openEHR Task Planning

Thomas Beale
openEHR Management Board
Joint lead, openEHR Specification Program
Principal, Ars Semantica

openEHR day
Helsinki 20 Mar 2018
Stockholm 21 Mar 2018

A: heart_rate
a: |<200|
b: |200..250|
What is ‘Task Planning’?

It’s something to do with workflow…
Are we completely mad?!?!

- It can’t be done!
  - Clinical process is tooooo complicated
  - Care Pathways, Guidelines, Care Plans, Processes – healthcare is tooooo complicated
It’s been done!

Healthcare:
- Published guidelines, NICE, ...

IT:
- BPEL, XPDL
- BPMN
- CMMN / DMN
- YAWL

Health Informatics:
- Arden, GLIF, Asbru
- ProForma
We have to do it, because

- **Team-based** care becoming normal
- **Complexity**, e.g. sepsis, ARDS, complex birth
  - Humans can keep 7 +/−2 things in our minds
  - Some clinical pathways have 20+ concurrent variables to take account of

- Existing approaches are either too deterministic (BPM), not semantically well defined (CMMN), or limited uptake (e.g. Arden, GLIF, ProForma).
Key use cases #1 – medication

- Routine drug administration
  - Timed admins but exceptions
  - Many days → shift changes

Copyright 2017 openEHR Foundation
E.g. chemotherapy

<table>
<thead>
<tr>
<th>Drug</th>
<th>Standard [R]-CHOEP</th>
<th>[R]-High-CHOEP</th>
<th>[R]-Mega-CHOEP, cycle 1</th>
<th>[R]-Mega-CH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R)ituximab</td>
<td>375 mg/m²</td>
<td>375 mg/m²</td>
<td>375 mg/m²</td>
<td>375 mg/m²</td>
</tr>
<tr>
<td>(C)yclophosphamide</td>
<td>750 mg/m²</td>
<td>1400 mg/m²</td>
<td>1500 mg/m²</td>
<td>4500 mg/m²</td>
</tr>
<tr>
<td>(H)ydroxydaunorubicin</td>
<td>50 mg/m²</td>
<td>65 mg/m²</td>
<td>70 mg/m²</td>
<td>70 mg/m²</td>
</tr>
<tr>
<td>(O)ncovin</td>
<td>1.4 mg/m² (max 2 mg)</td>
<td>2 mg</td>
<td>2 mg</td>
<td>2 mg</td>
</tr>
<tr>
<td>(E)toposide</td>
<td>100 mg/m²</td>
<td>175 mg/m²</td>
<td>600 mg/m²</td>
<td>960 mg/m²</td>
</tr>
<tr>
<td>(P)rednisone or (P)rednisolone</td>
<td>40 mg/m²</td>
<td>100 mg</td>
<td>500 mg</td>
<td>500 mg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dose, cycles 2 and 3</th>
<th>[R]-Mega-CHOEP, cycle 4 (last)</th>
<th>Mode</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>375 mg/m²</td>
<td>IV infusion</td>
<td>Day 1</td>
<td></td>
</tr>
<tr>
<td>6000 mg/m²</td>
<td>IV infusion</td>
<td>Day 1</td>
<td></td>
</tr>
<tr>
<td>70 mg/m²</td>
<td>IV bolus</td>
<td>Day 1</td>
<td></td>
</tr>
<tr>
<td>2 mg</td>
<td>IV bolus</td>
<td>Day 1</td>
<td></td>
</tr>
<tr>
<td>1480 mg/m²</td>
<td>IV infusion</td>
<td>Days 1-3</td>
<td></td>
</tr>
<tr>
<td>500 mg</td>
<td>PO qd</td>
<td>Days 1-5</td>
<td></td>
</tr>
</tbody>
</table>
Visualisation

