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Teamwork in the ICU: From Training Camp to the Super Bowl*

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It has long been understood that in order to improve patient outcomes, there needs to be teamwork and collaboration between healthcare professionals. *To Err Is Human: Building a Safer Heath System* (1) brought to light the poor patient outcomes that were attributed to errors made by healthcare professionals, particularly errors related to ineffective communication within and between professions. In a recent literature review, Dietz et al (2) found that the concept of teamwork is very widely defined in ICU research and it is unclear how, beyond, very specific situations, such as rounding, the ICU team functions. Also, although the ideas of teamwork and collaboration are felt to be important, there still exists a hierarchical culture within ICUs (3).

In order to improve the function of healthcare teams, and truly improve patient outcomes, we must first look to identify how, in reality, work is accomplished in the ICU. In this issue of *Critical Care Medicine*, Alexanian et al (4) look to identify how healthcare professionals work within the ICU environment.

Over a 6-month period, two medical anthropologists spent a total of 364 hours observing two medical-surgical ICUs, one an urban teaching hospital with a closed ICU and the other an open ICU in a community teaching hospital and conducted interviews with 21 and 15, respectively, healthcare professionals. They found that although the concepts of team and teamwork were frequently used to describe how the ICU functioned, this did not translate to what was observed outside of an emergent situation. What they found was that collaboration, coordination, and networking better described what was observed. Even during rounds, which were felt to be multiprofessional, frequently the medical professionals functioned as a team while other healthcare professionals provided information and answered questions that were asked of them, but did not always participate in the discussion and planning. Frequent, informal conversations also took place throughout the day that might or might not have had influence on the plan of care for a patient.

Although it is important for us to understand how healthcare professionals function within the ICU, there are only two ICUs that are observed in this study, both medical-surgical ICUs, and a small number of healthcare professionals interviewed. The number of medical professionals interviewed were 43% and 27%, respectively, with nursing accounting for 24% and 33%. The remainder of those interviewed at each site included, but were not limited to respiratory therapists, social workers, physical therapists, and nutritionists. They did not look at patient outcomes, as the goal of this study was to only describe how healthcare professionals work together.

***See also p. 1880.**

Key Words: collaboration; intensive care unit team; interprofessional communication; teamwork

Ms. Kelso provided expert testimony for various entities (nonrelated to this topic) and lectured for Mass General Hospital (Albert H. Brown Medical Visiting Nursing Scholar, April 2015; unrelated to this topic).

DOI: 10.1097/CCM.0000000000001177

Dietz et al (2) identified communication to be the construct that was most frequently identified when discussing the importance of teamwork, as communication was important within multiprofessional rounds as well as in transitions of care. However, Rose (5), in reviewing the literature, found that not only nurses but junior medical professionals rated interprofessional communication lower than senior medical professionals. This speaks to the concept of the team and how it works within the ICU. Wheelan et al (6) studied 17 ICUs and found that staff who felt their teams functioned at a higher level of group development had lower than expected mortality rates. As the healthcare team developed a level of trust, improved communication and discussion led to improved patient outcomes.

Aviation has long been the industry that healthcare has turned to in order to identify how we can improve communication and teamwork with the intent of better patient care and outcomes (7). Crew Resource Management has been adapted to train healthcare teams on how to be more effective; however, in a study conducted by Grogan et al (7), although healthcare professionals felt the course improved teamwork and was of value, participants did not feel as though it would change the way they performed. The intensity and stress of aviation and the ICU are similar; however, there are differences that might limit how important healthcare teams view the relationship between aviation and ICUs (8). In aviation, an error can lead to a catastrophic result impacting hundreds, while an error in the ICU may have a tragic result impacting one patient and their family.

Although the impact is certainly not life altering, the communication and teamwork needed in the ICU can be likened to that needed on the gridiron. In the 2-minute drill, the quarterback is the coordinator of all that occurs for the team to successfully drive down the field to win the game. All members of the offense have their predefined role, and how well they communicate and work together will determine how successful they will be. Throughout the rest of the game, all members of the team play a role in identifying how they can be successful in scoring or preventing their opponent from reaching the end zone. Anyone may point out an open route, pick up a blitz, or recognize a pattern that can be disrupted.

From the first day of training camp, players are identified and developed so that they can become successful members of the team. Throughout the season, each player continues to develop with one goal, to win and get that "RING." No matter how talented each individual member of the team may be, if they can't work together, they will find themselves sitting at home watching the Super Bowl.

It is clear, from the current study, that many ICU teams are still in training camp, have not really learned how to function as a team, and have a ways to go in order to truly impact patient outcomes. Although we may be great at the emergency, 2-minute drill, to be a successful team, we have to improve how we work together outside of an emergency. We start by identifying where we are.

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CRITICAL CARE

VIEWPOINT

Teamwork and team training in the ICU: Where do the similarities with aviation end?

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Abstract

The aviation industry has made significant progress in identifying the skills and behaviors that result in effective teamwork. Its conceptualization of teamwork, development of training programs, and design of assessment tools are highly relevant to the intensive care unit (ICU). Team skills are important for maintaining safety in both domains, as multidisciplinary teams must work effectively under highly complex, stressful, and uncertain conditions. However, there are substantial differences in the nature of work and structure of teams in the ICU in comparison with those in aviation. While intensive care medicine may wish to use the advances made by the aviation industry for conceptualizing team skills and implementing team training programs, interventions must be tailored to the highly specific demands of the ICU.

Introduction

Teamwork in the intensive care unit (ICU) refers to the leadership, decision-making, communication, and coordination behaviors used by multidisciplinary team members to provide patient care [1]. Patient safety research has demonstrated the importance of effective teamwork for ensuring positive patient outcomes in the ICU. Poor communication during rounds and handovers (or handoffs) is frequently cited as a cause of medical error [2-4], and units with high levels of nurse-doctor collaboration have improved patient mortality rates and reduced average patient length of stay [5]. In attempting to understand and improve teamwork in the ICU, researchers cite teamwork models and training techniques used to manage and improve teamwork skills in aviation [1,6]. Like work environments in aviation, the ICU is a complex, high-risk, and stressful setting, and it can potentially gain from adopting and integrating the principles and techniques used to train team skills in aviation [4]. We consider the case for this and reflect upon the similarities and differences that exist between aviation and intensive care.

