Title: **TASK ANALYSIS/WORKLOAD OF ANESTHETISTS PERFORMING GENERAL ANESTHESIA**

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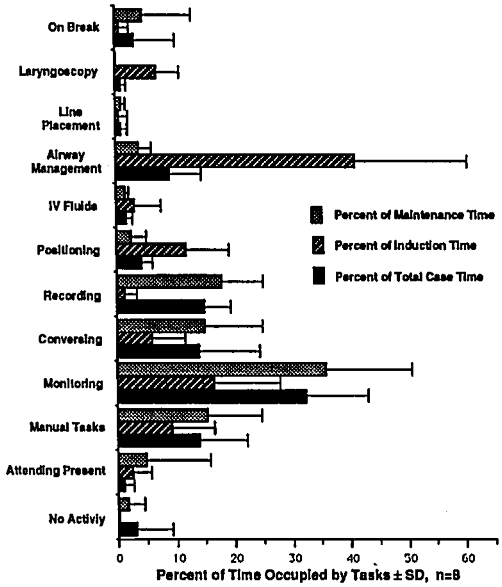
Evaluation of the anesthesiologist's task patterns and workload needs to occur, as it has in other fields, to permit rational decisions about modification of the workspace, but methodology is lacking. The purpose of this study was to evaluate methods of task analysis and workload measurement for use in the clinical environment. Approaches used were: 1) Discrete task analysis; 2) Secondary task probing (provides indirect measurement of the primary task workload); and 3) Subjective workload assessment.

Methods: Following institutional approval, subjects were selected who were all anesthesiology residents or CRNA's performing GETA for cases of 1 to 4 hours duration. Subject activity was resolved into 11 task categories and recorded by a trained observer, using an Apple Macintosh™ computer and a custom Hypercard™ program. The secondary task consisted of arithmetic questions presented on a second Macintosh ™ using another custom Hypercard™ program. Both the subject and the observer intermittently assessed workload subjectively, using the Borg Scale.

Results: Activity trends were evident, despite the small number of cases (n=8) evaluated. 25-35% of case time was spent 'Monitoring.' Analyzed for the induction period alone, 'Airway Management' occupied 40% of the time while 'Monitoring' dropped to 15%. 'Record Keeping' consumed 10-20% of case time but most record keeping (15%) took place during maintenance, with only 2% during induction. Secondary task measurements confirmed that workload was greatest during induction, decreased during maintenance and increased again during emergence. It was our impression that less experienced anesthetists rated their level of workload higher than an observer and the opposite was true for more experienced anesthetists, but further study of this observation is necessary.

Conclusions: Previously reported task analysis techniques have used sophisticated video or eye tracking equipment which is not readily available and requires considerable expertise. The present technique uses off-the-shelf-equipment, requires minimal resources, is easy to use and provides a high degree of task resolution. Secondary task probing is usable in the O.R. Our data confirm that workload varies during an anesthetic and the induction and emergence periods are most demanding. These techniques should be used in prospective, controlled studies to evaluate the impact of factors that may be important for safe and efficient anesthetic practice. The rational design of the anesthesia workstation of the future depends upon data obtained from such studies.

TASK TIMES EXPRESSED AS PERCENT OF THE WHOLE CASE, INDUCTION PERIOD AND MAINTENANCE PERIOD



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TITLE: **CORRELATION BETWEEN LEFT-VENTRICULAR END-DIASTOLIC VOLUME AND PWCP.**

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INTRODUCTION Pulmonary artery catheters measures intracardiac pressures; PWCP estimates the left ventricular end-diastolic pressure (LVEDP), and indirectly, left ventricular end-diastolic volume (LVEDV). This presupposes that during diastole the pulmonary venous bed, left atrium, and left ventricle are a common chamber. In the presence of valvular dysfunction, this assumption is not valid. In addition, the relation between LVEDP and LVEDV - ventricular compliance - is non-linear and varies from individual to individual. By directly imaging the heart, two-dimensional transesophageal echocardiography (2D-TEE) allows for a more precise determination of ventricular size. The present study examines the correlation of PWCP to echocardiographically measured left ventricular end-diastolic volume.

METHOD Mechanically ventilated ICU patients (n = 6) requiring invasive hemodynamic monitoring were included in this study. Informed consent for the procedure was obtained in each case. A super-VHS VCR was used to record all studies. The internal calipers and software incorporated in the Hewlett-Packard Sonos 1000 TEE were used for measurements and calculations. A standard long-axis four-chamber view was used to obtain volume measurements (end-diastolic and end-systolic) using the single-plane ellipse algorithm. Volumetric based cardiac outputs were calculated according to the formula - (EDV-ESV)*HR. PWCP and thermodilution cardiac output were measured in triplicate at end-expiration.

RESULTS Figure 1 illustrates the absence of correlation between PWCP and left ventricular end-diastolic volume ($P > 0.70$). There was instead excellent correlation between volumetric and thermodilution cardiac outputs. Regression analysis of the data yielded a correlation coefficient of $r = 0.82$ and a significance level $P < 0.043$ (Figure 2).

CONCLUSION This study demonstrates that ventricular volumes can be measured in a quantitative manner using 2-D transesophageal echocardiography. There is a an excellent correlation between echocardiographically measured stroke volumes, and those derived using a pulmonary artery catheter. However, the random relationship between PWCP and LVEDV emphasizes the limitations of PWCP as an estimate of LVEDV. Echocardiographic estimates of LVEDV by single-plane ellipse allow a far more precise determination of left-ventricular preload than PWCP. TEE offers a practical method to expand cardiac monitoring with objective volumetric information prior to therapeutic intervention.