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Human factors in anaesthetic practice: insights from a task analysis

D. Phipps[1]*, G. H. Meakin[3], P. C. W. Beatty[2], C. Nsoedo[2] and D. Parker[1]

[1]School of Psychological Sciences and [2]School of Medicine, University of Manchester, Manchester, UK.
[3]University Department of Anaesthesia, Royal Manchester Children's Hospital, Pendelbury, Manchester, UK

**Corresponding author. School of Psychological Sciences, The University of Manchester, Room 124E, Zochonis Building, Brunswick Street, Manchester M13 9PL, UK. E-mail: denham.phipps@postgrad.manchester.ac.uk*

Background. Despite a growing recognition of the role of human error in anaesthesia, it remains unclear what should be done to mitigate its effects. We addressed this issue by using task analysis to create a systematic description of the behaviours that are involved during anaesthesia, which can be used as a framework for promoting good practice and highlight areas of concern.

Methods. The task steps involved in preparing and delivering anaesthesia were identified using hierarchical task analysis (HTA). The systematic human error reduction and prediction approach (SHERPA) was then used to identify potential human errors at each task step and suggest ways of preventing these errors.

Results. The number and type of behaviours involved vary according to the 'phase' of anaesthesia, with tasks in the induction room, including induction of anaesthesia itself, being the most demanding. Errors during preoperative planning and perioperative maintenance could be avoided by measures to support information handling and decision-making. Errors during machine checking, induction, and emergence could be reduced by streamlining or automating task steps, or by making changes to the physical design of the work environment.

Conclusions. We have demonstrated the value of task analysis in improving anaesthetic practice. Task analysis facilitates the identification of relevant human factors issues and suggests ways in which these issues can be addressed. The output of the task analysis will be of use in focusing future interventions and research in this area.

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The adverse effect of human error on the safe and effective delivery of anaesthesia has been widely recognized for a number of years.[1–5] However, what is not clear is how and when the different types of human error have an effect, or what steps can be taken to mitigate their effects. The aim of the study described in this paper is to address this question by using task analysis to create a detailed behavioural description of the anaesthetic process. Although particular aspects of anaesthetic practice will be highlighted for illustrative purposes, the emphasis of the paper is on demonstrating the use of task analysis to identify issues of potential concern rather than making firm recommendations about how the issues raised by the illustrative examples should be addressed.

Task analysis has been described as a methodology for examining the actions or cognitive processes involved in a given work activity.[6] In surgery, it has been shown to have the following benefits:[7]

- A human-centred description of the medical and surgical team activities, which in turn allows key skills and knowledge to be identified;
- A means of identifying potential 'vulnerabilities' in the work processes, for example, gaps in procedures or interference from medical technologies;
- An aid to defining suitable interventions to enhance work activity, including the specification of user and system requirements for technology-based solutions;

Task analysis has also been used to study the activities in an intensive care unit, with the data subsequently being used as a baseline measure against which to identify and quantify errors.[8] Another study examined a clinical

pathway using task analysis, and in doing so identified potential 'bottlenecks' within the pathway;[9] for example, a task step that involved retrieval of an electronic patient record during patient admission was prone to error due to incorrect records being retrieved. Within anaesthesia, Weinger and colleagues[10] have used task analysis to compare the performance of novice anaesthetists with those of experts. However, although it generates useful insights into anaesthetic practice, the approach of Weinger and colleagues focused more on the tasks themselves than on task behaviour. It involved an observer recording the frequency and duration of pre-defined clinical task activities, such as 'i.v. adjustment' and 'conversing with surgeon'. Although this allows relevant activities to be identified, what appears to be less well captured in this technique is the sequence and organization of behaviours that make up the task activity.