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The aviation teamwork model

The aviation model of teamwork draws heavily from social and cognitive psychology and is based on an understanding that team behavior can both cause and protect against error. It considers the team-related 'active failures' (for example, failures to communicate the proximity of nearby aircraft) and 'latent failures' (for example, lack of team training, poor ergonomic design, and organizational culture) that influence behavior and error in the cockpit [7]. Psychology concepts relating to communication, shared decision-making, leadership, team cohesion, team mental models (shared knowledge structures for teamwork and taskwork), and team climate are applied to understand performance and error. Through the use of systemized models, these various concepts are bound together to explain how 'team processes' (for example, leadership and communication) predict 'team outputs' (for example, error and team effectiveness). Furthermore, shared knowledge structures and 'team inputs' (for example, group hierarchies and culture) are shown to influence teamwork behaviors, and safety culture is particularly significant [8].

To understand the specific team behaviors important for safety in aviation, human factor specialists have performed cognitive task analyses, error analyses, attitudinal surveys, observational studies, and ergonomic assessments. These data have structured the content of team training packages [9] and have contributed to the identification of teamwork knowledge, skills, and attitudes that underpin effective team performance (Table 1). Training and assessment in aviation focus on improving communication skills, briefing behaviors, self-critique, leadership skills, workload management, vigilance and stress management, knowledge of team member skills/roles, and attitudes toward teamwork. Teamwork

Table 1. Team knowledge, skills, and attitude competencies

Element	Description
Knowledge competencies	Knowing a team's goals, objectives, and resources Knowing the strategies used to cope with task demands for specific situations Knowing task procedures and how taskwork will be divided Knowing team roles and expected interaction patterns between team members Knowing team member competencies, behavioral tendencies, and strengths and weaknesses
Skill competencies	Monitoring team members to support their performance Providing feedback and coaching to team members whose performance is less than optimal Recognizing and assisting team members when they need help or are unable to perform effectively Rapidly adapting to changing events Ensuring receipt and verification of information when communicating with team members Ability to cooperate and share problem-solving tasks and to resolve conflicts with mutual satisfaction Leadership in coordinating and motivating team members, assessing performance, allocating and re-allocating tasks, and planning and organizing work Contributing to a positive team climate
Attitude competencies	Belief in team cohesion Preference for being part of the group Trust and confidence in team members Preference for approaching problems with a team rather than individual approach Belief in the importance of teamwork and team-oriented behaviors

This table, adapted from Baker and colleagues [21] and Salas and colleagues [9], is original and has not been reproduced elsewhere.

research in the ICU has shown that the systems and concepts used to understand team performance in aviation are also relevant for patient safety in intensive care medicine [1,10]. However, although team training has become increasingly common within the ICU [11], much can be learned from the aviation industry's advances in developing and integrating into practice the systems for measuring team behavior, providing feedback, and developing teamwork skills.

In aviation, team training is mandatory for commercial pilots in Europe and the US. Virtually all large airlines use team training packages. These use a combination of simulation and class-based training to help aircrews (a) prevent errors from occurring, (b) identify and trap errors, and (c) mitigate the consequences of error [12]. The aviation model provides aircrews with ongoing team training (for example, annually) and uses established pedagogic models to evaluate effectiveness. Such programs have a demonstrable impact on the attitudes of participants toward teamwork, teamwork behaviors, and knowledge of human factors [13]. Validation of crew resource management skills is a training requirement throughout the aviation industry, and best practice is determined by regulators [14]. Despite evidence that the importance of team training is widely accepted in health care, it has not been adopted uniformly and the number of teams that regularly participate in training is still small [15].

Key to the success of team training tools in health care is the identification of the domain-specific team skills required for effectively managing routine and emergency scenarios. In aviation, training strategies have focused on improving the skills required by aircrews to maintain effective decision-making under high levels of stress [9]. Techniques include exposing teams to high-stress situations, training pilots to facilitate team discussions before and after stressful team activities, and cross-training aircrew team members to understand the demands and needs of one another's role. Teams are trained in a multidisciplinary environment (for example, pilots and cabin crew) to facilitate an understanding of the challenges associated with different professional roles, to consider how group hierarchies influence behavior, and to develop expectations for behavior during different scenarios [16]. This training helps aviation teams to form shared and positive perceptions on teamwork and stress management. To assess performance, observational systems for rating teamwork behaviors in the cockpit have been developed. These tools assess teamwork through observable behavioral indicators that indicate good or poor aircrew team skills. Assessment and training can occur at either the individual or group level, and structured qualitative feedback is provided to participants.

It is clear that the team training and assessment techniques used in aviation are relevant to the ICU. For example, in the ICU, as in aviation, hierarchical team structures have a negative impact on the attitudes and behaviors of doctors and nurses and, in turn, on patient safety [4,17]. Furthermore, a range of teamwork and leadership behaviors important for team performance and patient safety have been identified [1,11,18,19]. In terms of applying this knowledge to formal team training programs, courses such as Advanced Trauma Life Support teach team skills and may provide a model for introducing team training into the teaching curriculum [20]. Training would consist of general principles underlying optimal team performance in the ICU (for example,

Table 2. Key stages in the design and implementation of a team training program [14,21]

Stage	
1. Conducting a needs assessment	An assessment of the team behaviors associated with effective and safe performance in the task domain must be made along with an evaluation of the gap between actual and optimal performance. From this assessment, a team training curriculum can be devised.
2. Developing training objectives	The objectives of team training should be explicitly stated (for example, to influence attitudes and behavior) in order for measures to be developed to assess training efficacy.
3. Selecting training methods	Common methods include instructional, demonstrative, or practice-based training, and their usage will depend on the training objectives. The setting used for team training should be considered carefully along with teaching resources (for example, availability of high-fidelity simulators and training staff).
4. Designing a training strategy	The training strategy should be designed to meet the stated training objectives. This might include (a) introducing participants to teamwork theory, (b) providing them with opportunities to practice and receive feedback on teamwork skills, and (c) providing recurrent training to reinforce teamwork skills.
5. Implementing the team training	The purpose of a team training program should be clearly articulated and communicated to participants and tutors prior to implementation. Team training should be blended into practitioner training, and managerial staff must display a commitment to the importance of team training. The quality of the curriculum and teaching should be constantly monitored, assessed, and adapted where necessary.
6. Evaluating the training	Measures should be devised to regularly test the impact of the training upon (a) individuals (for example, attitudes, knowledge, and observations of practice) and (b) the organization (for example, error rates and safety climate).

