**INTRODUCTION**
- The paradigm for monitoring patients’ vital signs has remained unchanged since the 1970s.
- After being detected by a sensor, vital sign values are displayed on a monitor.
- Serving as a basis for clinical decision making, it can lead to information overload and alarm fatigue in ICUs – factors that can cause fatal medical errors.
- To ease the burden of information overload, multiParameters graphically represents the multivariate relationship between vital sign parameters, in a way that allows the viewer to see both trends and physiologic state space.
- In addressing the serious issue of alarm fatigue, multiParameters will offer suggestions for alarm parameters based on physiological state of individual patients.

**BACKGROUND**
- Single Sensor Single Indicator (SSSI) provides large volumes of data from multiple sources.
- Patient variables are intermittently collected and recorded as single numbers in a paper chart or computer database.
- Clinical staff screen patient data for important events, and rely on clinical experience to synthesize the information and to formulate differential diagnoses and treatment plans.
- 80-90% of alarms in the ICU are false positives.
- Current practices accept all sources of alarms
- Alarm noise pollution leads to alarm fatigue which facilitates medical errors.

**SOLUTION**
- **Situational awareness**
  - Perception
  - Comprehension
  - Prediction

  - Used principles learned from Dr. Tim Buchman and prior work by Carlos A. Renjifo to develop an algorithm that produced graphical representation of patient’s vital sign parameters.

  - Beginnings of our attempts to visually display physiologic state space in a patient with sepsis.

  - Currently parameter thresholds for each sensor can be adjusted to meet patient's individual physiology. However, even when thresholds are adjusted, they are not done so in a standard or scientific way.

  - Our solution: Automatic recommendation for alarm settings. A function that is based on the trended data from the patient gives a proposal for the alarm threshold, which the nurse can then accept or reject.

  - Two variables: Heart Rate, HR (bpm) - Mean Arterial Pressure, ABP (Invasive, mmHg)
  - ABP/HR plot with circles representing state space determined by cluster analysis. These state spaces serve as the basis for new alarm thresholds.

**FUTURE**
- To increase the value and accuracy of graphically represented physiologic state space we can introduce another variable and make display 3D.
- We can better identify and display distinct physiologic state spaces by introducing variables such as heart rate variability – a parameter generated from the complex systems paradigm.
- Utilizing information about relationships between variables will allow us to move beyond use of single variable limit alarms.
- Ultimately, by using real-time patient data to create a continuously updating representation of physiologic state space, we hope to improve situational awareness and decrease the number of false alarms in the ICU.

**REFERENCES**
- Patient Monitoring in Critical Care: Lessons for Improvement, Frank A. Drews
- On-line adaptive trend extraction of multi-physiological signals for alarm filtering in intensive care units, Chapovsky & Gerlach
- On-line adaptive trend extraction of multi-physiological signals for alarm filtering in intensive care units, Chapovsky & Gerlach
- Real-Time Development of Patient Specific Alarm Algorithms for Critical Care, Ying Zhang
- Nonlinear dynamics, complex systems, and the pathobiology of critical illness, Tim G. Buchman
- Real-Time Development of Patient Specific Alarm Algorithms for Critical Care, Ying Zhang
- On-line adaptive trend extraction of multi-physiological signals for alarm filtering in intensive care units, Chapovsky & Gerlach
- Identification of complex metabolic states in critically injured patients using bioinformatic cluster analysis, Ghazanfar et al.
- Novel representation of physiologic states during critical illness and recovery, Buchman
- Visualization of Trends and State Space to Individualise Alarm Parameters, Adriana Fuentes, Jeffrey Jopling, Karsten Jensen, Lars Christensen

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