Clinical information use by medical and nursing staff in the ICU: Outcomes of a coded tables analysis

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The long-term, intensive nature of patient admission to an Intensive Care Unit necessitates passing responsibilities from one medical and nursing staff member to another. An ideal outcome of this process is a common team situation awareness of the patient's condition. However, medical and nursing staff have different training and practice regimes, which raise questions about the nature of the situation awareness needed by the two groups. Statistical and an exploratory data analysis techniques were used to explore the information content of video-cued recall interviews in order to identify differences in information use. Doctors were found to attend to future patient projections over a broader range of physiological functions than nurses, reflecting a strategic orientation, whereas, nurses attended to sensed information over shorter timeframes than doctors, reflecting a tactical orientation. When not aligned these orientations may lead to breakdown in coordination and discontinuities in patient care.

INTRODUCTION

The purpose of this paper is to present the findings of an analysis of clinical information use by medical and nursing staff during shift handovers and to discuss the implications of these findings.

Intensive Care Unit (ICU) patients have complex life-threatening medical conditions that resolve over days to months. ICU patients are cared for on a 24 hour basis by medical and nursing sub-teams (Herbertson & Walley, 1998). Thus the intensive nature of patient care necessitates shiftwork and with it the need to pass patient care from one staff member to another during shift handovers.

Shift handovers involve more than the transfer of responsibility. During handovers sub-team members evaluate a patient's current condition, identify emergent issues and define new goals and plans. Thus, shift handovers involve patient situation assessment and situation awareness. Endsley (2000) defines situation assessment as the set of cognitive processes involved in achieving situation awareness (SA). Endsley, Bolte and Jones (2003) define SA as the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the future projection of their status. Situational elements can be categorised within Klein's (1998) Recognition Primed Decision model (see Figure 1) which describes the relationships between categories of situational elements and the cognitive processes that may be applied to these. In Figure 1 the black nodes represent elements in situations and the grey nodes represent cognitive processes. A discussion of the modifications to Klein's (1998) original formulation is provided by Miller (2004b).

Klein (2001) further defines team coordination as a process involving multiple entities who attempt to act in concert to achieve a common goal by carrying out a commonly understood script or plan. Team situation awareness, the process by which team members achieve common understanding is a central component of team coordination. Klein (2001) also suggests that team coordination may be compromised when members lack common understanding. Likewise Cook, Render and Woods (2000) speculate that "losses of information or momentum or interruptions in delivery of care" (p.791) constitute gaps that may lead to adverse patient outcomes.

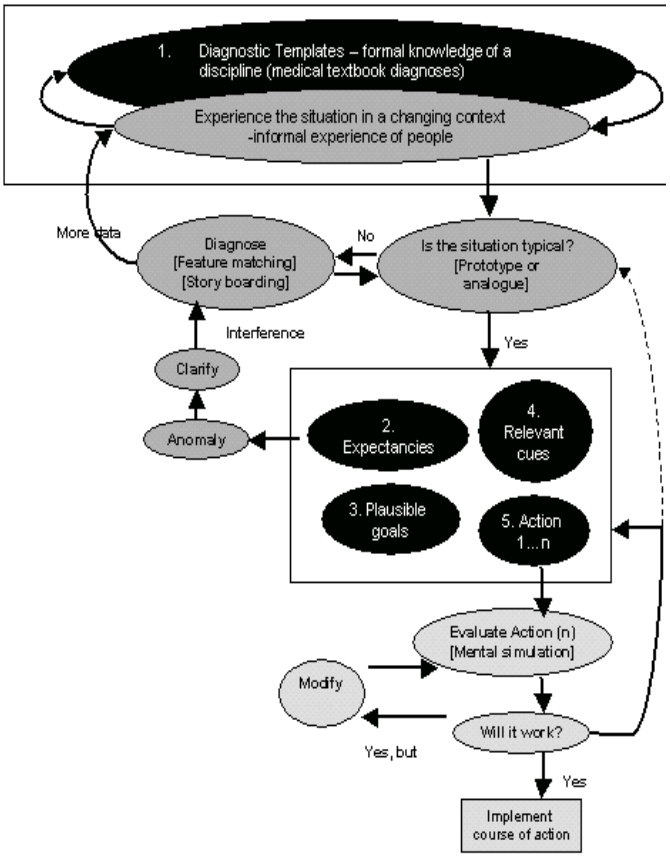


Figure 1. The Recognition Primed Decision model, modified from Klein (1998)

Doctors, nurses and other allied healthcare professionals are sub-team members within an overall care team. Each sub-team has its own training regime and practice is organised and regulated in different ways. In Australia, nurses undergo

a three-year Bachelor of Nursing degree, making them eligible for nurse registration. The primary role of nurses is to facilitate a patient's activities of daily living. Nurses also implement medical directions and they are involved in non-surgical procedures. ICU nurses undergo further post-graduate studies that extend these responsibilities. Nurses work with ICU patients on a 1:1 ratio, 24 hours per day. Nurses have their own professional associations, career paths, and salary structures. Full-time nurses work 36 hours per week. Within ICUs shift duration varies between 6 to 12 hours.