This table is original and has not been reproduced elsewhere.

communication openness) and also the behavioral strategies associated with specific practices (for example, resuscitations). Table 2 notes the key stages associated with implementing an organization-wide team training program [14,21].

Key difficulties in developing such a program would likely be related to the resources involved in managing a comprehensive team training program (for example, trainers, simulators, and clinician time to participate), ensuring that programs are consistent across intensive care medicine, avoiding duplication with other team training programs (for example, anesthesia), generating intuitional support for team training, and identifying the key team training requirements for multidisciplinary ICU teams. To develop team training programs for the ICU, it is necessary to consider the extent to which the models used to conceptualize team performance in aviation can be applied in intensive care medicine.

Comparisons between aviation and the intensive care unit

As discussed above, parallels have been made between teamwork in aviation and intensive care. ICU teams are also reliant upon teams that manage risk, complex technologies, changeable workloads, and uncertainty [22]. Fatigue and stress are known to negatively influence performance in the ICU [23], and non-technical factors such as team communication, situation awareness, and decision making frequently underlie error [4]. However, there are also a number of general critiques that can be made in the comparisons drawn between aviation and health care [24-26]. For example, owing to the catastrophic consequences associated with in-flight safety failures, there are positive perceptions (and a general awareness) of safety culture throughout aviation. This is not necessarily the case in health care [26]. In addition, medical errors often influence only a single patient (and their family) and, except in cases of negligence, the outcomes rarely impact other patients or health-care providers. In aviation, passengers and aircrews share the consequences of risk. Furthermore, aircrews typically manage stable interlinked systems that operate within expected parameters, and emergency events occur when the functioning of these systems is threatened. Conversely, teams in acute medicine frequently encounter emergency situations. They must tolerate high levels of risk and develop an ongoing understanding of the complex interactions between medical treatments and patient physiology.

In regard to differences between aviation and the ICU, a number of further distinctions can be drawn (Table 3). It is notable that comparisons between aviation and acute medicine often focus on the domains of anesthesia and surgery. This reflects similarities in procedures with aviation (for example, pre-operative checks, induction, extubation, post-operative checks, and awakening). However, the organization of work in intensive care medicine limits the extent to which these parallels can made. For example, unlike aviation work environments, ICUs consist of large medical and nursing teams that care for numerous patients simultaneously. Patients usually enter the ICU in an already critical state. Problem solving is key, and teams must diagnose poorly understood patient illnesses, stabilize the condition of patients, and stimulate recovery. Team members have minimal prior knowledge of patient histories, and patient populations are diverse in terms of demographic background, risk factors, and underlying pathology.

Table 3. Key similarities and differences in the challenges faced by intensive care unit and aviation teams

	Similarities	Differences
Environment/taskwork	Reliance on complex technology Constant innovation in technology and working practices Performance depends on cognitive performance of operators (for example, situation awareness, problem solving, and decision making) Ever-present need to manage uncertainty and risk, particularly during emergency scenarios Dependency on multidisciplinary expert teams Use of handovers to transfer information Need for collaboration with external agents/units	ICU work is more varied in nature, with teams diagnosing diverse illnesses, applying treatments, and managing emergencies. ICU teams tend to perform more 'hands-on' work than aviation teams. Patients are experiencing a crisis on admittance to the ICU; diagnosis is critical and often teams must apply risky and uncertain treatments. Emergency scenarios in the ICU are more common than in aviation. Resources in the ICU frequently are stretched to capacity (for example, patient numbers). Patient outcomes in the ICU are variable; a significant proportion of patients die. Duration of patient care can be undeterminable, and treatment continues after discharge.
Safety and error	Error threatens the safety and well-being of patients/passengers. Vigilance and monitoring behaviors are critical for avoiding error. Factors such as fatigue, stress, and burnout increase the likelihood that errors will occur. Non-technical factors such as communication, situation awareness, and decision making frequently feature as causes of error.	Errors in aviation can be identified more easily (for example, through computers and air traffic controllers). The magnitude of harm caused by errors in the ICU is less than in aviation, and consequences/causes of error may not be immediately noticeable. Aircrews and passengers share the potential consequences of error. Error reporting is more commonly discussed in aviation, and staff have more positive perceptions of safety culture.
Team performance	Generic skills, knowledge, and attitudes that underpin effective teamwork in aviation are likely to be similar in the ICU. Team hierarchies and group norms can negatively influence the performance of junior team members (for example, speaking-up behaviors). Communication behaviours for building shared mental models for teamwork and taskwork are important in both aviation and the ICU. Effective team leadership is a key determinant of team performance. Procedures used to maintain safety in aviation (for example, checklists) have been shown to have a favorable impact on outcomes in the ICU. Simulators can be used for team training in both domains.	Team structures in the ICU differ substantially, and senior doctors manage large groups of multidisciplinary team members. Teams in the ICU tend to be more hierarchical in nature. ICU team leaders have greater autonomy over leadership style and operating procedures, and leaders rotate on a daily or weekly basis. Expertise is widely distributed in the ICU, and trainee doctors learn 'on the job' and often without direct supervision (for example, at night). Team decision-making in the ICU can be influenced by a range of external parties, including patients, families, surgeons, and pharmacists. Protocols for communication tasks and handovers have greater standardization in aviation. Standardization for many team-related functions may not be possible or desirable.

This table is original and has not been reproduced elsewhere. ICU, intensive care unit.

In addition, the flow of work in the ICU differs considerably from that in aviation. For example, within a single ICU, teams will perform a diverse range of hands-on, problem-solving, and monitoring tasks [27]. In comparison, aircrews typically monitor and adjust a stable system in which outcomes are usually clear (and positive), and team and task skills are essential for avoiding or managing emergency situations. Problems in aircraft technical performance are often raised through automatic warning systems, and periods of activity tend to be discrete (for example, a 12-hour flight). In the ICU, length of patient care is frequently undeterminable, and the duration of stay depends on the likelihood that patients will experience a sudden deterioration, the stage of treatment, and system factors within a hospital (for example, available bed spaces). Patient outcomes are often unclear, and approximately 20% of UK patients do not survive intensive care. Furthermore, patient care within the hospital system does not cease when a patient is discharged from the ICU, and patients may return. Numerous clinical and nursing staff may provide patient care, and continuity of care is maintained through regular handovers. While these are key to maintaining the quality and safety of care, they can be un-standardized and subject to error [28]. Furthermore, an ICU will typically have several specialists leading the unit, and compared with their counterparts in aviation, each has substantial autonomy in terms of leadership style and preferred operating procedures. This can result in inconsistencies (between specialists) in their expectations for the standards and procedures used to manage patient care and in their expectations for teamwork behaviors and attitudes [19].

