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The implementation of clinician designed, human-centered electronic medical record viewer in the intensive care unit: A pilot step-wedge cluster randomized trial☆

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ABSTRACT

Objectives: AWARE (Ambient Warning and Response Evaluation) is a novel electronic medical record (EMR) dashboard designed by clinicians to support bedside clinical information management in the ICU. AWARE sits on top of pre-existing, comprehensive EMR systems. The purpose of the study was to test the acceptance and impact of AWARE on data management in live clinical ICU settings. The primary outcome measure was observed efficiency of data utilization as determined by time spent in data gathering before morning rounds.
Design: Step wedge cluster randomization trial.
Setting: Four ICUs (surgical, medical, and mixed) at an academic referral center.
Subjects: All members of the critical care team participating in morning ICU rounds.
Intervention: Pilot implementation of a novel EMR interface with direct observation and survey.
Measurements and main results: The study took place between April and July 2012. A total of 80 and 63 direct observations were made in the pre- and post-implementation study periods respectively. The time spent on pre-round data gathering per patient decreased from 12 (10–15) to 9 (7.3–11) min for pre- and post-implementation phases respectively ($p = 0.03$).

Compared to the existing EMR, information management (data presentation format, efficiency of data access) was reported to be better after AWARE implementation. AWARE made the task of gathering data for rounds significantly less difficult and mentally demanding.

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Conclusions: The introduction of a novel, patient-centered EMR viewer for the ICU was associated with improved efficiency and ease of clinical data management compared to the standard EMR.

1. Introduction

Information overload in the intensive care unit (ICU) setting is prevalent. It has been estimated that the care of patients in the ICU generates over 1200 data points per patient per day [1]. The adoption of electronic medical records (EMRs) increases the amount and accuracy of that data compared to handwritten notes [2]. An effective information management strategy is needed if clinicians are to avoid becoming overwhelmed by this data [3]. Consequences of information overload include communication failures and errors of omission that translate into worse patient outcomes [4–6]. EMRs have recently been promoted as vehicles for improving patient safety and outcomes while reducing costs and increasingly such systems are finding their way into the ICU environment [7–9]. The potential benefits of EMR adoption are largely unproven in the ICU setting and there is a recognized lack of systematic testing and validation of such systems in clinical settings [10,11]. Indeed, one of the few studies relating specifically to patient outcomes demonstrated a doubling of mortality in a pediatric ICU following implementation of a commercially available computerized order entry system [12]. While follow-up studies [13] and a commentary [14] on the findings indicate that implementation processes may have been responsible for most of the effect seen, it remains remarkable that many point of care users of EMRs continue to find them difficult to use and disruptive of workflow [15,16].

Commercially available EMRs were originally conceived as accounting tools to capture billing information for practices and the underlying development processes and architecture are rooted in that use case [17,18]. Data display is therefore typically, "database centered", i.e. the data source (laboratory, vital signs, medication etc.) determines how data is presented to the user (laboratory data presented in table form). Similarly, workflow is considered to be linear with little consideration of the multi-tasking, interruption prone nature of most medical environments [19]. As they are asked to deliver more, the gaps in this approach to development and implementation are more apparent [20,21].

In response to this, a clinician-developed novel EMR viewer has been refined and validated over a number of years in the study center [22]. AWARE (Ambient Warning and Response Evaluation) is a viewer that sits on top of the existing comprehensive EMR. High value data [23] are extracted from the EMR, and organized by organ system in a human-centered viewer. Concept orientated views such as these have been demonstrated to improve clinician understanding and decision making in other settings [24]. In simulated ICU settings AWARE has been demonstrated to improve efficiency, reduce clinician cognitive load and errors [25]. The purpose of the current study was to test the safety, efficacy and acceptance of AWARE in the clinical ICU setting. The primary outcome of interest was efficiency of data management by the ICU team preparing for morning rounds. Secondary outcomes of interest included impact on team safety, communication and performance as well as an assessment of AWARE acceptance and intention to use.

2. Materials and methods

The study protocol was reviewed by the institutional IRB and was approved as a minimal risk study.

2.1. Study design

Between March 26, 2012 and June 3, 2012, a pilot stepped wedge cluster randomized trial was conducted in four ICU locations at Mayo Clinic, Rochester, MN. This trial involved the sequential roll-out of AWARE (intervention) to each of the study ICUs (cluster) at two week intervals. By the end of the study period, all clusters had received the intervention. The order in which they received the intervention was determined at random [26].

2.1.1. Study units and participants

The four ICUs selected for this pilot study were a surgical (vascular/thoracic/orthopedic) ICU, a mixed medical and surgical (hematology, transplant, general surgery) ICU, a trauma ICU and medical ICU at St. Mary's Hospital and Methodist Hospital, Rochester. The study participants included ICU providers, physicians, nurse practitioners (NP), nurses (RN), respiratory therapists (RT), and pharmacists. A subgroup of study subjects were identified as primary data gatherers and took part in the direct observational studies. This subgroup consisted of residents, nurse practitioners and critical care fellows involved in the collection of patient data in preparation for morning rounds.

2.2. Description of the pre-existing EMR

A full description and additional screen shots of the existing EMR environment has been previously published [25]. Briefly, the standard EMR used in clinical ICU practice complies with the definition of a comprehensive EMR certified by the office of national coordination (ONC) and at the time of the study met all of the criteria for stage 1 meaningful use compliance. Computerized physician order entry is provided for patient orders and interventions (Mayo Integrated Clinical Systems, Rochester, MN). Access to patient data (demographic, laboratory data, vital signs, physiological data, investigations, images and documents) is achieved through a customized interface, Synthesis (Mayo Clinic, Rochester, MN). Patient data is organized by data category (laboratory, vital signs, fluids,