In contrast, doctors undergo a five to six year Bachelor of Medicine or Surgery degree, and are employed in hospitals as interns, residents, registrars and later consultants. Registrars are eligible for admission to specialist colleges (e.g. Australian & New Zealand College of Anaesthetists) where they undertake further training. ICU doctors typically work only in the ICU, but may be responsible for managing emergencies elsewhere. ICU shifts extend from 12 to 48 hours or more. The number of patients in a doctor's immediate care depends on the doctor's seniority. Registrars are responsible for all patients in an ICU and may refer to an on-call senior ICU consultant. ICU doctors are professionally and legally responsible for patient admission and discharge decisions, for the diagnosis of patient illnesses, and the prescription, assessment and implementation of therapeutic interventions

These differences in professional training and practice beg two questions: 1. during handovers do medical and nursing staff attend to the same elements of the patient situation thereby developing similar situation awareness, and 2. if not, what are the implications of any differences for team coordination and continuity of care. This paper addresses these questions using a novel exploratory data analysis approach. However, the questions arose in the context of a broader research project associated with the development of a modified work domain analysis framework for the ICU patient work domain and the evaluation of an ecological interface design (Miller & Sanderson 2000; Miller, 2000; Miller & Sanderson 2003a, 2003b; Miller, 2004a, 2004b). The following Method and Results sections describe the results of analyses designed to identify differences in medical and nursing sub-team use of information in patient situations. The implications of these results for team situation awareness and continuity of care conclude the paper.

METHOD

Miller (2004b) reported a video-cued recall field study procedure conducted at the Epworth Hospital ICU in Melbourne, Australia, between November 2000 and May 2001. The data collation and analysis method described in this section was undertaken on data collected from the *Procedure* process reported earlier. The data collection procedure is summarised in the following sub-sections.

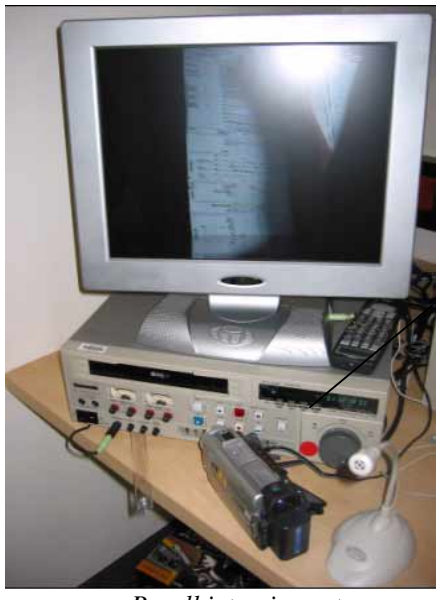
Participants

Eight senior intensive care doctors, 17 senior nurses and five ICU patients participated in the field study for the duration of the patient's admission. In total 57 video-cued recall interviews were conducted, 27 for nurses and 30 for doctors.

Materials

The materials used in a video-cued recall procedure are presented in detail by Miller (2004b), but in summary comprise a head-mounted audio-video recording apparatus and a VHS player/recorder and TV monitor as shown in Figure 2.

Head-mounted recording apparatus



Recall interview set-up

Figure 2 Video-cued recall apparatus

The video-cued recall procedure was used: a) to record the morning nurse and medical handovers for each patient; and b) to later replay the recorded footage to participants. The recorded footage cued a detailed interview designed to identify information elements in the patient situation. The recorded interviews were de-identified, transcribed, divided into speech units (Hill & O'Brien, 1999) and coded.

