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ADAPTIVE LEADERSHIP PROCESSES IN ANAESTHESIA TEAMS

Thesis
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by
Barbara Künzle Haake
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Barbara Künzle Haake
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Abstract

Ensuring patient safety has always been essential for critical care teams and more specifically, for anaesthesia teams. Human factors such as team coordination have been recognized as one of the main reasons for success or failure of teamwork in the operating room. With this growing understanding of the role of human factors for patient safety, leadership attracts more and more notice to researchers. In spite of this increasing interest in the role of leadership only few study exist on successful leadership strategies in critical care teams. This thesis attempted to better explain the relationships between team performance and leadership behaviours. The main assumption was that effective leadership in anaesthesia teams is contingent on contextual and individual factors such as task load, standardization and experience of team members.

Methods used for this thesis are twofold. Firstly, a comprehensive literature research aimed to provide a systematic review on effective leadership strategies in critical care teams. Seven electronic databases were searched for peer-reviewed research journal articles from the last twelve years. Findings from 41 studies were considered and presented alongside a traditional input-process-output model of team performance. Secondly, video-taped data were collected from 12 anaesthesia teams performing a simulated anaesthesia induction, which included the occurrence of a non-routine event. Technical team performance was assessed by measuring speed of adequate team reaction to the critical event. The leadership behaviours were coded as either content-oriented (e.g. information exchange) or structuring (e.g. giving order). Non-parametric test statistics was used to analyse the relationship between influencing factors, leadership behaviour and team performance, while a univariate analysis of variance was applied for assessing the degree of shared leadership among team members.

Results of the literature review identified leadership behaviour as a crucial factor for team performance in critical care teams. In general, effective leaders showed clear and unambiguous behaviour which ideally was adaptive to environmental factors. Particularly interesting was the evidence found for the effectiveness of shared leadership. Findings of the simulated setting observations showed that effective leadership adjusts according to the levels of routine and standardization, while it is only slightly related to team member experience. Lastly,

results revealed the effectiveness of shared leadership in situations with high task load and a clear distribution of leadership functions among team members.

The major feature of this thesis is its contribution to the understanding of leadership for team performance – both its importance and functional attributes – in anaesthesia teams. This work also gives further evidence for a contingency model of leadership. The findings clearly show the need for future studies in critical care teams. For example, further leadership functions necessary for effective team performance could be identified. As a practical application, the findings of this thesis could be useful for the design of anaesthesia team leadership training in developing the skills necessary to improve team performance and secure patient safety.

As the end-goal is to develop critical care team leadership to the point that the operating room becomes the high reliability organization it has the potential to become, a more sophisticated understanding of leadership functions necessary for effective critical care team performance should be developed. As a practical application, the findings of this thesis could be useful for the design of anaesthesia team leadership training in developing the skills necessary to create shared mental models, which would in turn improve team performance and secure patient safety.

Zusammenfassung

Die Sicherstellung der Patientensicherheit ist ein essentieller Bestandteil intensivmedizinischer Versorgung. Dies gilt sowohl allgemein für intensivmedizinische Teams, als auch im spezifischen Fall für Anästhesieteams. Menschliche Faktoren (human factors), wie beispielsweise die Teamkoordination, wurden als zentrale Variablen für den Erfolg oder Misserfolg von Teams im Operationssaal erkannt. Mit dem wachsenden Verständnis für die Bedeutung von menschlichen Faktoren für die Patientensicherheit rückt auch die Wichtigkeit von persönlicher Führung in den Fokus der Forschung. Doch trotz dem zunehmenden Interesse an der Rolle von Führungsverhalten existieren erst wenige Studien zu dessen Wirksamkeit. Das Ziel dieser Dissertation ist es, Zusammenhänge zwischen dem Führungsverhalten und der Leistung in intensivmedizinischen Teams zu untersuchen. Dabei wird der Einfluss von Arbeitsbelastung, Standardisierung und Erfahrung von Teammitgliedern berücksichtigt.

Diese Arbeit beruht auf zwei verschiedene Methoden. Erstens wurde eine umfassende Literaturrecherche durchgeführt mit dem Ziel, eine systematische Übersicht über effektive Führungsstrategien in intensivmedizinischen Teams zu schaffen. Dazu wurde in sieben Datenbanken nach Forschungsartikeln der letzten zwölf Jahre gesucht, wovon schliesslich 41 Studien im Artikel berücksichtigt wurden. Als Forschungsmodell diente das traditionelle Input-Process-Output Modell. Zweitens wurden Videoanalysen von 12 simulierten Anästhesieeinleitungen verwendet, bei denen ein kritisches Ereignis simuliert wurde. Die Teamleistung wurde anhand der Reaktionszeit auf dieses Ereignis gemessen. Das Führungsverhalten wurde entweder als *inhaltsorientierte* (z.B. Informationsaustausch) oder *strukturierende* (z.B. Erteilung einer Anweisung) Führung kategorisiert. Um den Zusammenhang zwischen den drei Einflussfaktoren, dem Führungsverhalten und der Teamleistung zu untersuchen, wurden nonparametrische Tests verwendet, während zur Analyse des Ausmasses an geteilter Führung (shared leadership) im Team eine univariate Varianzanalyse berechnet wurde.

Die Ergebnisse der Literaturrecherche zeigen die Wichtigkeit der Führung für die Teamleistung in intensivmedizinischen Teams. Im Allgemeinen zeigten effektive Führungspersonen klare und unmissverständliche Verhaltensweisen, welche der jeweiligen Situation angepasst wurden. Ausserdem wurden Hinweise für die Effektivität von geteilter Führung gefunden. Die Simulatorstudie zeigte, dass die

Leistung der untersuchten Anästhesieteams besser war, wenn das Führungsverhalten der Arbeitsbelastung und dem Grad an Standardisierung angepasst wurde. Allerdings wurden nur geringe Effekte der Erfahrung auf das Führungsverhalten von Teammitgliedern gefunden. Die Ergebnisse verweisen weiterhin auf die Wirksamkeit von geteilter Führung bei hoher Arbeitsbelastung und von einer eindeutigen Aufteilung der Führungsfunktionen auf die einzelnen Teammitglieder.

Der Hauptbeitrag dieser Dissertation liegt in der Förderung des Verständnisses von Führungsverhalten in Anästhesieteams. Sie unterstützt ausserdem das Kontingenzmodell der Führung. Die Ergebnisse zeigen den Bedarf für zukünftige Studien, die beispielsweise weitere Aspekte effektiven Führungsverhaltens identifizieren sollten. Schliesslich sollen die Ergebnisse dieser Arbeit hilfreiche Hinweise für die Entwicklung von Führungstrainings in der Anästhesie liefern.

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1 Introduction

This is a thesis on anaesthesia team leadership in a tertiary teaching hospital in Switzerland. The main assumption is that leadership in anaesthesia teams is adaptive relative to contextual and individual factors – specifically to task load, standardization and experience of team members. This assumption was tested within two empirical studies which were completed by a literature review. By identifying leadership as a central source for team performance, the thesis contributes to a better understanding of the importance of leadership in critical care teams and to the design of leadership training.

This chapter is organized as follows: First, the purpose of the thesis is explained by giving a short overview of studies leading to the goals of this research. Important concepts and definitions are then presented before discussing main findings and implications for further research. The chapter concludes with an illustration of the structure of the thesis.

1.1 The importance of leadership for patient safety

Many studies have demonstrated that coordination and the creation of a shared mental model are important to maintain effectiveness of teams within dynamic environments (e.g. Cannon-Bowers & Salas, 1998; Cannon-Bowers, Salas, & Converse, 1993; Klimoski & Mohammed, 1994). According to Salas, Burke, and Samman (2001), the team leader is responsible for developing these enablers. Leadership is needed to direct, plan, promote, and coordinate team member activities as well as to build shared mental models. Leadership quality level is one of the main reasons for the success or failure of team-based work systems implementation (e.g. Avolio, Jung, Murry, & Sivasbramaniam, 1996; Day, Gronn, & Salas, 2004; Gladstein, 1984; Kozlowski, Gully, Salas, & Cannon-Bowers, 1996; Zaccaro, Rittman, & Marks, 2001).

Anaesthesia teams are analogous to teams in air traffic control, nuclear power generation industries and especially to those in aviation with which anaesthesia has most often been compared (Gaba, 2000; Helmreich, 2000). All aforementioned teams operate in complex environments where risk varies from low to high, with threats coming from a variety of sources and failures potentially endanger human life. Therefore, safety in these industries has priority and teamwork and communication

are essential (Helmreich, 2000). However, contrary to teams in health care, other industries are already established as high reliability organizations which are “known to be complex and risky, yet safe and effective” (Leonard & Frankel, 2004, p. 15). They are characterized by a commitment to safety, a culture of continuous learning and improvement, and redundancy in safety measures and personnel (Weick, 2002). In order to maintain safety, they have improved their reliability by applying innovative concepts to interpersonal relationships and administrative hierarchical structures (Frankel, Leonard, & Denham, 2006). Furthermore, high reliability organizations have recognized the importance of non-technical skills[1] for safety outcomes and thereby offer special training programs to develop human factors (e.g. Salas, Bowers, & Edens, 2001; Wiener, Kanki, & Helmreich, 1993). Although health care aspires to high reliability and despite the general goal to increase safety (see, for example, the IOM report “To err is Human” (Kohn, Corrigan, & Donaldson, 2000)), there is general consensus that health care has not yet become satisfactorily safer and reliable (Frankel, et al., 2006; Leape & Berwick, 2005). Nevertheless, the importance of patient safety is more and more acknowledged and health care’s path to high reliability is becoming clearer (Frankel, et al., 2006). According to Beyea (2005), every operating room has the potential to become a highly reliable organization itself by learning more about the characteristics of the aforementioned industries. The findings from these high-reliability domains give evidence for the medical field to consider training in non-technical skills in order to increase safety. An ever increasing number of studies on human errors in various operating room teams reveal the consequences of the lack of error management. For instance, a recent review confirmed the importance of communications skill in the intensive care unit (Reader, Flin, & Cuthbertson, 2007). In more detail, Gawande, Zinner, Studdert, and Brennan (2003) noted that 43% of errors made in surgery are caused by miscommunication. Other studies reported communication breakdowns leading to patient injury (e.g. Greenberg, et al., 2007) and showed that a third of communication failures in the operating room resulted in effects which endangered patient safety (Lingard, et al., 2004). Similarly, more than 43.2% of critical incidents in general surgery were related to inappropriate team factors (e.g. poor communication among team members)

[1] The term “non-technical skills” has been adopted from European aviation (Flin, Fletcher, McGeorge, Sutherland, & Patey, 2003) and is defined as the cognitive and social skills of team members (e.g. leadership, decision making, team coordination, situation awareness).

whereof 18% led to severe incidents (Zingg, et al., 2008). A study of anaesthesia teams revealed that most of the preventable incidents involved human errors (82%) (Cooper, Newbower, Long, & McPeek, 2002). Furthermore, Catchpole, Mishra, Handa, and McCulloch (2008) suggested that errors in surgical technique were strongly associated with surgical situation awareness.

Thus far, much of the research on team coordination has focused on lateral, non-hierarchical forms of coordination, with little attention given to leadership behaviour (Flin, et al., 2003). Although the importance of leadership as a non-technical skill in operating room teams is recognized, research on leadership in health care has been relatively dormant with the exception of a few authors (e.g. Cooper & Wakelam, 1999; Helmreich, 2000; Xiao, Seagull, Mackenzie, & Klein, 2004). While these studies suggest that in coordinating medical teams, leadership plays a central role, no clear link to team performance could be established. The question of whether and how team leadership is effective is still unanswered and further explanation of team leadership processes during dynamic tasks specific to the exceptionally high-risk domain of anaesthesia is needed. In order for health care teams to become more reliable and safe, it is increasingly important that we understand the specific factors that determine high performance in critical care teams. The dissertation presented here is an attempt to meet this need. In the following section, the aims of this thesis are outlined in more detail.

1.2 Aims of the dissertation

Working in the operating theatre presents many cognitive, social and system challenges to practitioners. Coordination and communication under stress between team members representing a number of health care disciplines are critical for optimal care of the patient. Anaesthesia teams are the subject of the present thesis on team leadership because they are a microcosm of the integral parts of both the operating theatre and medical emergency teams. Their work is characterized by routine procedures and prolonged monitoring as well as by uncertainty, complexity, and rapidly shifting priorities. Whether teams are able to deal with these uncertainties and rapidly changing conditions does not only depend upon the knowledge and application of technical expertise, but also upon their ability to distribute tasks and to coordinate the team – whereby leadership plays a crucial role.

The general objective was to determine what kind of leadership behaviours and their distribution among team members were most predictive of team effectiveness in anaesthesia teams. By investigating these relationships, this thesis attempts to contribute to critical care teams becoming more highly reliable organizations. The primary research question was how various leadership patterns could explain the difference between high- and low-performing teams. The main assumption was that leadership must be adaptive in order to meet changing conditions. Gaining a better understanding of leadership processes should provide valuable insights regarding influences on team performance, which in turn might possibly contribute to the design and content of leadership training.

In order to achieve the goals outlined in the preceding paragraph, one comprehensive literature review and two empirical studies were conducted. They were incorporated in three separate peer reviewed articles which are listed below and reported in the subsequent chapters. The aims of the three articles are as follows:

- *Article 1:* provide a systematic review on the findings of effective leadership strategies in critical care teams and contribute to a better understanding of the skills, knowledge, and attributes leaders need and, in turn, apply in order to create and maintain patient safety.
- *Article 2:* study three substitutes of leadership in anaesthesia teams and their impact on team effectiveness: task (routine vs. non-routine situations), organizational (level of standardization) and subordinates (experience of team members).
- *Article 3:* further study the distribution of leadership functions among team members and the effectiveness of shared leadership in anaesthesia teams.

As a basis for this research, a comprehensive model of team effectiveness was used which is presented below. Before discussing the model, definitions of teams in general and anaesthesia teams in particular are presented.

1.3 Anaesthesia teams

Teams usually exist for several reasons (e.g. learning, producing a product, solving problems, gaining acceptance), and in various forms (e.g. virtual, co-located),

sizes and longevity (e.g. ad hoc, long-term) (Cohen & Bailey, 1997). Due to this diversity of team types, many definitions exist. According to Tannenbaum, Beard, and Salas (1992), all teams can be defined as groups but not vice versa. This makes it necessary to differentiate between groups and teams. One primary difference between groups and teams is that members in groups are more homogeneous with less assigned roles or functions, whereas teams consist of members with more clearly-defined roles and responsibilities than is found in groups (Cannon-Bowers, et al., 1993). In addition, teams can also be distinguished from groups because of their unique requirements for coordination and interdependency (Brannick & Prince, 1997).

In recent literature, teams are further distinguished from crews (Arrow & McGrath, 1995; Arrow, McGrath, & Berdahl, 2000; Ginnett, 1993; Kozlowski & Bell, 1993), which are described as performing specialized tasks, being limited in duration, but requiring to form and perform together immediately and effectively. Furthermore, they are characterized by high expertise, extensive training and standardized performance guidelines, making an extended group development process unnecessary. Some of these crew features such as performing specialized tasks, limited life span and performing immediately, often without previously knowing team members, correspond with anaesthesia teams (see below). Nevertheless, the decision was made to use “team” rather than “crew” because “team” is the more commonly used term in the field of medicine (a research in all databases in Science Direct (1999-2008) revealed 10,099 articles using the combination of terms “anaesthesia” and “teams” while only 522 medical papers used the term “crews”).

In an attempt to extract key features of teams, several often-cited definitions were reviewed (Avolio, et al., 1996; Baker, Gustafson, Beaubien, Salas, & Barach, 2005; Cannon-Bowers, et al., 1993; Dyer, 1984; Salas, Burke, & Cannon-Bowers, 2000). The five most common characteristics turned out to be:

- Two or more individuals
- A shared or common goal(s)
- Dependency among team members
- Specialized skills and knowledge of team members
- Limited lifespan, they often separate as soon as objectives are achieved

These general criteria of teams also apply to anaesthesia teams. Members of anaesthesia teams have high levels of skills and abilities, are specialized and come together for a short period of time to work interdependently toward a common goal. For example, several skills are necessary to ensure patient safety such as medical knowledge, use of rules and checklists, as well as good communication combined with ability to make decisions. Similar to other teams, members of anaesthesia teams have to work together very closely and the workflow is poly-directional, flexible and very intensive as teams repeatedly face novel situations. However, contrary to other teams, the distribution of roles is less defined in anaesthesia teams because they are often allocated ad hoc on site. Furthermore, the roles are weakly differentiated and the tasks of the several professionals are not always strictly separated nor need to be done by each team member. Also, roles may even reverse spontaneously during the collaboration (Künzle, 2003). Furthermore, work in anaesthesia is characterized by routine work phases (similar to the flight phase in aviation) but unforeseen time-critical events can arise at any time during induction of general anaesthesia. In order to maintain patient safety, team members must be aware of the situation moment to moment and be prepared to react immediately to those unforeseen events.

Due to these specific characteristics of anaesthesia teams, an extension of the above team characteristics with a definition of “action teams” is meaningful. Action teams are characterized by exclusive membership of specialists, short work cycles, frequent changes in conditions, high synchronization within the team and with support units, and requirements for extended training and preparation (Sundstrom, De Meuse, & Futrell, 1990). According to Ziegert (2001) action teams are *“highly skilled specialist teams cooperating in brief performance events that require improvisation in unpredictable circumstances”* (p. 3). Contrary to other team types (e.g. production, service, project teams), action teams contain more specialized skill sets, rely more heavily on coordination, perform in less familiar and more challenging environments, and may be more temporary. To operate successfully in challenging environments, action team members have specialized task-related skill sets and teamwork abilities to coordinate their activities with team members (Sundstrom, et al., 1990). Similar to the general team definition in the previous section, contribution from all team members and interaction among team members are necessary to achieve team performance because action teams are highly interdependent (Blickensderfer, Cannon-Bowers, & Salas, 1998).

A number of researchers identified factors influencing effectiveness of teams. Within the framework of the model of team effectiveness introduced in the following section, a selection of results found in the literature is presented.

1.4 Model of team performance

As a framework for analysing leadership behaviour and its relationship to team performance, an adapted input-process-output model of team performance was used for this thesis (see Figure 1.1). The model is based on earlier versions of the IPO Model (e.g. Gladstein, 1984; Hackman & Morris, 1975; Marks, Mathieu, & Zaccaro, 2001; McGrath, 1964) and specifies the stages related to team performance in anaesthesia teams as input, process and output.

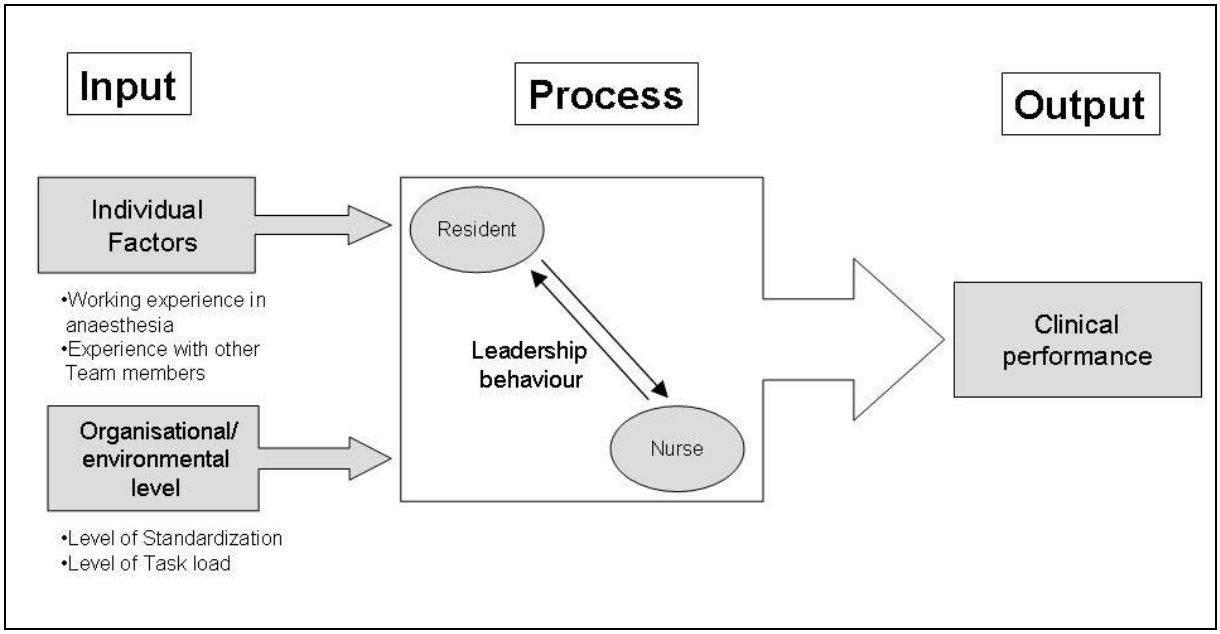


Figure 1.1: Frame Concept

The basic rationale is that the influence of input factors on team outcomes is mediated through the team process. At the *input* stage, team members, assigned with specific characteristics of team members or the context in which the team operates have an effect on team processes and indirectly influences the team output. Input factors include member, team, and organizational characteristics and can take, for example, the form of individual knowledge or skills.

Processes describe how team inputs are transformed into outputs. They are the intra- and intergroup actions that convert resources into a product (Gladstein, 1984) and include interactions and interpersonal behaviours among team members

(Hackman & Morris, 1975; McGrath, 1964). Processes refer to “members’ interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioural activities directed toward organizing task work to achieve collective goals” (Marks, et al., 2001, p. 357). According to Bales (1958) process behaviours are maintenance behaviours that “build, strengthen and regulate group life” or “solve the objective problem to which the group is committed” (see Philp & Dexter, 1959, p. 162). Process losses (Steiner, 1972) occur if no one facilitates the congruent, synchronous, and coherent actions within a team.

Finally, the *outputs* of the team effectiveness model are originally the quantity and quality of work or products by the team. According to Hackman and Morris (1975) effectiveness has three components: group performance, satisfaction of group-member needs, and the ability of the group to exist over time but there are further indicators for measuring performance, e.g. quality, quantity, time, errors, or costs (Tannenbaum, Salas, & Cannon-Bowers, 1996).

How input, process and output factors are defined for anaesthesia teams investigated in this thesis is outlined in the following sections (1.4.1. through 1.4.3).

1.4.1 Input Factors: Factors influencing leadership in anaesthesia teams

Past research on leadership has indicated that situational factors such as task structure and team characteristics are important in determining the effectiveness of a leader (Goodman, 1986). For example, Kerr and Jermier’s leadership substitutes approach (Kerr & Jermier, 1978) or Fiedler’s contingency theory (Fiedler, 1967) stated that leadership is dependent upon external factors such as situational characteristics or characteristics of other team members and that some situations make leadership behaviour even unnecessary. In accordance with these findings, one can expect that leadership in anaesthesia teams is dependent upon several input factors. Evidence for that was found in earlier research on coordination in anaesthesia teams (see e.g. Grote, et al., 2004a; Grote, Zala-Mezö, & Grommes, 2003, 2004b). For example, by comparing cockpit crews and anaesthesia teams, evidence was found for the occurrence of adaptive coordination and the relevance of standardization and the task load as important input factors having impact on team coordination. These studies have also shown that effective leadership in teams is a key to successful team performance. In a similar vein, a few studies on team leadership in the medical setting have analysed whether leadership depends on

changing task demands and characteristics. They all found evidence for the effectiveness of adaptive leadership behaviour. For example, Yun, Samer, Xiao, and Henry (2003) reported the results of a survey study on team leadership in trauma settings using a set of varying scenarios. The main finding was that directive leadership is more effective when a patient is severely injured, whereas empowering leadership is more effective when a patient is not severely injured. Xiao et al. (2004) developed a catalogue of team leadership functions (strategic planning, reporting plans, critiquing plans, coaching, maintaining awareness, and information requests) which were shown to differ in their appropriateness relative to varying situational triggers. For example, strategic planning was often triggered by resource inadequacy or time pressure, while coaching behaviour occurred when the urgency appeared low. In time pressure situations, coaching was often replaced by team-structure modification. Similarly, a previous interview study revealed that team members expect a directive leadership style if task load is high (Künzle, 2003; Zala-Mezö, Künzle, Wacker, & Grote, 2004).

As described above, input factors in the IPO Model are related to individual, team, and organisational factors. For operating room teams, main input factors are on the *individual level*, the physical condition or the experience of leaders, on the *team level*, the team composition; and on the *organisational and environmental level*, patient condition or organisational norms (Helmreich & Schaefer, 1994). In accordance with our previous findings and the characteristics of anaesthesia teams described in the literature, three major input factors are considered in this thesis:

- On the *organisational and environmental level*, task conditions (level of task load) and impersonal coordination mechanisms (level of standardization) are analysed.
- On the *individual level* team member experience that members bring to the team is assessed.

1.4.2 Process Factors: Leadership in anaesthesia teams

The high degree of interdependence in anaesthesia teams requires coordination (see e.g. Grote, et al., 2004b; Zala-Mezö, Wacker, Künzle, Brüesch, & Grote, 2009). Leaders are paramount for ensuring good coordination among team members. In this sense, what leaders are or do in team contexts can essentially be

conceptualized as part of the process that links team input to team output. As such, in this thesis, leadership is seen as a critical process factor to ensure team effectiveness under various conditions. Before discussing in more detail what adaptive leadership means to anaesthesia teams, a general definition of leadership is provided below. Furthermore, leadership will be distinguished from the more general notion of coordination.

1.4.2.1 Definition of leadership

Since comprehensive reviews exist elsewhere (e.g. Jago, 1982; Yukl, 2006), only a brief overview is presented of the current leadership theories and definitions as well as an outline of the leadership focus of this thesis.

The underlying research question among most leadership research is how leaders influence the effectiveness of teams and organizations. Several theories have been developed for these purposes. From the trait (Stogdill, 1948) and behaviour (Fleishman, 1953) approach through contingency (Fiedler, 1967) and situational theory (Hersey & Blanchard, 1977), to transformational and charismatic leadership (House, 1977) and, more recently, conceptualizations of functional (Hackman & Walton, 1986) or shared leadership (Pearce & Conger, 2003); researchers have attempted to understand the determinants of effective leadership. Although different terms have been used, it seems that in order to be successful, leaders must be concerned with both task- and people-focused issues in the workplace (e.g. Burke, et al., 2006a) and, according to the more contemporary theories, shared responsibility for some of the leadership functions (Pearce & Conger, 2003; Yukl, 2006).

Numerous definitions of leadership are available in the literature (Bass, 1990; Yukl, 2006). While these definitions vary considerably, most involve the ability of an individual to get others to accomplish things willingly in a particular situation. In this sense, Stogdill (1974) described leadership as *"the process (act) of influencing the activities of an organized group in its efforts toward goal-setting and goal achievement"* (p. 114f.). Similarly, Katz and Kahn (1978) defined leadership as *"(…) the influential increment over and above mechanical compliance with the routine directives of the organizations"* (p. 528). Hersey and Blanchard (1974) posited that leadership is the process of personal interaction in order to influence and direct people's behaviour in a specific situation towards organizational goals. Similar, Yukl

and Van Fleet (1992) suggested that leadership should be viewed *"as a process that includes influencing the task objectives and strategies of a group or organization, influencing people in the organization to implement the strategies and achieve the objectives, influencing group maintenance and identification, and influencing the culture of the organization"* (p.149). From this variety of definitions and studies on leadership, basic principles can be extracted: Leadership is geared to an objective, it is executed within a group or team and it includes influencing behaviour to achieve individual or organizational goals.

Much leadership research has focused on organisational rather than on team leadership and only a few have examined by what concrete behaviours effective leadership is executed. Recognizing the void, Kozlowski and Bell (1993) suggested studying leadership on the team level to further develop and validate the functional roles of team leaders. The literature suggests that team leaders engage in many different kinds of behaviours in order to promote team effectiveness such as directing team members, coordinating interdependent work, or interpersonal and affective activities (Hackman & Walton, 1986; Wageman, 2001). As previously outlined, anaesthesia teams most closely resemble action teams, having to deal with complex tasks in uncertain and fast-paced situations and therefore facing a great need for coordination. Consequently, the more directive, task-based leadership behaviour (vs. interpersonal or developing behaviours) is critical for task fulfilment in these settings (Künzle, 2003; Zala-Mezö, et al., 2004). As action teams, anaesthesia teams are often temporarily organized with an ad hoc-like structure and usually have a clear goal such as maintaining patient's safety (see Künzle, 2003). Consequently, leader roles are important to provide structure within such a team as well as task-relevant leadership behaviour in order to achieve the goal for the current task. As an ad hoc action team, no long-term functions of leadership such as developing activities are required. Evidence for this was reported by Klein, Ziegert, Knight, and Xiao (2006) who found no motivating and inspiring leadership behaviour in trauma teams. Similar results were reported for anaesthesia teams (Zala-Mezö, et al., 2004) and other high reliability organizations (e.g. Bierly & Spender, 1995). This might be explained by the inherently shared motivation and the clear-cut goal to save patients' lives (Klein, et al., 2006). This view is in line with the substitutes for leadership theory suggesting that a pressing and important task might substitute or eliminate the need for, a motivating leader (Kerr & Jermier, 1978).