Despite these differences, intensive care and aviation teams do share similarities. Both settings involve team-centric, risky, time-pressured work. They are multidisciplinary in nature and exhibit clear differences in the expertise and authority of team members. Furthermore, team performance is influenced by factors such as team leadership and shared cognition [19,29,30], and lessons can be drawn from the psychology literature on error avoidance and performance-enhancing strategies [8]. It is notable that both ICU specialists and pilots believe in the importance of teamwork for safety and reject steep team hierarchies [31]. However, in comparison with pilots, ICU specialists are less likely to report making errors (or to feel comfortable discussing error), and they tend to have overly positive perceptions (compared with junior team members) toward team communication [17,32]. Furthermore, although both aviation work environments and the ICU are highly stressful, intensive care specialists are less likely (than pilots) to acknowledge the detrimental impact of factors such as stress and fatigue upon safety and performance [31].

Team structures in the ICU also differ somewhat from those in aviation. Senior intensivists are generally considered 'expert' in the ICU, and the majority of medical staff are in a training role. Trainees perform much of the hands-on clinical work and must learn to coordinate with nursing teams that have their own team structures, hierarchies, and levels of expertise. At an advanced level, trainees must learn to manage the ICU on their own (for example, at night). Although senior intensivists are available to provide support, the thresholds for requesting help can depend on the trainee's disposition to solicit help and on perceptions of the senior intensivists' attitude toward false alarms. A further difference with aviation is the participation of other actors in 'operational' decision-making. For example, patient decision-making in the ICU can be influenced by non-clinical staff (for example, patients and families) and colleagues from other departments (for example, surgery). However, like aviation teams, ICU teams regularly work with colleagues in other departments (for example, surgery, microbiology, and radiology). Cockpit crews must also coordinate with teams in disparate locations (for example, air traffic control towers). Yet in the ICU (and in healthcare in general), the lines and protocols of communication between hospital units are often informal, un-centralized, and fragmented [26].

An additional parallel between the ICU and aviation is the reliance on protocols to ensure safety and quality. In the ICU, a range of technical protocols are used to structure patient care and ensure safety. Aviation teams also use numerous protocols (for example, pre-flight checks), and within the ICU the emulation of aviation-style protocols to improve patient handovers has been shown to have positive outcomes [33]. However, owing to high levels of uncertainty associated with ICU patients, clinical judgment remains key for determining patient treatments and outcomes, and the extent to which it is desirable to extend protocols to aspects of teamwork and decision making is unclear [15]. Finally, the use of simulation in ICU training is increasing, and this will help to facilitate the adoption of the multidisciplinary team training methods used in aviation.

Conclusions

On the surface, the aviation model does provide a strong initial platform against which to design and implement team training programs for the ICU. The generic teamwork skills that underpin effective performance are similar, and the process of team training should draw on similar methods and techniques. However, it can be seen that there are many differences between aviation and the ICU in the nature of work and team performance (Table 3). It is not sufficient or desirable to simply transfer to the ICU the programs developed for aviation or the operating theatre (where, it can be argued, the cognitive structure of work is quite similar to that of aviation). Rather, team training in the ICU must consider the ebb and flow of work in critical care, and programs must focus on routine and non-routine events, and be reflective of cognitive tasks, team structures, and group norms. The specific team skills and behaviors that underpin team performance must be captured and explicitly stated if we are to develop a relevant and sustainable model of team training and assessment for the ICU.

This article is part of a series on *Healthcare Delivery*, edited by Dr Andre Amaral and Dr Gordon Rubenfeld.

Abbreviation

ICU, intensive care unit.

Competing interests

The authors declare that they have no competing interests.

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Published: 30 November 2011

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doi:10.1186/cc10353
Cite this article as: Reader TW, Cuthbertson BH: Teamwork and team training in the ICU: Where do the similarities with aviation end? *Critical Care* 2011, **15**:313.

Head To Head

Have we gone too far in translating ideas from aviation to patient safety? Yes

BMJ 2011; 342 doi: http://dx.doi.org/10.1136/bmj.c7309 (Published 14 January 2011) Cite this as: BMJ 2011;342:c7309

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James Rogers thinks that attempts to learn from aviation are ignoring fundamental factors in healthcare, but **David Gaba** (doi:10.1136/bmj.c7310) argues that much more could be done

Why are doctors constantly told to adopt aviation safety practices? My own specialty of anaesthesia is particularly vulnerable, based on the dubious analogy that giving an anaesthetic is similar to flying an aircraft. Although initiatives such as the World Health Organization's surgical safety checklist are generally welcome, the aviation model has only a limited place in medicine because there are fundamental differences between the ways in which doctors and pilots work.

Using a checklist should never detract from the priorities of flying an aircraft or looking after a patient safely. Immediate actions should be committed to memory, followed by reference to a concise aide memoire. Crucially, a checklist is distinct from a briefing, which is normally given at two specific times during a flight—before departure and before descent. A briefing deals with all the "what ifs?"(where to divert to in bad weather, what to do if an engine fails on take-off) and deliberately takes place at a time in flight when workload is relatively low. In the operating theatre the checklist and briefing have merged untidily— team introductions, discussions, and concerns are integral to a briefing but shouldn't feature on a checklist.

A proper checklist prompts a "challenge-response" dialogue that is conducted in a rapid, efficient way. This works well on the flight deck with only two people involved, both of whom are suitably qualified and alternating between flying and non-flying pilot roles. Standard operating procedures have defined these roles clearly, allowing a captain and first officer who have not previously met to fly a route, both confident of each other's actions and responsibilities. Such standardisation is an unrealistic aspiration in the operating theatre, where there are more people, a varied skill mix, and a constant to-ing and fro-ing. The person reading the checklist often responds to his or her own challenge, thus losing the element of cross checking of items with another team member and negating the value, and there are more likely to be “authority gradients,” discouraging junior team members from questioning their seniors. Crew resource management programmes have enabled airlines to reduce such behaviour on the flight deck, but overbearing personalities are still widespread in medicine.