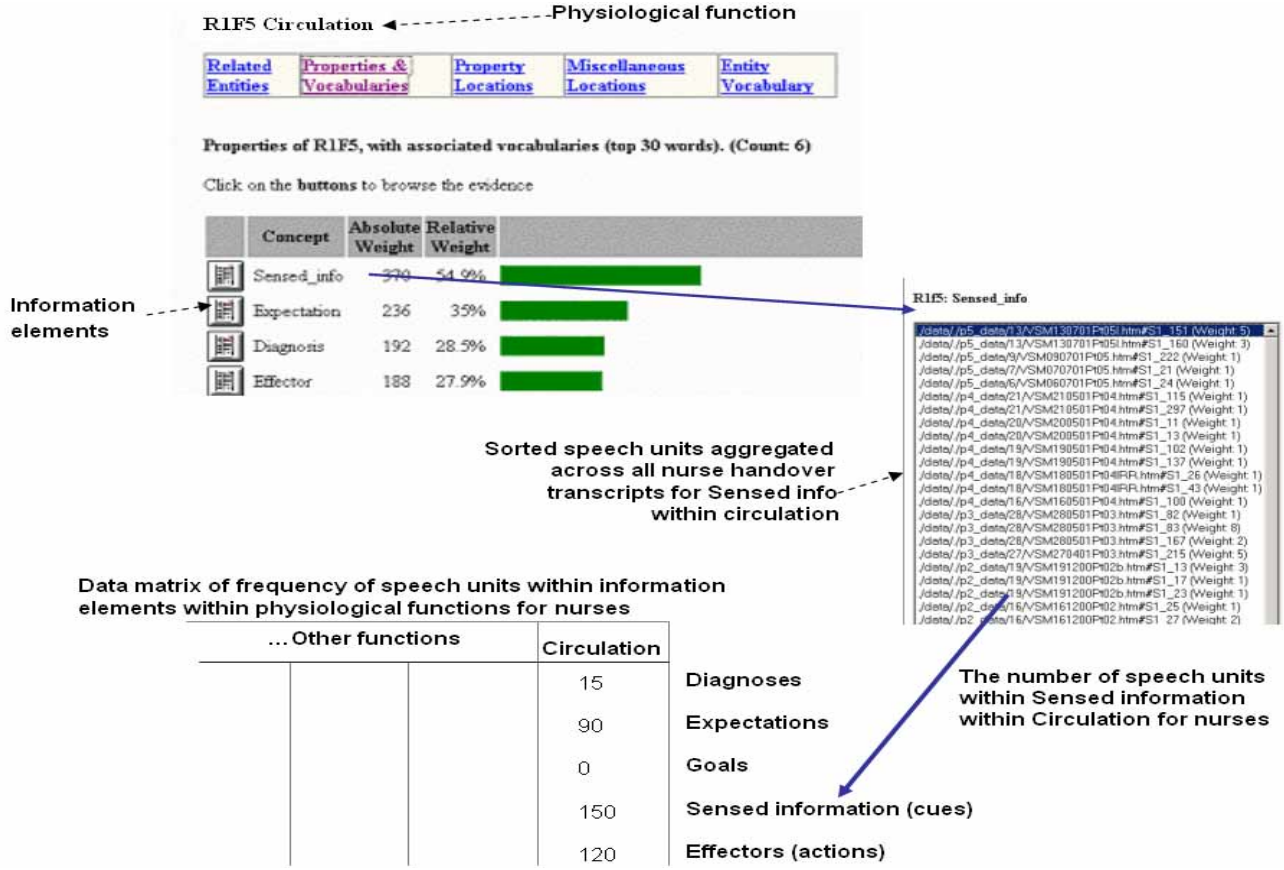


Figure 3 Schematic representation of the speech unit aggregation and sorting process within Leximancer

Data collation, coding and analysis

The transcript coding scheme was reported by Miller (2004b). In summary, each speech unit was given two codes that located the speech unit within the modified work domain analysis framework (Miller, 2004a). The first code located the speech unit in the whole-part dimension of the framework, which describes patients in terms of physiological function. The second code located the speech unit on the diagnostic dimension of the framework which is based on the elements of situation (black nodes only in Figure 1). All relevant speech units in the 57 transcripts where coded in this way. Once coded, the transcripts were submitted to Leximancer, a text-based data analysis tool (Smith, 2000a; 2000b). Using Leximancer the coded speech units were sorted as in Figure 3.

The outcome of this process was matrix of frequencies of elements of situations within physiological functions for doctors and nurses for each patient. A spreadsheet allowed the frequencies to be sorted and summed at different levels of aggregation. The resulting data matrices where subjected to statistical and descriptive analyses.

RESULTS

This section reports the findings of two data analyses: 1. t-tests for differences between mean proportions of speech units across physiological functions (columns in the data matrices) and elements of situation (rows in the data matrices) for doctors and nurses; and 2. coded table analyses for each patient for doctors and nurses.

