MAN-MACHINE INTERFACE: THE POSITION OF THE ANAESTHETIC MACHINE IN THE OPERATING ROOM

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Abstract

The question posed for this study was: "While holding a watching brief during an uneventful intra-abdominal surgical procedure do anaesthetists adopt the same position in the operating room with reference to the patient's head and 'anaesthetic machine' and, if they do, what is it?"

A study of the relative positions of the patient, the anaesthetist, and the "anaesthetic machine" during routine laparotomy showed great variation. The implication was that there was also great variation in the amount of movement necessary by the anaesthetist if the same amount of information was to be obtained with the same frequency. The significance of this with reference to the quality of patient care is discussed. The role of changes in apparatus and the declared need for this by anaesthetists is mentioned and recommendations regarding the visual acquisition of data during anaesthesia are made.

Key Words: Equipment, monitors, ergonomics.

Instruction in the care of equipment, information processing, and decision-making are essential parts of anaesthesia training. The process of acquisition of information by the anaesthetist in the operating room has received less attention. This subject, albeit in a different milieu, is familiar to engineers [1,2,3] and psychologists, being referred to as the man-machine interface, human factors, or ergonomics. The study reported here deals only with the location of the anaesthetist and anaesthetic machine in the operating room during operations under general anaesthesia with reference to the visual acquisition of information by the anaesthetist. The term 'anaesthetic machine' refers to the movable table on which is customarily attached gas and vapour delivery system, mechanical ventilator, scavenging and fluid suction systems and monitors. Monitors include indicators of blood pressure, cardiac rate and rhythm, pulmonary inflation pressures, body temperature, inspired oxygen concentration and gas tank pressures.

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Data collection sheets consisting of a scale diagram of head of the patient, anaesthetist's chair, and anaesthesia machine – "a bird's eye view" – were made (Figure 1). The diagram on the data collection sheets facilitated recording the real positions of these items when they were observed in an operating room. Information was collected during visits to operating rooms in which abdominal operations were in progress. These occurred serially on any one day and only one recorded observation was made regarding one operating room on any one day. All these operating rooms had been constructed similarly. They were 5.8 m broad and 6.4 m long, with the operating table in the centre aligned along the long axis of the room. Lighting was uniform and the spot-lights were supported by traverses above the table. Power, gas and suction supply reached the anaesthetic machine from a 1.5 m boom originating from a point half way along an end wall and 2.4 m above the floor. This boom could be moved from side to side in a 180° plane. The anaesthetic machine itself was mobile. Sixty copies of this diagram (Figure 1) were completed. Subsequently on each of these the angle subtended by a line from the anaesthetist's head to the patient's head, and a line from the anaesthetist's head to the midpoint of the back of

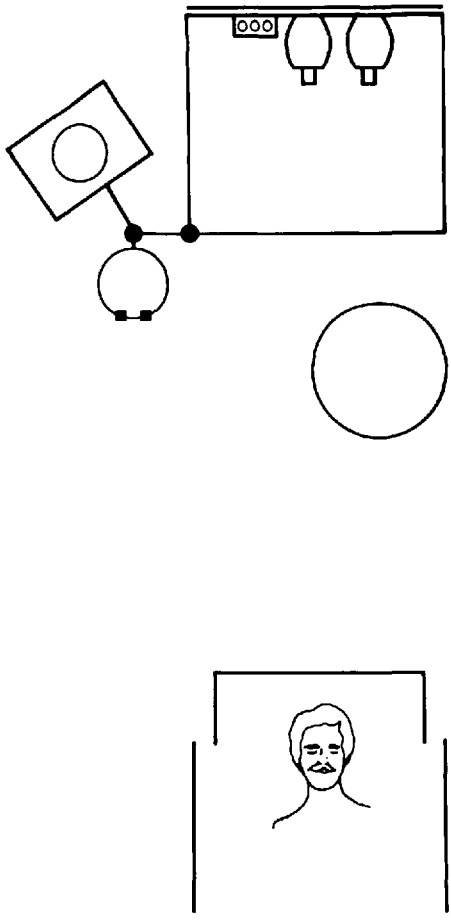

FIGURE 1 Diagram representing relative positions of patient, anaesthetist and anaesthetic machine that was used for collection of data.

the anaesthetic machine (Medishield Boyle Apparatus MS 5056) was measured.

The results (Figure 2) showed there was great variation in the angles found on different occasions (Figure 3). The largest group subtended an angle of approximately 150° and a smaller group approximately 95°. The smallest angle was 48°. An incidental finding was that, in some instances, should the anaesthetist have turned to view the instrumentation on it, the angle of view would have been very oblique and in some instances the monitors would be hidden altogether. An example of this is an oxygen flow meter concealed by a projecting vaporiser.