In the present study, the tasks involved in preparing and delivering anaesthesia were identified using hierarchical task analysis (HTA), as advocated by Ainsworth and Marshall.[11] This begins with a general task goal (for example, 'provide preoperative care'), and breaks this down, or 'decomposes' it, into the task steps that must be performed in order to achieve the main goal. The end result is a hierarchy of task steps that represent the behaviours that need to be performed in the conduct of a task. By way of illustration, an HTA of setting up an i.v. infusion is shown in Figure 1.

The output of an HTA can be used in its own right as a self-contained description of task activity, but given that a major objective of this study was to identify potential human errors, we have employed an extension to HTA, known as the systematic human error reduction and prediction approach (SHERPA).[12] This facilitates the identification of errors that could occur, and of the points during the task at which they might occur, by applying a classification of potential errors to the output of an HTA. The classification scheme lists a number of error types, from which the analyst selects those that are likely to apply to the task under consideration. Using the example shown in Figure 1, the errors listed in SHERPA that could credibly occur during task step 3.2 ('check flow switches') might be judged to include 'check omitted' and 'wrong line checked'. Having identified the potential errors, each is examined further to determine its potential for occurring, the consequence of it occurring, and what could be done to reduce its occurrence. The advantage of SHERPA is that it is relatively straightforward and has a good level of reliability.[13] Its use has recently been demonstrated to identify potential errors in the administration of medicines[14] and in laparoscopic surgery.[15]

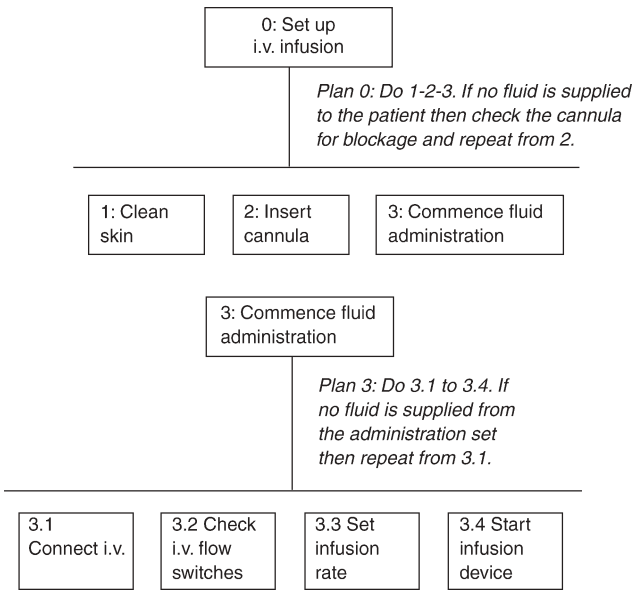

Fig 1 A hierarchial task analysis of setting up an i.v. infusion, showing the initial decomposition (top) and then a further decomposition of one of the subgoals (bottom).

Methods

Hierarchical task analysis

The task analysis covered the anaesthetist's main activities from the start of the preoperative visit to the postoperative handover of the patient to the recovery staff. Data were collected for the task analysis from the following sources.

- *Literature*: In order to provide a theoretical background and ensure full coverage of anaesthetic practice, two anaesthetic textbooks[16 17] and the AAGBI guidelines on preoperative machine checking[18] were consulted and key anaesthetic tasks identified from these and organized into a timeline.
- *Observations*: Having obtained institutional and NHS REC approval [Ethical approval for conduct in the NHS was granted by the Central Manchester Research Ethics Committee and the Salford and Trafford Local Research Ethics Committee (COREC project no. 06/Q1407/16)], two members of the research team (D.P. and C.N.) observed anaesthetic teams performing pre- and perioperative tasks at an adult teaching hospital and a paediatric specialist hospital. The researchers were present for several types of list at both hospitals, as listed in Table 1. In total, approximately 200 h of anaesthetic practice was observed, from which the researchers noted the behaviours that were carried out during performance of anaesthetic tasks.
- *Subject matter expert*: Technical advice, and an initial review of the information gathered from the literature and observations, was provided by a member of the research team (G.H.M.).