Taking into consideration the above leadership requirements of anaesthesia teams, this thesis focuses on task-based components of leadership behaviour on the team level, while other leadership components such as motivation and strategy development are considered to be less relevant for anaesthesia teams and therefore will not be examined.

In order to understand the relevant task-based behaviour of team leadership, a behavioural approach was used in this thesis. Research on such behaviours began with the Michigan and Ohio State leadership studies which identified two primary, independent factors: consideration and initiation of structure (e.g. Fleishman, 1953; Likert, 1961). As a review on classification taxonomies for leader behaviour has shown (Fleishman, et al., 1991), it is possible to classify leadership behaviour as behaviour dealing with task accomplishment (task-focused behaviour) or as behaviour that facilitates team interaction and/or development (person-focused behaviour). This two-dimensional leadership paradigm has been used for both individual and team leadership. Other researchers have divided the task-oriented dimension into two sub-categories and distinguished between behaviours concerned with the content of tasks and behaviours concerned with structuring the behaviours of team members (e.g. Badke-Schaub & Lorei, 2003; Bales & Slater, 1955; Stempfle & Badke-Schaub, 2005). To meet the functionally-differentiated leadership requirements of anaesthesia teams outlined above, this thesis employs the idea of Bales and Slater (1955) and Stempfle and Badke-Schaub (2005) and divides the initial category of task-oriented leadership, looking at both content-oriented leadership and structuring leadership behaviour.

Content-oriented leadership concentrates on the understanding of the task situation and on actual or potential challenges. Leaders play an important role in processing information since they offer the grist for meaning making and sense giving to team members by information search and exchange (Zaccaro, et al., 2001). In this thesis, content-oriented leadership behaviour is considered important to anaesthesia teams as this is when information is garnered, exchanged and structured in a fashion that is usable to team members. It helps to develop effective team mental models that have been shown to be critical for team coordination and performance and promoting team adaption in dynamic environments (see Zaccaro, et al., 2001).

Structuring leadership is about guiding and structuring team processes by coordinating team activities on the task. According to Badke-Schaub and Lorei (2003) and Stempfle and Badke-Schaub (2005), coordinative leadership refers to planning and structuring work processes. Zaccaro et al. (2001) note that leaders take on several coordination activities such as role distribution, offering clear strategies and managing resources and propose that *"teams whose leaders match individual member capabilities to role requirements, offer clear performance strategies, monitor and provide feedback on the accomplishment of these strategies, and recalibrate team member actions when environmental conditions change, will be better coordinated and more effective than teams whose leaders do not display such activities"* (p. 476). The aim of structuring leadership is to minimize process loss within a team (e.g. Steiner, 1972).

To sum up, in this thesis team leadership is regarded as any goal-oriented activity that either supports team members with task-relevant information or provides structure within the team. It is analysed by applying behaviour observation of content-oriented and structuring leadership. By definition, these behaviours resemble team coordination behaviours. Thus, in order to provide an even clearer definition of leadership, the following section further distinguishes leadership from coordination. This section will also define adaptive leadership as it applies to this thesis.

1.4.2.2 Team Coordination versus Team Leadership

In teams, the differentiated roles and tasks to be performed usually require coordination between the team members. Coordination among team members has been recognized as vital for general team effectiveness (e.g. Espinosa, Lerch, & Kraut, 2004; Kolbe, 2007b; Wittenbaum, Vaughan, & Stasser, 1998) and especially critical for medical teams (e.g. Grote, et al., 2004b; Zala-Mezö, et al., 2009). Without appropriate coordination, random team interaction causes process losses and communication breakdowns with negative impact on team performance (Marks, Sabella, Burke, & Zaccaro, 2002; Steiner, 1972). Therefore, coordination is essential for the effectiveness of teams in situations where a successful outcome for the entire group is the end result of numerous and integrated contributions by all team members and where successful contributions by one participant are contingent upon a correct and timely contribution by another participant (Guastello & Guastello, 1998).

In this sense, coordination is a process of adjusting interdependent actions (Marks, et al., 2001) and usually occurs when two or more people work on the same or corresponding tasks at the same time (Guastello & Guastello, 1998; Hackman & Morris, 1975). Coordination includes activities such as information exchange and mutual adjustment of action (Brannick, Roach, & Salas, 1993).

According to some authors, leadership is one of the crucial behaviours through which coordination is achieved. For example, Van de Ven, Delbecq, and Koenig (1976) refer to three modes of coordination, leadership as a personal, vertical form of coordination being one them. Furthermore, leadership can be seen as one of seven coordination dimensions and refers to behaviours as directing the activities, monitoring and assessing the performance of team members, motivating members, and communicating task-relevant information (Bowers, Morgan, Salas, & Prince, 1993). This concept of establishing leadership as one of multiple coordination mechanisms is also supported by others (Kolbe, 2007a; Leedom & Simon, 1995; Stout, Salas, & Carson, 1994).

The working definition of leadership in this work is modelled after these authors, namely as being one type of coordination. As outlined in the previous section, leadership describes task-based and target-oriented behaviours and includes activities such as structuring a task or communicating task-relevant information (see also Bowers, et al., 1993). Furthermore, while coordination also includes mutual adjustments of a task (see e.g. Brannick, et al., 1993), leadership always requires one individual who explicitly coordinates team activities at a particular time in a directive manner.

1.4.2.3 Adaptive leadership

Within the dissertation the focus is on team leadership in anaesthesia – specifically on adaptive team leadership. In accordance with the IPO Model, the underlying assumption is that leadership behaviour is a process factor transforming inputs into outputs. To meet the varying input factors typical of anaesthesia team tasks, flexible leadership behaviour and distribution of leadership is crucial. The aim of this section is to find an appropriate definition of the term *adaptive* derived from earlier research and theoretical contributions.

Several authors highlight the importance of adaptive team coordination (e.g. Manser, Howard, & Gaba, 2008; Salas, Rosen, & King, 2007; Zala-Mezö, et al.,

2009) and more specifically, adaptive leadership in critical care teams in order to deal with complex and interdependent work processes (e.g. Cooper & Wakelam, 1999; Klein, et al., 2006; Xiao, et al., 2004). Thus, adaptive leadership seems to be especially necessary in complex and ambiguous situations (Klein & Pierce, 2001, June) and it has been recognized to be essential in order to establishing safety and to cope with uncertainty (e.g. Salas, et al., 2007).

Numerous authors have discussed adaptability relative to individual, team, and organizational levels. Although applying the same term, they often use different definitions for this concept. In an attempt to develop an appropriate working definition of adaptive leadership, often-cited definitions of adaptive team processes were reviewed. An overview of the main definitions is presented in Table 1.1

Table 1.1: Definitions of Team Adaptability and Team Adaption

Authors	**Definition**
Bowers, Morgan, Salas & Prince (1993)	Crew adaptability is one of 7 coordination dimensions. Ability to alter one's course of action as necessary, to maintain constructive behaviour under pressure, and to adapt to internal or external changes.
Cannon-Bowers, Tannenbaum, Salas, & Volpe (1995)	Team adaptability is the process by which a team is able to use information gathered from the task environment to adjust strategies through the use of compensatory behaviours and reallocation of intra-team resources. A process whereby a team can shift the workload among its team members to achieve balance during high-workload, time pressured, or emergency situations.
Kozlowski, Gully, Nason, & Smith (1999)	The ability of the team to continually improve team process by reconfiguring the network to meet the immediate contingencies within the environment. Adaptability refers to a metamorphic shift in the team network in the short term to deal with the performance demands of a non-routine task.
Entin & Serfaty (1999)	Team adaption to stressful situations is the appropriate switching from implicit to explicit coordination and vice versa.
Pulakos, Arad, Donovan, & Plamondon (2000)	A shift in attention or focus in response to unpredictable and uncertain work conditions.
Klein & Pierce (2001, June)	Adaptive teams (as opposed to inflexible, rigid teams) are able to make the necessary modifications in order to meet the demands of a new situation or event or a changed environment.
Kozlowski, Toney, Mullins, Weissbein, Brown, & Bell (2001)	Adaptability as an individual, team, and organizational capability. The generalization of trained knowledge and skills to new, more difficult and more complex task situations.
Xiao, Seagull, Mackenzie, Klein, Ziegert (2002)	Adaptation of team structures according to the needs of tasks is found as being based on four archetypes. E.g. as teams gain experience working together, the leader may reduce involvement and adapt the laissez-faire leader team structure.

Authors	Definition
	Under stress, the team may adopt the efficiency team structure, as the leader may be directly involved in team performance.
Fleming, Wood, Dudley, Bader, & Zaccaro (2003)	Functional change in response to altered environmental contingencies and a higher order process that emerges from an integrated set of individual attributes.
LePine (2003)	Adaption of team role structure (when faced with a change in the task). Team adaptability includes reactive and nonscripted adjustments to a team's system of member roles that contribute to team effectiveness.
Baker, Horvath, Campion, Offermann & Salas (2005)	Process by which a team is able to use information gathered from the task environment to adjust strategies through the use of compensatory behaviour and reallocation of intra-team resources. Strong adaptability/flexibility skills are demonstrated by team members who provide assistance, reallocate tasks, provide/accept feedback, and monitor/adjust performance.
White, Mueller-Hanson, Dorsey, Pulakos, Wisecarver, Deagle & Mendini (2005)	Adaptability is an effective change in response to an altered situation.
Burke, Stagl & Salas (2006b) Stagl, Burke, Shawn, Salas & Pierce (2006)	Change in team performance, in response to a salient cue or cue stream, which leads to a functional outcome for the entire team. Team adaption is witnessed in the functional innovation of new, or modification of existing, structures, capacities, or cognitive and behavioural goal directed actions.

Reviewing the several definitions, one key feature of adaptive team processes can be extracted. Most of the authors agree on the fact that being adaptive means to make necessary modifications in order to meet immediate contingencies within the team environment. More specifically, one can adapt, for example, by reallocating intrateam resources and team structures or by altering one's course of action. Based on these characteristics adaptive leadership is defined, in this thesis, as follows:

> *Adaptive leadership means to adjust leadership strategies in order to meet external or internal demands by shifting the team structure or by modifying the kind of leadership behaviour.*

Building on this definition, adaptive leadership in anaesthesia is seen as the ability of an individual engaging in leader behaviour to modify his/her leadership behaviour in order to meet the demands of a situation (e.g. a non-routine task) or within team factors, including sharing their leadership role with another team member when circumstances require this form of adaptability. In the subsequent section,

adaptive teams will be distinguished from adaptive leaders and the importance of adaption at the individual level will be discussed.

Applying the IPO Model to the concept of adaptive leadership, the following assumptions can be made:

Firstly, it is assumed that this kind of leadership behaviour is adaptive to contextual factors. This idea is similar to the contingency approach of leadership, implying that the success of the leader is a function of adapting to various contingencies in the form of subordinate, task, and/or team variables. These theories stress using different styles of leadership appropriate to the needs created by different organizational situations (e.g. Fiedler's contingency theory (Fiedler, 1967), Hersey & Blanchard's situational theory (Hersey & Blanchard, 1974), Vroom and Yetton's decision participation contingency theory (Vroom & Jago, 1973)). Furthermore, House (1971) recommended adapting leadership behaviours to the needs of their subordinates. A similar approach to contingency and/or situational leadership theories is provided by the theory of substitutes which indicates that some environmental factors (e.g. high standardization, low task load) diminish the need of leadership behaviour (Kerr & Jermier, 1978). What these approaches all have in common is that they highlight the dependency of leadership behaviour on external factors and that effective leadership strategies need to be adapted in response to changing needs.

Secondly, adaptive leadership is not only the kind of leadership behaviour which is assumed to shift depending on input factors. Furthermore, it is also expected that sharing leadership creates the capacity for adaptability (Day, et al., 2004). As such, the transference of leadership functions from one team member to another seems to enable an adaptive response to varying input factors such as changes in task complexity. This means that team members participate in the leadership process even if they are not assigned as a formal leader. This phenomenon has been recently investigated as the concept of shared leadership (e.g. Pearce & Conger, 2003), defining leadership as a *"collaborative, emergent process of group interaction in which members engage in peer leadership while working together"* (p. 53). In this vein, leadership is seen not as concentrated in the hands of a single person or a small group but divided and performed by many, if not all team members, simultaneously or sequentially (Shamir, 1999) and describes *"the collective influence of members […] as opposed to one individual within or external to the group"*

(Sivasubramaniam, Murry, Avolio, & Jung, 2002, p. 67). As our previous study has shown, roles in anaesthesia may change spontaneously during collaboration, new team leaders can emerge (Zala-Mezö, et al., 2004) and it might be possible that an anaesthesia team has two or more leaders: the informal and the formal one. According to this leadership paradigm, leadership in anaesthesia is in line with recent concepts of leadership portraying leadership as a shared social process involving a group of people rather than an individual being singled out as superior to the rest. This implies that research of leadership in anaesthesia needs to be approached as a dynamic and interactive influence process among members who lead one another to help reach the goals of the group or organization (Pearce & Conger, 2003), rather than through the study of internally-assigned leaders alone.

To sum up, adaptive leadership is conceptualized as a process factor which enables teams to react appropriately to varying input factors such as task complexity, level of standardization, and experience of team members. In this thesis, *adaptive* means to either modify the kind of leadership behaviour (demonstrated in Article 1) or to alter the distribution of leadership among team members (demonstrated in Article 2).

1.4.3 Output factors: Clinical performance in Anaesthesia

As Gaba (2001, p. 2614) formulates: “Performance itself is an intuitively meaningful concept that is difficult to define precisely. There are no gold standards for the clinical decisions and actions of anaesthetists. They depend heavily on the context of specific situations.” To achieve an adequate understanding of performance, it is also necessary to accept data that seem “uncomfortably subjective to the physical or biologic scientist”. The most promising approach to creating a performance definition appears to be the focus on the most important challenges the anaesthesia team faces: unexpected and non-routine events (Weinger, Slagle, Jain, & Ordonez, 2003). A non-routine event in anesthesia is defined as “any event that is perceived by care providers or skilled observers to be unusual, out-of-the-ordinary, or atypical” (Weinger & Slagle, 2002). A rapid, adaptively lead reaction to these events could have life-or-death consequences regarding the patient’s safety. In this thesis, it is expected that phases of low task complexity are interrupted by a time-critical, non-routine event during the induction. The critical event in the observed simulated

anaesthetic setting was an asystole (cardiac arrest) during laryngoscopy. Cardiac arrest during anaesthesia induction represents a rare but potentially life-threatening situation where a timely response is critical. Although being rare and relatively unexpected, an asystole is not an unknown phenomenon for anaesthetists and has been reported repeatedly (Sutera & Smith, 1994; Wang, Winship, & Russell, 1998). Reaction time in response to non-routine, time-critical events can therefore be used as an indicator of team performance. Thus, the speed of adequate team reaction to these time-critical events will be the measure of the team performance.

The following section will summarize each study regarding goal, methodology and results. Finally, findings of these three studies will be discussed in order to give implications for further research.

1.5 Summary of Articles 1, 2 and 3

1.5.1 Article 1: Literature Review

As no systematic overview on the growing body of literature on leadership behaviour in critical care teams existed, the goal of Article 1 was to review and integrate previous findings on leadership strategies in critical care teams. In a comprehensive literature analysis, eight electronic databases were searched for peer-reviewed research journal articles focusing on leadership in action teams. Overall, 41 articles from 1995 to 2007 were included in the review. An extended IPO Model served as a conceptual framework and findings were structured around the model. Results on input factors include *personal* (e.g. experience and knowledge of the leader), *team* (experience of team members) and *environmental* (workload and standardization) levels. In context of leadership processes, the review identified three different kinds of leadership behaviours: *task-oriented* (e.g. building structure within a team, giving direction), *relations-oriented* (e.g. supportive leadership behaviour, developing team members) and *change-oriented leadership* (e.g. monitoring the environment, adaptive leadership behaviour). Findings on leadership outcomes were classified according the methodology used as either *external ratings of leadership behaviour*, *self assessment of leadership quality*, or *quantitative measurement of clinical outcomes*.

The review results clearly indicate that leadership behaviours play a critical role in promoting team performance and patient safety in critical care teams. For

example, clear and unambiguous leadership behaviour, which is adaptive to external conditions, was shown to be the most effective in critical care teams. It also appears that leadership in critical care teams is dependent upon a current situation, leading to the assumption that a specific behaviour is appropriate to a specific situation (i.e. a behaviour is successful in one but ineffective in another situation). Furthermore, the review implied that leadership training may enhance team performance. Regarding directions for future research, it was suggested to further include team performance measures more systematically, to integrate more concepts from work or social psychology and to better operationalize the term adaptability in the context of medical teams. This would allow for analysing its relevance for the effectiveness of leadership. Furthermore, additional research on teachable leadership functions is proposed so as to integrate those findings into leadership training programs.

1.5.2 Article 2: Substitutes for leadership in anaesthesia teams

Article 2 aimed at shedding more light on contextual factors in anaesthesia teams and their impact on leadership performance. The level of routine, level of standardization and experience of team members were analysed as substitutes for leadership influencing the amount of leadership and team performance. The study took place in a simulated setting where during inductions of general anaesthesia, a non-routine event (asystole) occurred. A taxonomy of leadership behaviour was developed and leadership behaviour of 12 anaesthesia team members was coded and included into analysis. In order to analyse changes in leadership behaviour according to the levels of routine and standardization the video recorded simulated inductions were classified into three main work phases (preparation, preintubation, and intubation). Experience, measured by the time team members have been working in anaesthesia, was also included in the analysis. Team performance was examined with the reaction time of the entire team to the unexpected simulated event (asystole). Mann-Whitney U-tests, Spearman rank order correlations and a Scheirer-Ray-Hare extension of the Kruskal-Wallis test were applied for statistical analysis.

The results support the Substitutes of Leadership theory, indicating that leadership behaviour varies depending upon contextual factors and, to some extend, on the experience of team members. Findings showed that the amount of leadership increases significantly during non-routine, high task load situation while it was significantly smaller if level of standardization was low. Contrary to expectations, only

nurses adapt their amount of leadership to the experience of residents. Residents were less likely than nurses to adapt their level of leadership to the experience level of nurses. However, this finding was not significantly related to team performance. Regarding implications for further research, it was suggested that a future study should be completed by using data from a live setting as well in order to get more generalizable data and allowing for other than nonparametric statistics. Furthermore, it was proposed to extend the measurement of experience by including also the experience in other medical domains or, more specifically, with the simulated non-routine event.

1.5.3 Article 3: Distribution of leadership behaviour

The aim of Article 3 was to analyze in more detail the distribution of leadership behaviour among team members. The study involved a reanalysis of the data obtained in Study 2, although not all available variables were included into the analysis (e.g. level of standardization). Furthermore, not all phases were included. Instead, an extreme group analysis comparing Phases 1 and 3 was applied. Mann-Whitney tests revealed no differences between low and high performing teams for residents, nurses and shared working experience in anaesthesia. After a logarithmic transformation, a univariate analysis of variance (ANOVA) using the GLM procedure of SPSS was computed.

The findings reveal the effectiveness of shared leadership in situations with high task complexity. Results showed that high performing teams shared their leadership during both low and high task load situations whereby in low performing teams, residents used significantly more leadership behaviour than nurses when task complexity was high. Furthermore, the findings revealed that members of high performing teams used more heterogeneous leadership functions, especially in high task load situations. For residents, structuring leadership seemed to be more effective in contrast to the content-oriented leadership of nurses. These findings lead one to conclude that a team is more effective if its members distribute their leadership roles. In order to improve further research, it was suggested that future studies should complete data with interviews or surveys in order to get a more comprehensive understanding of the nature of shared leadership. Furthermore, studying shared leadership in a live setting could reveal new aspects of shared

leadership as it may be that role stability differs in live situations vs. simulated settings.

1.6 Overall Discussion and Implications for future research

This section summarizes the main conclusions of all three studies and provides an integrated conclusion. Taken together, the studies confirm the importance of leadership behaviour in anaesthesia teams. Both from the intense literature research and the empirical studies, the findings reveal significant relationships between input, process and outcome factors. The literature review in Article 1 shows that leadership behaviour in critical care teams is contingent upon various inputs from the team, contextual and personal levels. Beside many other factors, the literature review emphasises the importance of input factors such as patient condition, level of standardization, and maturity of team members. Articles 2 and 3 provide empirical evidence for the importance of these input factors by investigating the influence of task load, standardization, and experience of team members on leadership behaviour and performance. For example, as shown in Article 2, in effective teams the amount of leadership increases with increased task load and lower standardization but is lower with routine situations and high levels of standardization. Furthermore, it is shown that nurses adapt their leadership to the experience level of residents by demonstrating more leadership behaviour with lower experienced residents. Article 3 reveals that the distribution of leadership within the team alters depending upon the task load of a situation. Particularly germane to this thesis is the evidence found for the effectiveness of sharing leadership during high task load situations.

The primary conclusion that can be derived from the three studies is that team leadership is strongly contingent upon contextual factors. All three studies provided evidence that adaptive leadership behaviour is an effective strategy for promoting effective team performance in the transition from a routine to non-routine situation – a critical task characteristic in anaesthesia. These findings support other studies which state the importance of adaptive leadership in critical care teams in order to deal with complex and interdependent work processes (e.g. Cooper & Wakelam, 1999; Klein, et al., 2006; Xiao, et al., 2004). In addition to promoting the success of

interdependent processes, adaptive leadership has also been recognized to be essential in establishing safety and coping with uncertainty (e.g. Salas, et al., 2007).

Furthermore, these results are in line with contingency theories of leadership which emphasize the ability of successful leaders to adapt to a changing environment. Particularly in anaesthesia, there is a variety of situational changes which might require different leadership styles and team members must be ready to modify their leadership behaviour accordingly. For instance, a routine induction might reduce the call for leadership behaviour whereas a sudden cardiac arrest would probably require a more directive leadership style. The Substitutes of Leadership theory (Kerr & Jermier, 1978) and the situational theory of leadership (e.g. Hersey, Blanchard, & Johnson, 1996) indicate that the most effective leaders are those capable of adapting their behaviours in response to the demands of the situation and to the level of experience of team members. It seems, then, that flexibility in leadership behaviour is paramount if a high level of leadership effectiveness is desired and required by the situation.

As shown in Study 3, it is not only the amount of leadership but also its distribution among team members which is ideally adaptive in accordance with the task load. Thus, shared leadership is an effective strategy for maintaining team performance, especially during high task load phases. One can assume that shared leadership enables a team to be adaptive to non-routine situations as its inherent nature of shared responsibility prevents the appointed leader from being cognitively overloaded or overwhelmed by an unwieldy task load. As complexity increases, which it did during the asystole simulated in this study, a single leader may have difficulties completing necessary leadership functions for effective teamwork. This finding differs from other research. For example, Vroom (2000) held that in time-critical situations, a leader should make decisions that at other times would be delegated to team members. Similarly, members of anaesthesia teams reported that during high task load, one person should take over all leadership functions (Zala-Mezö, et al., 2004).

In order for team members to share leadership behaviours, it is vital to have a shared mental model (Burke, Fiore, & Salas, 2003) – that is, a common situational assessment among team members. Since shared mental models need time to develop, it seems likely that shared leadership in early team life would be less effective, implying that it may be best to rely more on the appointed leader at the

beginning of collaboration. Conger and Pearce (2003) even recommend avoiding shared leadership in temporary teams of extremely short duration. However, the current finding that shared leadership successfully occurs in anaesthesia teams despite their ad hoc nature contradicts these assumptions. The results indicate that shared leadership is more effective in non-routine situations than vertical leadership, even though it occurs in ad hoc organized anaesthesia teams working together without previously knowing each other.

Taken together, the results derived from all three studies generally support the hypothesis that adaptive, shared leadership behaviour is a functional process factor in anaesthesia teams which enhances clinical team performance.

In addition to the conclusions outlined above, further implications derived from this general discussion are highlighted in the subsequent sections.

1.6.1 Training implications

Based on the summarized results of this dissertation, the following implications regarding the design of leadership trainings are offered in terms of ‘good practices’. Since all conclusions point to the effectiveness of adaptive, shared leadership behaviour, it seems reasonable to recommend ways to enhance this behaviour by offering training for team members in anaesthesia. For over a decade now, team leadership training has been used to successfully train specific team leader behaviours and the implementation of these programs has been shown to increase team performance (Tannenbaum, Smith-Jentsch, & Behson, 1998). It also appears that for medical settings, leadership trainings seem to be critical to promote effective leadership and significantly improve team performance (e.g. Cooper, 2001; Driscoll & Vincent, 1992; Sugrue, Seger, Kerridge, Sloane, & Deane, 1995). To date, crew resource management trainings have been offered in aviation (Prince & Salas, 1993) and medical (Gaba, Howard, & Small, 1995) settings. In general, those trainings aim to prevent or at least diminish errors by improving decision making, teamwork communication and coordination during emergencies (Day, et al., 2004).

However, despite the increasing acknowledgment of the importance of team training programs, specific training in leadership skills is still often neglected (e.g. Cooper & Wakelam, 1999; Schull, Ferris, Tu, Hux, & Redelmeier, 2001). According to the findings of this study, it seems reasonable to recommend the design and implementation of training that develops adaptive leadership behaviours. According

to Burke (Burke, Salas, Wilson-Donnelly, & Priest, 2004), there are some design features which could be included in team trainings that would facilitate team members' adaptive capacities. For example, it is known that learning to solve unknown or unexpected problems is essential to developing adaptive expertise (Smith, Ford, & Kozlowski, 1997). Thus, it is being proposed that adaptive skills should be taught first at the individual level before offering such training for the whole team. Furthermore, adaptive leadership training should present several examples of unknown situations in varying complexities. This would help team members to generalize their own skills, fostering cognitive flexibility and deepening trainees' cognitive structures. Varying the nature of examples and practice opportunities would provide trainees with a broader response repertoire, thereby increasing the potential for adaptability (Burke, et al., 2004; Burke, et al., 2006b).

According to Burke et al. (2004; 2006b), shared mental models serve as the foundation for a team's ability to be adaptive. One way to facilitate adaptive team behaviours is to thereby develop shared mental models within a team. Team training would allow employees to develop a better understanding of the variety of possible tasks facing the team in live settings, the distribution of relevant skills within a team, and how shared leadership behaviours would best be distributed depending upon different task scenarios. For example, cross training as one way of teaching teams to help team members experience task requirements and needs of other colleagues. Cross training has been shown to improve a team's anticipatory behaviour and foster communication and coordination strategies (see Day, et al., 2004). Furthermore, it can be assumed that team members who work closely together for longer periods of time would be better able to adopt a common vision of shared mental models and shared leadership. To enable adoption of shared mental models, the ad hoc nature of the anaesthesia teams investigated in this thesis should be questioned and one might recommend building long-term team training rather than preserving the current ad hoc nature of anaesthesia teams. For instance, scheduling could be modified so that identical team structures are maintained over a longer period.

Despite this clear call for more training programs, the initial recommendation is to broaden research on effective leadership strategies in medical teams. Article 1 revealed many factors which potentially can influence leadership effectiveness in anaesthesia. Future research is still needed to understand the proposed input-process-output model relative to anaesthesia teams and the relevant factors

influencing their effectiveness to identify more teachable leadership functions. Those findings could then be incorporated into training programs. Especially longitudinal studies would obviously be worthwhile in order to finally evaluate those trainings.

1.6.2 Methodological implications

Besides implications for future training programs, some methodological issues need critical reflection and as do suggestions for future research.

1.6.2.1 Scenario

With the simulated anaesthetic setting the aim was to garner standardized data in order to improve the current study setting as compared to settings of earlier research (Grote, et al., 2004b; Zala-Mezö, et al., 2009). The simulations allowed similar team constellations to be observed in a unique setting. But despite the standardized and regulated setting used, it was not possible to control for every variation (e.g. team composition). For future studies using a simulated setting, it is recommended to further control factors by manipulating team composition such as team member experience, female/male member composition, level of task load, and level of standardization. This would allow researchers to analyze leadership effects with regard to moderating and mediating effects of said variables. Furthermore, a larger sample size than was available for the current study is also a recommended precondition for further research.

1.6.2.2 Measuring experience

The lack of significant results concerning the experience of team members may be explained by the experience measure used in this thesis. According to Bettin and Kennedy (1990), it may not have been sufficiently valid to distinguish significantly between high- and low-performing teams. They argue that time is not an adequate measure of experience because “it does not capture the knowledge and skills that a leader acquires by participating in various activities.” (p. 226). Furthermore, the authors contend that time as a measure of experience simply correlates a leader’s performance with the number of months they have been in an organization and ignores the nature of an individual’s specific work history. Although time is necessary to gain experience, it is not enough to fully measure the knowledge and skills a leader has acquired. Therefore, we suggest that both time working in anaesthesia

and previous experience in other medical domains as well as concrete experience with simulated non-routine events might be more fruitful extensions of the meaning of experience.