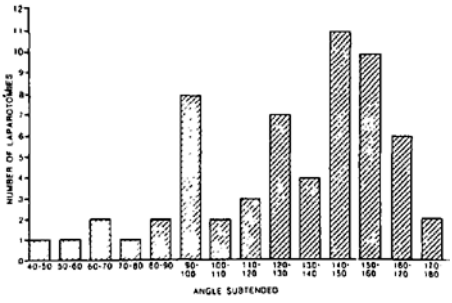

FIGURE 2 Variation in the angles measured and their frequency.

The theme for discussion of these results is their possible significance for the welfare of anaesthetized patients. A normal person's field of accurate vision is very small – 75 per cent at a distance of 33.02 cm (13 inches) for an angle of 1°, and 25 per cent for an angle of 6°.[4] Objects nearest the visual axis are seen with the greatest clarity and as their position deviates from this axis so the objects must provide stimuli of increasing size or intensity if they are to be seen.[5] Information is usually obtained by scanning. Horizontal or vertical eyeball movement to utilize focal vision is augmented with movement of head, shoulders and even the whole body. Thus the findings in this study imply that, to obtain the same visual information with the same frequency, some anaesthetists have to move more than others. The amount of additional work involved is small and bothering to obtain that information is much more likely to be influenced by the conscious decision by the anaesthetist that such information is necessary. However, it is likely that to a greater or lesser degree anaesthetists make continual use of subliminal visual observations, but the visual field is not augmented by body movement. This manner of following the patient's progress is important because it provides an opportunity to notice the unexpected event, an opportunity absent in the prediction of need for an information item.

The results of this study were obtained from the practise of experienced anaesthetists. Correlations with other events during the anaesthetic were not sought or heard of. It may be that the results merely represent variations in behaviour which can result in the same quality of patient care, provided that the behaviour pattern is appropriate for that particular anaesthetist on that particular occasion. During the course of the observations described it appeared that cer-

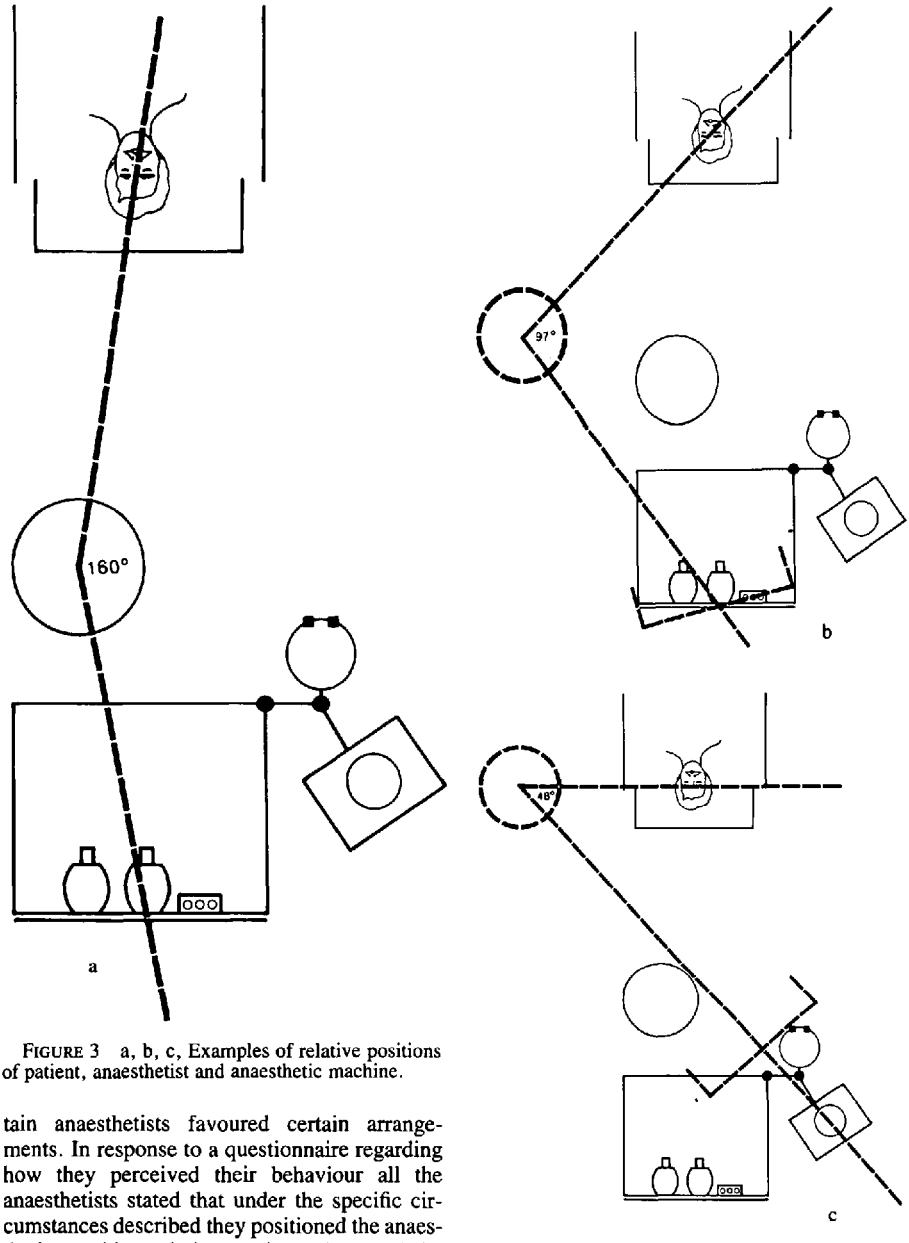

FIGURE 3 a, b, c, Examples of relative positions of patient, anaesthetist and anaesthetic machine.

