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INFLUENCE OF THE HELICOPTER ENVIRONMENT ON PATIENT CARE CAPABILITIES: FLIGHT CREW PERCEPTIONS

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ABSTRACT

INTRODUCTION: Flight crew perceptions of the effect of the rotary wing environment on patient care capabilities have not been subject to statistical analysis. We hypothesized that flight crew perceived significant difficulties in performing patient care tasks during air medical transport.

METHODS: A survey instrument was distributed to a convenience sample of flight crew members from twenty flight programs. Respondents were asked to compare the difficulty of performing patient care tasks in rotary wing and standard (emergency department or intensive care unit) settings. Demographic data collected on respondents included years of flight experience, flights per month, crew duty position, and primary aircraft in which the respondent worked. Statistical analysis was performed as appropriate using Student's t-test, type III sum of squares, and analysis of variance. Alpha was defined as $p \leq .05$.

RESULTS: 55% of programs (90 individuals) responded. All tasks were rated significantly more difficult in the rotary wing environment. Ratings were not significantly correlated with flight experience, duty position, flights per month, or aircraft used.

CONCLUSIONS: We conclude that the performance of patient care tasks are perceived by air medical flight crew to be significantly more difficult during rotary wing air medical transport than in hospital settings.

KEY WORDS: Air medical transport, assessment, procedures, helicopters, emergency medical services, critical care

INTRODUCTION

The provision of medical monitoring and intervention during air medical transport has been shown to exert a positive influence upon patient outcome. In reflection of this fact, the American College of Emergency Physicians has published guidelines for the emergent patient transfer which suggests the use of a vehicle equipped with appropriate life support equipment and personnel (1).

Many obstacles have been encountered as we have sought to expand the envelope of medical capabilities in the rotary wing environment. Vibration and noise are among the most formidable of these. Excessive cabin noise may render stethoscopes and conventional means of communication minimally effective, and vibratory forces may result in equipment disconnects and make pulses difficult to detect. Other factors may also impact inflight patient care. Limitations of cabin space may interfere with manipulations of patients and equipment. Turbulence may require patient restraint and compromise occupant safety, and low levels of cabin illumination may impair clinical observations. Altitude effects may require modification of monitor interpretation, equipment operation, and patient care techniques. The use of adjunctive monitoring equipment such as pulse oximeters and end-tidal carbon dioxide detectors may provide assistance in resolving some of these difficulties, but these devices do not overcome these factors. Further, the impact of the rotary wing environment on patient care capabilities is not always recognized or considered in studies evaluating new monitoring equipment, patient care devices, or procedural techniques (2-5).

It was the goal of this work to evaluate the perceived effect of rotary wing flight on patient care capabilities during air medical transport. A descriptive study was undertaken to determine which medical care tasks are perceived by air medical flight crew to be adversely affected by the rotor wing environment.

METHODS

Factors within the rotor wing environment which might impact the provision of inflight medical care were identified. These factors included ergonomics (the body mechanics and movements required to perform the task), visibility (the degree of interference form sunlight glare or cabin lighting upon the reading of instrument displays or performance of tasks, and noise (the degree of interference in the provision of care from cabin noise). Other identified stressors were vibration (the interference with the provision of care from cabin vibration), flight gear (the effect of crew clothing on performance), cabin temperature, and cabin altitude. For the purpose of study, these factors were grouped together and termed the inflight rotor wing air medical transport environment.

A survey instrument was designed by the authors and distributed to a convenience sample of Medical Directors from twenty rotor wing air medical transport services in the United States. Each Medical Director was requested to have each member of his or her flight crew complete the survey. Completed surveys were subsequently returned to the authors.

Demographic data acquired from each subject included the type of helicopter flown by the respondent's program, the subject's years of experience as a medical flight crew member, the number of flights per month by the crew member, and the crew members professional category (physician, nurse, paramedic, or other).

