value-description type="less-or-equal">
                  <numerical-constant value="40"/>
                </value-description>
              </parameter-proposition>
            </constraint-combination>
          </complete-condition>
          <abort-condition>
            <constraint-combination type="or">
              <parameter-proposition parameter-name="FiO2">
                <value-description type="greater-than">
                  <numerical-constant value="90"/>
                </value-description>
              </parameter-proposition>
            </constraint-combination>
          </abort-condition>
        </conditions>
        <plan-body>
          ...
        </plan-body>
      </plan>
      <plan name="controlled_ventilation_plan">
        <plan-body>
          <subplans type="parallel">
            ...
          </subplans>
        </plan-body>
      </plan>
    </plan-group>
  </plans>
</plan-library>
Data Characteristics

1. treatment plan specification data
2. treatment plan execution data
3. patient data

time-oriented data (incl. uncertainties)
logical sequences
hierarchical decomposition
flexible execution order
non-uniform element types
state characteristic of conditions
Users’ Tasks

1. becoming acquainted with a treatment method

2. guidance in the treatment process
   run-time support; patient status;
   upcoming treatment steps; treatment history

3. analyzing the treatment process
Our Solution: CareVis

multiple simultaneous coordinated views
Our Solution: CareVis

QuickView Panel

multiple simultaneous coordinated views
Our Solution: CareVis

QuickView Panel

Logical View

multiple simultaneous coordinated views
Our Solution: CareVis

QuickView Panel

Logical View

Temporal View

multiple simultaneous coordinated views
Our Solution: *CareVis*

**Logical View**  
**Temporal View**

multiple simultaneous coordinated views
Our Solution: CareVis

Temporal View

multiple simultaneous coordinated views
Our Solution: CareVis

multiple simultaneous coordinated views
Logical View

AsbruFlow

based on clinical algorithm maps / flow chart algorithms
[Society for Medical Decision Making, 1992]
Logical View

AsbruFlow

based on clinical algorithm maps / flow chart algorithms
[Society for Medical Decision Making, 1992]
Logical View

AsbruFlow
based on clinical algorithm maps / flow chart algorithms
[Society for Medical Decision Making, 1992]
Temporal View
Temporal View

Planning Lines

based on LifeLines [Plaisant et al., 1998]
View Coupling

1. common color palette for plans
2. synchronous selection
3. user triggered navigation propagation
# Data Characteristics in Views

<table>
<thead>
<tr>
<th></th>
<th>Logical View</th>
<th>Temporal View</th>
<th>QuickView Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asbru plans</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-oriented data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>logical sequences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hierarchical decomposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>execution order</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-uniform element types</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conditions (state-characteristic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patient data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parameters &amp; variables</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
User Centered Design

3-step evaluation process
qualitative
scenario-based
Summary & Future Work

visualization and interaction methods specific to users’ tasks using familiar visual representations
3 tightly coupled views different data aspects & tasks user-centered development approach

prototype improvement reinvestigation of coordination model
Thank you for your attention!

http://www.asgaard.tuwien.ac.at
Plan Examples

Ventilation Plan

- **STOP** FIO2 > 90 or PIP > 25 or PCO2 > 100
- **FiO2 <= 40 and PIP <= 20**

Initial Plan

Controlled Ventilation

Handle PCO2

- **STOP** FIO2 > 90 or PIP > 25 or PCO2 > 100

PCO2_calc > 60?

- Yes: \( f = \frac{\text{PCO2}_{\text{calc}}}{\text{PCO2}_{\text{calc}} + 5} \times f \)
- No

PCO2_calc <= 40?

- Yes: \( f = \frac{\text{PCO2}_{\text{calc}}}{\text{PCO2}_{\text{calc}} - 5} \times f \)
Focus + Context
Focus + Context
Focus + Context
Layered Dispatch

- PlanViewManager
  - TemporalView
    - PlanGraph
  - LogicalView
    - LifeLine+, PlanningLine
Users’ Challenges

time saving
minimal learning effort
intuitive, simple, and clearly structured