Value of experience

Emergency drills and checklists don’t take experience into account. Pilots train for events they may never encounter, but doctors deal with emergencies frequently and develop judgment. For example, only a few patients with postoperative airway obstruction require re-intubation, but you need to have seen a fair number to decide which they are. In addition, pilots aren’t often faced with having to diagnose—the computerised monitoring systems will display not only exactly what is wrong but also the relevant actions to take. Even with this degree of automation, human confirmation of a problem at the initial stage is useful—as long as it’s correct. In the Kegworth disaster, the crew declared an engine failure on the right rather than the left and went on to mistakenly shut down the good engine.

Are checklists and emergency drills infallible in aviation? Not necessarily—but that’s usually apparent only with the wisdom of hindsight. For example, in the Concorde disaster at Paris, should the pilot have made a snap decision to abort the take-off even after having passed “V1,” the “must go” airspeed, contrary to established procedures? Would the outcome have been better if his burning aircraft had overshot the runway but come to a halt, rather than taking to the air?

Risk management

The expectation in aviation is that everything should go smoothly; equipment is standardised and pilots fly only aircraft on which they have been trained. Even variables such as weather are dealt with—there are strict minimum conditions that must be met before starting an approach to land. In contrast, ill patients come in all shapes and sizes, and diseases follow different courses, even before allowing for the fickleness of human behaviour. Unsurprisingly, the mindset of pilots and doctors is different—in medicine not only do we tackle situations that are inherently dangerous, such as operating on the moribund patient, but we are also obliged to outline the risk and obtain consent to proceed. This doesn’t happen in commercial aviation; if something—equipment, weather, runway condition—doesn’t meet standards, you simply don’t fly (and you don’t consult the passengers in reaching that decision).

The evolution of simulators in aviation has been financially driven. Yes, it helps that emergency situations can be reproduced and drills practised, but using a simulator instead of an empty aircraft for conversion training represents a massive saving. Pilots are able to fly a new aircraft type for the first time on a routine passenger flight (albeit alongside an experienced training captain and extra pilot), such is the quality of their preceding simulator experience. Simulators in medicine don’t offer the same degree of realism, or such obvious value for money.

Safety culture

What would transfer well to medicine? Firstly, the established Confidential Human Factors Incident Reporting Programme (CHIRP), for self reporting near misses and human errors—for example, being distracted and not following an important air traffic clearance. The National Patient Safety Agency operates a similar scheme but, unlike CHIRP, does not publish the original firsthand accounts of incidents. Secondly, a recommended procedure in an emergency situation is given by the mnemonic "DODAR"—diagnosis, options, decision, assign tasks, and review. This offers a structured framework for decision making and using resources to best effect. In particular, "review" encourages situational awareness—do my original assessment and actions still fit with the overall picture?

Doctors need to understand why certain practices work well in aviation but not necessarily in medicine. We should not be seduced by the polished image of flying or introduce unsuitable systems into a different environment. After all, pilots enjoy their job without feeling the need to mimic doctors.

Notes

Cite this as: *BMJ* 2011;342:c7309

Footnotes

- I thank Tim Tuckey, an Airbus A320 captain.

- Competing interests: The author has completed the unified competing interest form at www.icmje.org/coi_disclosure.pdf (available on request from him) and declares no support from any organisation for the submitted work; no financial relationships with any organisation that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

- Provenance and peer review: Commissioned; not externally peer reviewed.

The Link Between Teamwork and Patients' Outcomes in Intensive Care Units

By Susan A. Wheelan, PhD, Christian N. Burchill, RN, PhD, and Felice Tilin, PhD. From GDQ Associates, Inc, Provincetown, Mass (SAW), University of Pennsylvania Health System (CNB), and University of Pennsylvania (FT), Philadelphia, Pa.

• BACKGROUND *Links between teamwork and outcomes have been established in a number of fields. Investigations into this link in healthcare have yielded equivocal results.*
• OBJECTIVE *To examine the relationship between the level of self-identified teamwork in the intensive care unit and patients' outcomes.*
• METHOD *A total of 394 staff members of 17 intensive care units completed the Group Development Questionnaire and a demographic survey. The questionnaire is a reliable and valid measure of team development and effectiveness. Each unit's predicted and actual mortality rates for the month in which data were collected were obtained. Pearson product moment correlations and analyses of variance were used to analyze the data.*
• RESULTS *Staff members of units with mortality rates that were lower than predicted perceived their teams as functioning at higher stages of group development. They perceived their team members as less dependent and more trusting than did staff members of units with mortality rates that were higher than predicted. Staff members of high-performing units also perceived their teams as more structured and organized than did staff members of lower-performing units.*
• CONCLUSIONS *The results of this study and others establish a link between teamwork and patients' outcomes in intensive care units. The evidence is sufficient to warrant the implementation of strategies designed to improve the level of teamwork and collaboration among staff members in intensive care units. (American Journal of Critical Care. 2003;12:527-534)*

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The purpose of this study was to examine the relationship between the level of self-identified teamwork in the intensive care unit (ICU) and patients' outcomes. The link between teamwork and productivity has been established in many public, private, and nonprofit work settings.[1-3] However, the results of studies of the relationship between teamwork and patients' outcomes have been mixed. For example, some researchers[4-8] reported positive relationships between variables related to patients' outcomes and the level of collegiality, or teamwork, among staff members. On the other hand, others[9-12] concluded that the level of teamwork does not significantly influence patients' outcomes.

Previous research neither confirmed nor disconfirmed the existence of a link between teamwork and patients' outcomes. Possible reasons for these conflicting findings include the fact that most of these studies contained methodological and theoretical limitations. Small sample sizes and the use of subjective data and untested assessment instruments also may account for these equivocal results. Finally, most of these studies lacked a theoretical perspective and clear definitions of the constructs under investigation.

More research clearly is needed to determine whether a relationship exists between staff teamwork and patients' outcomes. Research that takes previous shortcomings into account by investigating this question with a larger sample, by using reliable and valid measures, and by providing clear definitions of terms that emanate from an established theoretical perspective is necessary. In this study, we attempted to meet all of these criteria.

Theoretical Perspective

In the social science literature, levels of teamwork and productivity have been linked to the concept of group development.[13] The idea that groups develop across time has received wide acceptance among social scientists and practitioners for more than half a century. During that time, impressionistic studies, which relied on experiences and reflections of observers, and empirical studies that used observational systems were conducted.[14-22] The accumulated research evidence supports the general conclusion that groups move through successive stages that can be specifically demarcated and described.

