How to Best Display Physiologic Signals and Therapeutic Interventions.

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Introduction

Traditional information displays are not designed specifically to help clinicians detect life-threatening events or manage medications. Most use a "single-sensor-single-indicator" display paradigm. As a result, clinicians must observe and integrate multiple data elements generated by independent sensors. This process of sequential, piecemeal data gathering may be an impediment to a coherent understanding of the patient's underlying physiological processes. Traditional physiological displays can be enhanced by integrating the disparate data elements with graphic representations that are consonant with clinicians' cognitive representation (mental model) of patient physiology. Such integrated graphical displays support diagnosis and treatment decision making, especially of clinical problems involving complex alterations of multiple physiological variables.

Methods

Weinger evaluated a display in which variables are displayed as histograms. When all variables are normal, the display shows a normal "horizon". Michels developed a graphic anesthesia display that organized 32 variables by organ system, showing the absolute value for each variable in relation to a "normal" reference frame. Blike mapped physiologic variables into display objects with meaningful shapes. Agutter arranged variable to mimic physiologic blood flow through the circulatory system. His display was designed using normally-shaped and uniformly-spaced elements to create a smooth, balanced design, which allows the clinician to quickly detect change. Effkin displayed anatomical relationships and causal constraints between key hemodynamic data.

Results

Test subjects detected changes in 15% less time with the normal horizon display and an average of three minutes sooner with reference frames and ordered structure. Meaningful shapes resulted in 27% faster recognition and diagnosis of the etiology of shock. By showing nurses how etiological factors related to symptoms, subjects solved 97% of the episodes when using the new display, but only 90% of the episodes when using a traditional display. Jungk demonstrated that anesthesiologists succeeded in controlling circulatory variables 89% of the time when they used a graphic display as compared with 63% of the time when they used a traditional trend display.

Conclusions

When patient variables are clearly displayed graphically, critical event are resolved in one-third the time, diagnosis is more accurate and patient variable are better controlled. A graphic display can reduce cognitive demands during multiple events, cascading events, or when the clinician is distracted by multiple tasks in a stressful clinical situation. This savings in mental effort could translate into improved safety and in improved overall care.