1.6.2.3 Data coding

One further methodological suggestion concerns the category system used in this thesis to capture leadership behaviour. Codes were theoretically grouped into rationally and meaningful determined categories based on their conceptual similarities. However, more systematic methods to group codes and to judge similarities between codes exist such as multidimensional scaling, factor analysis, and functional similarity grouping (e.g. Jacob & Krahn, 1987). Ideally, rational grouping should be combined with statistical summarizing strategies to identify similarities and differences among codes. In order to comprehensively validate the codes, future research needs to consider other methods to check for code similarities rather than checking only those that appear meaningful theoretically.

1.6.2.4 Data analysis

A median split was used in order to compare high- and low-performing teams. All cases falling below the median were classified as *low* and all cases above the median were classified as *high*. The main problem with this distribution form is that all teams lower the median were classified as equal even though scores of teams near the median might be much closer to a team slightly above the median than to the other teams within the lower performing group. As a solution for these shortcomings, an extreme group analysis is proposed. Extreme group analysis entails selecting individuals on the basis of extreme scores (e.g. in the upper and lower tertiles) and investigating the relationship only for those extreme scoring individuals (see Feldt, 1961).

1.7 Structure of the dissertation

Following this introductory chapter, the three studies are presented in detail thusly: Article 1 is reported in Chapter 2, Article 2 in Chapter 3, and Article 3 in Chapter 4. Chapters 2 through 4 are based on previously submitted papers.

- Chapter 2 is entirely based on: Künzle, B., Kolbe, M. Grote, G. (under revision). Ensuring Patient Safety through Effective Leadership Behaviour: A Literature Review, Safety Science.
- Chapter 3 is entirely based on: Künzle, B., Zala-Mezö, E., Kolbe, M., Wacker, J. & Grote, G. (under review). Substitutes for Leadership in Anaesthesia Teams and their Impact on Leadership Effectiveness, European Journal of Work and Organizational Psychology.
- Chapter 4 is entirely based on: Künzle, B., Zala-Mezö, E., Wacker, J., Kolbe, M. Grote, G. (under review) Leadership in Anaesthesia Teams: the most effective Leadership is shared, Quality and Safety in Health Care

Appendix A (see Chapter 6) contains an overview of the contribution of each author to the papers.

2 Ensuring Patient Safety through Effective Leadership Behaviour: A Literature Review

2.1 Abstract

Ensuring patient safety has always been important for critical care teams. Since team and leadership skills are increasingly recognised as important for the patient's safety, a body of literature on leadership in critical care exists. The purpose of this paper is to provide a systematic review on the findings of effective leadership strategies in critical care teams. We aim to contribute to a better understanding of the skills, knowledge, and attribute leaders need and in turn, apply in order to create and maintain patient safety. An input-process-output model of leadership is used to systemize the findings. The results of this review clearly show that leaders play a pivotal role in promoting team performance and safety. Effective leadership is characterized by clear and unambiguous behaviour which is adaptable to situational demands and shared between team members. The review concludes with recommendations for future research directions.

2.2 Introduction

Teams are one of the basic functional units of organisations and are used in one way or another in all organisations including healthcare institutions. Leadership has been identified as a key variable for the functioning of teams and as one of the main reasons for the success or failure of team-based work systems implementation (e.g. Avolio, et al., 1996; Day, et al., 2004; Gladstein, 1984; Kozlowski, et al., 1996; Stewart & Barrick, 2000; Zaccaro, et al., 2001).The importance of leadership for the functioning of organisational teams is a stable finding (Yukl, 2006) and it is also becoming increasingly recognised as important for a patient's safety. This development is in line with other industries such as airlines or energy and manufacturing sectors where a culture of safety is common and where the entire system of organisation and culture, including team behaviour and leadership, is designed to enhance safety behaviours (see e.g. Flin & Yule, 2004; Schimpff, 2007). Teams in critical care environments are known as high reliability teams, and value reliability as a priority over any other organisational objectives due to the criticality of

failure and mistakes (Yun, et al., 2003). Their work is characterized by intense time pressure, unforeseen and critical events, resource limitations, competing goals, increasing complexity, and diversity of personnel. To assure safe and efficient work in these complex systems, interactive human factors such as communication, supervision or team structure have been considered vital (Donchin, et al., 1995; Kosnik, 2002). Conversely, breaks in communication, lack of coordinated care or teamwork failure can result in an unfavourable outcome for the patient (e.g. Fletcher, McGeorge, Flin, Glavin, & Maran, 2002; Flin, et al., 2003; Gaba, Maxwell, & DeAnda, 1987; Helmreich & Schaefer, 1994; Sexton, Thomas, & Helmreich, 2000). With the growing understanding of the importance of human factors alongside medical knowledge and technical skills, researchers have turned their attention to the topic of team leadership, asking questions such as how leadership behaviours influence the effectiveness of teams and describing elements that might moderate the effect of leadership on team performance and patient safety. It has been shown that failure to establish leadership for critical care teams can cause suboptimal teamwork and therefore, an increased risk to patients (e.g. Helmreich, 2000; Pollack & Koch, 2003). Moreover, positive correlations between the quality of leadership and goal achievement (Stockwell, Pollak, Turenne, Gibson, & Slonim, 2005) or task completion (e.g. Undre, Healey, Darzi, & Vincent, 2006a) were found.

Although a growing body of literature on leadership in critical care teams exists, to our knowledge no systematic summary of this knowledge is available. As the findings differ in complexity as well as in the selected aspects on leadership behaviour and methodology, it is difficult to keep an overview of the key features of effective leadership in critical care teams. With this review we thereby aim to provide an important theoretical contribution to a better understanding of the skills, knowledge, and attributes leaders need in order to create and maintain patient safety. The focus will be on critical care teams, including all teams which are specialized in the intensive care of patients whose conditions are life-threatening and who require comprehensive care.

We believe that giving a systematic overview of the state of the art findings on leadership in critical care teams is necessary in order to delineate the unique characteristics and critical functions of leadership and also to uncover future research needs.

Since there appears to be considerable variation in the description of leadership in critical care teams, this paper will first provide a definition of leadership by bringing together the various characterisations from previous studies. This will be followed by details of the methodology used to identify the empirical articles and highlight the key features of critical care teams. As a next step, we will critically examine studies linking leadership behaviour in critical care teams working in the operating theatre to the teams' performance, as well as studies focusing on factors mediating the relationship of leadership behaviour and performance. Doing so, we will also highlight the differences of findings and methodology across investigations. As a conceptual framework we will use the Input-Process-Outcome-Model. To conclude, implications for further research and practice are suggested.

2.3 Conceptual framework of the review

When considering studies investigating leadership in critical care teams working in the operating theatre, three elements of research can be distinguished: concrete leadership behaviour, its influencing factors, and its effect on team performance. This structure fits within a general input-process-output (I-P-O) or functional perspective of team effectiveness (Wittenbaum, et al., 2004). The I-P-O model has also been adapted for medical teams (e.g. Flin & Maran, 2004; Healey, Undre, & Vincent, 2004; Helmreich & Schaefer, 1994) and serves as a useful framework for studying team processes in the operating room (Healey, et al., 2004; Helmreich & Schaefer, 1994). As the I-P-O model is the dominant framework used in the study of teams, it provides a useful basis for organizing and integrating the literature on leadership in critical care teams.

Originally, McGrath (1964) and Hackman and Morris (1975) described team performance as a sequence of inputs which affect team processes that in turn lead to outcomes. Inputs refer to characteristics of the team members and to the context in which the group operates. Main inputs for critical care teams are organisational and environmental characteristics (e.g. patient condition, operating room design), team (e.g. composition, climate) and individual factors (e.g. physical condition, leader's skill and experience).

Processes were initially defined as the interactions and interpersonal behaviours among team members (Hackman & Morris, 1975; McGrath, 1964) that "transform resources into a product" (Gladstein, 1984 p. 500). According to Marks

and colleagues (2001), processes refer to “members interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioural activities directed toward organizing task work to achieve collective goals” (Marks, et al., 2001, p. 357). Processes in critical care teams contain technical aspects of patient management (e.g. management of anaesthetic level), cognitive and interpersonal activities such as forming the team, carrying out planned tasks or maintaining situational awareness.

Outputs refer to team effectiveness and include performance, satisfaction, and attitudes of team members (Marks, et al., 2001). In the case of medical teams, patient safety is the most obvious outcome of teamwork. Furthermore, Helmreich and Schaefer (1994) defined efficiency at completing tasks as important as well as team morale and attitudes, which are influenced by the quality of group interaction.

In early I-P-O models of team effectiveness, it was implied that outcomes had a final end state. Although Hackman and Morris (1975) stated that the relation of input-process-output might be circular, subsequent research had only rarely taken into account its iterative character. However, teams develop over time and contexts; so recent models recognised the importance of feedback loops from outcomes to inputs and processes. Thus, at a given time, team performance is an output while possibly also an input and part of the process leading to performance in a subsequent time period. Therefore, outcomes are not only an output but also serve as input for future processes and can indirectly influence patient safety (e.g. Day, et al., 2004; Ilgen, 1999; Marks, et al., 2001).

After having presented the conceptual framework for this literature review, the question arises as to where leadership should be integrated into the I-P-O model. Past models of team effectiveness do not explicitly consider leadership processes as part of team interaction processes. Some authors include leadership as a structural characteristic, which affects team processes and influences team outputs indirectly (e.g. Kozlowski, et al., 1996; Marks, et al., 2001; Stewart & Barrick, 2000; Zaccaro, et al., 2001). However, keeping the findings on leadership in critical care teams in mind, leadership must not be considered solely as an input factor. One may expect that a leader not only brings specific leadership skills and competencies to a team and influence team processes, but also engages in team process functions, which may in turn affect the leader’s skills and further behaviour. Based on a generalized model of teamwork (Dickinson & McIntyre, 1997), Healey and colleagues (2004) provided a framework for surgical team studies. Apart from Borrill, West, Shapiro, and Rees

(2000) they are, to our knowledge, some of the few authors who have explicitly regarded team leadership as part of team processes. Given these findings, we have extended the traditional team model of operating room performance (Helmreich & Schaefer, 1994) and added leadership processes as part of team performance functions (see Figure 2.1).

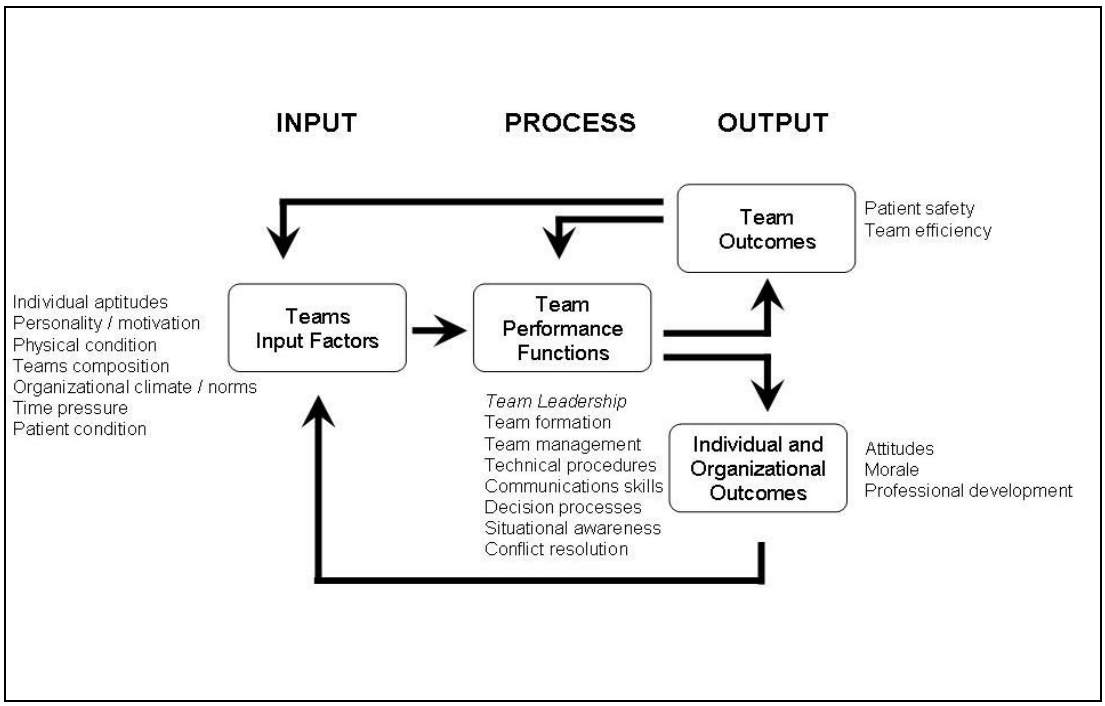


Figure 2.1: A model of operating room performance (adapted from Helmreich & Schaefer, 1994 and extended (variable in italics))

The model shown in Figure 2.1 contains three main sections: Inputs, processes, outcomes. It serves as a framework for this literature review and the findings are presented in line with the three key elements of the model. However, since this review specifically analyzes the relevance of leadership behaviour in critical care teams, we will only mention findings on leadership and will not consider other team process functions. In this thesis the model is interpreted as indicating that the input factors are the circumstances and resources a leader has to deal with. Process factors are related to the behaviour of a leader. Output factors define the effectiveness of leadership behaviour.

2.4 Procedure of literature analysis

Much of the literature on teamwork and leadership in medicine is about settings that require psychosocial care, about teams existing over a long period of

time or about leadership on the executive level (e.g. president, CEO) (e.g. Pronovost, et al., 2003). Studies focusing on these aspects are not included in this literature review. This review is limited to leadership at the team level and to high reliability teams with temporal functioning, also known as action teams (Sundstrom, et al., 1990) or as crews (Arrow, et al., 2000). Seven electronic databases were searched for peer-reviewed research journal articles from the last twelve years (1995-2007): PsycINFO, Psyndex, PubMed, Medline, Science Direct, ISI Web of Knowledge and Francis. Additionally, a beta-research on Google Scholar searched for the same key words, the first fifty results being examined only.

The key words employed for all searches were “leadership” combined with “teams”, “hospitals”, “surgery”, “anaesthesia”, “medical personnel”, “operating room”, “emergency services”, and “high reliability”. Additionally, reference lists of journal articles meeting the eligibility criteria were used to identify citations of potential relevance. A specific search for publications of well-established authors in this research area was also conducted.

Two reviewers screened titles, key words, and abstracts of each article independently. Full text articles were retrieved for those studies appearing to meet the eligibility criteria, as well as for those where the title, abstract, and key words gave insufficient information for immediate exclusion. Upon retrieval of the full text article, the eligibility of a study was determined by one reviewer.

Papers that fulfilled the following criteria were considered: (1) sample included leadership and/or teamwork in critical care teams such as operating room teams or acute care settings in surgical, anaesthesia or trauma teams; (2) studies investigated either the influencing factors on leadership behaviour and/or the relationship between leadership behaviour and team effectiveness; (3) articles appeared in peer-reviewed journals; (4) papers were written in either English or German. Overall 41 articles met the criteria and were included in this review. An overview of the characteristics of the reviewed studies and their main findings are presented in Table 2.1. These articles were examined in detail with regard to their theoretical groundings, materials and methods, main findings and discussion elements, with particular attention being paid to the influencing factors of leadership, leader behaviour and its effect on team outcomes. Evaluating the studies revealed that the majority have concentrated on a more practical approach and only a few drew on psychological leadership theory. The results of the analysis of these studies will be presented in the following section.

Table 2.1: Summary of the studies reviewed on leadership in critical care teams structured following the I-P-O model

Function in the team work	**Authors (year of publication)**	**Country**	**Research question/ Purpose of the paper**	**Participants/ Object of investigation**	**Methods**	**Major findings**
RESEARCH ON INPUT FACTORS						
Personal factors						
Experience & Knowledge	Cole & Crichton (2006)	Britain	Exploration of trauma team culture in relation to the influence that human factors have on team performance	Trauma teams	Ethnographic observations, Semi-structured interviews	Team leader experience and seniority is beneficial for the leadership role.
	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Experience of more than 3 years correlates positively with effective leadership behaviour.
	Driscoll & Vincent (1992)	Britain	Effects of team structure on resuscitation stage time	Trauma resuscitation teams	Prospective study	Seniority of the team leader does not greatly affect performance; experience and training may be more important than seniority.
	Hynes et al. (2006)	Canada	Provide approach to difficult leadership situation. Identification of core problems of and proposition of solutions.	Interdisciplinary cardiac arrest teams.	Presentation of clinical scenarios including leadership failures to interdisciplinary critical care leaders	Stress is likely caused by an individual's being ill-equipped for the role.
	Sugrue et al. (1995)	Australia	Performance of trauma team leader	Trauma teams	Observation External expert ratings	Also junior doctors skilled in team

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
						leadership can take charge of trauma teams.
Leadership training	Burke et al. (2004)	United States	Translation of lessons learned from the military and aviation communities into practical guidance for the medical community	Medical community	Literature Review	Training task work skills will no longer be sufficient, teamwork skills (e.g. leadership) are also necessary.
	Cole & Crichton (2006)	Britain	Exploration of trauma team culture in relation to the influence that human factors have on team performance	Trauma team	Ethnographic observations, Semi-structured interviews	There is a need for formal team leader training to learn leadership, communication and collaboration skills.
	De Vita et al. (2004)	United States	Experience in improving a crisis response design and training multidisciplinary teams to respond to in-hospital crisis events.	Critical care nurses, respiratory therapists, and physicians	Video Recordings training sessions in patient simulator	Teaching team skills is rare in healthcare education. Training will improve clinical outcomes.
	Hynes et al. (2006)	Canada	Provide approach to difficult leadership situation. Identification of core problems and proposition of solutions.	Interdisciplinary cardiac arrest teams.	Presentation of clinical scenarios including leadership failures to interdisciplinary critical care leaders	Lack of training on important leadership/management skills can result in inappropriate behaviour of a team leader.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
Personal characteristics	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Some individuals are better leaders than others, because they are predisposed to the behaviour required to manage an emergency.
	Thilo (2005)	United States	Role of emotional intelligence for performance	Anaesthesiologists in ambulatory surgery centre	Review	Effective leadership styles involve developing emotional intelligence and self-awareness.
	Wetzel et al. (2006)	Britain	Effects of stress on surgical performance	Consultants, surgeons	Semi-structured interviews	Leaders need self-control to keep calm and reduce their own stress responses.
Team Factors						
Competence of team members	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Less direction of a leader is required if degree of team member skills is high.
	Hancock & Easen (2006)	Britain	Explore realities of research and evidence-based practice through examination of nurses' decision making	Cardiothoracic Intensive Care Unit	Participant observation, semi-structured interviews	Decision-making of nurses is rather influenced by their experience but by their appointed grade.
	Yun et al. (2003)	United States	Team leadership and coordination during	Trauma teams	Observation, shadowing of	Effectiveness of leadership differs

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			trauma resuscitation		following, interviews	depending on the level of team experience, e.g. empowering leadership is better when team is experienced.
	Yun et al. (2005)	United States	Leadership and effectiveness of teams operating in a high-velocity environment.	Trauma resuscitation teams	Questionnaires	Empowering leadership more effective when trauma when team experience was high.
Environmental factors						
Workload	Hancock & Easen (2006)	Britain	Explore realities of research and evidence-based practice through examination of nurses' decision making	Cardiothoracic Intensive Care Unit	Participant observation, semi-structured interviews	Nurses' responsibility for unstable and complex patients was removed compared to routine patients.
	Ketharpal et al. (1999)	United States	Impact of attending trauma surgeon during trauma team activation on system function and patient outcome	Trauma teams	Retrospective review of medical records and trauma	Resuscitation was more effective for severely injured patients in the presence of a trauma surgeon.
	Klein et al. (2006)	United States	Examination of leadership of extreme action teams	Trauma teams	Semi-structured Interviews Observations	The more routine and less urgent the patient's injuries the more likely the

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
						attending surgeon is to delegate the active leadership role to the fellow.
	Wetzel et al. (2006)	Britain	Surgical stressors, their impact on performance and coping strategies used by surgeons.	Consultants, surgeons	Semi-structured interviews	In high-stress situations it's usually the surgeon who takes the leadership role, communication must be clear and assertive.
	Xiao et al. (2003)	United States	Comparison of team communication patterns under varying conditions.	Trauma team members	Behavioural observations, external coding	Leader gives more instructions when task urgency increases.
	Yun et al. (2003)	United States	Team leadership and coordination during trauma resuscitation	Trauma teams	Observation, shadowing of following, interviews	Empowering leadership is more effective when a patient is not severely injured.
	Yun et al. (2005)	United States	Contingency model: Influence of leadership on team effectiveness during trauma resuscitation differs according to the situation	Trauma resuscitation teams	Written scenario method, questionnaires	Empowering leadership was more effective when trauma severity was low.
	Zala et al. (2004)	Switzerl and	Effects of standardization and task load on	Anaesthesia teams	Interviews	More direct leadership is expected if workload is high.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			coordination processes			
Standardization	Grote et al. (2004)	Switzerland	Influences of standardization and task load on coordination	Anaesthesia teams, Cockpit crews	Observation Qualitative Content Analysis of Rules	Situations with few standard procedures require more leadership.
	Hynes et al. (2006)	Canada	Provide approach to difficult leadership situation. Identification of core problems and proposition of solutions	Interdisciplinary cardiac arrest teams.	Presentation of clinical scenarios including leadership failures to interdisciplinary critical care leaders	Written standards should include well-defined roles for each of the cardiac arrest team members and a code of conduct.
RESEARCH ON PROCESS FACTORS	Borrill et a. (2000)	Britain	Relationship between team member characteristics, team working processes and effective teamwork.	National health care teams	Questionnaire, interviews, observation, focus group, meeting, self and external ratings	Lack of clear leadership is associated with poor quality team working.
	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Leaders who make clear that they are in charge are more effective.
	Flin & Maran (2004)	Britain	Paper outlines non-technical rating systems and describes training course to develop these skills.	Operating theatre teams	Literature review	Repeated problems in team coordination are leadership role conflicts between emergency physician and anaesthetist.
	Künzle et al. (2007)	Switzerland/United	Development of an instrument for assessing trauma	Trauma teams	Observation of trauma patient resuscitation, expert	No apparent leader in charge is related to negative performance.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
		States	team performance		ratings	
Task-oriented leadership behaviour						
Clarifying roles and objectives	Cole & Crichton (2006)	Britain	Exploration of trauma team culture in relation to the influence that human factors have on team performance	Trauma team	Ethnographic observations, Semi-structured interviews	It is the responsibility of team leaders to send away surplus observers.
	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Leaders must initiate a structure within a team in order to enhance team performance. He is responsible to ask not actively involved people to leave.
	Hynes et al. (2006)	Canada	Provide approach to difficult leadership situation. Identification of core problems and proposition of solutions	Interdisciplinary cardiac arrest teams.	Presentation of clinical scenarios including leadership failures to interdisciplinary critical care leaders	Lack of effective delegation and communication lead to the inappropriate behaviour.
	Klein et al. (2006)	United States	Examination of leadership in extreme action teams	Trauma teams	Semi-structured Interviews Observations	The leadership function most critical to the active leadership role is providing strategic direction.
	Künzle et al. (2007)	Switzerl and/Unit	Development of an instrument for	Trauma teams	Observation of trauma patient resuscitation,	Too many people around the patient are

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
		ed States	assessing trauma team performance		expert ratings	related to negative performance.
	Marsch et al. (2004)	Switzerl and	Relation between human factors and quality of cardiopulmonary resuscitation.	Observation in a patient simulator, Behavioural Rating	Teams of three health-care workers during cardiopulmonary resuscitation	Absence of structured leadership behaviour was associated with unfavourable outcome.
	Sugrue et al. (1995)	Australia	Performance of trauma team leader	Trauma teams	Observation External expert ratings	Poor communication and deficiencies in delegation were the main pitfall of the leader.
Relations-oriented leadership behaviour						
Supportive leadership behaviour	Cole & Crichton (2006)	Britain	Exploration of trauma team culture in relation to the influence that human factors have on team performance	Trauma team	Ethnographic observations, Semi-structured interviews	Inappropriate leadership such as exasperation have negative rather than positive effects on team performance. Team leaders admitted using deliberate strategies get the best out of the team.
	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Leaders need to display a positive attitude, motivate and encourage the team to

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
						achieve high levels of performance.
	Edmondson (2003)	United States	Exploration of leader behaviour to promote speaking up and other proactive coordination behaviours	Cardiac surgery teams	Multiple case study design, Interviews, Observations	Motivating effort by communicating a rationale for change is a leadership behaviour that team leaders used to facilitate learning.
	Klein et al. (2006)	United States	Examination of leadership in extreme action teams	Trauma teams	Semi-structured Interviews Observations	TRU leaders' function does not include motivation of team members.
	Thilo (2005)	United States	Role of emotional intelligence for performance	Anaesthesiologists, Ambulatory surgery centre	Review	Leaders set the emotional tone of a team. Positive emotions can have a positive impact on a team's performance.
Developing team members	Cole & Crichton (2006)	Britain	Exploration of trauma team culture in relation to the influence that human factors have on team performance	Trauma team	Ethnographic observations, Semi-structured interviews	Leaders can improve individual performances by encouraging team members through positive behaviour and feedback.
	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	Team members are not being taught to lead, nor do they have a model to positively influence their

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
						behaviour.
	Helmreich & Schaefer (1994)	United States/Switzerland	Discussion of multiple factors that influence performance in operating room teams.	Operating room personal (surgeons, anaesthesiologists, surgical and anaesthesia nurses)	Survey (ORMAQ Operating Room Management Attitudes Questionnaires), Observation	Respondents mentioned a need for more feedback on performance.
	Klein et al. (2006)	United States	Examination of leadership of extreme action teams	Trauma teams	Semi-structured interviews Observations, Review of Resident Training Manual	Dynamic delegation of the active leadership role fosters learning and reliability.
	Schull et al. (2001)	Canada	Description of the process involved in an effective response to emergencies. Approaches to help diminish the stress.	Emergency medicine, anaesthesia, critical care	Literature Review	Debriefings offer an opportunity to praise good performance, or may uncover a negative process despite a positive outcome.
	Zala et al. (2004)	Switzerland	Effects of standardization and task load on coordination processes	Anaesthesia teams	Interviews	Metacognition rarely takes place.
Encouraging a cooperative organisational climate	Clarke et al. (2005)	United States	Relationship between characteristics of high reliability organizations and patient safety.	Surgeons	Literature Review	If subordinates speak up and are criticized, they are less likely to speak up again.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
	Clemmer et al. (1998)	United States	Five scientifically grounded methods to foster cooperation and to improve the performance of a unit.	Shock trauma Respiratory intensive care unit	Literature Review	Leaders can foster cooperative behaviour by modelling cooperation in their own interactions.
	Edmondson (2003)	United States	Exploration of leaders' activities to promote proactive coordination behaviours. How do organizational context may affect these team processes and outcomes?	16 cardiac surgery teams	Multiple case study design, Interviews, Observations	Team leaders can facilitate speaking up in the team which was important for a successful implementation of a new technology.
	Fleming et al. (2006)	Canada	Attitudes of cardiac surgery team members toward teamwork and safety, including team communication, leadership and error management	Cardiac surgery team members	Adapted ORMAQ (OR Management Attitudes Questionnaire)	In general, positive attitudes toward speaking up. Team members are willing to speak up if they have a concern or ask questions.
	Healy et al. (2006)	United States	Relevance of CRM and how it is being adopted in various settings	Surgeons	Case Study	Junior members were trained how to approach senior members, while attending surgeons were trained in how to listen to the input.
	Helmreich & Schaefer	United States/S	Discussion of multiple factors that influence	Operating room personal (surgeons,	Survey (ORMAQ Operating Room	Anaesthetists and nurses have more

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
	(1994)	witzerla nd	performance in operating room teams.	anaesthesiologists, surgical and anaesthesia nurses)	Management Attitudes Questionnaires), Observation	positive attitudes towards a flatter authority structure than surgeons.
	Helmreich & Davies (1996)	United States	Definition of human factors in the operating room based on research in aviation. Conceptual model of OR performance. Measures attitudes of operating teams toward human factors.	Data from 2 Hospitals, Anaesthesia and surgical staff	Literature Review, Questionnaire survey Observation	Anaesthetists and nurses have more positive attitudes towards a flatter authority structure than surgeons.
	Risser et al. (1999)	United States	Potentials of teamwork improvements for mitigation or prevention of incidents	Emergency-Department teams, 54 Incidents	Retrospective incident analysis, Checklist-based rating by teamwork-trained physician-nurse pairs	Better individual teamwork behaviours are essential for avoiding serious errors and breaking error chains, e.g. by speaking up.
	Schull et al. (2001)	Canada	Description of the process involved in an effective response to emergencies and pitfalls. Approaches to help diminish the stress.	Emergency medicine, anaesthesia, critical care	Literature Review	Pitfalls of team behaviour: poor communication, reluctance to question those with seniority.
	Sexton et al. (2000)	United States	Attitudes of operating theatre and intensive care unit staff about	Operating theatre and intensive care unit members, cockpit crew	Survey	Consultant surgeons were least likely to advocate flat