Reviews[13,23] of research on group development supported the idea that groups move through 5 stages. The initial stage of development focuses on issues of inclusion and dependency; during this stage, members attempt to identify behavior acceptable to the leader and other group members.[24] This early stage also is characterized as a time when members are anxious.[25]

> *Groups move through hierarchical stages of development.*

The next stage is described as a period of counterdependency and conflict.[26-28] During the second stage, issues of power, authority, and competition are debated. A number of theories[29-31] suggest that these early struggles regarding authority and status are prerequisites for subsequent increases in cohesion and cooperation. Confrontations with the leader establish solidarity and openness among members.[32] In addition, if conflicts are adequately resolved, member relationships with the leader and with each other become more trusting and cohesive.[33-35] This stage also provides the opportunity to clarify areas of common values, which increases the stability of the group.[36]

The third stage is devoted to the development of trust, increased collaboration and teamwork, and more mature and open negotiation about goals, roles, group structure, and division of labor.[37,38] The fourth, or work, stage is characterized by increases in group effectiveness and productivity. Groups that have a distinct ending point experience a fifth stage. Impending termination may cause disruption and conflict.[39] Increased expression of positive feelings also may occur, and separation issues are discussed.

Because of the preponderance of evidence for the existence of phases in group development, the research focus shifted to the investigation of the relationship between the level of development attained by work groups and the effectiveness and productivity of those groups. The results of these investigations confirmed a link between group development and productivity. Groups functioning at higher stages of development are more productive and more effective than groups at lower stages in accomplishing group goals.[2,3,40]

> *Groups functioning at higher levels are more productive and achieve goals more effectively than groups functioning at lower levels.*

These studies were conducted in corporations, the service sector, and educational institutions by using a variety of measures of productivity, and the findings were consistent. The theory and research in this area suggest that findings would be similar in studies of staff groups in healthcare settings. Our study was designed to test that prediction. The study was intended to determine whether a relationship exists between the level of group development in ICU staff groups and patients' outcomes. Specifically, the following questions were addressed.

- Is there a relationship between certain individual or organizational demographic data in ICUs and staff members' perceptions of unit productivity?
- Is there a relationship between the level of group development in ICUs and patients' outcomes?

Table 1 Scales of the Group Development Questionnaire and their corresponding stage of group development

Scale	Stage of group development
I	1, Dependency/inclusion
II	2, Counterdependency/fight
III	3, Trust/structure
IV	4, Work and productivity

Method

Seventeen ICUs in 9 hospitals located on the east coast of the United States participated in this study. The total number of staff members who participated in the study from all 17 units was 394. Data collected included staff members' responses to the Group Development Questionnaire (GDQ) and a demographic survey. In addition, data were collected about the teaching status of the hospital (medical teaching vs nonteaching), the setting of the hospital (urban, community, or rural), and each unit's results on the Acute Physiology and Chronic Health Evaluation (APACHE) III[41] Mortality Prediction. The APACHE system is used to predict a patient's risk of dying in the hospital. The APACHE data were collected from 1 month's ICU admissions. Patients' medical records were reviewed to determine the standardized mortality ratio (SMR) for each unit.

Setting and Sample

Because this was a field study of active work groups, a sample of ICUs that volunteered to participate was used. Approximately 50 hospitals were contacted and asked to participate.

Data Collection

Permission to begin data collection was arranged with the ICU management team or the hospital's intensive care committee. Every hospital assigned 1 person as the facilitator for the data collection. This person was usually the APACHE III data coordinator in ICUs that used APACHE III or the nurse manager in ICUs that did not use APACHE III. Each participating hospital was visited for a 5-day period; each unit was visited several times in each 24-hour period to accommodate all possible shifts of workers. The data collector solicited participation from individual staff members as their time permitted during the normal workday. This practice was followed in order to be minimally intrusive with regard to patients' care. Staff members who agreed to participate were given a standard set of instructions about completing the demographic questionnaire and the GDQ. After the 5-day data collection period, either the APACHE III coordinator reported the SMR or the charts of patients admitted to the ICU were reviewed to determine the SMR for the month in which data collection occurred.

Table 2 Sample items contained in each scale of the Group Development Questionnaire

Scale	Sample items
I	Members tend to go along with whatever the leader suggests. There is very little conflict expressed in the group. We haven't discussed our goals very much.
II	People seem to have very different views about how things should be done in this group. Members challenge the leader's ideas. There is quite a bit of tension in the group at this time.
III	The group is spending its time planning how it will get its work done. We can rely on each other. We work as a team. The group is able to form subgroups, or subcommittees, to work on specific tasks.
IV	The group gets, gives, and uses feedback about its effectiveness and productivity. The group acts on its decisions. This group encourages high performance and quality work.

Research Instruments

The GDQ and the Apache III SMR were used in this study for 2 reasons. First, both measures have demonstrated reliability and validity. Second, both measures have been used in similar studies.

Based on the Integrated Model of Group Development, the 60-item GDQ contains 4 scales that correspond to the first 4 stages of group development (Table 1). Each scale contains 15 items.

The items on scale I measure the amount of energy a group is expending in attempting to deal with issues of dependency and inclusion. Test questions were designed to detect the presence or absence of the characteristic behaviors of groups at this first stage of development. Questions on scale II seek to ascertain the degree of group focus on issues of conflict, counterdependency, and other characteristics associated with the second stage of development. The third scale assesses the degree of trust and structure that is pre-

Table 3 Determining group stages of development on the basis of scores on the scales of the Group Development Questionnaire

	Group Development Questionnaire scale			
Stage	I	II	III	IV
1	>42	<42	<53	<56
2	<45	>46	<53	<56
3	<44	<40	54-58	57-62
4	<44	<40	>59	>63

sent in the group. Scale III is related to issues associated with the third stage of group development (trust). The characteristics of the fourth developmental stage (work) are assessed by using scale IV. Table 2 contains sample items from each GDQ scale.

Each item is scored from 1 (never true of this group) to 5 (always true of this group). Therefore, the minimum score on each scale is 15 and the maximum score is 75. An effectiveness ratio also is determined by dividing a team's actual mean score on GDQ scale IV by its potential maximum score (75). The minimum effectiveness ratio, then, is 20% and the maximum is 100%. A group's productivity mean represents the mean response to the question "In your opinion, how productive is this group?" Respondents rate the group from 1 (not productive at all) to 4 (very productive).

