CPS: TTP Option: Synergy: Collaborative Research: An Executable Distributed Medical Best Practice Guidance (EMBG) System for End-to-End Emergency Care from Rural to Regional Center Hospitals

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UIUC: https://publish.illinois.edu/mdpnp-architecture SDSU: https://icip.sdsu.edu

Challenges:

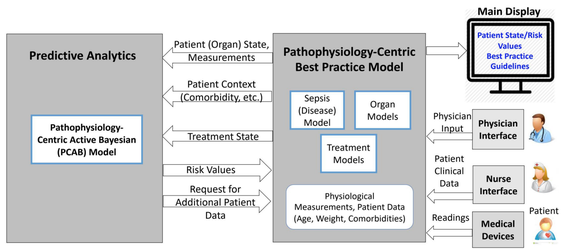
- EMBG System:
  - How to make medical knowledge executable in the form of a guidance system validated by medical doctors, and verifiable safe through formal methods?
- TTP
  - How to ensure that the EMBG system does not introduce software related errors that may cause patient danger?
  - How to adaptively deploy the EMBG system at different medical facilities?
  - How to accurately quantify the medical best practice adherence improvement with EMBG system ?

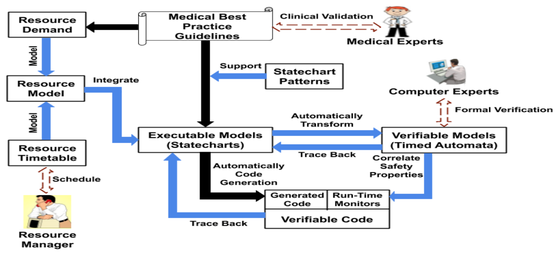
Solutions:

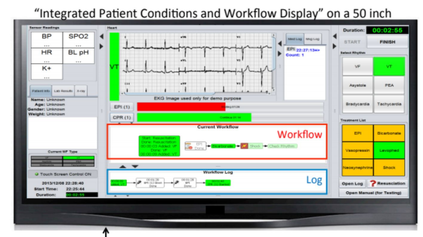
- EMBG System:
  - Computational pathophysiology models
  - Integrated model verification and clinical validation
- TTP
  - Extensive testing the EMBG system with focus on functional testing, conformance testing, destructive testing, and usability testing.
  - Quantitative measurements for adherence to standardized medical treatment guidelines: number and types of medical errors
  - Agile Adaption to Different Healthcare Facilities

Scientific Impact:

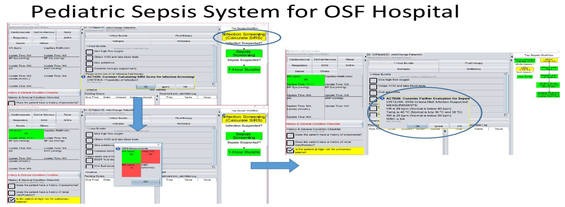
- Computational pathophysiology model:
  - Executable model of medical knowledge in the form of networked organ disease statechart and best practice statechart
- Integration of clinical validation and formal verification
  - The statechart's stimulation capability allows close interaction with physicians to check the validity of the model.
  - The computer-aided translation of statecharts to timed automata allows formal methods be applied to verify safety critical properties.
  - The clinical assumption management system prevents invalid assumptions.



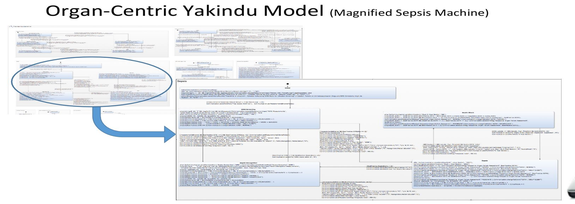




Pediatric Sepsis System for OSF Hospital



Organ-Centric Yakindu Model (Magnified Sepsis Machine)



Broader Impact:

- Cardiac Arrest Resuscitation Guidance System: the system has been approved by IRB for Phase II clinical evaluation at Carle Foundation Hospital.
  - More rapid and accurate identification of critical changes of patient conditions
  - Stricter adherence to up-to-date standardized medical treatment guidelines and protocols
  - Reduced medical errors from an altered sense of time and memory lapses (due to high stress)

Broader Impact:

- Pediatric Sepsis Guidance System: the system is in the progress of preparing for Phase I clinical evaluation at JUMP.
  - Assist clinicians with early detection of pediatric sepsis
  - Provide real-time assistance with clinical management of pediatric sepsis
  - Improve adherence to accepted practice standards for management of pediatric sepsis

Broader Impact:

- Education:
  - Assist hospitals and medical schools to train less experienced clinicians and clinicians-in-training important tenants of cardiac arrest and pediatric sepsis management
  - Involve computer science undergraduate and graduate students in medical cyber-physical systems and software engineering research

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