<table>
<thead>
<tr>
<th>Day</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rituximab IV infusion</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dexamethasone PO</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Ara-C cytarabine IV infusion</td>
<td>A</td>
<td>2h</td>
<td>A</td>
<td>2h</td>
<td>A</td>
</tr>
<tr>
<td>Platinol IV infusion</td>
<td>P</td>
<td>24h</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drugs:
- Rituximab IV infusion
- Dexamethasone PO
- Ara-C cytarabine IV infusion
- Platinol IV infusion

Dosage:
- Rituximab: 24h
- Dexamethasone: 2h
- Ara-C: 2h
- Platinol: 24h
Key use cases #2 – Stroke

- Acute ischaemic stroke
  - Multiple simultaneous performers
  - Multi-disciplinary
  - Hand-offs between them
  - Time-critical
EMERGENCY MANAGEMENT OF

Acute Ischemic Stroke

This care process model (CPM) was created by the Neurosciences, Intensive Medicine, and Cardiovascular Clinical Programs at Intermountain Healthcare. These groups include multidisciplinary representation from neurovascular medicine, interventional radiology, cardiology, anesthesia, hospitalists, and others. The CPM provides expert advice for the emergency management of acute ischemic stroke and summarizes current medical literature and national practice guidelines. (See guideline references on page 8.)

Intermountain’s care management system for stroke also includes:

- **Education materials and programs** for providers and patients.
- **Data systems** that help providers and facilities track stroke management success.
- **Multidisciplinary coordination** of stroke care.

**Why Focus on Ischemic Stroke?**

**What’s new in this update?**

- Updated treatment algorithms for diagnosis and classification, emergency management of acute ischemic stroke, and endovascular therapy (see pages 2–7)
- Telestroke process details (see page 2)
- New ED Acute Stroke Process Checklist (see page 6)
- Concentrated focus on emergency management
ALGORITHM 1: DIAGNOSIS AND CLASSIFICATION

ALGORITHM 2: EMERGENCY MANAGEMENT OF ACUTE ISCHEMIC STROKE

**Acute Ischemic Stroke**

**(a) Intravenous (IV) tPA relative exclusion criteria for < 3 hours since symptom onset**

- **Contraindications (risk of bleeding is greater than the potential benefit)**
  - Thrombolytic therapy initiated by another hospital prior to arrival
  - CT findings (ICH, SAH, or major infarct signs)
  - SBP > 185 or DBP > 110 mmHg despite maximal treatment
  - Plts < 10,000
  - Contraindication to major surgery (e.g., heparin, warfarin, apixaban, enoxaparin, dabigatran)

- **BTW: this keeps changing!**

- **Warnings and Precautions (use clinical judgment)**
  - Blood glucose concentration ≤ 50 mg/dL greater than or equal to 400 mg/dL
  - Seizure at onset
  - Recent surgery/major trauma (< 15 days)
  - Active internal bleeding (< 22 days)
  - Significant stroke or head trauma (< 3 mo)
  - Intracranial or spinal surgery (< 3 mo)
  - Myocardial infarction (MI) (< 3 mo)
  - Non-disabling stroke symptoms
  - Life expectancy < 1 year or severe co-morbid illness
  - History of vascular malformation
  - History of intracranial hemorrhage
  - History of brain aneurysm or brain tumor
  - Pregnant or lactating

**(b) Additional criteria for IV tPA at 3–4.5 hours**

- Age > 80
- Imaging finding of infarction with hypodensity involving >33% of the cerebral hemisphere
The challenge of team work – Coordination and hand-offs

**CONDUCT stat imaging (c)**

- **CT Tech**
  - Performs non-contrast CT of brain
  - Performs CTA and CT perfusion if requested by neurologist and available at facility (if requested but not available, see Telesroke info at right).
  - Alerts radiologist to read STAT CT scan

- **Radiologist**
  - Reads scan and reports to neurologist the “bleed/no bleed” and ASPECTS score. If Telestroke facility, radiologist contacts neurologist through the Transfer Center. *(See Telesroke info at right.)*