A group's overall stage of group development is determined by considering the mean scores of all 4 scales. During the first stage of group development, the mean score on GDQ scale I is at its highest, and scores on the other 3 scales are relatively low. During stage 2, the mean score on GDQ scale II is at its highest, and scores on the other 3 scales remain relatively low. At stage 3, mean scores on GDQ scales III and IV begin to increase, and mean scores on GDQ scales I and II decrease. Finally, at stage 4, mean scores on GDQ scales III and IV continue to increase, and mean scores on GDQ scale I and II remain low. Table 3 gives the range of scores on each GDQ scale for groups at different stages of development.

In order to ensure its reliability and validity, the GDQ has been subjected to a number of statistical tests.[42] Test-retest correlations, the internal consistency of each scale, and concurrent validity were explored. All correlations were highly significant. Criterion-related validity also was investigated. Work groups that ranked high on organizational measures of productivity had significantly higher scores on GDQ scales III and IV, the effectiveness ratio, and the productivity mean than did groups that ranked low on these external productivity measures. Likewise, groups ranked high on organizational measures of productivity had significantly lower scores on GDQ scales I and II. Thus, work groups at higher stages of development were more effective and productive.[2,3,40]

The APACHE III system can be used to predict a patient's risk of dying in the ICU.[43] A patient's medical profile is compared with thousands of cases before a prognosis is reached. APACHE III predictions are very accurate and make it possible to evaluate the effectiveness of the ICU. The APACHE III–derived predicted mortality rate for each patient is used to determine the unit's SMR. Individual scores are averaged to determine the unit's predicted mortality rate. Dividing each unit's actual mortality rate by the predicted mortality rate provides the unit's SMR. An SMR of 1 indicates that the actual death rates and the predicted death rates are the same. An SMR less than 1 indicates that the actual death rate is lower than predicted, and an SMR greater than 1 indicates that the actual death rate is higher than predicted. Thus, a lower than predicted SMR means that more patients than expected, on the basis of their risk factors, survived.

The APACHE instrument has been used previously in similar studies as an indicator of a unit's effectiveness and the quality of care provided by that unit.[4,5,44] Although some researchers have questioned the use of the SMR as a quality measure in ICUs, few measures of patients' outcomes have been as thoroughly tested as APACHE III.[44,45]

Results

Description of the Sample

Nine hospitals in which both administrators and institutional review boards agreed to participate were included in the study. Participating hospitals were as far north as Connecticut and as far south as Florida. Of the 17 ICUs, 12 used the APACHE III system. Five of the hospitals were medical training hospitals staffed with both resident and attending physicians. Only 1 hospital was rural; 5 were community based, and 3 were urban.

Participants' responses to the demographic survey are reported next. Most participants (75%) were registered nurses. The remaining 25% was almost equally divided among other categories of healthcare workers (physicians, unit clerks, and unlicensed assistive personnel). Only 4 licensed practical/vocational nurses participated in the study. Licensed practical nurses are not typically employed in ICUs because of practice limitations.

Most participants (80%) were women, and 70% of participants were between 20 and 40 years old. A

Table 4 Intercorrelations for staff age, occupational tenure, and staff members' perceptions of unit conflict and productivity

Variable	Conflict	Unit productivity
Age	0.098	0.112*
Occupational tenure	0.111*	0.053

*P = .05.

Table 5 Intercorrelations for number of respondents, standardized mortality ratio (SMR), and developmental stage

Variable	Respondents	SMR	Stage
Respondents	1.00	0.164	0.246
SMR	0.164	1.00	-0.662*
Stage	0.246	-0.662*	1.00

*P = .01.

total of 74% of the participants were white; the remaining 26% were split about evenly between Hispanic Americans, Native Americans, African Americans/Non-Hispanic, and other.

The majority (42%) of participants had completed a bachelor's degree, and 31% held an associate's degree. Eighteen nurses (5%) had master's degrees. Thirty-five physicians participated (9%). Thirty-nine participants (10%) had either a high school diploma or a trade school diploma.

Intensive care units showing higher levels of group development have lower mortality rates than predicted.

The mean time that participants had been employed by their respective hospitals was 16.6 years, with a mean of 12 of those years in the ICU. The mean time that participants had been employed in their current occupation was 24 years. Because ICUs operate around the clock, participants were asked to indicate the shift on which they spend the majority of their work time; a total of 250 worked the day shift, 108 worked the night shift, and 36 worked the evening shift.

Relationship Between Certain Individual or Organizational Demographic Data in ICUs and Staff Members' Perceptions of Unit Productivity

Pearson product moment correlations and analyses of variance were used to determine if a relationship existed between certain individual or organizational demographic data in ICUs and staff members' perceptions of unit productivity. Of the 13 demographic variables, only 3 were significant. Education was significant in relation to GDQ scale II ($F = 3.113$, $df = 6{,}377$, $P = .005$). Post hoc analyses revealed that the 18 nurses who held masters' degrees perceived significantly more conflict in their various units than did other staff members.

Occupational tenure correlated with perceptions of conflict. Participants who had been in their respective professions longer tended to view their staff groups as engaging in more conflict with unit leaders and other staff members. Also, older staff members tended to view their staff groups as more productive (Table 4).

Relationship Between the Level of Group Development in ICUs and Patients' Outcomes

Data were collected to determine each unit's SMR. Units that used the APACHE III Mortality Prediction Model provided the SMR for the month of data collection. Units that did not use the APACHE III Mortality Prediction Model allowed a chart review of 1 month's ICU admissions to determine each patient's predicted mortality. The mean of these values was used to create the unit's mean predicted mortality. Data on patients' mortality for that month also were gathered from the chart review.

Traditionally, research on groups requires statistical analyses on the group level as well as the individual level. We did analyses at both levels.

Group Level Analyses

In order to ensure that results were not due to the unequal numbers of staff members who participated in the study in the 17 units, the number of participants in each unit was correlated with that unit's SMR and stage of group development. No significant correlations were noted. A significant correlation ($r = -0.662$, $P = .004$) was noted, however, between a unit's stage of group development and that unit's SMR. As staff members' perceptions of their level of group development increased, SMR decreased. That is, as stage of group development increased, fewer deaths occurred than had been predicted (Table 5).

