Situation Awareness in Anaesthesia and Intensive Care – Implications for the Design of Monitoring Devices.

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Background:

According to Endsley's definition, Situation Awareness (SA) is "the *perception* of elements of the environment within a volume of time and space, the *comprehension* of their meaning and the *projection* of their status in the near future"[1]. In medicine, SA describes the health care provider's ability to perceive and understand patient related information and the ability of foreseeing patient's future development[2]. Accurate SA is crucial for effective team work, task management and decision making and therefore, it is an indispensable part of high performance. Developing SA requires integration of perceived information with experience and knowledge. This knowledge includes mental models about (patho-)physiology, therapy goals, guidelines and medical knowledge in general[2].

In anaesthesia, patient monitors provide basic as well as extended information about the patient's state. Actual patient monitors offer increasing numbers of parameters that almost exclusively base on the single- sensor-single-indicator (SSSI) design[3]. To comprehend and to integrate these parameters can be a time- consuming task, especially during dynamic phases of anaesthesia, e.g. during anaesthesia induction or the management of critical incidents[4]. An overload of the anaesthetist's working memory with impaired patient safety is a possible consequence. For accurate development of SA, improvements of monitor designs for optimal presentation of information are rare but favourable. Therefore, the ability of the present generation of patient monitors to increase SA optimally remains questionable.

Evaluating designs of patient monitors

Since patient monitors provide information about the patient's state, the physicians' SA or their performance (being a result of accurate SA) are potential objects of assessment and evaluation. Performance and SA-related behaviour are considered to be indirect indicators of SA. For evaluation of performance, time markers (e.g. time to detect a problem, time until correct diagnosis, time until clinical decision) and checklists evaluating key tasks have been used. In contrast, direct measures of SA use standardized queries like “The Situation Awareness Global Assessment Technique (SAGAT)” which is applied during random scenario freezes in simulation environments[5]. The queries have to be adapted to scenario contents and evaluate SA on the *perception*, *comprehension* and *projection* level providing more detailed knowledge about the processes how information is acquired.

For example, one study[6] used SAGAT to compare a traditional SSSI display with an object display providing information about functional cardiovascular physiology through the integration of hemodynamic variables. The object display was not found to be superior with respect to SA and performance and the authors concluded that the unfamiliarity with the new display stated a major problem even after training. Therefore, for unbiased testing of new displays, several month of training have been recommended[3].

A promising tool to evaluate patient monitors is eye-tracking[4]. This technique records anaesthetists' gaze targets with a high timely and spatial resolution and can be applied in the real work place as well as in simulation environments. In combination with SAGAT, it simultaneously determines what information had been *seen* and to what degree this information has been *perceived* and *understood* by the individual.

Implications

New monitor displays are a promising tool to reduce cognitive workload and errors[3]. In anaesthesia, the integration of basic data from multiple SSSI variables by means of physiologic models is suitable to present information graphically and in a single display field. Another important option is the development of an "intelligent" patient monitor: given a certain constellation of basic data (low blood pressure, tachycardia, increased airway pressures), such a monitor might offer several differential diagnoses (e.g. anaphylaxia, tension pneumothorax) and suggest additional diagnostic and therapeutic tasks. Progress in display design was initiated and realized in other domains to obtain information on the *comprehension* and *projection* level of SA which reduces both workload and errors[7]. However, it has been recommended that traditional display information should remain available along with the integrated information because it may be necessary to understand individual parameters for an in-depth analysis of a complex situation.

Literature

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