Patient monitoring and care tasks were listed on the survey instrument. Respondents were requested to rate the difficulty of each task on a scale where 0 represented no difficulty in performance of the task and 4 represented that the task was impossible to perform. Subjects were asked to rate the difficulty of performing the task in a standard hospital acute care setting (emergency department or intensive care unit) and in the rotor wing environment.

Statistical testing was applied as appropriate to determine significance. Level of significance (alpha) was defined as $p \leq .05$.

RESULTS

Flight crew members from eleven programs returned completed surveys for a response rate (by program) of 55%. The total number of respondents was 90; the mean number of respondents per program was 8.4. Six of programs were sponsored by private hospitals and eight were based at university affiliated institutions. No respondents represented public service agencies.

The mean differences between the "standard" environment and the rotor-wing setting for the surveyed patient monitoring and care tasks were determined and reviewed using Analysis of Variance (ANOVA). All tasks were noted to be significantly more difficult in the rotor-wing setting by survey respondents (Table I). In general, tasks relying on detection of sound, utilizing palpation, or involving manipulation of the patient within the confined aircraft cabin were considered most difficult by respondents.

The mean number of years as a flight crew member for all respondents was 3.8, and the mean number of flights per month per respondent was 41.3. Student's T-test was used to compare years of experience and flights per month with perceived task difficulty. No significant differences were noted between these parameters (Table II).

50 respondents categorized themselves as flight nurses, 19 as flight paramedics, 10 as flight physicians, and 11 as other. The Fisher's Protected Least Significant Difference Test was used to compare professional category with perceived task difficulty. No significant difference was seen between nurses, paramedics, and physicians (Table II).

Primary rotor-wing aircraft used by programs participating in the study included the BK 117, BO 105, Aerospatiale 365 N-1, Bell 222, and Bell 412. Analysis of Variance (ANOVA) Type III Sum of Squares revealed an overall disparity between helicopter types for perceived task difficulty. However, when corrected for "standard" environment (ED or ICU) difficulty ratings by individual respondents using environment as a covariant and Analysis of Covariance Sums of Squares, no significant differences were noted (Table II).

as compared with intubation in the ED or ICU. Some of these issues have begun to be addressed by Thomas and colleagues in their study of times to initiate CPR, external pacing, defibrillation, and intravenous drug therapy in one ground based and two rotor wing aircraft environments (9).

The importance of this work lies in that, for the first time, the perceived difficulties of patient care while aloft have been quantified. Those procedures felt to be most difficult have been identified, and a method has been tested for evaluating the impact of changes in equipment or techniques upon the perception of difficulty in performing the procedure in the helicopter. These results may spur equipment manufacturers, physicians, and educators to develop new devices and techniques specific to the setting of air medical transport.

CONCLUSIONS

The performance of patient care tasks is perceived to be significantly more difficult in the rotor wing environment as compared with the hospital setting. Differences are greatest for the manual determinations of breath sounds and blood pressure, application of the MAST suit (PASG), intravenous catheterization, urinary catheterization, endotracheal intubation, and communications between the care provider and the patient. Medical flight crew duty position, experience as a flight crew member, type of aircraft used by the flight program, and number of flights per month by crew members has no effect on perceived task difficulty.

DISCUSSION

The effect of the aviation environment upon patient care tasks has long been a subject of active debate within the air medical transport community. However, little published data exists to aid in evaluating the issue. The rapid expansion of air medical services in the United States, coupled with questions about the efficacy of such services and the need for cost containment, makes analysis of these factors a critical need in the air medical transport community.

Many difficulties with patient care in the helicopter environment are intuitive. Those who have participated in rotor wing air medical transport know from experience that certain patient assessment and care tasks can be difficult while in flight due to operational factors and lack of cabin space. Several works have documented the difficulty of auscultating breath sounds, palpating carotid pulses, and performing closed chest cardiopulmonary resuscitation in rotor wing aircraft (6-8). This experience is the major reason why air medical transport programs stress to their "customers" (referring physicians, institutions, and emergency medical services agencies) the need for optimal stabilization prior to transport, as untoward events which occur during transport may be undetectable by flight crew.

