Example Mobile Health Application Development in openEHR

Here we aim to outline a use case that would be applicable to modern medical practice. We will:

1) Describe the clinical problem.
2) Identify the required dataset.
3) Map out the required work process using *BPMN* (business process model and notation) 2.0.
4) Identify pre-developed international *archetypes* to match the dataset.
5) Constrain these archetypes using *operation templates*, limiting the maximal datasets of the archetypes to only the variables we require.
6) Generate json instance data artifacts from the operational templates to demonstrate the ease with which the data can be addressed.
7) Provide a general outline for the application GUI.

The entire process took 6 days in total. All work was done by a team of 3, in the spare time between busy day jobs and home lives.

Description of the clinical problem

Remote Monitoring of Cancer Chemotherapy Patients Allowing Recuperation Out of Hospital

During the treatment of blood cancers, we administer toxic chemotherapy medicines which can suppress the immune system of our patients. This makes patients susceptible to life-threatening infection, and although they may appear to be clinically well in the early stages of infection, patients can deteriorate quickly.

Many patients prefer to be treated in an ambulatory setting - usually staying at a patient hotel or at home, if this is near the hospital - with daily review at the hospital. This allows the patient to recuperate in a more relaxing environment surrounded by friends and family, not surrounded by hospital patients with infections of their own. The costs of care are also significantly reduced.

Patients are however expected to take some responsibility for their own care. For example they usually monitor their own temperatures manually every 4 hours, and are given an emergency 24-hour hotline to call should they become unwell. If they have a temperature

above 37.5 °C, they will ring for advice. If they feel unwell or if their temperature remains high, they are admitted into hospital for assessment.

There have however been instances where the system has failed due to human lapses. Occasionally patients have not measured their temperatures or did not want to bother the staff at night (instead waiting until the next morning). Patients can however deteriorate extremely quickly with serious consequences, therefore we must have timely notification when there are signs of infection.

To achieve this we require:

1. More frequent and reliable monitoring of patients' vital signs with minimal patient effort.
   a. Temperature, heart rate, respiratory rate, blood pressure and indirect oximetry.
   b. This data should ideally be automatically fed back into the hospital EHR system or an associated hospital application, monitored by hospital staff.
2. An intuitive way for patients to report their state of well-being.
   a. A quick regular survey of relevant danger symptoms which can be reported on their mobile device.
   b. A "call for help" button if there is an emergency.
3. Greater transparency of process for the patient.
   a. Patients often have to await the results of daily blood tests, which can cause anxiety.
   b. We would ideally allow patients to monitor progress of the test through the system.

Potential patient devices:
1. Apple iPad.
2. Telemetry tools such as the Apple iWatch, SensiumVitals (or Thermometer). In this example, we will assume a novel sensor which provides us with temperature, heart rate, respiratory rate, blood pressure and indirect oximetry (theses are currently being developed).

For the healthcare professional:
1. Phone to receive phone-calls / messages and notifications.
2. Tablet or PC to view more complex patient data.

Required Dataset

Item	Comments / Example data
Temperature	37.0 Deg C or Deg F (in US)
Heart Rate	92 /min

Respiratory Rate	12 /min
Indirect Oximetry	94%
Blood Pressure (expressed as 2 fields - systolic and diastolic	130 / 70 mmHg is expressed as: Systolic = 130 Diastolic = 70
Symptoms (with SNOMED-CT Codes) Multiples allowed	386661006 - Fever 267036007 - Breathless 422587007 - Nausea 422400008 - Vomiting 49727002 - Cough 22253000 - Pain
Lab tests	Haemoglobin _ g/L WCC x10^9/L Neut x 10^9/L Lab test comment Result currently obtained from the hospital labs system, but in the future it could be point of care (POC) testing e.g. http://www.caltech.edu/news/counting-white-blood-cells-home-38975
Request for Advice message	Patient documents reason for request "I am feeling a bit unwell and my temperature is up", presses a Please give me advice' button which alerts hospital staff. hospital worker documents recommendation in response as an update to the same document e.g "You had better come in to hospital immediately" or "Nothing to worry about"
Emergency button engaged	An automated event/ composition is captured on the EHR when this button is pressed
MASCC Score	This is a risk score derived from a number of parameters, not all of which are captured by the patient but will generally be available from the rest of the patient record. http://www.mascc.org/mascc-fn-risk-index-score. Calculating the score is beyond the scope of this scenario.