In order to explore this finding in more depth, the 17 ICUs were divided into 3 subgroups on the basis of the naturally occurring gaps in the SMR results for

Table 6 Classification of intensive care units (ICUs) by standardized mortality ratio (SMR)

	ICU	No. of respondents	SMR	Stage
Low SMR/ high performing	1	14	0.134	3
	2	14	0.154	3
	3	23	0.207	3
	4	13	0.36	2
	5	35	0.424	2
	6	31	0.619	3
Middle SMR/middle performing	7	10	0.66	2
	8	48	0.68	3
	9	19	0.69	3
	10	35	0.72	2
	11	16	0.81	2
High SMR/low performing	12	12	0.88	1
	13	25	0.88	2
	14	28	0.88	2
	15	12	0.98	2
	16	43	1.34	2
	17	16	1.40	1

the various units (Table 6): low-SMR/high-performing, middle-SMR/middle-performing, and high-SMR/low-performing groups. Analyses of variance revealed significant differences in the SMR results of the units within each subgroup (Table 7). In addition, the mean stage of group development within each subgroup differed significantly from the mean stage in the other 2 subgroups (Table 8). That is, staff members of ICUs with low SMR rates perceived their staff group as functioning at higher stages of group development than did staff members of ICUs with midrange or high SMRs.

Individual Level Analyses

Analyses of variance revealed significant differences among the 3 subgroups on 3 of the 4 GDQ scales and group stage (Table 9). On GDQ scale I, staff members of low-SMR/high-performing ICUs perceived their staff groups as significantly less dependent than did members of middle-SMR/middle-performing ICUs and high-SMR/low-performing ICUs. No significant difference was noted between middle-SMR/middle-performing ICUs and high-SMR/low-performing ICUs on this scale.

On GDQ scale II, staff members of low-SMR/high-performing ICUs perceived their staff groups as less engaged in conflict with authority figures and other members than did members of middle-SMR/middle-performing ICUs and high-SMR/low-performing ICUs. No significant difference was noted between middle-SMR/middle-performing ICUs and high-SMR/low-performing ICUs on this scale.

Table 7 Analysis of variance for standardized mortality ratio (SMR) and stage of development in low-SMR/high-performing vs middle-SMR/middle-performing vs high-SMR/low-performing intensive care units

Variable	Sum of squares	*df*	Mean square	F	*P*
Stage					
Between groups	3.192	2	1.596	5.779	.015
Within groups	3.867	14	0.276		
Total	7.059	16			
SMR					
Between groups	1.661	2	0.831	23.821	.001
Within groups	0.488	14	3.487×10^{-2}		
Total	2.149	16			

On GDQ scale III, staff members of low-SMR/high-performing and middle-SMR/middle-performing ICUs perceived their staff groups as more organized and staff members as more trusting of each other than did members of high-SMR/low-performing ICUs. No significant difference was noted between low-SMR/high-performing ICUs and middle-SMR/middle-performing ICUs on this scale.

Finally, staff members of low-SMR/high-performing and middle-SMR/middle-performing ICUs perceived their staff groups as functioning at higher levels of group development than did members of high-SMR/low-performing ICUs. No significant difference was noted between low-SMR/high-performing ICUs and middle-SMR/middle-performing ICUs on this variable.

Discussion

Our results suggest the following conclusions. First, demographic data has little bearing on members' perceptions of their staff group's development or productivity. This finding is consistent with the findings of other studies.[2,3,40]

Second, individuals in low-SMR/high-performing ICUs perceived their staff groups as functioning at higher levels of development than did individuals in middle-SMR/middle-performing ICUs or high-SMR/low-performing ICUs. A link between teamwork and patients' outcomes is established by these results.

These findings lend support to those of a number of previous researchers.[5,7,8] The weight of evidence for the validity of a link between teamwork and outcomes for ICU patients is mounting. Although more research is needed to confirm these results, it may be time to consider ways to improve the level of teamwork and collaboration among staffs in the ICU. Other factors

Table 8 Mean developmental stage and standardized mortality ratio (SMR) for low-SMR/high-performing, middle-SMR/middle-performing, and high-SMR/low-performing intensive care units

Type of intensive care unit	SMR	Stage
Low-SMR/high-performing	0.32	2.7
Middle-SMR/middle-performing	0.72	2.4
High-SMR/low-performing	1.10	1.7

doubtless contribute to patients' outcomes as well. However, on the basis of these results, it seems advisable to consider ways to improve the level of teamwork in the ICU and in healthcare in general.[46]

Currently, the preparation of physicians, nurses, and support personnel does not include sufficient emphasis on teamwork and teamwork skills. The healthcare industry and its consumers would benefit from revised curricula with increased emphasis on these important skills. In-service training for all healthcare employees also would be helpful.

Also, in many industries, teams have access to professional consultants when team problems emerge. Although a small number of healthcare settings have this option, help with team problems is not readily available in most healthcare settings. A number of intervention strategies designed to increase teamwork and collaboration have had beneficial results.[47,48] Access to such strategies could improve not only patients' outcomes but also the quality of work life for healthcare professionals. Good outcomes for patients and a high quality of work life for healthcare professionals are core goals of the healthcare industry and are inextricably linked. Increasing efforts to create supportive, productive healthcare teams may help the industry to reach both these goals.

Table 9 Analysis of variance for scales of the Group Development Questionnaire (GDQ) and stage of development in low-standardized mortality ratio (SMR)/high-performing vs middle-SMR/middle-performing vs high-SMR/low-performing intensive care units

GDQ scale	Sum of squares	*df*	Mean	F	*P*
I					
Between groups	251.767	2	125.883	5.542	.004
Within groups	8653.973	381	22.714		
Total	8905.740	383			
II					
Between groups	680.010	2	340.005	5.445	.005
Within groups	23788.949	381	62.438		
Total	24468.958	383			
III					
Between groups	382.319	2	191.159	4.034	.02
Within groups	18054.908	381	47.388		
Total	18437.227	383			
IV					
Between groups	179.199	2	89.600	1.453	.24
Within groups	23497.290	381	61.673		
Total	23676.490	383			
Stage					
Between groups	54.770	2	27.385	124.059	.001
Within groups	84.103	381	.221		
Total	138.872	383			

ACKNOWLEDGMENTS

Susan Wheelan is president of GDQ Associates Inc, a consulting firm and distributor of the GDQ.

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