Differences in mean proportions of speech units for doctors and nurses

The frequency data was aggregated across all patients for doctors and nurses for physiological functions and for elements of situations. Frequencies were converted to proportions to reduce the effects of two doctors who were involved in a disproportionate number of medical handovers. Student's t-test with pooled sample variances for unequal sample sizes (Howell, 2000) showed no significant differences between doctors and nurses in relation to physiological functions. Doctors and nurses appeared to attend to the same physiological functions in the same proportions.

There were however, statistically significant differences for the mean proportion of speech units for the elements of situation. Doctors had significantly higher proportions of speech units for 'Expectations' ($t_{23} = 4.5771$, $p<0.001$) and lower proportions of speech units for 'Sensed Information' ($t_{23} = -3.3978$, $p<0.001$) and 'Effectors' ($t_{23} = -2.6849$, $p<0.001$) than nurses. There were no statistically significant differences for 'Diagnoses' and 'Goals'.

Exploratory data analysis using coded tables

Coded tables were constructed for each patient for doctors and nurses to explore the previous findings in greater detail. Coded tables are based on the distribution of ranked frequencies around the median frequency for the physiological functions (Fig 4a) and then for the elements of situation (Fig 4b). Proportions were not used because within each patient there was no disproportionate representation of any one participant. Frequencies were ranked across the entire

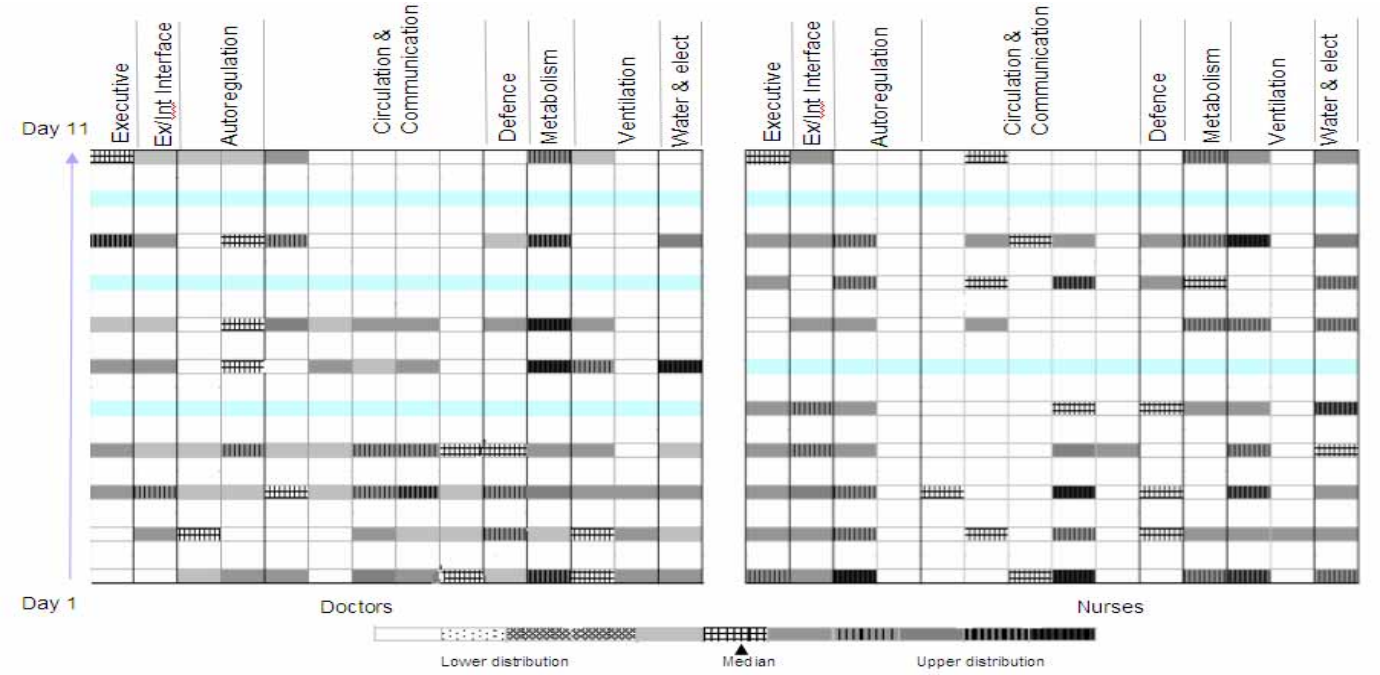


Figure 4a Distribution of frequencies for Patient 2 for doctors and nurses

patient admission episode for each patient. Once ranked, the distribution of the frequencies was determined using Tukey's (1977) fenced letter displays where the median ranked value is the measure of central tendency and upper and lower hinge depths are the measures of data spread (analogous to standard deviation). Velleman and Hoaglin (1981) describe coded tables as a graphical **r**epresentation of frequency distributions based on fenced letter displays. Figure 4a shows the coded table for patient 2 as a representative case.