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			concerning error, stress, and teamwork. Comparison with airline cockpit crew members	members		hierarchies, while cockpit and intensive care staff advocated flat hierarchies.
	Undre et al. (2006b)	Britain	Cohesiveness of the multidisciplinary operating theatre team.	Operating team professionals, n=24	Semi-structured interviews	Findings seem to suggest that operating team professionals would like to see their teams becoming more collaborative.
	Waisel (2005)	United States	How to develop social capital in the operating room.	Operating room teams	Literature Review	An environment of greater trust leads to improved communication throughout hierarchies, because of a greater comfort in articulating potentially contentious concerns, and more effective negotiations.
Change-oriented leadership behaviour						
Monitoring environment	Klein et al. (2006)	United States	Examination of leadership of extreme action teams	Trauma teams	Semi-structured interviews Observations, Review of Resident Training Manual	Monitoring is one of the key functions of a TRU team leader. Monitoring means watching team members to ensure

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
						that they make no serious errors in patient treating.
	Risser et al. (1999)	United States	Potentials of teamwork improvements for prevention of incidents	Emergency-Department teams, 54 Incidents	Retrospective incident analysis, Checklist-based rating by teamwork-trained physician-nurse pairs	Monitoring others' behaviours and creating organizational climate where cross-monitoring is acceptable is most cited for avoiding serious errors and breaking error chains.
Adaptive leadership behaviour	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	18 resuscitation team leaders in 20 resuscitations	Behaviour observation, Expert rating	The results showed that the more adaptable performed better, e.g. competent teams may require less input from a leader.
	Klein et al. (2006)	United States	Examination of leadership of extreme action teams	Trauma teams	Semi-structured Interviews Observations	If urgency and novelty of a patient's condition is high, senior leaders take active leadership role, while they step back and delegate active leadership when task load is low.
	Wetzel et al. (2006)	Britain	Surgical stressors, their impact on performance and	16 surgeons in training and consultants	Semi-structured interviews	Communication patterns change in stressful situations.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			coping strategies used by surgeons.			
	Xiao et al. (2003)	United States	Comparison of team communication patterns under varying conditions.	18 resuscitation team-cases	Behavioural observations, external coding	Teams adapt their structures and underscore the fluid and shared nature of team leadership, e.g. when task characteristics change leader involvement change too.
	Yun et al. (2005)	United States	Contingency model of influence of leadership on team effectiveness during trauma resuscitation.	Trauma resuscitation teams, 91 staff members	Written scenario method, questionnaires	Effective leaders should be able to adjust their behaviours to better influence team outcomes.
RESEARCH ON OUTCOMES	Borrill et al (2000)	Britain	Relationship between team member characteristics, team working processes and effective teamwork.	National health care teams	Questionnaire, interviews, observation, focus group, meeting, self and external ratings	Six principal outputs are distinguished, e.g. effectiveness, team member mental health, cost-effectiveness.
	Gfrörer & Schüpfer (2004)	Switzerl and	Analysis of teams in the operation room based on psychological and economic research on teams.	OP Teams	Literature Review	Goal of OR teams is effective accomplishment of a surgery.
	Helmreich & Davies (1996)	United States	Definition of human factors in the operating room based on	Data from 2 Hospitals, Anaesthesia and surgical staff	Questionnaire survey	Multiple outcomes are related to performance in the operating room:

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			research in aviation. Conceptual model of OR performance is presented. Measures attitudes of operating teams toward human factors.			patient safety, efficiency in completing tasks, team morale.
External ratings	Cooper & Wakelam (1999)	Britain	Relationship between leadership behaviour, team dynamics and task performance	Resuscitation teams	Observations, Questionnaires, External Ratings	External ratings of performance on a team tasks scale developed from performance competences of ALS courses.
	Healey et al. (2004)	United States	Description, explanation, and discussion of theoretical and practical issues of developing observational measures of team performance in surgery.	50 operations observations, Surgeons	Behaviour observation of tasks and team behaviour	OTAS (Observational Teamwork Assessment for Surgery) assess team performance and enables to record detailed information on what the theatre team does and how they do it.
	Risucci et al. (1999)	United States	Personality types and preferences of emergency medicine residents and association with faculty evaluations of clinical performance.	22 emergency medicine residents	Self-rating personality questionnaire (MBTI Myers-Briggs Type Indicator), external rating	Extroversion/Introversion correlated significantly with overall clinical performance.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
	Sugrue et al. (1995)	Australia	Performance of trauma team leader	Trauma teams	Observation, external ratings	Team leader assessment form was completed by the coordinator during each initial patient assessment.
	Undre et al. (2006a)	Britain	Development of an observational assessment method of team performance in surgery.	Operation teams, 50 general surgery operations	Behaviour observation of tasks and team behaviour	OTAS (Observational Teamwork Assessment for Surgery) tool is feasible, purposeful and informative. More research needed to make them robust and standardized
Self-assessments	Flin et al. (2003)	Britain	Measure attitudes towards human and organisational factors that can have an impact on effective team performance and on patient safety	222 anaesthetists from 11 Scottish hospitals	Questionnaire	Attitudes were measured using the ORMAQ (Operating Room Management Attitudes Questionnaire).
	Helmreich & Davies (1996)	United States	Definition of human factors in the operating room based on research in aviation. Conceptual model of OR performance is presented. Measures attitudes of operating	Data from 2 Hospitals, Anaesthesia and surgical staff	Questionnaire survey (ORMAQ: Operating Room Management Attitudes Questionnaire)	Staff rated organizational climate, leadership-structure, information sharing and stress recognition using the ORMAQ.

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			teams toward human factors.			
	Meerabeau & Page (1999)	Britain	Reflection on aspects of teamwork within health care delivery.	Debriefing sessions on 8 cardiopulmonary resuscitation incidents with staff nurses	Grounded theory approach	Debriefing sessions are used as a vehicle to reflect upon teamwork
	Yun et al. (2005)	United States	Leadership and effectiveness of teams operating in a high-velocity environment.	Trauma resuscitation teams	Questionnaires	Team effectiveness was measured through ratings from expert staff members with 5-point Likert scale adapted to a TC context.
Measuring clinical output	Borrill et al (2000)	Britain	Relationship between team member characteristics, team working processes and effective teamwork.	National health care teams	Questionnaire, interviews, observation, focus group, meeting, self and external ratings	Clinical outcomes were measured, e.g. quality of health care
	Marsch et al. (2004)	Switzerl and	Relation between human factors and quality of cardiopulmonary resuscitation.	Teams of three health-care workers during cardiopulmonary resuscitation	Observations in a patient simulator, Behavioural Rating	Teams were successful if ventricular fibrillation was converted into sinus rhythm by appropriate administration of counter shocks and basic life support.
	Pollack & Koch (2003)	United States	Impact of neonatal intensive care unit	Neonatal intensive care units	Ratings of managerial practices and	Outcomes included survival or death after

Function in the team work	Authors (year of publication)	Country	Research question/ Purpose of the paper	Participants/ Object of investigation	Methods	Major findings
			managerial practices and organisational processes on outcomes of births.		organizational processes by nurses, physicians and respiratory therapists.	28 days, classification of morbidities, length of hospital stay, days of mechanical ventilation.
	Risser et al. (1999)	United States	Potentials of teamwork improvements for mitigation or prevention of incidents	Emergency-Department teams, 54 Incidents	Retrospective incident analysis, Checklist-based rating by teamwork-trained physician-nurse pairs	Absence of 48 teamwork actions rated as a failure.
	Stockwell et al. (2005)	United States	Relationship between leadership in teams, team efficiency and output.	Physician team leaders in intensive care unit (ICU)	External rating	At the end of the ICU physician team leader's shift, the number of daily goals accomplished was recorded.

2.5 Research findings

Leadership in critical care teams is faced with major structural challenges. Teams usually consist of different professional groups (surgeons, anaesthesiologists, nurses), each with their own tasks but equally responsible for the patient. While hierarchical and status differences help to assign roles within a professional group (Helmreich & Davies, 1996) there is often no clear division of authority and leadership between the groups. The senior surgeon and the senior anaesthesiologist may feel they have equally important status in relation to the patient's management (Cole & Crichton, 2006). These observations lead to the assumption that leadership in the operating theatre is not always clearly assigned, most likely because the definition of leadership is ambiguous. Thus, we first aim to find a clear definition of leadership in critical care teams by examining how it is characterized by various studies, before analyzing concrete leadership behaviour and its impact factors.

2.5.1 Defining leadership in critical care teams – who is the leader?

Numerous definitions of leadership are available in the trade literature on leadership and definitions vary considerably (for an overview see e.g. Yukl, 2006). From the variety of definitions and studies on leadership, the following basic principles can be summarised: Leadership is geared to an objective, it is executed within a group and it refers to the process of influencing others to accomplish individual or organisational goals (Yukl, 2006). While leadership behaviour in critical care teams can be defined in a similar way there are specific characteristics concerning the assignment of leadership within those teams. Some authors defined leadership as a position of authority while others suggested that leadership is not dependent on one single individual but can be shared among all team members. We will discuss both approaches below.

2.5.1.1 Leadership as a position of authority

Authors defining leadership as a position of authority referred to the power a person derives from a particular rank in a formal organisational system. It is also known as "formal authority", which is a result of training qualifications and professional degree (Thilo, 2005) and may be associated with the senior team

member who has been given full authority over all team members (Cooper & Wakelam, 1999; Lloyd, Patterson, Robson, & Philips, 2001; Meerabeau & Page, 1999). Kazemi and Nayeem (1997) reported that it is the most senior doctor who leads the team. Filling the leadership position with an experienced team member acting as consultant would offer advantages, such as "fewer problems achieving collaboration and control of the team" (Cole & Crichton, 2006, p. 1261). The consultant's role would be comparable to a senior doctor, advising the attending physician without taking charge of the patient. In addition to formal authority, an individual may be given informal authority by other team members through building "strong relationships in the workplace based on respect, integrity and commitment to excellence" (Thilo, 2005, p. 11). Besides seniority, education and experience are also necessary to become a leader (e.g. Driscoll & Vincent, 1992; Hoff, Reilly, Rotondo, DiGiacomo, & Schwab, 1997; Risser, et al., 1999). In another study (Cole & Crichton, 2006), the team leader was simply defined as the "key team member with or through whom everyone communicated" with "ultimate responsibility for its [the team's] success or failure" (p. 1259). Other authors considered a leader as present if one team member gave directions and commands, made decisions or assigned roles to team members (Marsch, et al., 2004).

2.5.1.2 Leadership as shared behaviour among team members

Conversely, other authors emphasize that leadership is not necessarily dependent on a single individual's decision on the correct course of action. Flin and colleagues (Flin, et al., 2003) reported that anaesthetists preferred non-hierarchical structures with shared responsibilities for leadership. Therefore, leadership may be shared between the formal leader and other team members (Klein, et al., 2006; Xiao, et al., 2004). Investigations of trauma resuscitation teams[2] have shown that team leadership can be executed by the attending surgeon, the fellow, and the admitting resident. The attending surgeon is the formal leader of the trauma resuscitation team, responsible for supervising and coordinating team members' activities. However, the fellow and the admitting resident may execute leadership functions as well. The fluidity of leadership mainly occurs "when a senior leader (the attending or the fellow)

[2] A trauma team provides medical care to victims of shooting, stabbing, car crash, or other traumatic blows to the body. For a wider definition see Yun, Faraj, Xiao & Sims, (2003); Yun, Faraj & Sims, (2005); Klein, Ziegert, Knight & Xiao, (2006).

takes over strategic direction of the team, assuming a more active and influential role in the team, or conversely, when a senior leader recedes from strategic direction, assuming a more passive and less influential role" (Klein, et al., 2006, p. 19). Similarly, Kazemi and Nayeem (1997) found no specific grade of specialty implicating team leadership. Thus, leadership behaviour is not necessarily bound to one individual. Nevertheless, a formal leader and an ultimate authority with responsibility for the team performance are expected by team members (Yun, et al., 2003).

In sum, leadership can be seen as a fluid and shared process among team members, but authority remains an important requirement for leadership because the more senior individual can always take over leadership behaviour whenever necessary to assure the patient's safety (Klein, et al., 2006).

In subsequent sections we will present the research findings regarding leadership in critical care teams. The sections are organized around the input-process-output model. Thus, the research findings are either classified as input variables influencing the leadership behaviour, as process elements or as output factors.

2.5.2 Findings on input factors

In this section we will summarize research which investigated the relationship between leadership behaviour and its influencing factors explicitly. The literature indicates several factors associated with the impact on leaders' behaviour: workload, standardization, competence of team members, leaders' experience and knowledge, training, and personal characteristics. It seems that these variables can be grouped into three categories: personal factors (personal characteristics, experience & knowledge, training), team requirements (competence of team members) and task requirements (workload, standardization). We will now focus in detail on these three categories of input factors.

2.5.2.1 Personal factors

Personal factors reflect personal competencies of leaders that can affect leadership behaviour such as experience as a leader, technical knowledge, leadership training, and personality factors.

Experience and Knowledge of the leader

Several studies referred to a relationship between leadership performance and the experience as a leader, showing that the number of years of leadership experience was a critical factor. Only experience of more than 3 years was positively correlated with effective leadership behaviour, which implies that only extensive experience made a difference to performance. Therefore, in this case it is not only the technical knowledge that makes a good leader, it is also the longevity and depth of experience of resuscitation attempts (Cooper & Wakelam, 1999). Conversely, a lack of knowledge of procedures or guidelines may result in low leadership performance whereas a lack of education might result in stress in individuals and therefore inappropriate leadership behaviour (Hynes, Kissoon, Hamielec, Greene, & Simone, 2006). Similarly, Cole and Crichton (2006) observed that the clinical confidence and competence of a leader may be beneficial for the leader's role. Other research on trauma teams recommended that effective leadership is not dependent on seniority but on training and experience of a leader (Driscoll & Vincent, 1992; Sugrue, et al., 1995).

Leadership Training

Leadership training is associated with expertise in leading teams. Several studies reported that the lack of leadership behaviour could be due to a lack of leadership training. Although leaders in critical care teams have completed professional training courses, these courses have typically focused on algorithms and task work skills rather than on leadership skills and team behaviour. Many authors mentioned a need for leadership training in order to learn human factor techniques and personnel management skills (e.g. Cole & Crichton, 2006). A lack of leadership training can have a negative influence on leadership behaviour and therefore on team dynamics: "Potentially, this lack of training leaves team leaders feeling anxious and unprepared (…) [in situations where] their primary role is as a leader rather than that of a clinician" (Hynes, et al., 2006, p. 225). Next to these findings, there are some studies that have investigated special features of leadership training. For instance, as noted by Hynes and colleagues (2006), leadership training works better when it includes not only the leader but also the whole team. Likewise, De Vita and colleagues (DeVita, Schaefer, Kutz, Dongilli, & Wang, 2004) reported that training all key team members can release team leaders from directing treatment interventions

and improve team performance. These results can be explained by the concepts of transactive memory and shared mental models, showing that groups perform better after being trained together (e.g. Moreland & Myaskovsky, 2000).

Personality Characteristics

Few studies have examined the personality characteristics of critical care team leaders (such as the standard "Big Five" characteristics of extraversion, openness to experience, conscientiousness, agreeableness, and neuroticism). In general, personality was shown to be an influencing factor for leadership behaviours as some individuals have better leadership ability than others because they are "predisposed to the form of behaviour required to manage an emergency" (Cooper & Wakelam, 1999, p.38). Apart from the traditional big five personality traits, some studies examined the role of self-awareness in leaders and their ability for self-control. For example, control of oneself is an essential feature of providing effective leadership in stressful situations (Wetzel, Kneebone, Woloshynowych, Moorthy, & Kidd, 2006). To reduce tension among the surgical team, leaders need to keep calm and reduce their own stress responses. A strong sense of self is important for a leader to know when to let go and to allow team members to develop into the role (Christie, 2000). Furthermore, developing self-awareness of one's own emotions has been described as important in helping manage the emotions of other team members better and to build up a more appropriate leadership style (Thilo, 2005).

2.5.2.2 Team factors

Team characteristics refer to features of team members which can affect leadership patterns. Little research has examined the influence of team members' attitudes, skills or abilities on leadership processes. However, the competence and knowledge of team members has been shown to be related to leadership behaviour:

Greater experience among team members may decrease the amount of input needed from the leader. Nevertheless, the need for leadership is still present in competent teams, but the role shifts from guiding and structuring to more monitoring behaviour (Cooper & Wakelam, 1999). A team leader needs to be more directive and involved when a team is inexperienced, while in more experienced teams empowering leadership is more effective (Yun, et al., 2005; Yun, et al., 2003). In a study on the decision-making processes of nurses (Hancock & Easen, 2006), it

became clear that power was not limited to medical staff because the nursing staff was also responsible for decision-making. However, the responsibility given to nurses by team members was based on the nurses' appointed grade rather than on their individual knowledge or experience.

2.5.2.3 Environmental Factors

Environmental factors address the circumstances in which leaders are operating. Depending on the patients' condition, for example, different leadership patterns are required. Research has revealed two main environmental factors influencing leadership: workload and standardization. These will be explained in the following section.

Workload

Workload is a key factor for teams performing in critical care environments and basically, it relies on the severity of patient status. The more urgent a medical intervention and the less familiar the tasks, the more directive and active influential leadership was required (Klein, et al., 2006; Xiao, Seagull, Mackenzie, Ziegert, & Klein, 2003b; Zala-Mezö, et al., 2004). Similar findings have been obtained by other researchers (Khetarpal, Steinbrunn, & McGonigal, 1999; Yun, et al., 2005), who demonstrated that effective treatment of severely injured patients required the most experienced team member to make decisions. Continuing this line of thought, Wetzel and colleagues (2006) reported that it is usually the senior surgeon who takes the leadership role in high-stress situations; thus the team structure changes from flat to hierarchical. Other authors have also suggested that leaders provided more instructions when the workload was high (Grote, et al., 2004b; Xiao, et al., 2003b; Zala-Mezö, et al., 2004). On the other hand, when no complicated treatment was necessary and workload was low, effective leaders used empowering leadership strategies (Yun, et al., 2005; Yun, et al., 2003). Apart from a change in the kind of leadership behaviour, the leaders' role shifts between team members depending on the condition of the patient. Nurses' responsibility for critical patients, for example, was quite different from that for routine patients (Hancock & Easen, 2006). Decisions about unstable patients with complex problems were not only made by nurses; instead the nurses made their decisions in collaboration with medical staff. Even senior nurses who had greater involvement than other nurses were not given ultimate

responsibility. In sum, the findings suggest that the workload of a given task affects leadership behaviour and results in shifts in responsibility.

Standardization

Standardization (e.g. written rules) can serve as a substitute for leadership (Kerr & Jermier, 1978). Grote and colleagues (2003) showed that personal leadership in anaesthesia teams was required more in situations with few standard procedures. Moreover, high levels of personal leadership in highly standardized situations, where team members did not need much direction, seemed to have a negative effect on team outcomes (Grote, et al., 2004b). Hynes and colleagues (2006) reported a lack of policies or standards for individuals' roles and responsibilities related to cardiac arrest situations. In risky situations, such as cardiac arrest, clinicians may be unsure of the chain of command. To avoid ambiguous situations for team leaders, written standards - including well-defined roles for each of the team members - as well as a code of conduct may be recommended (Hynes, et al., 2006).

2.5.3 Findings on leadership processes

While the previous section focused on factors impacting leadership behaviour, the following section outlines leadership activities associated with influencing team effectiveness. In general, the findings clearly demonstrated that team leaders are pivotal for the effectiveness of critical care teams. However, they also show that leadership behaviour must be unambiguous and visible in order to succeed. Several studies examined the relevance of unambiguous leadership behaviour for team performance. Teams without instantly recognisable leadership were associated with lower levels of effectiveness and poor quality of team work (e.g. Borrill, et al., 2000). For different reasons leadership must be comprehensible and visible for team members. Firstly, it is important to make clear who the leader is in order to gain control and avoid confusion within a team (e.g. Cooper & Wakelam, 1999; Künzle, et al., 2007). Conflicts in assuming the role of the leader between the emergency physician and the anaesthetist have been shown to produce problems in team coordination (Flin & Maran, 2004). Cooper and Wakelam (1999) reported negative effects of shared responsibility between two senior team members: "both gave orders which at times contradicted and countermanded each other" (p. 36).

In addition to the findings on the importance of the unambiguous nature of leadership behaviour, studies have also shown that it is likely that some leadership behaviours ensure team performance more than others. The literature indicates three salient categories of leadership behaviour in critical healthcare teams: Behaviour concerned with the task fulfilment; with adaptation to the environment; or with the development and support of team members. These categories are in line with the three-dimensional classification system for leadership behaviour provided by Yukl (2006) who made a distinction between task-oriented, relations-oriented, and change-oriented behaviour, which will be explained in the following paragraphs.

2.5.3.1 Task-oriented leadership behaviours

Task-oriented leadership behaviour is primarily concerned with accomplishing the task in an efficient and reliable way. Behaviours related to task-oriented leadership are coordination activities, such as organizing work, assigning work to team members, and explaining rules and standard procedures (Yukl, 2006).

In critical care teams, leaders should structure and direct team members' activities or prioritize medical treatments (Klein, et al., 2006). This leadership behaviour in turn enables team members to coordinate and cooperate themselves. Similarly, leaders who are able to build a structure within a team through maintaining standards and who clearly communicate what needs to be done and how it should be done were shown to promote team performance. Therefore, giving direction is essential (Cooper & Wakelam, 1999) and explicit task distribution as well as assigning team members to particular tasks has been reported to be important for successful team performance (Cooper & Wakelam, 1999; Marsch, et al., 2004). Likewise, confusion of responsibility causing disorientation within the team can result if leaders fall short in giving direction or guidance (Cooper & Wakelam, 1999). Marsch and colleagues (2004) have reported a tendency for adverse outcomes triggered by the absence of structured leadership. Similarly, Hynes and colleagues (2006) reported lack of effective delegation and communication skills to be one characteristic of inappropriate leadership of cardiac arrest teams which might result in a poor team climate and therefore have unfavourable consequences for patients' treatment. In a study of trauma team leaders performance (Sugrue, et al., 1995), the main pitfalls were due to poor communication with other team members.

Besides being responsible for structure and coordination within a team, a leader is also responsible for keeping the area around a patient organized. For example, the presence of too many people around the patient has been shown to have negative consequences on team performance (Künzle, et al., 2007). Unclear leadership can promote uncontrolled group size because it is the team leader's responsibility to send people not actively involved and observers away (Cole & Crichton, 2006; Cooper & Wakelam, 1999).

These findings imply that unambiguous leadership behaviour and explicit communication are essential to enhance team performance. However, structuring and guiding should not be equated with autocratic leadership behaviour (Cooper & Wakelam, 1999), which can have negative effects on team motivation and effectiveness. This is explained further in the next section.

2.5.3.2 Relations-oriented leadership behaviours

The aim of relations-oriented behaviour is to increase mutual trust, cooperation, or job satisfaction. It is used to build commitment to work objectives and identification with the team. Effective leaders use a variety of relations-oriented behaviour such as supporting or developing team members (Yukl, 2006). A supportive leader is supposed to be friendly, cooperative, and shows consideration and concern for the needs and feelings of team members. Developing leadership behaviour enhances skills of team members, for instance, by providing feedback about effective and ineffective behaviour or by demonstrating appropriate behaviour. In critical care teams, three relations-oriented leadership strategies could be identified as having an influence on team outcomes: supportive leadership behaviour, developing strategies, and encouragement of a cooperative climate.

Supportive leadership behaviour

Several studies examined the role of the leaders' emotional and motivational behaviour. For instance, Thilo (2005) described the importance of the leader's emotion for team performance. Appropriate humour, for example, may be used to lighten the situation in times of stress and to enhance the mood and the performance in an operating room. The team leader is responsible for setting the emotional tone of a team and keeping emotions positive. Similarly, Cooper and Wakelam (1999) addressed the importance of motivating and encouraging team members. Leaders

who took an active role in creating motivating rationale for change in operating room teams made it easier for their team to learn how to use new technology and therefore helped them cope with new, interpersonally-challenging behaviour (Edmondson, 2003). Modelling positive behaviour can also help to improve individual performance by involving all team members from the outset and using humour to get the best out of the team (Cole & Crichton, 2006). By contrast, Klein and colleagues (2006) found motivating and inspiring leadership behaviour was not related to team outcomes in trauma teams.

While a positive mood among team members can foster cooperation and increased participation, team research has shown that a negative affective climate can result in less motivation and lower group performance (see Zaccaro, et al., 2001). This negative relationship has also been found in medical teams. Communication behaviour, such as shouting, had deleterious effects on team members, resulting in embarrassment and a reduction in confidence (Cole & Crichton, 2006). Furthermore, using authority and power to restrict their behaviour regardless of team members' feelings, negatively influenced team performance (Christie, 2000).

Developing team members

Leadership can advance team members by enhancing metacognitive processes such as debriefing or feedback. Consistent with other team research (e.g. Kozlowski, et al., 1996; Tannenbaum, et al., 1998; Zaccaro, et al., 2001), studies on leadership in the operating theatre suggested that leaders can facilitate team effectiveness by providing feedback and debriefing. For instance, feedback can be an important factor in increasing individual performance of team members in trauma teams (Cole & Crichton, 2006). By giving performance feedback leaders offer team members a model with which they can influence their behaviour (see Cooper, 2001; Cooper & Wakelam, 1999). Debriefing, which can be defined as a "collective reflection upon team processes" (Zaccaro, et al., 2001, p. 464), is seen as one of the most effective methods of reinforcing team membership and for quality improvement of health care workers. Debriefings provide an opportunity to praise good performance after successful teamwork or to uncover a negative process despite a positive outcome (see Schull, et al., 2001). Although collective metacognition and provision of feedback seems to be widely recognised and not only in medical teams

(Gurtner, Tschan, Semmer, & Nägele, 2007), some studies revealed that it is rarely implemented. For instance, although members of anaesthesia teams emphasised the importance of collective metacognition, such communication rarely took place (Zala-Mezö, et al., 2004). Similarly, the finding by Helmreich and Schaefer (1994) showing that most of the respondents would have preferred more performance-related feedback, allows one to conclude that metacognitive activities are used insufficiently in critical care teams. Another way of developing team members was detailed by Klein and colleagues (2006). They suggest that leaders can foster learning of junior leaders if they delegate the active leadership role.

Encouraging a cooperative organisational climate

Studies measuring attitudes of operating theatre personnel towards teamwork and error found that surgeons generally supported a structured hierarchy of authority in which junior members do not question the decisions made by senior team members. Contrary to this, anaesthetists and nurses preferred a flatter team hierarchy (Helmreich & Davies, 1996; Helmreich & Schaefer, 1994; Sexton, et al., 2000). These results contrast to those presented by Undre and colleagues (2006b). In an interview study they have shown that across all disciplines (anaesthesia, surgery, nursery) operating theatre specialists prefer cooperative and low hierarchical structures and more collaborative teamwork between disciplines. Similarly, Fleming, Smith, Slaunwhite, and Sullivan (2005) reported generally positive attitudes towards speaking up if team members have concerns in cardiac surgery teams. However, attitudes towards speaking up differ between occupational groups. Junior team members are uncertain about taking charge of a situation and are not confident about questioning the decisions made by more senior staff. The authors suggest leadership behaviour could be more effective if subordinates were encouraged to speak up if they have any concerns. Furthermore, junior team members should be taught to handle situations in which a takeover of leadership behaviour would be appropriate (Fleming, et al., 2005). On the other hand, if team members do speak up and are criticized, they are probably less likely to speak up again, even if a safety concern is observed (Clarke, Marella, Johnston, & Davis, 2005). Healy and colleagues (2006) mentioned these problems in the closely related field of aviation. Problems in aviation often occurred because team members failed to communicate and were afraid to speak up. The same communication hazards were found in operating rooms

(Helmreich & Schaefer, 1994); problems are often based on poor communication across hierarchies (Waisel, 2005). Thus, hierarchical structures may discourage subordinates from giving critical information to team members of higher authority and worsen communication between team members which in turn has been shown to be responsible for errors in medical teams (see Schull, et al., 2001). In a retrospective study of emergency department malpractice incidents, speaking up when one believes the patient is at risk was identified as important team behaviour if errors are to be avoided (Risser, et al., 1999).