This work is the first that attempts to evaluate flight crew's perceptions of the influence of the helicopter environment on patient care tasks during air medical transport. Because the study involves perceptions, however, the results must necessarily reflect any prejudices held by subjects or any influences upon the respondents. As an example, we did not control the settings in which the surveys were completed. If they were completed in a group meeting, there may have been a desire to "not look bad" in comparison to one's peers. This specific influence may have diminished reported differences between performance of procedures in the hospital and helicopter. In addition, we did not control for the manner in which difficulty is perceived. To some respondents, increased difficulty may have meant increased time to perform the procedure; to others, a decreased level of comfort or confidence. We also did not control to ensure that each respondent had actually performed the task he or she was rating. With few exceptions, the patient care tasks listed are likely common to all flight programs and all crew duty positions. Finally, we did not evaluate the flight crew member's experience with each task before joining the flight program. Increased levels of experience on the ground might have mitigated some of the perceived differences in task performance while aloft. While the wide distribution of the survey and the lack of significant differences in reported difficulties between different categories of flight crew, varied levels of experience, and aircraft utilized may ameliorate some of this error, the fact remains that this study reviews perceptions and is subject to the sources of error inherent in such work.

It is important to note that this study does not rate the objective impact of these perceived difficulties. Further work is clearly indicated to determine the operational influence of this data. It would be useful for air medical transport providers to know if the increased difficulty of performing endotracheal intubation in flight results in longer procedure times, an increased rate of error in tube placement, or increased morbidity and mortality rates

TABLE II

RATINGS OF TASK DIFFICULTY BY DEMOGRAPHIC DATA

Demographic parameter	Statistical test used	p compared with task difficulty
Flights per month	Student's t-test	0.46 (not significant)
Years flight experience	Student's t-test	0.99 (not significant)
Professional category	Type III sum of squares	0.12 (not significant)
Primary aircraft type	Type III sum of squares	0.42 (not significant)

[redacted]

TABLE I

DIFFICULTY IN PERFORMING MEDICAL TASKS

Task	Ground	Aircraft	Difference**
Lungs (conventional stethoscope)	1.19	3.19	2.00
Arterial line start	1.25	2.54	1.26
PASG application	1.13	2.35	1.26
Manual cuff BP	0.69	1.90	1.20
Verbal communication	0.57	1.77	1.20
Urinary catheter insertion	0.88	2.00	1.12
Orotracheal intubation	1.04	2.09	1.05
Drug assisted intubation	0.79	1.82	1.03
IV start	0.65	1.58	0.93
Lungs (amplified stethoscope)	0.87	1.79	0.92
Nasotracheal intubation	1.01	1.91	0.90
Tube thoracostomy	1.38	2.22	0.86
CPR chest compressions	0.73	1.59	0.86
Temperature (glass thermometer)	0.40	1.26	0.86
Written communication	0.59	1.40	0.81
IM meds administration	0.36	1.11	0.75
BP (automatic cuff)	0.36	0.96	0.60
NG/OG tube placement	0.48	1.08	0.60
Pulse oximetry	0.31	0.83	0.52
IV med administration	0.19	0.70	0.51
Needle thoracostomy	0.53	1.03	0.50
End tidal capnometry	0.28	0.76	0.48
Pulse assessment	0.20	0.65	0.45
Bag-valve-mask ventilation	0.29	0.73	0.44
Respiratory rate assessment	0.20	0.63	0.43
Headset communication	0.23	0.65	0.42
Temperature (electronic)	0.20	0.61	0.41
Mechanical ventilation	0.58	0.96	0.38
Electrocardiographic monitoring	0.10	0.45	0.35
BP via arterial line	0.55	0.90	0.35

** *All differences were statistically significant ($p \leq .05$) as determined by analysis of variance.*

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