Patient 2 was admitted to the ICU with acute pancreatitis and respiratory failure. On day 1 the nurse (right-hand table, bottom) is highly attentive to neurological, respiratory and some aspects of circulatory function, all being life-critical. Across all patients most high frequencies for nurses were located within these functions in the early part of the admission episode. Other high frequencies at day 3 are associated with the emergence of adult respiratory distress syndrome and septic shock, and at day 5 with acute renal failure. Despite these complications nurses tend to focus on the same physiological functions throughout the admission and do not focus on some functions at all. This produces a 'banding effect' down the table. Doctors in contrast (left-hand table) focus on a broader range of physiological functions (there is no banding effect). Doctors also focus more on the function associated with the patient's admission that is metabolic functions associated with pancreatitis. These general patterns were consistent across all study patients.

In Figure 4b each block of five bands represents the five elements of situation for one day as per the key. Again differences emerge between the elements of situation attended to by nurses and doctors. Nurses focus on 'Sensed Information' (the second bottom band in each block, labelled 's'), in the early days of admission. In contrast, doctors focus on 'Expectations' or future projections about the patient's disease trajectory in association with Sensed

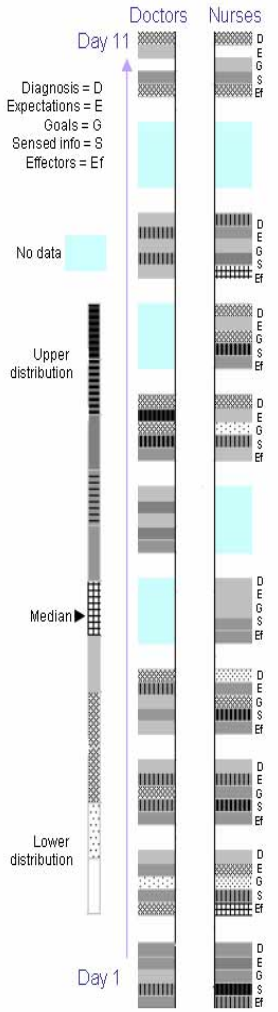


Figure 4b Elements of Situation

Information. For Patient 2 this is especially so at day 7 when the doctor is concerned about the patient's outcome As the doctor stated at interview, "this patient has manifest failure in eight physiological functions but none of the failures are extreme. This patient will probably pull through".

In summary, these analyses show that doctors and nurses attend to different physiological functions and different elements of situation for different reasons across a patient's admission. Focusing on Expectations (future projections), doctors take a longer-term view across a broader range of physiological functions. Nurses focus on 'Sensed Information' especially in the early phases of admission when uncertainty about the patient situation is highest.

DISCUSSION AND CONCLUSIONS

The results reported for doctors and nurses are arguably a function of their training and practice-based responsibilities. Nurses are continuously present with patients and are responsible for the monitoring and the detection of change in

physiological functions with immediate life-threatening consequences on a minute to minute, and hour to hour basis. This role-based responsibility shapes their attention to patient information in ways that suggests a tactical orientation that would require a tactical situation awareness. Nurses are not so concerned predominantly about the 'big picture' of a patient's illness or their illness trajectory. Speculatively, this may lead to discontinuities in information processing as a consequence of attentional problems such as tunnelling and misplaced salience (Endsley et al 2003).

In contrast the doctors' coded tables suggest a broader, longer-term view, which may be described as a strategic orientation requiring a strategic situation awareness. Again speculatively discontinuities may occur when there are mismatches in goals over extended timeframes or when high priority goals are not communicated to nurses so that they can be effectively monitored.

In a multi-disciplinary care team clearly both orientations are important. The strategic orientation should inform tactical priorities, while tactical monitoring informs strategic assessment and re-evaluation. Notably, neither professional group focuses on 'Goals' which may serve to align strategic and tactical orientations. The implications of this finding are unclear. It may be that care related goals are implicitly understood by both groups as a consequence of collective experience in many patient care situations. Alternatively, behavioural, communication, coordination and cultural factors may mitigate against the articulation of goals. In general the speculative implications of these outcomes overall are that misalignments between tactical and strategic situational orientations may lead: a) to breakdowns in team coordination and b) to discontinuities in patient care. Research is currently under way to investigate these possibilities.

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