Therefore, in order to enhance team effectiveness, it is necessary that leaders create an organisational climate where speaking up is possible (Risser, et al., 1999). By building a cooperative environment in a shock trauma respiratory intensive care unit, for example, costs have decreased by 30% in areas where a culture of cooperation was implemented and by 19% overall in total hospital costs (Clemmer, Spuhler, Berwick, & Nolan, 1998). Edmondson (2003) supports the effectiveness of speaking up in the operating room. In her study, the most effective leaders created psychological safety by reducing power-based barriers to speak up and they therefore minimized power and status differences. ‘Speaking up’ encouraged people to communicate with other members of the organisation about changes and “constituted a multifaceted team learning process that enabled successful implementation of the new technology” (Edmondson, 2003, p. 1446).

By reviewing previous studies it becomes apparent that supporting team members in speaking up and creating an organisational climate where speaking up is possible and indeed, wished-for, might be one key in reducing communication barriers among team members (e.g. Risser, et al., 1999). Healy and colleagues had positive experiences with interactive training sessions for all members of operative teams. To foster a culture of speaking up in those teams, junior team members were trained in how to safely and respectfully approach senior members to discuss their concerns, while the attending surgeons were trained in how to listen to the perspectives of the other team members but at the same time, to continue to serve as the final authority and decision maker (Healy, et al., 2006). To foster cooperation the leader is responsible for building an environment conducive to cooperation. Ideally, leaders should express cooperative behaviour during their own interactions to signal that direct and open communication is desired (Clemmer, et al., 1998).

2.5.3.3 Change-Oriented Leadership Behaviour

The third category of Yukl's (2006) three-dimensional classification system for leadership behaviour is change-oriented behaviour. This category is usually used to describe the influence of leaders on organisational processes and is strongly related to change management and the organisations' coping methods with and adaptation to turbulent environments. Therefore, change-oriented behaviour can be explained using a different level of analysis than that which is able to be observed in an operating room team. On the one hand, it contains visible behaviour such as monitoring of the environment, explaining the need for change, and envisioning change. On the other, it is anticipating situations and problems, allowing critical care teams to manage change and react appropriately to unforeseen events. For example, leaders need to assess the situation continually and determine what types of leadership activities might be relevant for changing conditions. For medical teams, different studies have shown that effective teams react to changing situations by monitoring performance of other team members and/or by adapting their leadership behaviour to the requirements of the situation. This type of behaviour will be explained in the following sections.

Monitoring environment

Team leaders have been observed monitoring their team's performance in order to enhance its reliability by detecting and correcting treatment errors in time (Klein, et al., 2006). Equally, failure of cross-monitoring has been shown to be a primary cause of error in emergency departments. Therefore, watching each other's behaviour is a necessary tool in order to avoid serious errors and leaders are responsible for creating an organisational culture in which cross-monitoring is an acceptable behaviour (Risser, et al., 1999).

Adaptive leadership behaviour

Next to continuously monitoring the team, several studies have shown a second type of change-oriented leadership behaviour in critical care teams: adaptive leadership. This kind of leadership is adaptive with respect to environmental conditions. It enables teams to maintain high levels of performance, even if environmental circumstances become adverse (e.g. critical patient status). As presented below, a few studies demonstrated the effectiveness of leader adaptability,

suggesting that team leaders should change their behaviour depending on two critical input-factors: the severity level of a trauma patient and the experience level of team members. Critically injured patients required more direct leadership behaviour, while patients injured less seriously needed less directive and more empowering leadership (e.g. Cooper & Wakelam, 1999). Highly experienced team members needed less directive and more empowering leadership than less experienced team members (e.g. Cooper & Wakelam, 1999). In a high-stress situation, an effective leader must communicate clearly and be assertive (e.g. Wetzel, et al., 2006), while the importance of sharing leadership behaviour among team members in low workload situations was apparent (e.g. Cooper & Wakelam, 1999; Klein, et al., 2006; Xiao, et al., 2004; Yun, et al., 2005). These findings are strongly related to results found in studies on leadership in the military or aviation setting. While during a high workload situation, for example combat or deployment, more directive leadership became increasingly important, supportive leadership behaviour is likely to be salient in garrison settings where the emphasis is on developing soldiers' skills, for instance. This gives reason to believe that adaptability is also important in military leadership. As Wong, Bliese, and McGurk (2003) confirm, direct leaders are expected to make the transition from one setting to another which a high level of adaptability. Similar results were found in the field of aviation. During a crisis, communication becomes more hierarchical, compared to a more horizontal structure in routine situations (e.g. Davis, Driskell, & Salas, 1991; Weick, 1990).

2.5.4 Findings on leadership outcomes

In order to determine successful leadership strategies, behaviour must be systematically linked to team outcomes. Before estimating whether a type of behaviour is successful or not, outcome and effectiveness have to be clearly conceptualized. Traditional approaches often defined team effectiveness as a three-dimensional construct distinguishing the team's productive output such as quantity and quality (e.g. Campbell & Campbell, 1988; Hackman & Walton, 1986), team viability over time (e.g. Hackman, 1990; Hackman & Walton, 1986; Sundstrom, et al., 1990) and personal criteria such as the personal well-being of team members (e.g. Campbell & Campbell, 1988; Hackman & Walton, 1986; Sonnentag, 1996). Similar outcomes can be distinguished for critical care teams: Success in the operating room is strongly associated with the safety of a patient (e.g. Helmreich & Davies, 1996) as

a performance output. Apart from clinical outcomes, economic criteria, such as efficiency in completing tasks (Gfrörer & Schüpfer, 2004; Helmreich & Davies, 1996) and cost effectiveness (Borrill, et al., 2000) are critical success factors as well as personal criteria, e.g. team morale (Helmreich & Davies, 1996) and team member mental health (Borrill, et al., 2000). Various attempts have been made to try to identify effective leadership strategies in critical care teams and alternative methods have been articulated for examining the effectiveness of leadership. The following sections outline the different approaches used to measure leadership success in critical care teams. They can be classified according to the methodology used as either external ratings of leadership behaviour, self assessment of leadership quality, or quantitative measurement of clinical outcomes.

2.5.4.1 External ratings of leadership behaviour

Performance was often externally assessed by medical experts using different rating scales. For example, Cooper and Wakelam (1999) measured team performance with a team dynamics and a task performance scale. While the team dynamics scale was used to measure interaction between team members (e.g. level of cooperation, team spirit, and morale), the measurement of team task performance was based on the performance criteria set for the assessment of competence on advanced life support (ALS) courses where the aim is to practice resuscitation skills as a team (for definition see e.g. Nolan, 2001). Total scores of both scales were linked to leadership ratings, which were based on and adapted from the Leadership Behaviour Description Questionnaire (LBDQ) (e.g. Stogdill, 1963) 1974). Two studies (Healey, et al., 2004; Undre, et al., 2006a) applied the OTAS (observational teamwork assessment for surgery) instrument to assess team performance. While a surgical observer completed a task checklist centred on the patient (e.g. safe transport to the operating table), equipment (e.g. counting surgical instruments) and communication behaviour (e.g. information exchange), a psychologist rated behaviour on five dimensions (e.g. communication, coordination, shared leadership) as effective or ineffective. Risucci, LaMantia, and Ryan, (1999) independently assessed clinical effectiveness of leadership of emergency medicine faculty using a rating form which included 13 areas of clinical performance. Similarly, in another study several specialists with experience in trauma management rated medical team leader performance with an objective scoring system (Sugrue, et al., 1995).

2.5.4.2 Self-assessment of leadership behaviour

Yun et al. (2005) measured team effectiveness through ratings from expert staff members with 12 items from a previously validated scale (Pearce & Sims, 2002) adapted to a trauma centre context. Team performance has also been assessed indirectly by asking participants about attitudes regarding leadership and other team activities using the Operating Room Management Attitude Questionnaire (ORMAQ) (e.g. Flin, et al., 2003; Helmreich & Davies, 1996). Other authors conducted interviews to assess the quality of leadership and team performance. For example, interviewees were asked about the leadership characteristics in well and poor performing teams (Meerabeau & Page, 1999). By combining professionals' perceptions of leadership and team performance, both methods revealed critical information on effective leadership strategies in critical care teams.

2.5.4.3 Measuring clinical outcomes

Pollack and Koch (2003) investigated the impact of managerial practices and organisational characteristics on patient outcomes of neonatal intensive care units. Outcomes were measured by indicating survival or death after 28 days. Additionally, morbidities were classified (e.g. bronchopulmonary dysplasia) and length of hospital stay was measured. Clinical outcomes were also used by Marsch and colleagues (2004). In a simulated scenario of witnessed cardiac arrest due to ventricular fibrillation, technical success was defined as being able to convert the patient into sinus rhythm, and this was linked to behaviour ratings including, for example, leadership or task distribution. To measure the efficiency of physicians' leadership skills the achievement of goals in the intensive care unit was rated (Stockwell, et al., 2005). During morning rounds the team chose to achieve specific goals. At the end of the team leader's shift, the number of goals accomplished for each patient was classified as a performance measure. Borrill and colleagues (2000) studied team effectiveness by measuring clinical outcomes such as the quality of health care in terms of patient care, effective organisation and interdependent working, and team-member mental health. The elements of team effectiveness were either self or externally assessed using team questionnaires. Another possibility would be to measure team performance retrospectively by reviewing malpractice incidents (Risser, et al., 1999). This method implies that all investigated cases had an

ineffective outcome. To find out whether leadership impacted team outcomes, each incident was judged by teamwork-trained physician-nurse pairs as being avoidable if there were better teamwork.

2.6 Conclusion and practical implications

With this paper we have aimed to give a systematic overview on the state of the art findings on leadership in critical care teams. We have attempted to describe the many facets of leadership and to identify effective leadership skills in critical care teams. We integrated research at the input, process and output levels and addressed the main characteristics of leadership behaviour in critical care teams with regard to its importance for team performance. We also addressed the methods that have been used to measure the effectiveness of leadership behaviour. Due to our integration conditions, there might well be other important studies on leadership which were left out but which contain certain aspects that would also be relevant for critical care teams. Despite the number of papers that were not taken into consideration, the results of this review clearly indicate that leaders play a decisive role in promoting team performance and, therefore, in maintaining the safety in critical care teams.

In this section we summarize the main conclusions from our review before moving on to consider the future directions for both theory and research. We discuss the characteristics and influencing factors of effective leadership in critical care teams, address the need for leadership trainings, and point to requirements of performance measure systems.

2.6.1 Characteristics of effective leadership in critical care

In sum, leadership behaviour in critical care teams could be defined as a fluid process among team members, dependent on a joint function of individual and group behaviour. Most literature agreed on two critical functions of leadership: 1) to help the team to complete a task and 2) to keep team members maintained and functioning. The task function aims to get the job done, make decisions, adapt to changes or achieve goals, while the maintenance function includes behaviour such as developing a positive climate or cohesion (Northouse, 2004). One of the most obvious task-oriented factors in critical care teams influencing outcomes positively is clear leadership behaviour. Unclear leadership pattern and ambiguous role

assignment has been reported to have a negative impact on team effectiveness. These findings are supported by the results of other domains which prove the importance of structuring and clarifying leadership patterns for team performance. As noted by Yukl (2006), several studies have found a positive correlation between coordinating work activities and managerial effectiveness. Recent findings support the assumption that initiating structure (e.g. assignment of tasks, establishment of clear channels of communication) is related to leadership outcomes (see Burke, et al., 2006a). Clear leadership is essential for effective teamwork because it leads to clear objectives, higher levels of participation and effective participation in team decision-making (West, Borrill, Dawson, Shapiro, & Haward, 2003). Furthermore, the findings indicate that to be effective, leadership functions should be adaptive with respect to environmental conditions. This enables teams to maintain high levels of performance, even as team and environmental circumstances become difficult.

The findings also referred to team development functions of leadership such as supportive, developing and encouraging leadership behaviour. Taking the numerous studies on relations-oriented leadership, behaviour reported here strongly demonstrates its significance for team performance in critical care teams. Keeping emotions positive among team members, providing feedback or encouraging a cooperative organisational environment are all factors which aim to enhance the motivation of team members. With relations-oriented behaviour, a leader can raise the task confidence and collective efficacy of the team (team members believe that a team is successful) (Zaccaro, et al., 2001). The findings also suggest that giving feedback for enhancing team performance is a critical leadership function. These results are in line with Ketchum (1984) and Kolodny and Kiggundu (1980) who reported that team effectiveness depends on precise and timely feedback on performance (see Sundstrom, et al., 1990).

Finally, the literature indicates two opposing definitions of the leadership position in critical care teams: On the one hand leadership can be a position of authority, such as when the senior team member is given full authority (Cooper & Wakelam, 1999; Lloyd, et al., 2001; Meerabeau & Page, 1999; Thilo, 2005). On the other hand, leadership can be shared among team members (Flin, et al., 2003; Klein, et al., 2006; Xiao, et al., 2004). According to these findings, it can be assumed that some leadership functions may be performed by one team member - typically by the

most suitably qualified person - while other leadership functions may be shared by all members of a group. It is a unique feature of critical care teams therefore, that leadership is a position of authority (role or experience) as well as a fluent function that can be passed onto or shared between different team members. This view is in line with recent developments in leadership research which state that leadership is a shared social process concerned with human beings and their relationships to each other and that leadership functions are distributed among different team members (Yukl, 2006). Along with the notion of adaptive leadership discussed above, we suggest that leadership functions may not only be adaptive according to situational demands but also to team members allocating these functions. Effective leadership should not focus on the leader's position of power alone but instead focus on the critical functions of leadership. Any team member (if qualified) should perform the critical leadership functions in order that appropriate actions are taken.

2.6.2 Factors influencing leadership

Input factors influencing leadership behaviour have been identified as falling into three main categories: team, environmental and personal. The first two factors (team and environmental requirements) both involve the environment in which the leaders are operating. Depending on external factors such as patients' condition, standardisation, experience and knowledge of other team members, leader involvement – whether considerable or small - and different leadership patterns seem to be effective. The effectiveness of a leader in critical care teams appears to be strongly contingent on the particular situation which is associated with a number of theories describing leadership effectiveness as a function of situational moderator variables (see Yukl, 2006, p.214f). The main assumption is that there is no best way of leading because a specific behaviour might be successful in one situation but ineffective in other circumstances. To maintain team performance leaders should adapt their behaviour according to external factors. This assumption has also been validated for teams in the operating theatre. Those leaders who are able to change their behaviour are more effective when using, for example, more directive leadership behaviour in critical situations. Some studies also indicated that situational variables in the operating theatre, such as highly standardized situations or competent team members, make leader behaviour unnecessary. Thus, it is recommended that

leaders of critical care teams analyse the given situation deeply and adapt their leadership behaviour accordingly in order to enhance team performance.

The third input factor reflects personal competencies of team members in a leadership position. There are a number of individual variables that may influence leadership patterns and the effectiveness of a leader, such as experience gained as a leader, technical knowledge, training of leadership skills as well as personal preferences and the ability to be a leader. Results indicate that the personality plays a role for leadership behaviour: high Extraversion is positively associated and Neuroticism negatively associated with effectiveness. These findings are in line with a meta-analysis of studies of personality and leadership by Judge and Ilies (2002) who reported that good leaders were found to be high in Extraversion, Conscientiousness, and Openness to experience, and low in Neuroticism.

2.6.3 Leadership trainings

Although some factors, such as the personality of leaders, seem to be highly resistant to change (Helmreich & Davies, 1996), the findings of this review imply that leadership training may be one of the crucial factors enhancing team performance. Experiences from aviation settings demonstrate the importance of teamwork training (also known as crew resource management training) for team performance and safety improvements (e.g. Leedom & Simon, 1995; Risser, et al., 1999; Salas, Fowlkes, Stout, Milanovich, & Prince, 1999). The main objective of training is to reduce errors caused by a lack of teamwork or poor communication (Day, et al., 2004; Risser, et al., 1999). Thus, the focus of leadership trainings is not on personality but on concrete behaviour. Although the need for training is recognised by medical teams and traditional protocol-based medical courses such as Advanced Cardiac Life Support are accepted, training in more subtle elements of effective teamwork and communication seem to be missing (Schull, et al., 2001). Hence, a number of studies reviewed reported a lack of team management and leadership skills (e.g. Cooper & Wakelam, 1999) although most of the teams observed were experienced with training (e.g. ALS). This suggests that individuals are usually not being taught to lead (Cooper & Wakelam, 1999). Nevertheless, some authors reported experiences with aviation-like teamwork training in medical settings. Cooper (2001), for example, demonstrated the effectiveness of training sessions and programmes for leadership development resulting in significantly changed behaviour

and increase in team performance. Similarly, improvements in medical teamwork were reported to significantly improve the quality of emergency care and reduce future costs (Risser, et al., 1999). Despite these positive experiences, the findings indicate that more training in leadership skills is still needed. In sum, leadership training was recognised as a critical factor for enhancing leadership effectiveness. However, recommendations for implementing findings on effective leadership behaviour into training programs were made only rarely and very specifically. Thus, further research is required to reveal effective and teachable leadership behaviour.

2.6.4 Assessing leadership effectiveness

For medical organisations as well as teams it is important to know how they perform and how team performance can be assessed and influenced. Within the studies reviewed above, leadership behaviour was measured either by external ratings of leadership behaviour (e.g. LBDQ, OTAS), self-assessment (e.g. ORMAQ, interviews) or clinical outcomes (e.g. classification of morbidities, length of hospital stay). Besides the studies considered for this review, there are a number of published reports looking at measurement of team performance. Rall and Gaba (2005), for example, suggest measuring technical and behavioural performance separately. Expert ratings therefore seem to be appropriate for assigning levels of technical performance. As well as ratings by supervisors one could also suggest peer or follower evaluations of leadership as an adequate method of measuring leadership effectiveness, used for instance in military teams, a similar context (e.g. Adams, Prince, Instonea, & Rice, 1984; Paunonen, Lonnqvist, Verkasalo, Leikas, & Nissinen, 2006).

Given these results on performance measure systems, we assume that a thorough assessment of team performance would ideally comprise of a combination of both quantitative and qualitative data. However, determining what outcome measures to capture can be difficult because of the multi-disciplinary nature of medical teams and variability of clinical situations (Rosenthal, et al., 2006). As noted by Hackman and Walton (1986) there is no single, one-dimensional criterion of team effectiveness. Determining how well a team has performed always involves much more than simply counting outputs. Measuring the performance of critical health care team means measuring both the safety and efficiency of patient care (Helmreich & Davies, 1996). However, defining those main characteristics of team performance

remains a key challenge. To shed more light on the effectiveness of leadership in medical teams, future studies should provide a clear definition of safe and efficient patient care before systematically linking leadership behaviour to team outcomes.

A number of approaches to evaluate the effectiveness of leadership exist. Most researchers assess leadership performance in terms of the consequences of the leader's behaviour by measuring quantitatively financial key features such as net profits or productivity (e.g. Yukl, 2006). Furthermore, qualitative factors are used to evaluate leader effectiveness, for example, follower satisfaction and well-being. The selection of appropriate performance criteria depends on these objectives and on the person evaluating the performance (Yukl, 2006). Given these various conceptions of leader effectiveness, Yukl (2006) suggested that "multiple criteria should be considered to deal with these complexities and the different preferences of various stakeholders" when evaluating leader effectiveness.

2.7 Directions for future research

The main goal in writing this article was to identify some of the key research needs for leadership behaviour in critical care teams. Thus, we want, as a final step, to discuss the possibilities for further theoretical development and to uncover research needs. The results of this review revealed that effective team performance in critical care teams is inextricably linked to leadership behaviour. A variability of team outcomes as a result of the leadership behaviour was shown by studies drawn from the last twelve years of research presented in this paper. External conditions and personal characteristics directly or indirectly influence team performance. Various leadership patterns have been assumed to have a direct impact on team outcomes such as clear and visible leadership and adaptive leadership strategies. However, only a few studies systematically measured team performance, thus making it difficult to differentiate effective and ineffective leadership patterns. In addition to the research opportunities described in the article, we propose some areas of further research that we think would be of top priority:

1. One important area for future research is to examine the link between leadership and effectiveness. More attempts regarding standardized team performance measures should be made in order to allow for systematically investigating the impact of leadership on performance. Ideally, further research should test hypotheses on causality which would allow conclusions to be

drawn on which leadership behaviours significantly enhance team performance.

2. Research on leadership in critical care teams should broaden its perspective by integrating methods, concepts, and results of work, organisational and social psychology research on leadership. This would allow for a mutual synergy including further theoretical development. From a work psychology perspective, for example, studies on leadership in critical care teams could make important contributions to traditional leadership research by using a transformational leadership (Bass, 1998) or shared leadership (Pearce & Conger, 2003) approach. Additionally, concepts and findings from social psychology could also be applied to studying leadership in critical care teams. Given the findings regarding poor small group decision-making, an area of relevance would be the relation of leadership and small group information management (Wittenbaum & Stasser, 1996) and decision-making (e.g. Larson, Christensen, Franz, & Abbott, 1998; Larson, Foster-Fishman, & Franz, 1998; Stasser & Titus, 2006).
3. While the impact of adaptability of critical care leaders is clear, the operationalisation of the term has not yet been solved satisfactorily. Future work is needed to define adaptability in the medical context. In addition, further research needs to determine whether adaptability skills can be taught as a way of enhancing leadership effectiveness.
4. There is a strong need for more leadership training programmes. Further studies should systematically identify those (teachable) leadership functions associated with effective team performance. Behaviours demonstrated by effective teams could help distinguish effective leadership patterns which need to be integrated into leadership training. Findings on the links of leadership behaviour and team performance should then be integrated into leadership training, which should in turn be systematically evaluated in longitudinal studies. On a long-term base, knowledge of the efficiency of leadership should be made more available and incorporated into training in order to enhance patient safety.

Critical care teams are facing uncertainty and rapidly changing circumstances. The ability to handle such conditions strongly depends on effective coordination

within a team. Leadership, as one type of coordination mechanism, has been considered vital for the maintenance of the patient's safety. It is our hope that this article strengthens the acceptance of leadership as a critical factor in improving safety in critical care teams and that it ignites the interest of researchers and medical practitioners to further the development of effective leadership behaviour in critical care teams.

3 Substitutes for Leadership in Anaesthesia Teams and their Impact on Leadership Effectiveness

3.1 Abstract

In order to ensure adequate patient care, anaesthesia teams need to coordinate effectively. In this study we aim to increase our understanding of leadership in anaesthesia teams by investigating the relationship between substitutes for leadership, leadership behaviour and team performance in situations with varying levels of routine and standardization. The present study relied on video recordings of 12 anaesthesia teams in a simulated setting with the occurrence of a non-routine event. Clinical team performance was measured by the speed of adequate team reaction to this event. The leadership behaviours observed were coded either as content-oriented (e.g. information transmission) or structuring (e.g. assigning tasks). Results showed that leadership behaviour changed depending upon the level of routine of a situation, the degree of standardization and, to some extent, on the experience of team members. Leadership tends to be positively related to team performance during non-routine and low standardized situations but negatively related to team performance in routine and highly standardized situations. Furthermore, findings suggest that leadership behaviour is only slightly related to team member experience. This study improves our understanding of influences of substitutes for leadership on successful leadership behaviour in anaesthesia teams. The findings also lead to suggestions for both further research and the enhancement of team leadership in critical care.

3.2 Introduction

Anaesthesia teams prioritize reliability over any other organizational objective due to the criticality of failure and mistakes (Yun, et al., 2003). Their work is characterized by intense time pressure, unforeseen and critical events, resource limitations, competing goals, high task complexity, and diversity of personnel. To assure safe and efficient work in these complex systems, leadership has been considered to be vital and various factors such as task load and level of standardization have been recognized to influence leadership in critical care teams

(e.g. Grote, et al., 2004b; Klein, et al., 2006; Zala-Mezö, et al., 2009). Despite the growing acknowledgement of the importance of leadership behaviour, we still know little about what makes leadership in critical care teams successful. To our knowledge, few studies have systematically linked leadership in critical care teams to team performance (e.g. Cooper & Wakelam, 1999; Marsch, et al., 2004; Yun, et al., 2005), especially with regards to anaesthesia teams. Anaesthesia teams are charged with handling unexpected, high task load situations deviating from routine yet a large part of their work processes are habitual and well regulated via written standards. Taking these apposing characteristics of anaesthesia teams into account, we postulate that the Substitutes for Leadership theory (Kerr & Jermier, 1978) is a fitting strategy for explaining leadership effectiveness in this highly dynamic setting. The main goal of the present study is to provide a better understanding of substitutes for leadership in critical care teams such as anaesthesia and its influence on team performance. We will explore the effects of task characteristics (non-routine vs. routine procedures), individual characteristics (team member experience levels) and contextual factors (standardization levels) on leadership and analyze its effect on team performance.

This article is organized as follows: first, the characteristics of anaesthesia teams are presented. This is followed by a review of existing leadership theories relevant to anaesthesia teams. On the basis of this review, we then generate and test hypotheses and present related results. Finally, the relevance of the results for both theory and practice is discussed.

3.3 Literature Review and Hypotheses

3.3.1 Anaesthesia teams

Anaesthesia teams are characterized as action teams with an exclusive membership of specialists, short work cycles, frequent changes in conditions, high synchronization within the team and with support units, and requirements for extended training and preparation (Sundstrom, et al., 1990). Their existence as a unit is limited as they often work together for only part of the day (Guzzo & Dickson, 1996). Members of anaesthesia teams have to work together very closely and workflow is poly-directional, flexible and very intensive as teams repeatedly face unusual situations (Tesluk, Mathieu, Zaccaro, & Marks, 1997) and, depending upon

the urgency of the situation, fast, accurate decisions have to be made. In addition to clinical competencies, non-technical skills such as leadership, decision making, assertiveness and team coordination are crucial for error management in the operating theatre (e.g. Fletcher, et al., 2002; Flin, et al., 2003). In coordinating medical teams, leadership plays a central role. The tasks within the anaesthesia teams studied here are not always strictly separated, meaning that team members have to be able and willing to do each of the tasks regardless of their profession. Roles may also change spontaneously during collaboration. For example, a new team leader can emerge if an experienced nurse takes over the tasks of an inexperienced resident physician in order to assure the patient's safety during a non-routine event[3] (Künzle, 2003; Zala-Mezö, et al., 2004). Therefore, the performance of leadership in anaesthesia teams is not restricted to the hierarchically senior team member (e.g. the physician). The flexibility needs to be in place for more than one team member to demonstrate leadership rather a single team member carrying the responsible for every type of leadership behaviour. Leadership roles in anaesthesia are important to provide structure and task-relevant information within a team in order to achieve the goal for the current task. In this regard, long-term functions of leadership such as developing and motivating team members are less important (Zala-Mezö, et al., 2004).

Taken together, anaesthesia teams are characterized by two main factors: first, they are faced with frequent changes in the routine level of task demands such as high-routine, protracted patient monitoring vs. non-routine, complex, rare events. Secondly, anaesthesia teams must also deal with recurrent changes in team resources, mainly due to the ad hoc nature of anaesthesia teams. These characteristics as well as the fact that residents as hierarchical leaders are often less experienced in medical work than nurses holding positions lower in the organization indicate that asserting strengths in personal leadership might pose a challenge. Highly flexible leadership is required in order to adapt effectively to these changing conditions (Yukl, 2006) and leaders need to repeatedly and rapidly adapt their leadership behaviour. For example, this could mean that team members need to have the ability to emerge as leaders in a non-routine situation but to step back in

[3] Non-routine event in anesthesia is defined as any event that is perceived by care providers or skilled observers to be unusual, out-of-the-ordinary, or atypical" (Weinger & Slagle, 2002).

routine situations where no leadership behaviour is required. This view is in line with the ideas of the Substitutes for Leadership theory (Kerr & Jermier, 1978), suggesting specific ways in which leaders can adapt their behaviours to the changing nature of their team's tasks and/or composition. The possibility that situational factors or team composition can act as a substitute for leadership in critical care teams – literally substituting the need for leadership – has been previously noted by others (e.g. Grote, et al., 2004b; Klein, et al., 2006; Xiao, Seagull, Mackenzie, Ziegert, & Klein, 2003a; Yun, et al., 2005; Yun, et al., 2003). However, their effect as a substitute has not been studied in detail and hardly any link to team performance has been made. In this study we aim to fill this gap by identifying potential substitutes for leadership and analyzing their effect on leadership behaviour and team performance. Based on the above identified characteristics of anaesthesia teams, we decided on three substitutes fitting all three levels of substitutes suggested by Kerr and Jermier (Kerr & Jermier, 1978). These investigated leadership substitutes are as follows: as a subordinate characteristic we chose team member experience, as task characteristics we chose the effects of routine vs. non-routine situations and as a leadership substitute on the organizational level we looked at the effects of task standardization.

In the following section, we will first focus on the leadership theories which we think best characterize leadership in anaesthesia teams. We will then take a closer look at specific leadership behaviours before outlining what kind of leadership substitutes are important for anaesthesia teams.

