STEPP: A Model-Integrated Clinical Decision Support System for Protocol Based Treatment of Sepsis
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The CPML Metamodel:
- Implemented as a GME meta-model
- Medical knowledge modeling using ontology language
- General medical ontology HCO specific ontology
- Workflow modeling, protocols
- processors, triggering events, actions, temporal relations, reporting

The Sepsis CPML Model:
- 5 top level protocols:
  - Diagnostics, Therapeutics, Fluid Challenge, Early Goal Directed Therapy, Prophylaxis
- 77 orderables:
  - Medication, Labs and Procedures
- 24 categorized antibiotics

CPML Behavior State Machine:
- Every Activity, Process, Protocol has a state machine
  - Starts in inactive
  - Then it monitors its guard conditions
  - Then it executes itself and activates its children
  - It might repeat this process.

Verification Methodology and a related software suite (middle):
- Target Platform: Matlab Simulink/Stateflow
- Generators:
  - Template-based generation of behavioral models
- Simulation and formal analysis:
  - Simulink Design Verifier

The Sepsis Alerting tool:
- Based on a modified SIRS criteria
- Unified criteria for MICU and SICU
- Initial alert mechanism was modeled and verified
- Implemented in ILOG by VUMC Informatics center

The verification in simulink:
- Example property:
  - Following the start of the Protocol, after a fixed amount of time the Process completes
  - Expresses linear temporal logic (LTL)

The Dataflow of the Execution Engine:
- Model is loaded into EE
- Protocols and Patient data is persisted into a DB
- Decision Support acts on persisted Protocols
- Execution is data driven using HL7 Patient and proprietary CPOE Data

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The STEEP UI (middle):
- Treatment view:
  - Generated from the model
  - Follows the Patient through the treatment (even gray tracking)
- Lab and Vital view:
  - Mixed textual and graphical
  - Adapts to the protocol
- Real-time feed from EMR

Architecture of the STEEP

CLINICAL TRIAL and EXPERIMENTAL RESULTS
- Pre Trial:
  - Performed by Attendants and Fellows in the MICU and SICU
  - Long period of hands-on tests, GUI debugging, quality reviews and evaluations
- Started in October, 2010 (6 months late)
- Trial:
  - Data Collection 2012 April –October
  - 311 Patients
  - 729 ordered items on 76 patients
  - 7.6 hours of usage on 176 patients
- Conclusion:
  - ICU physicians are experts in handling Sepsis without guidance
  - ICU physicians found the tools guidance on the status of the treatment upon the patients transfer to the ICU very helpful

Other Collaborators
- VUMC Informatics:
  - Dan Albert, Steve Clark, Norm Deane, Torria Cason, Chester Rogers
- VUMC Human Factors:
  - Ann Miller
- VUMC SICU/MICU physicians:
  - Matthew Wall Semler and all rotating residents
- VUMC HEO Team