tain anaesthetists favoured certain arrangements. In response to a questionnaire regarding how they perceived their behaviour all the anaesthetists stated that under the specific circumstances described they positioned the anaesthetic machine relative to themselves and the patients head in the same way on most occasions. They also stated that they deliberately placed the machine where it suited them best. This was in contradistinction to being satisfied with a haphazard location; finding it where they wanted it; or siting themselves to suit the situation they discovered. If this is so then the findings in the operating room represent a variety of anaesthetists' needs that cannot be met by most current anaesthetic equipment and environs for the diverse circumstances in which anaesthetics must be given. Certainly this view

is held by some anaesthetists in practice. In response to the question:

"During an anaesthetic have you personally been associated with a hazardous event which in your opinion could have been prevented if visual information from monitoring equipment had been presented in a more prominent position?"

which was presented in a questionnaire to anaesthetists from different hospitals, eighteen out of thirty-two answered in the affirmative. In reply to the question:

"During your work in the operating room would you like to be able to position the visual information from your monitoring equipment for more convenient viewing that is presently possible for you?"

thirty anaesthetists out of thirty-two answered in the affirmative. This indicates considerable dissatisfaction with existing possibilities.

The critical incident analysis reported by Cooper, *et al.*[6,7] does not include specific reference to visual data acquisition as described here, but it is implicit in the presentation. The Canadian Medical Protective Association consider the process of data acquisition to be one cause of mishaps during anaesthesia.[8]

In the past various attempts have been made to provide the anaesthetist with improved opportunity for data acquisition. Radical changes in the anaesthetic machine have been proposed[9,10] and more recently particular attention to this matter has been made in the design of Ohio Medical Products anaesthetic apparatus. The use of a gas delivery system which permits the permanent removal of the carbon dioxide absorber facilitates the positioning of the "anaesthetic machine" for optimum viewing during very many kinds of surgery. The location of the carbon dioxide absorber on a retractable carriage under the "anaesthetic machine" table (Boyle apparatus with a Coxeter-Mushin carbon dioxide absorber) has a similar effect.[11] However, during anaesthesia training emphasis is rarely placed on the actual process of visual acquisition of data and the factors influencing it while an anaesthetic is being administered. The subject considered here is only one of a great many that concern anaesthetists, but though in this sense miniscule, the process of data acquisition is a vital link between the patient and the other expertise of the anaesthetist.

In conclusion, it seems that the following recommendations should be made to the trainee anaesthetist:

1. Displays of information derived from monitors, gas and vapour delivery systems should be located on the anaesthetic machine consistent with the positioning of the machine in the operating room; preference to be given to the most convenient site for attachment of the item of equipment.
2. The anaesthetist should adopt a position where the patient and apparatus can be seen most conveniently.
3. Lighting consistent with the acuity of vision of the anaesthetist and what is to be observed must be present at all times.
4. A work pattern that helps to maintain vigilence and that is consistent with the most effective viewing of patient and apparatus must be adopted.
5. Arrangements to be made for delivery of information by an appropriate balance of visual, auditory, and tactile signals.

Summary

A study of the relative positions of the patient, the anaesthetist, and the "anaesthetic machine" during routine laparotomy showed great variation. The implication was that there was also great variation in the amount of movement necessary by the anaesthetist if the same amount of information was to be obtained with the same frequency. The significance of this with reference to the quality of patient care is discussed. The role of changes in apparatus and the declared need for this by anaesthetists is mentioned and recommendations regarding the visual acquisition of data during anaesthesia are made.

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RÉSUMÉ

Cette étude a été réalisée dans le but de répondre à la question suivante: lorsqu'ils surveillent une anesthésie brève non compliquée pour chirurgie intra-abdominale réglée les anesthésistes adoptent-ils une position uniforme en relation avec la tête du patient et de l'appareil d'anesthésie et si tel est le cas, qu'elle est cette position?

Les positions respectives du patient, de l'anesthésiste et de l'appareil d'anesthésie pendant une laparotomie ont été sujettes à de grandes variations. Pour obtenir une même quantité et une même fréquence de renseignements utiles, les anesthésistes avaient à effectuer plusieurs changements de positions. L'importance de cette constatation sur la qualité des soins est discutée. Le rôle des modifications de l'appareillage et les besoins rencontrés par les anesthésistes sont décrits et des recommandations sont faites au sujet de l'acquisition de données visuelles pendant l'anesthésie.