3.3.2 Leadership perspectives

From the perspective of functional leadership (Zaccaro, et al., 2001), effective team leaders follow team processes closely and take over whatever functions are required in the team at the required point in time. Thus, a leader's primary responsibility is to plan the care process as a whole, continuously following the course of action, determining what functions are missing or not being handled adequately and either performing them or otherwise ensuring that they get done. The central premise of functional leadership theory is that team circumstances prescribe certain necessary leadership activities for success, negating the utility of other activities (Zaccaro, 2002). In many situations, it appears that leadership behaviours are irrelevant or even ineffective and that often times, no leadership is required for

teams to perform effectively. This is in line with contingency theories of leadership which assume that the effectiveness of leadership depends on contextual and situational factors such as organizational conditions (e.g. House, 1971). Furthermore, characteristics of team members and of the group as a whole can take the place of leadership processes. Group leadership viewed as functions rather than individuals (Benne & Sheats, 1948) leads to the logical extension that these functions can come from sources other than individuals. This idea has been adopted by the Substitutes for Leadership theory (Kerr & Jermier, 1978), identifying a number of ways in which this can happen. According to Kerr and Jermier, a substitute is defined as any organizational or situational characteristic that renders "relationship and/or task-oriented leadership not only impossible but also unnecessary" (p. 395). A substitute can be a characteristic of the subordinates, the task, the group or the organization. A classic leadership substitute would be a well-documented routine procedure providing enough clarity about what needs to be done that only little room is left for a leader. Furthermore, little direction from a leader is required when subordinates are experienced or tasks are repetitive and routine (Yukl, 2006). Expert and experienced members not only require less direction from a formal leader, they can substitute for several leadership functions. The key to effective leadership is that the leader identifies when he or she is needed vs. when the situational or contextual variables could serve as substitutes for his or her leadership – and adapts accordingly (Maas & Grad, 2004). That adaptive leadership is an effective strategy has also been shown for critical care teams. For example, leaders need to adapt their leadership behaviours to the needs of their subordinates or to the demand of a situation (Klein, et al., 2006), implying that under some circumstances a high amount of leadership is necessary whereas in other situations less or no leadership is required.

As mentioned previously, leaders in anaesthesia teams are mainly needed to perform task-relevant leadership functions. This study therefore focuses on task-based components of leadership behaviour on the team level. Other leadership components considered being less relevant for anaesthesia teams such as motivation and strategy development will not be examined. To meet the functionally differentiated leadership behaviours of anaesthesia teams (see e.g. Zala-Mezö, et al., 2004), the idea of a two-dimensional leadership suggested by the behavioural perspective of leadership (e.g. Bales & Slater, 1955; Fleishman, 1953; Fleishman, et

al., 1991; Likert, 1961) was adapted. In line with more recent work (e.g. Stempfle & Badke-Schaub, 2005), we looked at content-oriented and structuring leadership behaviour. *Content-oriented leadership* refers to technical processes regarding task content which are necessary for task accomplishment. This leadership behaviour mainly concentrates on the understanding of the task situation; including providing team members with task-relevant information in order to enhance collective sense- and decision-making (see Zaccaro, et al., 2001). *Structuring leadership* is similar to the traditional leadership behaviours of initiating structure (see e.g. Bass, 1990; Yukl, 2006). It is concerned with the structuring of work processes necessary for task accomplishment, including planning, coordinating activities and assigning tasks (see e.g. Badke-Schaub & Lorei, 2003; Stempfle & Badke-Schaub, 2005). The aim of structuring leadership is to minimize the loss of coordination within a team (e.g. Steiner, 1972).

Taken together, one could assume that whereas content-oriented and structuring leadership might be important during fulfilment of non-routine anaesthetic tasks, they could be less relevant or substituted when fulfilling routine and highly standardized anaesthetic tasks.

3.3.3 Substitutes for Leadership in Anaesthesia Teams

3.3.3.1 Routine Tasks

As previously mentioned, the work of anaesthesia teams is characterized by uncertainty, complexity and rapidly shifting priorities and conversely by routine situations and protracted monitoring. In this study, routine and non-routine tasks are distinguished by the level of task load[4], which corresponds to the severity of patient status and is a key factor regarding the need for leadership in critical care teams such as anaesthesia teams. The more urgent and less routine a medical intervention task is, the more directive, active leadership is required (Klein, et al., 2006; Xiao, et al., 2003b; Zala-Mezö, et al., 2004) and therefore the more likely the team structure changes from flat to hierarchical (Wetzel, et al., 2006). There is also evidence that the urgency of an event influences the amount of time a leader spends managing the

[4] Task load describes an external indicator of objective load including factors like task demands or situational requirements (e.g. Grote, et al., 2004a)

event (Morgeson & DeRue, 2006). Furthermore, task-focused leadership behaviours such as planning, problem definition and keeping team members informed about the task nature seem to be more important for team performance in non-routine tasks (e.g. Burke, et al., 2006a; Waller, 1999; Yukl, 2006). Other studies have outlined the importance of structuring leadership. In general, directive leadership such as assigning tasks or requesting specific behaviour is important for coping effectively with unexpected team events (e.g. Burke, et al., 2006a; Lord & Rowzee, 1979; Waller, 1999; Yukl, 2006) as is the case for non-routine critical care team events (e.g. Cooper & Wakelam, 1999; Klein, et al., 2006; Marsch, et al., 2004; Tschan, et al., 2006).

Taken together, these studies suggest that the demand for leadership behaviour seems to vary depending upon the routine level of a situation. Basically, anaesthesia teams are characterized by rapid shifts from simple, repetitive, routine tasks to unexpected, non-routine events. Bearing the Substitutes for Leadership theory in mind, one might take from all this that routine situations require less leadership behaviours or even make them redundant. Conversely, new, unknown non-routine situations require more leadership behaviour in order to ensure team effectiveness (Yukl, 2006). Collectively, these assumptions lead us to the first hypothesis:

> *Hypothesis 1: During non-routine situations, teams engage in more leadership behaviour than in routine situations (H1a). Teams which engage in more leadership behaviour during non-routine phases and less leadership behaviour during routine tasks show higher levels of performance than teams which engage in contrary leadership behaviour patterns (H1b).*

3.3.3.2 Standardization

In high risk work environments, standard operating procedures such as written rules and clear job descriptions are often used to support coordinated action (Van de Ven, et al., 1976) in order to reduce the influence of non-predictable human action as a risk factor and make a system's behaviour more predictable and controllable (Grote, 2007; Grote, et al., 2004b). Standardization is defined as the degree to which task activities are specified in detail and the extent to which

standard operating procedures are established to direct behaviour within an organizational unit (Van de Ven, et al., 1976). Besides formal standardization, teams often seek to develop routines that specify what behaviours should be performed in different circumstances in order to manage their own activities (Gersick & Hackman, 1990). Both written and tacit rules help teams develop a shared mental model of the situation and of the actions required from each team member. This allows routine and quick action without requiring additional resources for coordination (Grote, et al., 2004b).

In the context of substitutions for leadership, standardization represents a potential substitute variable for leadership by providing non-leader sources of task guidance (Howell, Bowen, Dorfman, Kerr, & Podsakoff, 1990; Kerr & Jermier, 1978). Subordinates need less direction if their work is regulated by written rules or policies (Yule, Flin, Paterson-Brown, & Maran, 2006). This tendency toward self-regulation has also been found among anaesthesia teams (Grote, et al., 2003; Künzle, 2003). Moreover, high levels of leadership expressed in highly standardized situations, where team members did not need much direction, seemed to have a negative effect on team outcomes (Grote, et al., 2004b; Sexton, et al., 2004). Thus, one can assume that leadership can even be detrimental when high standardization is present.

> *Hypothesis 2: In situations with higher levels of standardization, less leadership behaviour occurs than in situations with a lower level of standardization (H2a). Teams which engage in less leadership behaviour during high standardized work phases and teams which show more leadership in low standardized situations will exhibit higher levels of performance than teams which engage in contrary leadership behaviour patterns (H2b).*

3.3.3.3 Experience of Team Members

Few would argue with the general notion that experience with a task and with other team members is likely to improve team effectiveness (Sundstrom, et al., 1990). It has been shown that when subordinates are experienced and trained, they need less direction from a leader because they have the appropriate skills and knowledge to know what to do and how to do it (e.g. House, 1971; Vroom & Jago, 1988; Yukl, 2006). This leads us to the notion that ability combined with experience

can also serve as a substitute for hierarchical leadership (e.g. Howell, et al., 1990). This said, studies on leadership in critical care teams have revealed that the need for leadership is still present in competent teams but the role of leadership shifts from guiding and structuring to monitoring (Cooper & Wakelam, 1999). Leaders need to be more directive and involved when a team is inexperienced while in more experienced teams, empowering leadership is more effective (Yun, et al., 2005; Yun, et al., 2003). Hence, in this study we expect that the more experienced the team members are, the less leadership behaviour is necessary and that teams which consider the level of experience of team members regarding the level of directive leadership expressed show better performance:

> *Hypothesis 3: The more experienced team members are, the less leadership behaviour from other team members occurs (H3a). In high-performing teams, team members show less leadership activity when co-workers are experienced than in low-performing teams (H3b).*

3.4 Methods

3.4.1 Participants

The study used data collected from 13 anaesthesia teams engaged in a simulated anaesthesia induction. Anaesthesia inductions are the first step in all operations requiring general anaesthesia. The inductions were analyzed because they offered the opportunity to study coordination within anaesthesia teams without much interference from other teams such as surgical or operating room teams. Prior to the study, local institutional ethics committee approval was obtained and participating staff gave their written informal consent (see Appendix B, Chapter 6). Staff resources determined the sample size and all team members were employees of the hospital where the study was carried out. An inclusion criterion for participation was 6 months or more experience in anaesthesia and participants were randomly assigned to one of the 13 teams. Teams consisted of 2 team members each: one anaesthesia resident (5 females, 8 males) and one anaesthesia nurse (6 females, 7 males). A male consultant anaesthetist was immediately available if requested. Teams assigned the normative roles to anaesthesia team members (the resident performed intubation while assisted by the nurse). Within this classic hierarchical

team structure, the anaesthesia resident was appointed the formal leader, positioned at the head of the patient. The formal leader was responsible for the coordination of the anaesthesia induction and performed tracheal intubation while the nurse prepared the necessary material and equipment and injected sleep-inducing medication. The elimination of one outlier case (see Team performance) resulted in a sample size of 12 teams in the present study.

3.4.2 Study Design

The simulated setting took place in the same operating room as live anaesthesia inductions. All teams were videotaped during simulated anaesthesia inductions with the same resuscitation mannequin for advanced life support (MegaCode®, Laerdal), allowing simulation of a non-routine event (cardiac arrhythmias) to occur during laryngoscopy[5] during each simulation. There were no further exceptions to the normal operating room environment. Video and vital parameter recordings were obtained using a setup allowing synchronized recording and DVD playback of video, monitor, and ventilator data. Time periods were determined, comparing the three synchronized data sets based on observable occurrences. Appendix C contains a flow sheet presenting the content of the simulator case.

3.4.3 Data Coding

Coding procedure. The videotapes were analyzed using the software ATLASti™ (Muhr, 2003), appropriate for the qualitative analysis of large bodies of video data. Two of the authors plus a research assistant blind to the research question coded the videotaped teams segment by segment. The unit of coding was one uttered statement, usually a phrase. A new unit started as soon as the speaker and/or the topic changed. The occurrence of leadership behaviour was recorded on the basis of verbalized team interactions. As a protection against biases, all three coders were blind to the teams' performance ratings when coding leadership behaviour.

[5] During laryngoscopy, vocal cords are directly visualized with the laryngoscope blade. A light beam from the blade tip facilitates the introduction of the orotracheal tube through the vocal cords into the trachea under visual control (orotracheal intubation).

To check the coding scheme for inter-rater reliability, the raters independently coded a test sample of 5 out of the 13 cases. The first coder divided the sample into coding units, to which the two other coders assigned codes. To assess the agreement, Kappa statistics were employed for the main categories. The results indicated a very good inter-rater reliability across the raters for the structuring leadership dimension (K=0.88) and a good inter-rater agreement for content-oriented leadership behaviour (K=0.76). Where differences in coding occurred, the final category was agreed upon by the observers reviewing and discussing these differences.

Leadership behaviour. In the absence of a coding scheme to analyze leadership in anaesthesia teams, we developed a new coding scheme by drawing on our previous study (Zala-Mezö, et al., 2004) and on the existing body of leadership literature (e.g. Bales & Slater, 1955; Stempfle & Badke-Schaub, 2005). We proposed a category system that distinguishes between content-oriented and structuring leadership behaviour (for theoretical derivation see *Leadership Behaviour*, p. 6). Table 3.1 provides descriptions and examples of these categories (see Appendix D for the complete category system).

Table 3.1: Samples of coded videotape segments

Main Category	Code	Observable behaviour	Example
Content-oriented leadership	Information collection	Team members proactively acquire task relevant information.	"Do we have Atropine on hand?" "Did you inject 1% solution?"
	Information transfer	Team members proactively provide task relevant information or knowledge.	Information about the state of the patient, e.g. "ventilating is easy." Information about strategy or decisions: "Blood pressure measurement is set to 2 minutes."
	Problem-solving	Team members verbalize a problem, provide interpretation of a problem, are looking for a solution, and setting new goals.	"I'm not worried about the bradycardia – that's due to the Fentanyl." "Maybe this instrument is broken?"
Structuring leadership	Distribution of roles and assigning tasks	Team members assign tasks or roles to other team members.	"Please inject 10 mg propofol." "Could you hold the mask for me, please?"
	Decision about procedures	Team members offer clear performance strategies or show other team members how to do something	„We're going to provide respiration without a filter" "We prepare atropine but wait before injecting."
	Initiate an action	Team members initiate an action without being asked.	"I'll start with the blood pressure measurement."
	Structuring work process	Team members determine the sequence of actions, coordinate pace and rhythm of activities and plan next steps.	"Let's wait until the frequency goes up, then we'll try it again." Nurse asks whether she is allowed to pre-oxygenize the patient. Resident answers: "No, not yet. Let me first fill out the report."
	Resource management	Team members manage staff and equipment resources.	Additional equipment or staff is requested. Somebody is asked to help.

Work phases. Changes in leadership behaviour were analyzed during work phases differing with respect to the level of routine (task load of tasks) and degree of standardization (e.g. written regulations and standardized procedures). An experienced anaesthetist trained in human factors defined the three main phases of the simulated anaesthesia induction thusly: During the first phase (preparation), all the material and equipment were prepared. The second phase (preintubation) began with administering the first drug and ended when the patient fell asleep and no longer showed muscle reaction. The third phase (intubation) was when orotracheal intubation was performed. This is a significant phase during anaesthesia induction because the patient is not ventilated and cannot breathe spontaneously. During intubation, asystole occurred as the simulated non-routine event.

Routine. The level of task load (low, moderate, or high) was assessed in order to distinguish the routine level of the three work phases. Low task load represented highly routine, moderate represented medium routine and high represented low routine situations. We drew this information from 20 in-depth, one-on-one interviews conducted with the participating team members and routine rating levels were confirmed by the same anaesthetist who defined the three phases of anaesthesia induction. They rated routine levels on a scale from 1 to 10, 10 being the highest value for high stress, low-routine situations.

Standardization. Work phases were classified as low, moderately, or highly standardized according to the number of written rules (Hale & Swuste, 1998) pertaining to the respective phase in the instructions for standard anaesthesia, handling medication and treating non-routine incidences of difficult respiration and intubation (see Appendix E, Chapter 6, for relevant extracts from these three written rules).

Table 3.2 depicts the three phases of simulated anaesthesia induction analyzed for this study. In this study, the level of routine and standardization were confounded because the levels of both routine and standardization decrease with the progression of each phase. For example, Phase 1 was routine and highly standardized at the same time whereas Phase 3 was characterized by non-routine and low standardization. Thus, the influence of varying levels of routine and standardization on leadership behaviour could not be discretely analyzed. This leads to the decision to report the results of Hypotheses 1 and 2 together as they are both related to the same phases although they test different variables.

Table 3.2: Level of routine and standardization of phases during simulated anaesthesia induction

		Phase 1 Preparation	**Phase 2 Preintubation**	**Phase 3 Intubation incl. Asystole**
	Main tasks	Preparation of material and equipment.	Administration of drugs.	Induction of endotracheal tube into trachea; non-routine event (asystole) occurs.
	Mean duration in minutes	7.71	5.77	0.62
Routine Level	Mean ratings of task load	3.8	4.8	7.2
	Level of Task load	Low	Moderate	High
Standardization Level	Type of rules	Directions about material and equipment needed	Directions about drugs	Directions about intubation procedure
	Number of rules	20	15	7
	Level of standardization	High	Moderate	Low

Experience. Team members were surveyed prior to the study to assess their level of experience. The question “how many years have you been working in this position at this hospital?” measured individual experience in anaesthesia on a scale from 1 (less than 6 months) to 5 (more than 6 years). The experience of residents ranged from 1 to 4 years (M=2.33; SD=1.23) and the experience of anaesthesia nurses ranged from 1 to 5 years (M=2.67; SD=1.23). Appendix F contains the survey used to assess team member work experience.

Team performance. Since delays in reaction to non-routine events in anaesthesia can be devastating, team performance was assessed with time-based performance ratings measuring reaction time to the simulated asystole. Unlike other researchers who have investigated reaction time to unexpected events for single providers (DeAnda & Gaba, 1991; Gaba & DeAnda, 1989; Weinger, et al., 1994), we examined reaction time of the entire team to the unexpected simulated event using synchronized recording of video and vital parameters. Time periods were determined comparing the three synchronized data sets during DVD playback. Execution time,

defined as the time elapsed from onset of asystole until reinstallation of sinus rhythm, was used as the overall measure for team performance. Thus, the less time the team needed to solve the problem, the higher their performance was rating. To simplify the interpretation of correlations between leadership behaviour and performance, execution time values were transformed so that higher performance was related to lower time values. One outlier case with a reaction time of 124 seconds was identified via Stem-and-Leaf Plot and Grubb's test for detecting outliers. The duration of execution time for the remaining 12 teams ranged between 10 and 53 seconds (M= 30.33; SD= 13.52).

3.4.4 Data Analysis

Initially, data were analyzed by adding the number of leadership behaviours for both members of the anaesthesia team. To control for variation in length of the three phases, the raw data frequencies were transformed to rates per minute by dividing the sum of leadership behaviour in one phase by the duration in minutes of the same phase. The small sample size (N=12) diminished the ability to detect statistically significant relationships. Consequently, we used $p \leq .10$ as the critical level for statistical significance in our tests (see e.g. McClelland & Judd, 1993).

Because data did not meet the assumption of normal distribution, non-parametric test procedures were used. To study whether effective anaesthesia teams adapt their leadership behaviour to the level of routine and standardization (Hypotheses 1a and 2a), we computed Mann-Whitney U-tests. In addition, Spearman rank order correlations were performed to identify the effectiveness of leadership amount in each phase (Hypotheses 1b and 2b). Hypothesis 3 was tested by using the Scheirer-Ray-Hare extension of Kruskal-Wallis test (see e.g. Dytham, 2003), which is equivalent to a univariate ANOVA, albeit more conservative. Dependent variables consisted of leadership behaviour of nurses and residents respectively. The Scheirer-Ray-Hare test was followed by pairwise comparisons using the Mann-Whitney U-test in order to test whether a significant adaption of leadership behaviour to the experience levels of team members occurred in the expected direction.

3.5 Results

Hypothesis 1a suggested that during non-routine situations, teams engage in more leadership behaviour than in routine situations and Hypothesis 2a proposed that in situations with higher levels of standardization, less leadership behaviour occurs than in situations with a lower level of standardization. Table 3.3 depicts the mean of raw values per phase as well average rate of leadership behaviour per minute in each phase and displays the results of the Mann-Whitney U-tests. The Mann-Whitney U-tests found that the mean rank of all leadership behaviours per minute was significantly lower in the first phase than in the second: $U = 13$, $p < .001$, $r = -.70$; $U = 5$, $p < .001$, $r = -.79$; and $U = 37$, $p < .05$, $r = -.41$ for total, structuring, and content-oriented leadership, and also significantly lower compared to leadership behaviours shown in the third phase: $U = 0$, $p < .001$, $r = -.85$; $U = 12$, $p < .001$, $r = -.71$; and $U = 0$, $p < .001$, $r = -.85$ for total, structuring, and content-oriented leadership, respectively. Comparison of Phases 2 and 3 showed similar results: teams showed significantly more leadership behaviour during the third than the second phase: $U = 9$, $p < .001$, $r = -.74$; $U = 23$, $p < .01$, $r = -.57$; $U = 24$, $p < .01$, $r = -.57$ for total, structuring, and content-oriented leadership, respectively. These findings indicate that teams show significantly more leadership in non-routine and low standardized situations than in routine and highly standardized situations. Thus, Hypothesis 1a and 2a were confirmed for all variables.

Hypothesis 1b stated that teams which engage in more leadership behaviour during non-routine phases and less leadership during routine tasks show higher levels of performance than teams with contrary leadership patterns. Hypothesis 2b suggested that teams which engage in less leadership behaviour during highly standardized work phases and in more leadership in low standardized situations will exhibit higher levels of performance than teams that engage in converse leadership behaviour. Spearman's rank correlation coefficient was used to test the relationship between leadership behaviour levels and performance (see Table 3.3). As expected, the total amount of team leadership behaviours, $r_s(12) = .35$, $p > .10$, as well as content-oriented leadership behaviours, $r_s(12) = .37$, $p > 0.10$ in Phase 3 was positively related to team performance, indicating that more leadership behaviour during non-routine and low standardized phases is positively related to team performance. However, these correlations did not reach statistical significance. In

Phase 1, there were significant negative correlations between the total amount of leadership behaviours and team performance, $r_s(12) = -.56$, $p < 0.05$, between structuring leadership and team performance, $r_s(12) = -.58$, $p < 0.05$, and between content-oriented leadership and team performance $r_s(12) = -.52$, $p < 0.10$, indicating that more leadership behaviour during routine and highly standardized phases is negatively related to team performance. Thus, Hypotheses 1b and 2b are partially supported.

Table 3.3: Leadership behaviour mean rate per phase, mean rate per minute, Spearman rank order correlations, and results of Mann-WhitneyU- tests[a]

	Phase 1			**Phase 2**			**Phase 3**			**Comparison of mean rate per minute**		
Leadership behaviours	Mean rate per phase	Mean rate per minute	r_s	Mean rate per phase	Mean rate per minute	r_s	Mean rate per phase	Mean rate per minute	r_s	Phases 1 and 2	Phases 1 and 3	Phases 2 and 3
Total	14.17	1.85	-0.56*	24.33	4.44	-0.36	6.33	11.19	0.35	13.00***	0.00***	9.00***
Structuring	8.58	1.13	-0.59*	15.33	2.70	-0.00	3.67	6.16	-0.10	5.00***	12.00***	23.00**
Content-oriented	5.58	0.73	-0.52†	8.83	1.71	-0.55†	2.67	5.03	0.37	37.00*	0.00***	24.00**

Note.
[a]*N* = 12 (teams).
† p < .10. * p < .05. ** p < .01. *** p < .001.

Hypothesis 3 suggested that the more experienced team members are the less leadership behaviour from other team members occurs (3a), which is proposed to relate to team performance (3b). A median split was used to build two groups of experience levels for both nurses and residents. Team members with experience levels below the median were labelled “lower experienced”; team members with experience levels above the median were labelled “higher experienced”. The non-parametric analysis of variance revealed no significant main effects of nurse experience levels on the leadership amount shown by residents, $H(1, 8) = 1.46$, $p > .10$, $\eta_p^2 = 0.15$ whereas there was a significant main effect of resident experience levels on the leadership amount shown by nurses, $H(1, 8) = 5.50$, $p < .05$, $\eta_p^2 = 0.55$, indicating that the amount of leadership shown by nurses depends upon the experience level of the resident (see Table 3.4). Mann-Whitney U-tests revealed that nurses showed significantly more leadership if residents were inexperienced ($M_{\text{lower experienced residents}} = 10.76$, $SD_{\text{lower experienced residents}} = 3.13$), than they did when working with higher experienced residents ($M_{\text{higher experienced residents}} = 4.91$, $SD_{\text{higher experienced residents}} = 2.18$), $U = 0$, $p < 0.01$, $r = -.78$. No significant main effects of performance were found for leadership levels shown by both residents and nurses nor were any significant interaction effects between performance and level of experience found (see Table 3.4), indicating that the adaptation of leadership behaviour to the experience level of team members was not related to team performance. Thus, Hypothesis 3a is partially supported regarding the reduction of nurse leadership behaviours in response to higher resident experience levels whereas Hypothesis 3b is not supported.

Table 3.4: Results of Kruskal-Wallis ANOVA with Scheirer-Ray-Hare extension for total amount of resident and nurse leadership

Source	*Sum of Squares*	*df*	*H*	*p*	η_p^2
Leadership behaviour of residents[a]					
Team Performance (P)	14.80	1	0.68	0.411	.076
Experience Nurse (N)	31.87	1	1.46	0.228	.150
P x N	14.25	1	0.65	0.420	.073
Error	179.99	8	(22.50)		
Leadership behaviour of nurses[b]					
Team Performance (P)	0.37	1	0.03	0.871	.006
Experience Resident (R)	76.95	1	5.50*	0.019	.553
P x R	0.03	1	0.01	0.966	.000
Error	62.08	8	(7.76)		

Note. Values enclosed in parentheses represent mean square errors.
[a]*n* = 12 (residents). [b]*n* = 12 (nurses).
* p < .05.

3.6 Discussion

With this study we aimed to answer two general questions: First, we wanted to know whether levels of routine and standardization serve as substitutes for leadership in anaesthesia teams and whether levels of leadership affect differences in high- and low-performing teams. Secondly, we were interested in the importance of experience for the leadership behaviour of teammates. Leadership behaviour of members of anaesthesia teams was investigated in a simulated anaesthesia induction setting with the occurrence of a non-routine event. Overall, the results support a contingency model of leadership, suggesting that the amount of leadership varies depending upon environmental factors and, to some extent, on the experience of team members. As hypothesized, effective teams engaged in less leadership behaviour during routine and highly standardized work phases while they tend to show more leadership during non-routine and low standardized situations. Contrary to our expectations, only nurses adapted their amount of leadership to the experience level of team members. However, this finding was not significantly related to team performance.

The study confirms that leadership in critical care teams is contingent upon contextual factors such as levels of routine and standardization and supports the notion that leadership can be substituted by said contextual work conditions (e.g.

Kerr & Jermier, 1978; Yule, et al., 2006), extending the findings from earlier research in similar domains (e.g. Cooper & Wakelam, 1999; Klein, et al., 2006; Zala-Mezö, et al., 2004; Zala-Mezö, et al., 2009). The amount of leadership increases during non-routine, unknown situations while both its importance and expressing diminish during more routine situations, confirming the notion of routine as a substitution for leadership in anaesthesia teams. Possible explanations are the situational and contextual characteristics of the teams analyzed in this study. During the routine intubation task in this study, a rare, non-routine event occurred, requiring more leadership behaviour (e.g. Yukl, 2006). Moreover, this non-routine phase was low standardized, requiring, as expected, more leadership behaviour than a highly standardized situation.

The second leadership substitute analyzed in this study was standardization. As expected, in highly standardized situations less leadership behaviour occurred than in low standardized conditions. This result is in line with previous findings on the role of standardization in medical settings (e.g. Grote, et al., 2003; Zala-Mezö, et al., 2009). As expected, more leadership in the highly standardized first phase was related negatively to team performance. This finding confirms the results found by Sexton and colleagues (Sexton, et al., 2004) who stated that high leadership levels shown during highly standardized situations could have adverse effects on team performance. This is in line with the notion of House (1971)., suggesting that routine jobs have clear path-goal relationships and leader-initiating structure is not necessary to neither clarify jobs nor improve performance. Instead, it may provoke dissatisfaction among subordinates.

The findings concerning the effects of experience on team member leadership quantity partially support the theory of substitutes for leadership (Kerr & Jermier, 1978). As the nurses in this study modified their behaviour according to the experience of residents, it may be reasoned that experienced team members need less leadership activities from their colleagues and also that non-hierarchical leaders (in this case, nurses) are more likely to adapt their amount of leadership to the experience of team members than hierarchical leaders (in this case, residents).

3.7 Study limitations and implications for future research

The present study relies on data gathered in a simulated setting. With this approach we aimed to garner standardized data with similar critical care team

constellations in a setting familiar to the participants that also allows for manipulation of variables without risk of life. However, despite the standardized and regulated setting, we could not control for every variation such as team composition, experience of team members, or role assignments. Future research based on a similar setting should control for these variables. Furthermore, levels of routine and standardization were confounded because they also respectively characterized the progression of phases of general anaesthesia induction. Thus, their influences on leadership behaviour could not be discretely analyzed. A future simulation study should be constructed in such a way as to enable an independent analysis of influencing contextual factors.

Due to the small sample size we found it necessary to access nonparametric statistics. Although these methods are appropriate for basic analysis, a larger sample size would have provided more opportunities for data analysis. For example, since moderator and mediator analyses were widely used previously in research on substitutes of leadership (e.g. Howell, Dorfman, & Kerr, 1986), one might expect that those analyses might have been useful to answer the question in more detail as to whether experience has an influence on team performance. Also due to the small sample size one might question the generalizability of the findings. In order to get more generalizable data we recommend augmenting this study with data from a live setting.