**TABLE 1. ED Acute Stroke Process Checklist**

<table>
<thead>
<tr>
<th>Role</th>
<th>Action (for patient presenting with stroke-like symptoms)</th>
<th>Tips</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RN</strong></td>
<td>□ Determines acuity; RN determines if patient is possible stroke alert (remains symptomatic AND LSN &lt;6 hrs.)</td>
<td>Example scripting: <em>room XX.</em></td>
</tr>
<tr>
<td></td>
<td>□ Notifies HUC of stroke alert</td>
<td></td>
</tr>
<tr>
<td><strong>HUC</strong></td>
<td>□ Notifies Stroke Alert to ED staff and stroke team, if available, using standard communication methods</td>
<td>Example scripting: *</td>
</tr>
<tr>
<td><strong>MD</strong></td>
<td>□ Assesses for stroke immediately</td>
<td>For BP treatment, consult chart: <em>Labetalol (10–20 mg, repeat 1 time), Nicardipine (5 mg)</em></td>
</tr>
<tr>
<td></td>
<td>□ Notifies HUC to activate Telesroke if applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Conducts NIHSS-PE (page 3) / Reviews tPA contraindications (page 5) and eligibility for endovascular therapy (page 7)</td>
<td></td>
</tr>
<tr>
<td><strong>Pharmacist</strong></td>
<td>□ Responds to patient room ASAP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Obtains brief medication history</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Reviews tPA eligibility criteria, as needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Prepares for possible tPA administration/pharmacy protocol</td>
<td></td>
</tr>
<tr>
<td><strong>ECG/RT Tech</strong></td>
<td>□ Performs 12-lead ECG</td>
<td></td>
</tr>
</tbody>
</table>

*Note: If these services are unavailable, RN/provider may delegate tasks as appropriate.*
Breast cancer treatment decision map
- Complex decision pathways
- Need data items from EHR
- Decision expressions, representing rules
- 3 levels of system support
  - Fully automated – e.g. TNM → category of treatment
  - Recommendation – e.g. ‘consider contra-indications’
  - Ad hoc – multiple choices, but criteria only known at execution time
Other requirements

- Order sets
- Long-term treatments – changes in staff, locations, units, institutions
- Checklist / signoff
Other requirements

- Adaptiveness
  - Skip a Task
  - Cancel a Task
  - Abandon a Plan
  - Retry Task(s)
  - Override preconditions
Other requirements

- Task List for worker vs Task Plan for patient
- Costing info?
- Analytics?
Design concepts

Figure 1. The care pathway / care plan / task plan triad
Design concepts

The workflow engine doesn’t do the work – performers do.
Design concepts

Workflow, decision support and the EHR are intimately related...

Do a bit
Decide a bit
Record a bit (side-effect)
A basic choice in the Task Plan architecture is that it is executable in the sense of all elements used in creating Plan definitions have an objective computational meaning and can be executed according to defined semantics.

The intention is that developing task plans is a kind of high level programming, performed using dedicated tools, and whose resulting artefacts are executable.
Design considerations

Solving the ‘curly brackets’ problem - how to connect workflow elements to external data:

- Breast cancer treatment plan
  - plans
    - context
      - variables
        - TNM - tumour (T)
          - type
            - Str (TYPE_DEF_STRING)
          - name
            - 1 (STRING)
          - populating_request
            - q() (QUERY_CALL)
            - call_name
              - 1 (STRING)
            - query_id
              - 2 (STRING)
            - system_id
              - 4 (STRING)
      - test
        - (CONTEXT)
        - expres
          - 1 (S)
      - members
        - Decide check
          - Molecular subtype = Luminal A
          - value_constraint
          - members
            - TNM (Luminal A)
            - override_type
            - members
              - TNM: T < 3 and N:
              - TNM: T >= 3 or N:
            - test
              - (CONTEXT)
              - expres
                - 1 (S)
          - members
            - Molecular subtype = Luminal B (HER2+)
            - Molecular subtype - Luminal B (HERF)
            - Molecular subtype = HER2 type
            - Molecular subtype = Triple negative
      - Breast cancer treatment plan
        - plans
          - context
            - variables
              - TNM - tumour (T)
                - type
                  - Str (TYPE_DEF_STRING)
                - name
                  - 1 (STRING)
                - populating_request
                  - q() (QUERY_CALL)
                  - call_name
                    - 1 (STRING)
                  - query_id
                    - 2 (STRING)
                  - system_id
                    - 4 (STRING)
          - test
            - (CONTEXT)
            - expres
              - 1 (S)
          - members
            - Molecular subtype = Luminal A (ER+)
            - value_constraint
            - members
              - TNM: T < 3 and N:
              - TNM: T >= 3 or N:
            - test
              - (CONTEXT)
              - expres
                - 1 (S)
          - members
            - Molecular subtype = Luminal B (HER2+)
            - Molecular subtype - Luminal B (HERF)
            - Molecular subtype = HER2 type
            - Molecular subtype = Triple negative