Another limitation of the study relates to the measure of experience. One can assume that the weak findings in the context of team member experience are caused by the time measurement of experience used in this study. According to Bettin and Kennedy (Bettin & Kennedy, 1990), time is not an adequate measure of experience because “it does not capture the knowledge and skills that a leader acquires by participating in various activities.” (p. 226). It seems that measures other than time spent working in anaesthesia might enhance the experience measurement and in turn the consequential findings. For future research we suggest extending the measurement of experience by taking into account previous experience in other medical domains and/or actual experience with the simulated non-routine event.

Medical teams have a hierarchical structure and consequently it could be assumed that the formal leader, that is the senior member of the team, would demonstrate behaviour accordingly. However, the results presented in this paper suggest that both team members actively participated in leadership behaviour,

although we only reported results on a team level. Former studies report similar results, indicating that leadership in critical care teams can be shared between the formal leader and other team members (Flin, et al., 2003; Klein, et al., 2006; Xiao, et al., 2004). To see whether this is also the case for anaesthesia teams, an extension of the current study would be to measure and analyze leadership behaviour at the individual level.

Our aim was to extend research on team performance by applying reaction time to a non-routine event as a measurement of team performance. The intent was to use an objective, quantitative measurement of team performance. However, the time measured revealed only small variances among teams, impeding a clear discrimination between low and high performance. In future research, other outcome measures could be considered such as applying various expert rating scales (e.g. Healey, et al., 2004; Risucci, et al., 1999; Sugrue, et al., 1995, Undre, 2006 #5547) and ratings of non-technical skills (Fletcher, et al., 2003). Longer-term quantitative measures could also be taken into account such as classification of morbidities or length of pre- and post-operative hospital stay (e.g. Pollack & Koch, 2003). According to Hackman and Walton (1986), there is no single, one-dimensional criterion for measuring team effectiveness. One could therefore assume that the ideal, comprehensive assessment of team performance would include a combination of both quantitative and qualitative data.

3.8 Conclusions and practical implications

This study systematically links observed leadership behaviour to performance of critical care teams. The results lead to a better understanding of the role of leadership in anaesthesia teams, revealing three factors that this type of team leadership is contingent upon and therefore can be substituted for: levels of routine, standardization and, to some extent, experience of team members.

The findings indicate that leadership in anaesthesia adapts to these three factors, and, to some extent, this has been shown to be an effective strategy. It seems therefore worthwhile to foster adaptability of leadership behaviour in order to cope with varying levels of standardization, team member experience, and in particular, uncertainty such as the occurrence of non-routine events. In accordance with other research on leadership (e.g. Burke, et al., 2006b; Pulakos, et al., 2000), it seems advisable to recommend individual and/or team training which provides

techniques and opportunities for identifying and practicing adaptability and flexibility in both routine and non-routine critical circumstances within a safe, simulated environment. Team adaptability training has already been shown to promote adaptability under stressful circumstances (Entin & Serfaty, 1999) and since leadership training seems to be a critical factor for effective leadership (e.g. Driscoll & Vincent, 1992; Sugrue, et al., 1995) as well as significantly improving team performance (Cooper, 2001), critical care environments should acknowledge this finding and devote more resources to flexibility and team management training. As these findings concern team performance, training should not only be offered to formal leaders, as has so often happened in the past, but to all team members (DeVita, et al., 2004; Hynes, et al., 2006).

4 Leadership in Anaesthesia Teams: the Most Effective Leadership is Shared

4.1 Abstract

Leadership plays a crucial role in teams working in complex environments and research has shown that shared leadership is an especially effective strategy. We aimed to describe shared leadership patterns during anaesthesia induction and analysed whether they are linked to team performance. 12 simulated anaesthesia inductions including a non-routine event (asystole) were video taped and two kinds of leadership behaviour (content-oriented and structuring) were coded. Three phases within anaesthesia inductions were determined according to their task complexity (level of task load). The degree of shared leadership was compared between low and high-performing teams for those phases. Team performance was measured with the reaction time to the non-routine event. A univariate analysis of variance (ANOVA) revealed that significantly more leadership occurred if task load was high. In high-performing teams, residents and nurses shared their leadership, while in low-performing teams, residents showed significantly more leadership behaviour than nurses. Further analyses revealed different distributions among team members: While residents of low-performing teams showed both more content-oriented and more structuring leadership, members of high-performing teams seemed to have distinct leadership roles. Nurses were more active in content-oriented leadership while residents showed more structuring leadership. The study reveals the effectiveness of shared leadership in situations with high task complexity and indicates that a clear distribution of content-oriented and structuring leadership functions among team members is an effective strategy. The findings have important implications for training in shared leadership and also give rise to a number of recommendations for further research.

4.2 Background

Although leadership is increasingly considered vital for optimal teamwork and patient management in critical care teams, few studies have focused on leadership, e.g. (Cooper & Wakelam, 1999; Helmreich, 2000; Xiao, et al., 2004). However,

theses studies did not measure team performance, making it difficult to identify effective leadership behaviour. This study aims to fill this gap and shed more light on the effectiveness of leadership in anaesthesia teams by linking leadership behaviour to team effectiveness focusing on shared leadership which has been shown to be a relevant strategy for critical care (Klein, et al., 2006; Xiao, et al., 2004).

This study relies on the functional approach of leadership, arguing that effective leaders take over specific leadership actions as required by the team and leadership being fulfilled by formal as well as by informal leaders (Zaccaro, et al., 2001). Recent developments in leadership research state that leadership is a shared social process where functions are distributed among team members even if a formal leader is present (Yukl, 2006). Shared leadership refers to a dynamic process among members who lead one another to help reach the team goals (Pearce & Conger, 2003). There is evidence that team performance can be significantly improved by sharing leadership (Avolio, et al., 1996; Ensley, Hmieleski, & Pearce, 2006; Hooker & Csikszentmihalyai, 2003; Pearce, Yoo, & Alavi, 2004; Shamir & Lapidot, 2003). As task complexity and urgency increase, shared leadership is expected to have a positive effect on team outcomes (Cox, Pearce, & Perry, 2003; Mayo, Meindl, & Pastor, 2003; Pearce, 2004). Under low complex tasks, leadership need (shared or vertical) is minimal (Pearce, 2004) while leadership requirements increase with the difficulty and complexity levels (Kerr & Jermier, 1978; Marta, Leritz, & Mumford, 2005).

Following this line of research, one can assume that low task complexity, which for the purpose of this study refers to the level of task load, requires hardly any leadership, leading us to the first hypothesis:

Hypothesis 1: The amount of leadership is significantly lower if task load is low than if task load is high.

As anaesthesia is characterised by high task complexity, making great demands on leadership, we focus on high task complexity and its influence on leadership distribution. According to the theory outlined above, we expect that with increasing task complexity, a single leader may have difficulty fulfilling leadership functions for effective teamwork. Sharing leadership could reduce task overload and increase team performance. We therefore propose the following hypothesis:

Hypothesis 2: High-performing teams have a higher degree of shared leadership than low-performing teams if task load is high.

From the perspective of functional leadership, a leader's primary responsibility is to determine what functions are missing or not being handled adequately and ensure they are done. Building on this, functional leadership models identify key functions a leader needs to fulfil (Zaccaro, et al., 2001). Different leadership functions were also revealed for trauma care (Xiao, et al., 2004) and anaesthesia teams (Zala-Mezö, et al., 2004). We considered this functionally differentiated leadership within anaesthesia teams by analysing two leadership factors – content-oriented and structuring leadership – which have been found to be relevant (Bales & Slater, 1955; Stempfle & Badke-Schaub, 2005; Zala-Mezö, et al., 2004). Because these two leadership functions require different skills, it can be assumed that teams are more effective when they appropriately distribute these functions according to the respective skills of team members (Stempfle, Hubner, & Badke-Schaub, 2001). Since nurses tend to work for a longer time within the same work unit, we assume that they generally have more hospital work experience than residents who often come directly from university. We expect nurses to provide more content-oriented leadership and residents – as formal leaders and higher in hierarchy – to perform more structuring leadership and expect these distinct leadership roles to be positively related to team performance. Focusing on high task complexity, we propose:

Hypothesis 3: In high-performing teams, residents take over the structuring leadership function whereas nurses take over the content-oriented leadership function.

4.3 Methods

We analysed 12 video recordings of anaesthesia teams performing simulated routine anaesthesia inductions in regular operating rooms using a resuscitation mannequin for advanced live support allowing arrhythmia simulation (MegaCode®, Laerdal). Team composition represented common practice at the tertiary teaching hospital where the study was conducted. All teams consisted of one resident, one nurse, with a staff anaesthetist not in the room but immediately available. Availability of staff determined sample size. Local institutional ethics committee approval was

obtained and participating staff were informed and gave their written consent (see Appendix B, Chapter 6). During induction, a cardiac arrest (asystole) was simulated in reaction to laryngoscopy as the unexpected non-routine event – defined as an unusual, out-of-the-ordinary, or atypical event (Weinger & Slagle, 2002). Videos and vital parameter data were recorded using a setup allowing synchronised recording of video, monitor, and ventilator data. Appendix C contains a flow sheet presenting the content of the simulator case.

Changes in leadership behaviour were analysed during work phases differing in the level of task load, one of four relevant components of task complexity (Xiao, et al., 1996). Task load describes an external indicator of objective load, including factors such as task demands and situational requirements (Grote, et al., 2004b). An experienced anaesthetist trained in human factors defined three main phases of the simulated anaesthesia induction and rated their level of task load. During the first phase, *preparation*, material and equipment are prepared. Task load is low during this phase and work processes are highly standardised. Task load increases with the second phase, *preintubation*, starting with administering initialising drug and ends when patient falls asleep and shows no muscle reaction. During the high task load phase, *intubation*, the cardiac arrest (non-routine event) occurs while the tube is induced. This phase starts with the intubation and ends once the heart beats again. An extreme group analysis comparing Phases 1 and 3 (low versus high task load; Table 4.1, shaded columns) was applied.

Table 4.1: Phases of simulated induction to general anaesthesia and respective level of task load

	Phase 1 Preparation	**Phase 2 Preintubation**	**Phase 3 Intubation incl. Asystole**
Main tasks	Preparation of material and equipment.	Administrations of drugs.	Induction of endotracheal tube into trachea through the mouth. Asystole occurs.
Mean duration in minutes	7.71	5.77	0.62
Level of task load	Low	Moderate	High

Team performance was measured as reaction time after asystole. Unlike other studies that investigated reaction time to unexpected events for single providers

(DeAnda & Gaba, 1991; Gaba & DeAnda, 1989; Weinger, et al., 1994), we examined reaction time of the entire team. “Execution time” was used as an overall measure for team performance and was defined as the time elapsed from onset of asystole until reinstallation of sinus rhythm. Duration of execution time ranged from 10 to 53 seconds (*M*= 30.33; *SD*= 13.52).

The *leadership taxonomy* recording leadership behaviour relied on earlier leadership research (Badke-Schaub & Lorei, 2003; Bales & Slater, 1955; Stempfle & Badke-Schaub, 2005) and included two categories: *content-oriented* and *structuring* leadership (see Table 4.2). Both categories are orientated towards task accomplishment. Appendix D contains the full category system, including examples for sub-categories.

Table 4.2: Main leadership categories

Category	**Definition**
Task oriented leadership	Refers to technical and content processes which are necessary for task accomplishment such as problem definition, exchange of task relevant information
Structuring leadership	Concerned with structuring of work processes which are necessary for task accomplishment. Includes planning and coordination activities such as assigning tasks, organising and providing personnel or material resources.

Note. Definitions are based on Badke-Schaub & Lorei (2003)

The *degree of shared leadership* was defined by comparing the leadership behaviour levels of both team members: a high degree of sharedness means both team members demonstrate similar amounts of leadership, a low degree means one team member shows significantly more leadership.

To check for *inter-rater reliability* of the behaviour codings, three raters independently coded a test sample of five cases out of the 12. The first coder divided the sample into coding units which were coded by the other two. A coding unit was one uttered statement, usually a phrase. Kappa statistics revealed a very good inter-rater agreement for structuring leadership (K=0.88) and a good inter-rater reliability for content-oriented leadership (K=0.76).

Data analysis began with adding team member leadership behaviours. To control for variation in length of the three phases, raw data frequencies were transformed to rates per minute by dividing unit frequencies within a phase by

duration of that phase. We controlled for team member anaesthesia work experience and for shared work experience by calculating Mann-Whitney tests. No differences were found between the low and high-performing teams, $U_{\text{expierence nurses}} = 7$, $p = 0.09$, $r = -.53$, $U_{\text{experience residents}} = 17.5$, $p = .94$, $r = -.24$ and $U_{\text{shared working experience}} = 10$, $p = .24$, $r = -.38$ (see Appendix E for the survey used to assess team member work experience). A median split of team performance was used to build two groups of performance (above the median = high-performing teams, below the median = low-performing teams). After visual inspection of data (Stem-and-leaf plots, Boxplots), we performed a logarithmic transformation to calculate a univariate analysis of variance (ANOVA) using the GLM procedure of SPSS, used to answer Hypotheses 1 and 2. For Hypothesis 3, Wilcoxon signed-rank tests were performed.

4.4 Results

Hypothesis 1 stated that the amount of leadership is significantly lower if task load is low than if task load is high. The ANOVA revealed significant main effects of task load for both low-performing, $F(1, 20) = 58.57$; $p < .001$, $\eta_p^2 = .75$ and high-performing teams, $F(1, 20) = 11.26$; $p < .01$, $\eta_p^2 = .36$, indicating that leadership was higher with high task load (Tables 4.3 and 4.4; Figure 4.1), supporting Hypothesis 1.

Hypothesis 2 proposed that high-performing teams have a higher degree of shared leadership than low-performing teams if task load is high. Members of low-performing teams showed almost identical amounts of leadership during low task load, while residents showed twice as much leadership than nurses during high task load (Table 4.3, Figure 4.1). Univariate ANOVA revealed a significant effect of leadership differences between nurses and residents, $F(1, 20) = 7.14$; $p < .05$, $\eta_p^2 = .26$. Even though the amount of leadership between nurses and residents differed significantly, the interaction between task load and differences in their leadership behaviour was not significant $F(1, 20) = 1.41$, $p = .25$, $\eta_p^2 = .07$, indicating that these differences were not dependent upon task load (Table 4.4). In high-performing teams, nurses and residents were evenly engaged in leadership during low and high task load situations (see Table 4.3; Figure 4.1). ANOVA revealed no significant effect for differences of leadership amount between nurses and residents $F(1, 20) = 0.00$, $p = .97$, $\eta_p^2 = .0$, indicating that leadership was equally distributed. The interaction between task load and differences in leadership behaviour was not significant $F(1,$

20) = 0.51, p = .49), η_p^2 = .03, suggesting that the distribution of leadership was not due to task load (see Table 4.4). Thus, Hypothesis 2 is only partially confirmed.

Table 4.3: Means and standard deviation of total leadership in low- and high-performing teams

	Low-performing teams[a]				**High-performing teams[b]**			
	Nurses		Residents		Nurses		Residents	
Phases	M	SD	M	SD	M	SD	M	SD
Low task load	0.87	0.45	1.32	0.60	0.56	0.31	0.96	0.52
High task load	3.78	1.99	6.85	2.64	5.77	3.77	5.82	5.83

Note. The values represent mean rates of leadership behaviour per minute.
[a]n = 12 (6 nurses, 6 residents). [b]n = 12 (6 nurses, 6 residents).

Table 4.4: Results of univariate ANOVA for leadership distribution in low- and high-performing teams

Source	***Sum of Squares***	***df***	***F***	***p***	η_p^2
	Low-performing teams[a]				
Task load (T)	1.25	1	58.57***	0.000	.745
Difference in leadership of team members (D)	0.15	1	7.14*	0.015	.263
T x D	0.03	1	1.41	0.248	.066
Error	0.43	20	(0.02)		
	High-performing teams[b]				
Task load (T)	1.21	1	11.26**	0.003	.360
Difference in leadership of team members (D)	0.00	1	0.00	0.971	.000
T × D	0.05	1	0.51	0.485	.025
Error	2.14	20	(0.11)		

Note. Values enclosed in parentheses represent mean square errors.
[a]*n* = 12 (6 nurses, 6 residents). [b]*n* = 12 (6 nurses, 6 residents).
*p < .05. ** p < .01. ***p < .001.

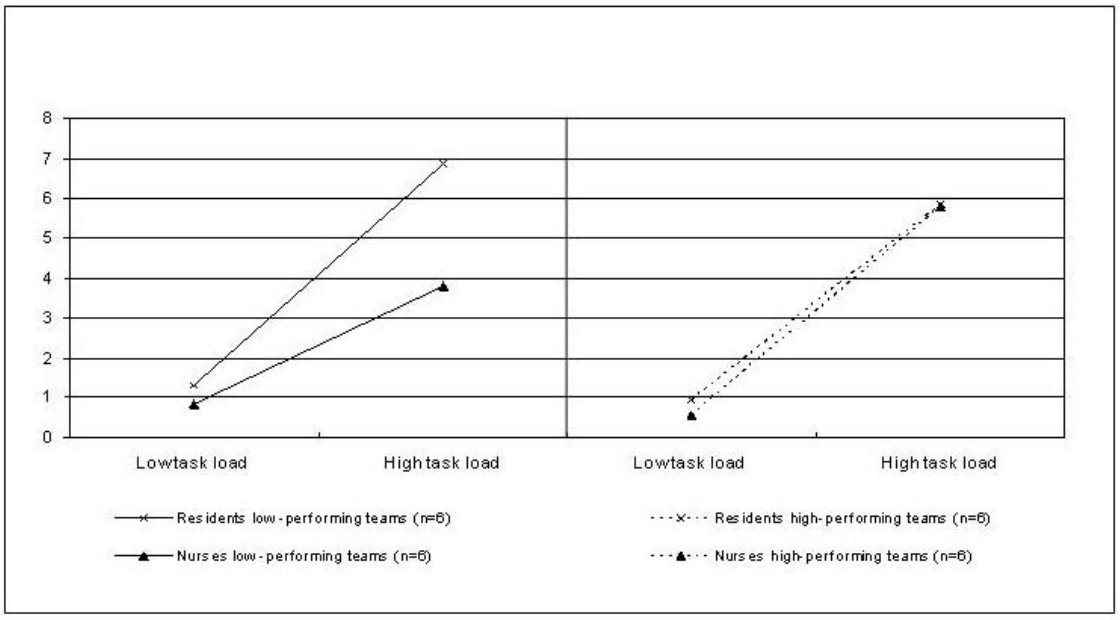


Figure 4.1: Leadership distribution between nurses and residents in low- and high-performing teams

Hypothesis 3 proposed that in high-performing teams, residents take over the structuring leadership function whereas nurses take over the content-oriented leadership function during high task complexity. Nurses in high-performing teams demonstrated more content-oriented leadership behaviour compared to residents, z = -.734, p = .46, r = -.43, while residents showed more structuring leadership than nurses, z = -1.483, p = .14, r = -.21, indicating distinct leadership roles. However, these differences were not significant (Table 4.5). In low-performing teams, residents showed more content-oriented leadership compared to nurses, z = .000, p = 1, r = 0 as well as significantly more structuring leadership, z = -2.023, p = .04, r = -.58, indicating that no distinct leadership roles exist (Table 4.5). Thus, Hypothesis 3 is supported.

Table 4.5: Distribution of leadership among team members in low- and high-performing teams during high task load situation

	Low-performing teams[a]					High-performing teams[b]				
	Nurses		Residents		Wilcoxon rank sum test	Nurses		Residents		Wilcoxon rank sum test
Leadership	M	SD	M	SD	z	M	SD	M	SD	z
Content-oriented	2.35	2.00	2.52	3.58	.000	3.43	3.96	1.6	1.86	-.734
Structuring	1.43	0.85	4.33	1.34	-2.023*	2.35	2.20	4.22	4.11	-.1.483

Note. M and *SD* represent mean rates of leadership behaviour per minute.
[a]*n* = 12 (6 nurses, 6 residents). [b]*n* = 12 (6 nurses, 6 residents).
*$p < .05$

4.5 Discussion

This study investigated leadership in anaesthesia teams operating in a simulated setting. We aimed to shed more light on leadership distribution among team members and its effectiveness. The results give evidence for the appropriateness of sharing leadership in situations with high task load and support earlier research on the effectiveness of shared leadership (Klein, et al., 2006; Pearce & Sims, 2002).

Members of high-performing teams seem to use distinct leadership functions, especially in high task load situations. For residents, structuring leadership might be more effective as is true for content-oriented leadership of nurses. One could explain this by their respective functions: residents intubated the patient and are consequently highly focused, making it necessary to directly guide and coordinate team activities. Due to their physical perspective, nurses have a comprehensive view of circumstances and are more likely to provide residents with task-relevant information. As they were more willing to share leadership functions with the nurses, this indicates that residents of high-performing teams acknowledge the medical know-how of nurses, who usually have more experience working in clinical settings even if not specifically in anaesthesia. Members of low-performing teams did not distribute the two leadership functions clearly among each other, neither on purpose nor subconsciously. This might indicate that residents were overloaded by completing both functions.

We recommend fostering shared leadership through leadership training, especially for highly complex tasks. For instance, team members could be trained to promote an environment in which team members support each other and acknowledge the contributions of each other. This means that a formally appointed leader would allow other team members to take over leadership functions and speak up whenever beneficial to the team, especially if they have concerns (Edmondson, 2003; Fleming, et al., 2005), facilitating shared leadership within a team (Carson, Tesluk, & Marrone, 2007). Furthermore, team members should be taught to identify situations where takeover of leadership is appropriate (Fleming, et al., 2005).

The present study gives rise to recommendations for further research. More research is needed to reveal whether the effectiveness of sharing leadership is significantly dependent upon task complexity as suggested by earlier research. Since results are limited to tandem teams in a simulated anaesthesia setting, we recommend using data from live settings to garner data that can be more generalise as well as augmenting observational data with interviews or surveys. Another shortcoming of this study is the team composition. Due to the simulated setting, team composition remained static during the whole task. Studies of anaesthesia teams would benefit from observing live settings where additional team members often join the team, most likely redistributing the leadership structure, which seems to be critical to team performance (Tschan, et al., 2006).

We conclude that shared leadership within anaesthesia teams may facilitate performance in complex tasks given that no individual team member possesses all resources necessary to address all task demands. Sharing leadership seems to be an effective strategy to overcoming resource shortcomings – especially if task complexity is high. As complexity increases where an individual leader has difficulties completing all necessary leadership functions, distributing roles means that anaesthesia teams could handle non-routine events more effectively. Sharing leadership could release formal leaders from the pressure of being an all-knowing central source of influence as sharing increases the team’s sources of effective leadership.

5 References

Adams, J., Prince, H. T., Instonea, D., & Rice, R. W. (1984). West Point: Critical incident of leadership. *Armed Forces & Society, 10*(4), 597-611.

Arrow, H., & McGrath, J. E. (1995). Membership dynamics in groups at work - A theoretical framework. *Research in Organizational Behavior, 17*, 373-411.

Arrow, H., McGrath, J. E., & Berdahl, J. L. (2000). *Small groups as complex systems: Formation, coordination, development, and adaption*. Thousand Oaks, CA: Sage.

Avolio, B. J., Jung, D. I., Murry, W., & Sivasbramaniam, N. (1996). Building highly developed teams: Focusing on shared leadership process, efficacy, trust, and performance. In M. M. Beyerlein, D. A. Johnson & S. T. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams: Team leadership* (Vol. 3, pp. 173-209). Greenwich, CT: JAI Press.

Badke-Schaub, P., & Lorei, C. (2003). Führung und Entscheiden [Leadership and decision-making]. In S. Strohschneider (Ed.), *Entscheiden in kritischen Situationen [Decision-making in critical situations]* (pp. 153-167). Frankfurt: Verlag für Polizeiwissenschaft.

Baker, D. P., Gustafson, S., Beaubien, J. M., Salas, E., & Barach, P. (2005). Medical team training programs in health care. *Advances in Patient Safety, 4*, 253-267.

Baker, D. P., Horvath, L., Campion, M., Offermann, L., & Salas, E. (2005). The ALL teamwork framework *International adult literacy survey, measuring adult literacy and life skills: New frameworks for assessment*. Ontario Statistics Canada.

Bales, R. F. (1958). Task roles and social roles in problem-solving groups. In E. E. Maccob, T. M. Newcomb & E. L. Hartley (Eds.), *Social Psychology* (3rd ed.). New York: Holt, Rinehart & Winston.

Bales, R. F., & Slater, P. E. (1955). Role differentiation in small decision-making groups. In T. Parson & R. F. Bales (Eds.), *Family, Socialization, and Interaction Process* (pp. 259-306). Glencoe: The Free Press.

Bass, B. M. (1990). *Bass and Stogdill's Handbook of Leadership* (3rd ed.). New York: Free Press.

Bass, B. M. (1998). *Transformational leadership: Individual, military and educational impact*. Mahwah, NJ: Erlbaum.

Benne, K. D., & Sheats, P. (1948). Functional roles of group members. *Journal of Social Issues, 4*(2), 42-47.

Bettin, P. J., & Kennedy, J. K. (1990). Leadership experience and leader performance: Some empirical support at last. *The Leadership Quarterly, 1*(4), 219-228.

Beyea, S. C. (2005). High reliability theory and highly reliable organizations. *AORN Journal, 81*(6), 1319-1322.

Bierly, P., & Spender, J. (1995). Culture and high reliability organizations: The case of the nuclear submarine. *Journal of Management, 21*, 639–656.

Blickensderfer, E., Cannon-Bowers, J. A., & Salas, E. (1998). Cross training and team performance. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 299–311). Washington, DC: American Psychological Association.

Borrill, C., West, M., Shapiro, D., & Rees, A. (2000). Team working and effectiveness in health care. *British Journal of Health Care Management, 6*, 364-371.

Bowers, C. A., Morgan, B. B., Salas, E., & Prince, C. (1993). Assessment of coordination demand for aircrew coordination training. *Military Psychology, 5*, 95-112.

Brannick, M. T., & Prince, C. (1997). An overview of team performance measurement. In M. T. Brannick, E. Salas & C. Prince (Eds.), *Team performance assessment and measurement. Theory, methods, and applications* (pp. 3-16). Mahwah, NJ: Lawrence Erlbaum.

Brannick, M. T., Roach, R. M., & Salas, E. (1993). Understanding team performance: A multimethod study. *Human Performance, 6*, 287–308.

Burke, C. S., Fiore, S. M., & Salas, E. (2003). The role of shared cognition in enabling shared leadership and team adaptibility In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the how's and why's of leadership*. Thousand Oaks, CA: Sage.

Burke, C. S., Salas, E., Wilson-Donnelly, K., & Priest, H. (2004). How to turn a team of experts into an expert medical team: Guidance from the aviation and military communities. *Quality and Safety in Health Care, 13*(Suppl 1), i96-i104.

Burke, C. S., Stagl, K. C., Klein, C., Goodwin, G. F., Salas, E., & Halpin, S. M. (2006a). What type of leadership behaviors are functional in teams? A meta-analysis. *The Leadership Quarterly, 17*(3), 288-307.

Burke, C. S., Stagl, K. C., & Salas, E. (2006b). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology, 91*, 1189-1207.

Campbell, J. P., & Campbell, R. J. (1988). Industrial-organizational psychology and productivity: The goodness of fit In J. P. Campbell & R. J. Campbell (Eds.), *Productivity in Organizations* (pp. 82-93). San Francisco: Jossey Bass.

Cannon-Bowers, J. A., & Salas, E. (1998). Individual and team decision making under stress: Theoretical underpinnings. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress* (pp. 17-38). Washington, DC: American Psychological Association.

Cannon-Bowers, J. A., Salas, E., & Converse, S. A. (1993). Shared mental models in expert team decision-making. In N. J. Castellan, Jr. (Ed.), *Current issues in individual and group decision making* (pp. 221-246). Hillsdale, NJ: Lawrence Erlbaum.

Cannon-Bowers, J. A., Tannenbaum, S., Salas, E., & Volpe, C. E. (1995). Defining competencies and establishing team training requirements. In A. Guzzo & E. Salas (Eds.), *Team Effectiveness and Decision Making in Organizations* (pp. 333-380). San Francisco: Jossey-Bass Publishers.

Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecedent conditions and performance. *Academy of Management Journal, 50*(5), 1217-1234.

Catchpole, K., Mishra, A., Handa, A., & McCulloch, P. (2008). Teamwork and Error in the Operating Room. Analysis of Skills and Roles. *Annals of Surgery, 247*(4), 699-706.

Christie, J. (2000). Collaborative practice. In D. Langstaff & J. Christie (Eds.), *Trauma Care: A Team Approach* (pp. 310-322). Oxford: Butterworth Heinemann.

Clarke, J. R., Marella, W., Johnston, J., & Davis, M. (2005). A surgeon who CARES can be safer. *The American Journal of Surgery, 190*, 356-358.