openEHR
Architecture

Figure 4. Computational Environment
Basic structure

Figure 15. Task Plan linking
Task Taxonomy

Figure 5. Task Taxonomy
Context switch and fork

- Context switch = stop and wait
- Context fork = >1 thread of work
- Call-back mechanism
- Optionally, new restart location
Task lifecycle
Events

- **Time**
  - Clock
  - Calendar

- **Plan Internal**
  - Task transitions
  - Callback notification

- **External world**
  - Patient – state changes, e.g. heart rate > 160
  - Performer tells TP engine something
  - Another system tells TP engine something
Decision Structures

3 levels of ‘support’
- Automated
- Recommended
- Ad hoc – user– decided at runtime

Considerations:
- Many decision criteria not (completely) encodable – clinician often ‘knows better’
- Need to record a reason for override
Decision Structures

Type 1: automatable

Consider the tumor's molecular subtype

Luminal B (HER2 positive)
ER positive
PR any
HER2 positive
Ki67 any

Consider TNM

T1 = A and N = 0
T1b or T1c and N = 0
2 ≤ T ≤ 4 or N > 0

No prescribed chemotherapy
Chemotherapy prescription
Chemotherapy prescription
Decision Structures

Type 2: recommendation

- **Consider the prognosis**
  - Rather good
  - Rather bad
    - Rather bad:
      - Ki67 > 20%
      - nodes positive
      - \( T \geq 3 \)
      - age < 40y

- **11**
  - 16
    - No
      - Consider contraindications to anthracyclines
        - No
          - \( D \times 4 \)
        - Yes
          - \( D \times 12 \)
        - No
          - \( D \times 4 \)
    - Yes
      - Add trastuzumab to paclitaxel/docetaxel
      - DCH (or TCH)

- **18**
  - No
    - Pick the pattern
  - Yes
    - Consider contraindications to anthracyclines
      - No
        - \( (D + \text{trastuzumab}) \times 4 \)
      - Yes
        - \( \text{FEC} \times 3 \rightarrow (D + \text{trastuzumab} + \text{pertuzumab}) \times 4 \)
Type 3: ad hoc

Decision Structures

Rather bad:
- Ki67 > 20%
- nodes positive
- T ≥ 3
- age < 40y

18

Consider contraindications to anthracyclines

19

No

Pick the pattern

Yes

(DCH + pertuzumab)×4

FEC×3→(D + trastuzumab + pertuzumab)×4
Relationship to openEHR Entries
Summary

- Can represent fine-grained mixture of decision points and actions
- Connects variables in definition to external data (openEHR or not)
- Adaptive – allows Task skipping, repeating
- 3 levels of decision support
- Explicit representation of allocation, data variables
Roadmap

- Moscow City implem underway
- Visual language underway
  - May lead to Camunda or draw.io mode
- Archetypes being tested

- Marand / Moscow – polyclinic workflows
- DIPS / Arena – hospital workflows
- Tieto – tracking
Resources

- http://www.openEHR.org
- http://www.openEHR.org/releases/PROC/latest/task_planning.html