Clemmer, T. P., Spuhler, V. J., Berwick, D. M., & Nolan, T. W. (1998). Cooperation: The foundation of improvement. *Annals of Internal Medicine, 128*(12), 1004-1009.

Cohen, S. G., & Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management, 23*, 239-290.

Cole, E., & Crichton, N. (2006). The culture of a trauma team in relation to human factors. *Journal of Clinical Nursing, 15*, 1257-1266.

Conger, J. A., & Pearce, C. L. (2003). A landscape of opportunities. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the how's and why's of leadership* (pp. 285-303). Thousand Oaks, CA: Sage.

Cooper, J. B., Newbower, R. S., Long, C. D., & McPeek, B. (2002). Preventable anesthesia mishaps: A study of human factors. *Quality & Safety in Health Care, 11*(3), 277-282.

Cooper, S. (2001). Developing leaders for advanced life support: evaluation of a training programme. *Resuscitation, 49*(1), 33-38.

Cooper, S., & Wakelam, A. (1999). Leadership of resuscitation teams: `Lighthouse Leadership'. *Resuscitation, 42*(1), 27-45.

Cox, J. F., Pearce, C. L., & Perry, M. L. (2003). Toward a model of shared leadership and distributed influence in the innovation process. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the how's and why's of leadership* (pp. 48-76). Thousand Oaks, CA: Sage.

Davis, R., Driskell, J. E., & Salas, R. (1991). Group decision making under stress. *Journal of Applied Psychology, 76*, 473-478.

Day, D., Gronn, P., & Salas, E. (2004). Leadership capacity in teams. *The Leadership Quarterly, 15*, 857-880.

DeAnda, A., & Gaba, D. M. (1991). Role of experience in the response to simulated critical incidents. *Anesth Analg, 72*, 308-315.

DeVita, M., Schaefer, J., Kutz, J., Dongilli, T., & Wang, H. (2004). Improving medical crisis team performance. *Critical Care Medicine, 32*(2), 561-565.

Dickinson, T. L., & McIntyre, R. M. (1997). A conceptual framework for teamwork measurement. In M. T. Brannick, E. Salas & C. Prince (Eds.), *Team performance assessment and measurement* (pp. 19-43). Mahwah, NJ: Lawrence Erlbaum.

Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., & Sprung, C. (1995). A look into the nature and causes of human errors in the intensive care unit. *Crit Care Med, 23*, 294-300.

Driscoll, P. A., & Vincent, C. A. (1992). Organising an efficient trauma team. *Injury, 23*, 107-110.

Dyer, J. L. (1984). Team research and team training: A state-of-the-art review. In F. A. Muckler (Ed.), *Human factors review* (pp. 285-323). Santa Monica, CA: Human Factors Society.

Dytham, C. (2003). *Choosing and using statistics. A biologist's guide* (2nd ed.). Malden: Blackwell Science.

Edmondson, A. C. (2003). Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams. *Journal of Management Studies, 40*, 1419-1452.

Ensley, M. D., Hmieleski, K. M., & Pearce, C. L. (2006). The importance of vertical and shared leadership within new venture top management teams: Implications for the performance of startups. *The Leadership Quarterly, 17*(3), 217-231.

Entin, E. E., & Serfaty, D. (1999). Adaptive team coordination. *Human Factors, 41*, 312-325.

Espinosa, A. J., Lerch, J. F., & Kraut, R. E. (2004). Explicit versus implicit coordination mechanisms and task dependencies: one size does not fit all. In E. Salas & S. M. Fiore (Eds.), *Team cognition. Understanding the factors that drive process and performance* (pp. 107-129). Washington, DC: American Psychological Association.

Feldt, L. (1961). The use of extreme groups to test for the presence of a relationship. *Psychometrika, 26*(3), 307.

Fiedler, F. E. (1967). *A theory of leadership effectiveness*. New York: McGraw-Hill.

Fleishman, E. A. (1953). Leadership climate and human relations training. *Personnel Psychology, 6*, 205-222.

Fleishman, E. A., Mumford, M. D., Zaccaro, S. J., Levin, K. Y., Korotkin, A. L., & Hein, M. B. (1991). Taxonomic efforts in the description of leader behavior: A synthesis and functional interpretation. *The Leadership Quarterly, 2*(4), 245-287.

Fleming, M., Smith, S., Slaunwhite, J., & Sullivan, J. (2005). Investigating interpersonal competencies of cardiac surgery teams. *J can chir, 49*(1), 22-29.

Fleming, P. J., Wood, G. M., Dudley, N. M., Bader, P. K., & Zaccaro, S. J. (2003). *An adaptability training program for military leaders and teams.* Paper presented

at the 18th annual conference for the Society for Industrial and organizational Psychology (SIOP), Orlando, FL.

Fletcher, G., Flin, R., McGeorge, P., Glavin, R., Maran, N., & Patey, R. (2003). Anaesthetists' non-technical skills (ANTS): Evaluation of a behavioural marker system. *British Journal of Anaesthesia, 90*, 580-588.

Fletcher, G. C. L., McGeorge, P., Flin, R. H., Glavin, R. J., & Maran, N. J. (2002). The role of non-technical skills in anaesthesia: a review of current literature. *British Journal of Anaesthesia, 88*(3), 418-429.

Flin, R., Fletcher, G., McGeorge, P., Sutherland, A., & Patey, R. (2003). Anaesthetists' attitudes to teamwork and safety. *Anaesthesia, 58*, 233-242.

Flin, R., & Maran, N. (2004). Identifying and training non-technical skills for teams in acute medicine. *Quality and Safety in Health Care, 13*, i80-i84.

Flin, R., & Yule, S. (2004). Leadership for safety: industrial experience. *Qual Saf Health Care, 13*(Suppl II), ii45-ii51.

Frankel, A., Leonard, M. W., & Denham, C. R. (2006). Fair and Just Culture, Team Behavior, and Leadership Engagement: The Tools to Achieve High Reliability. *Health Research and Educational Trust, 41*(4), 1690-1709.

Gaba, D. M. (2000). Structural and organisational issues in patient safety: a comparison of health care to other high-hazard industries. *International anesthesiology clinics, 43*, 83-102.

Gaba, D. M. (2001). Structural and Organizational Issues in Patient Safety: A Comparison of Health Care to Other High-hazard Industries. *California management review, 43*(1), 83.

Gaba, D. M., & DeAnda, A. (1989). The response of anesthesia trainees to simulated critical incidents. *Anesth Analg, 68*, 444-451.

Gaba, D. M., Howard, S. K., & Small, S. D. (1995). Situation awareness in anesthesiology. *Human Factors, 37*(1), 20-31.

Gaba, D. M., Maxwell, M., & DeAnda, A. (1987). Anesthetic mishaps: Breaking the chain of accident evolution. *Anesthesiology, 66*, 670-676.

Gawande, A. A., Zinner, M. J., Studdert, D. M., & Brennan, T. A. (2003). Analysis of errors reported by surgeons at three teaching hospitals. *Surgery, 133*, 614-621.

Gersick, C. J. G., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes, 47*(1), 65-97.

Gfrörer, R., & Schüpfer, G. (2004). Das Operationssaal-Team [Operating room team]. *Zeitschrift für Führung und Organisation, 72*, 333-339.

Ginnett, R. C. (1993). Crews as groups: Their formation and their leadership. In E. L. Wiener, B. G. Kanki & R. L. Helmreich (Eds.), *Cockpit resource mangement* (pp. 71-98). San Diego, CA: Academic Press.

Gladstein, D. L. (1984). Groups in Context: A Model of Task Group Effectiveness. *Administrative Science Quarterly, 29*, 499-517.

Goodman, P. S. (1986). *Designing effective work groups*. San Francisco: Jossey-Bass.

Greenberg, C. C., Regenbogen, S. E., Studdert, D. M., Lipsitz, S. R., Rogers, S. O., Zinner, M. J., et al. (2007). Patterns of communication breakdowns resulting in injury to surgical patients. *Journal of the American College of Surgeons, 204*(4), 533-540.

Grote, G. (2007). Understanding and assessing safety culture through the lens of organizational management of uncertainty. *Safety Science, 45*(6), 637-652.

Grote, G., Helmreich, R. L., Sträter, O., Häusler, R., Zala-Mezö, E., & Sexton, J. B. (2004a). Setting the stage: Characteristics of organizations, teams and tasks influencing team processes. In R. Dietrich & T. M. Childress (Eds.), *Group interaction in high risk environments* (pp. 111-140). Aldershot: Ashgate.

Grote, G., Zala-Mezö, E., & Grommes, P. (2003). Effects of standardization on coordination and communication in high workload situations. In R. Dietrich (Ed.), *Communication in high risk environments.* (pp. 127-154). Hamburg: Helmut Buske.

Grote, G., Zala-Mezö, E., & Grommes, P. (2004b). The effects of different forms of co-ordination on coping with workload. In R. Dietrich & T. M. Childress (Eds.), *Group interaction in high risk environments* (pp. 39-54). Aldershot: Ashgate.

Guastello, S. J., & Guastello, D. D. (1998). Origins of Coordination and Team Effectiveness: A Perspective From Game Theory and Nonlinear Dynamics. *Journal of Applied Psychology, 83*(3), 423-437.

Gurtner, A., Tschan, F., Semmer, N. K., & Nägele, C. (2007). Getting groups to develop good strategies: Effects of reflexivity interventions on team process,

team performance, and shared mental models. *Organizational Behavior and Human Decision Processes, 102*, 127-142.

Guzzo, R. A., & Dickson, M. W. (1996). Teams in organizations: Recent research on performance and effectiveness. *Ann. Rev. Psychol., 47*, 307-338.

Hackman, J. R. (1990). *Groups that work (and those that don't): Creating conditions for effective teamwork.* San Francisco: Jossey Bass.

Hackman, J. R., & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 8, pp. 45-99). New York: Academic Press.

Hackman, R. J., & Walton, R. E. (1986). Leading groups in organizations. In P. S. Goodman (Ed.), *Designing effective work groups* (pp. 72-119). San Francisco: Jossey-Bass

Hale, A. R., & Swuste, P. (1998). Safety rules: procedural freedom or action constraint? *Safety Science, 29*, 163-177.

Hancock, H. C., & Easen, P. R. (2006). The decision-making processes of nurses when extubating patients following cardiac surgery: An ethnographic study. *International Journal of Nursing Studies, 43*, 693-705.

Healey, A. N., Undre, S., & Vincent, C. A. (2004). Developing observational measures of performance in surgical teams. *Quality and Safety in Health Care, 13*(suppl_1), i33-40.

Healy, G. B., Barker, J., & Madonna, M. (2006). Error reduction through team leadership: Applying aviation's CRM model in the OR. *Bulletin of the American College of Surgeons, 91*, 10-15.

Helmreich, R. L. (2000). On error management: Lessons from aviation. *British Medical Journal, 320*, 781-785.

Helmreich, R. L., & Davies, J. M. (1996). Human factors in the operating room: Interpersonal determinants of safety, efficiency and morale. *Bailliere's Clin Anaesthesiol, 10*(2), 277-295.

Helmreich, R. L., & Schaefer, H.-G. (1994). Team performance in the operating room. In M. Bogner (Ed.), *Human Error in Medicine* (pp. 225-253). Mahwah, NJ: Lawrence Erlbaum Associates.

Hersey, P., Blanchard, K., & Johnson, D. E. (1996). *Management of organizational behavior: Utilizing human resources* (7th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Hersey, P., & Blanchard, K. H. (1974). So you want to know your leadership style? *Training and Developmental Journal, February*, 1-15.

Hersey, P., & Blanchard, K. H. (1977). *Management of organization behavior: Utilizing human resources* (3rd ed.). Englewood Cliffs, N.J.: Prentice Hall, Inc.

Hoff, W. S., Reilly, P. M., Rotondo, M. F., DiGiacomo, C., & Schwab, C. W. (1997). The importance of the command-physician in trauma resuscitation. *Journal of Trauma: Injury, Infection and Critical Care, 43*, 772-777.

Hooker, C., & Csikszentmihalyai, C. (2003). Flow, creativity and shared leadership: Rethinking the motivation and structuring of knowledge work. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the hows and whys of leadership* (pp. 217-234). Thousand Oaks, CA: Sage.

House, R. J. (1971). A path -goal theory of leader effectiveness. *Administrative Science Quarterly 15*, 321-338.

House, R. J. (1977). A 1976 Theory of charismatic leadership. In J. G. Hunt & L. L. Larson (Eds.), *Leadership: The cutting edge* (pp. 189-207). Southern Ill: University Press.

Howell, J. P., Bowen, D. E., Dorfman, P. W., Kerr, S., & Podsakoff, P. M. (1990). Substitutes for leadership: effective alternatives to ineffective leadership. *Organizational Dynamics, 19*(1), 20-38.

Howell, J. P., Dorfman, P. W., & Kerr, S. (1986). Moderator variables in leadership research. *Academy of Management Review, 11*(1), 88-102.

Hynes, P., Kissoon, N., Hamielec, C., Greene, A. M., & Simone, C. (2006). Dealing with aggressive behavior within the health care team: A leadership challenge. *Journal of Critical Care, 21*, 224-228.

Ilgen, D. R. (1999). Team embedded in organizations. *American Psychologist, 54*(2), 129-139.

Jacob, T., & Krahn, G. (1987). The classification of behavioral observation codes in studies of family interaction. *Journal of Marriage and the Family, 49*(3), 677-687.

Jago, A. G. (1982). Leadership: perspectives in theory and research. *Management Science, 28* (3), 315-336.

Judge, T. A., & Ilies, R. (2002). Relationship of Personality to Performance Motivation: A Meta-Analytic Review. *Journal of Applied Psychology, 87*(4), 797-807.

Katz, D., & Kahn, R. L. (1978). *The social psychology of organizations* (2nd ed.). New York, NY: John Wiley and Sons.

Kazemi, A. R., & Nayeem, N. (1997). The existence and composition of trauma teams in the UK. *Injury, 28*, 119-121.

Kerr, S., & Jermier, J. M. (1978). Substitutes for leadership: Their meaning and measurement. *Organizational Behavior and Human Performance, 22*(3), 375-403.

Ketchum, L. (1984). How redesigned plants really work. *National Productivity Review, 3*, 246-254.

Khetarpal, S., Steinbrunn, B. S., & McGonigal, M. D. (1999). Trauma faculty and trauma team activation: Impact on trauma system function and patient outcome. *J Trauma, 47*, 576-581.

Klein, G., & Pierce, L. G. (2001, June). *Adaptive Teams.* Paper presented at the 6th ICCRTS Collaboration in the Information Age. Track 4: C2 Decision Making and Cognitive Analysis, Annapolis, USA.

Klein, K. J., Ziegert, J. C., Knight, A. P., & Xiao, Y. (2006). Dynamic delegation: Shared, hierarchical, and deindividualized leadership in extreme action teams. *Administrative Science Quarterly, 51*, 590–621.

Klimoski, R., & Mohammed, S. (1994). Team mental model: Construct or metaphor? *Journal of Management, 20*, 403-437.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000). *To err is human: Building a safer health system*. Washington, DC: National Academy Press.

Kolbe, M. (2007a). *Koordination von Entscheidungsprozessen in Gruppen. Die Bedeutung expliziter Koordinationsmechanismen*. Saarbrücken: VDM.

Kolbe, M. (2007b). *Koordination von Entscheidungsprozessen in Gruppen. Die Bedeutung expliziter Koordinationsmechanismen [Coordination of decision-making in groups. The meaning of explicit coordination processes]*. Saarbrücken: VDM

Kolodny, H. F., & Kiggundu, M. N. (1980). Towards the development of a sociotechnical systems model in Woodlands Mechanical Harvesting. *Human Relations, 33*(9), 623-645.

Kosnik, L. K. (2002). The new paradigm of crew resource management: Just what is needed to re-engage the stalled collaborative movement? *Journal on Quality Improvement, 28*, 238-241.

Kozlowski, S. W., & Bell, B. S. (1993). Work Groups and Teams in Organizations. In I. B. Weiner, W. C. Borman, D. R. Ilgen & R. J. Klimoski (Eds.), *Handbook of Psychology: Vol. 12. Industrial and Organizational Psychology* (pp. 349-391). Hoboken, NJ: John Wiley and Sons.

Kozlowski, S. W. J., Gully, S. M., Nason, E. R., & Smith, E. M. (1999). Developing adaptive teams: A theory of compilation and performance across levels and time. In D. R. Ilgen & E. D. Pulakos (Eds.), *The changing nature of work performance: Implications for staffing, personnel actions, and development* (pp. 240-292). San Francisco: Jossey-Bass.

Kozlowski, S. W. J., Gully, S. M., Salas, E., & Cannon-Bowers, J. A. (1996). Team leadership and development: Theory, principles, and guidelines for training leaders and teams. In M. M. Beyerlein, D. A. Johnson & S. T. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams: Team leadership* (Vol. 3, pp. 253-291). Greenwich, CT: JAI Press.

Kozlowski, S. W. J., Toney, R. J., Mullins, M. E., Weissbein, D. A., Brown, K. G., & Bell, B. S. (2001). Developing adaptability: A theory for the design of integrated-embedded training systems. In E. Salas (Ed.), *Advance in human performance and cognitive engineering research* (Vol. 1, pp. 59-123). Amsterdam: JAI/Elsevier Science.

Künzle, B. (2003). Teamprozesse und Koordination im Anästhesieteam [Team processes and coordination in the anaesthesia team]. Unpublished Lizenziatsarbeit. University of Zurich, Switzerland.

Künzle, B., Xiao, Y., Mackenzie, C., Seagull, F. J., Grissom, T., Sisley, A., et al. (2007). Development of an Instrument for Assessing Trauma Team Performance. *Proceedings of the Human Factors and Ergonomics Society Annual Conference 51*, 678-682.

Larson, J. R., Christensen, C., Franz, T. M., & Abbott, A. S. (1998). Diagnosing groups: The pooling, management, and impact of shared and unshared case information in team-based medical decision making. *Journal of Personality and Social Psychology, 75*, 93-108.

Larson, J. R., Foster-Fishman, P. G., & Franz, T. M. (1998). Leadership style and the discussion of shared and unshared information in decision-making groups. *Personality and Social Psychology Bulletin, 24*, 482-495.

Leape, L. L., & Berwick, D. M. (2005). Five Years after 'To Err Is Human': What have we learned? *Journal of the American Medical Association, 293*(19), 2384-2390.

Leedom, D. K., & Simon, R. (1995). Improving team coordination: A case for behavior-based team training. *Military Psychology, 7*, 109-122.

Leonard, M. S., & Frankel, A. (2004). Focusing on high reliability. In M. S. Leonard, A. Frankel, T. Simmonds & K. B. Vega (Eds.), *Achieving safe and reliable health care* (Vol. 15). Chicago: Health Administration Press.

LePine, J. A. (2003). Team Adaptation and Postchange Performance: Effects of Team Composition in Terms of Members' Cognitive Ability and Personality. *Journal of Applied Psychology, 88*(1), 27.

Likert, R. (1961). *New patterns of management*. New York: McGraw-Hill.

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R., et al. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Quality and Safety in Health Care, 13*(5), 330-334.

Lloyd, D. D., Patterson, M., Robson, J., & Philips, B. (2001). A stratified response system for the emergency management of the severely injured. *Annals of the Royal College of Surgeons of England, 83*, 15-20.

Lord, R. G., & Rowzee, M. (1979). Task Interdependence, Temporal Phase, and cognitive Heterogeneity as Determinants of Leadership Behavior and Behavior-Performance Relations. *Organizational Behavior and Human Performance, 23*, 182-200.

Maas, P., & Grad, A. (2004). Leadership by customers? New roles of service companies' customers. *German Journal of Human Resource Research, 18*(3), 329-345.

Manser, T., Howard, S. K., & Gaba, D. M. (2008). Adaptive coordination in cardiac anaesthesia: A study of situational changes in coordination patterns using a new observation system. *Ergonomics, 51*(8), 1153-1178.

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A conceptual framework and taxonomy of team processes. *Academy of Management Review, 26*, 356–376.

Marks, M. A., Sabella, M. J., Burke, C. S., & Zaccaro, S. J. (2002). The Impact of Cross-Training on Team Effectiveness. *Journal of Applied Psychology, 87*(1), 3-13.

Marsch, S. C. U., Müller, C., Marquardt, K., Conrad, G., Tschan, F., & Hunziker, P. R. (2004). Human factors affect the quality of cardiopulmonary resuscitation in simulated cardiac arrests. *Resuscitation, 60*(1), 51-56.

Marta, S., Leritz, L. E., & Mumford, M. D. (2005). Leadership skills and the group performance: Situational demands, behavioral requirements, and planning. *The Leadership Quarterly, 16*(1), 97-120.

Mayo, M., Meindl, J. R., & Pastor, J.-C. (2003). Shared leadership in work teams. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the how's and why's of leadership* (pp. 193-214). Thousand Oaks, CA: Sage.

McClelland, G., & Judd, C. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin, 114*, 376-390.

McGrath, J. E. (1964). *Social psychology: A brief introduction*. New York: Holt.

McGrath, J. E. (1970). *Social psychology. A brief introduction*. London: Holt, Rinehart & Winston.

Meerabeau, L., & Page, S. (1999). I'm sorry if I panicked you: Nurses' accounts of teamwork in cardiopulmonary resuscitation. *Journal of Interprofessional Care, 13*(1), 29-40.

Moreland, R. L., & Myaskovsky, L. (2000). Exploring the performance benefits of group training: Transactive memory or improved communication? *Organizational Behavior and Human Decision Processes, 82*(1), 117-133.

Morgeson, F. P., & DeRue, D. S. (2006). Event criticality, urgency, and duration: Understanding how events disrupt teams and influence team leader intervention. *The Leadership Quarterly, 17*, 271-287.

Muhr, T. (2003). ATLAS.ti Scientific Software Development (Version WIN 5.0). Berlin.

Nolan, J. (2001). Advanced Life Support Training. *Resuscitation, 50*(1), 9-11.

Northouse, P. G. (2004). *Leadership: Theory and practice* (3rd ed.). Thousand Oaks, CA: Sage.

Paunonen, S. V., Lonnqvist, J.-E., Verkasalo, M., Leikas, S., & Nissinen, V. (2006). Narcissism and emergent leadership in military cadets. *The Leadership Quarterly, 17*(5), 475-486.

Pearce, C. L. (2004). The future of leadership: Combining vertical and shared leadership to transform knowledge work. *Academy of Management Executive, 18*(1), 47-57.

Pearce, C. L., & Conger, J. A. (2003). *Shared leadership: Reframing the how's and why's of leadership*. Thousand Oaks, CA: Sage.

Pearce, C. L., & Sims, H. P. (2002). Vertical vs. shared leadership as predictors of the effectiveness of change management teams: An examination of aversive, directive, transactional, transformational and empowering behaviors. *Group Dynamics, 7*, 172-197.

Pearce, C. L., Yoo, Y., & Alavi, M. (2004). Leadership, social work and virtual teams: The relative influence of vertical versus shared leadership in the nonprofit sector. In R. E. Riggio, S. Smith-Orr & J. Shakely (Eds.), *Improving leadership in nonprofit organizations* (pp. 180–204). San Francisco, CA: Jossey-Bass.

Philp, H., & Dexter, D. (1959). Developmental trends in small groups. *Sociometry, 22*, 162-174.

Pollack, M. M., & Koch, M. A. (2003). NIH-District of Columbia Neonatal Network. Association of outcomes with organizational characteristics of neonatal intensive care units. *Critical Care Medicine, 6*, 665-670.

Prince, C., & Salas, E. (1993). Training and research for teamwork in the military aircrew. In E. L. Wiener, B. G. Kanki & R. L. Helmreich (Eds.), *Cockpit resource mangement* (pp. 337-366). San Diego, CA: Academic Press.

Pronovost, P. J., Berenholtz, S. M., Ngo, K., McDowell, M., Holzmueller, C., Haraden, C., et al. (2003). Developing and pilot testing quality indicators in the intensive care unit. *Journal of Critical Care, 18*, 145-155.

Pulakos, E. D., Arad, S., Donovan, M. A., & Plamondon, K. E. (2000). Adaptability in the Workplace: Development of a Taxonomy of Adaptive Performance. *Journal of Applied Psychology, 85*(4), 612-624.

Rall, M., & Gaba, D. (2005). Patient Simulators. In R. D. Miller (Ed.), *Anesthesia* (Vol. 6, pp. 3073-3103). Philadelphia: Elsevier Churchill Livingstone.

Reader, R. W., Flin, R., & Cuthbertson, B. H. (2007). Communication skills and error in the intensive care unit. *Current Opinion in Critical Care, 13*, 732-736.

Risser, D. T., Rice, M. M., Salisbury, M. L., Simon, R., Jay, G. D., & Berns, S. D. (1999). The potential for improved teamwork to reduce medical errors in the emergency department. *Annals of Emergency Medicine, 34*(3), 373-383.

Risucci, D., LaMantia, J., & Ryan, J. (1999). Personality types and preferences of emergency medicine residents: Correlation with clinical performance evaluations. *Annals of Emergency Medicine, 34*(4), 25.

Rosenthal, M. E., Adachi, M., Ribaudo, V., Mueck, J. T., Schneider, R. F., & Mayo, P. H. (2006). Achieving housestaff competence in emergency airway management using scenario based simulation training: Comparison of attending vs housestaff trainers. *Chest, 129*, 1453-1458.

Salas, E., Bowers, C., & Edens, E. (2001). *Improving Teamwork in Organisations: Application of Resource Management Training*. Mahwah, NJ: Laurence Erlbaum Associates.

Salas, E., Burke, C. S., & Cannon-Bowers, J. A. (2000). Teamwork: emerging principles. *International Journal of Management Reviews, 2*(4), 339.

Salas, E., Burke, C. S., & Samman, S. N. (2001). Understanding command and control teams operating in complex environments. *Information-Knowledge-Systems Management 2*, 311-323.

Salas, E., Fowlkes, J. E., Stout, R. J., Milanovich, D. M., & Prince, C. (1999). Does CRM training improve teamwork skills in the cockpit? Two evaluation studies. *Human Factors, 41*, 326-343.

Salas, E., Rosen, M. A., & King, H. (2007). Managing teams managing crises: principles of teamwork to improve patient safety in the Emergency Room and beyond. *Theoretical Issues in Ergonomics Science, 8*(5), 381 - 394.

Schimpff, S. C. (2007). Improving Operating Room and Perioperative Safety: Background and Specific Recommendations. *Surgical Innovation, 14*(2), 127-135.

Schull, M. J., Ferris, L. E., Tu, J. V., Hux, J. E., & Redelmeier, D. A. (2001). Problems for clinical judgement: 3. Thinking clearly in an emergency. *Canadian Medical Association Journal 164*(8), 1170-1175.

Sexton, J. B., Grommes, P., Zala-Mezö, E., Grote, G., Helmreich, R. L., & Häusler, R. (2004). Leadership and co-ordination. In R. Dietrich & T. M. Childress (Eds.), *Group interaction in high risk environments* (pp. 165-184). Aldershot, UK: Ashgate.

Sexton, J. B., Thomas, E. J., & Helmreich, R. L. (2000). Error, stress, and teamwork in medicine and aviation: Cross sectional surveys. *British Medical Journal, 320*, 745-749.

Shamir, B. (1999). Leadership in boundaryless organizations: Disposable or indispensable? *European Journal of Work and Organizational Psychology 8*, 49-71.

Shamir, B., & Lapidot, Y. (2003). Shared leadership in the management of group boundaries: A study of expulsions from officers' training courses. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership: Reframing the hows and whys of leadership* (pp. 235-249). Thousand Oaks, CA: Sage.

Sivasubramaniam, N., Murry, W. D., Avolio, B. J., & Jung, D. (2002). A longitudinal model of the effects of team leadership and group potency on group performance. *Group & Organization Management 27*, 66-96.

Smith, E. M., Ford, J. K., & Kozlowski, S. W. J. (1997). Building adaptive expertise: Implications for training design. In M. A. Quinones & A. Dudda (Eds.), *Training for a rapidly changing workplace: Applications for psychological research* (pp. 89-118). Washington, DC: American Psychological Association.

Sonnentag, S. (1996). Work group factors and individual well-being. In M. A. West (Ed.), *Handbook of Work Group Psychology* (pp. 345-367). Chichester, UK: John Wiley & Sons Ltd.

Stagl, K. C., Burke, C. S., Salas, E., & Pierce, L. (2006). Team adaptation: Realizing team synergy. In L. P. S. Burke, & E. Salas (Ed.), *Understanding Adaptability: A Prerequisite for Effective Performance within Complex Environments* (pp. 117-141). Cambridge, MA: Elsevier Science.

Stasser, G., & Titus, W. (2006). Pooling of unshared information in group decision making: Biased information sampling during discussion. In J. M. Levine & R. Moreland (Eds.), *Small groups* (pp. 227-239). New York and Hove: Psychology Press.

Steiner, I. D. (1972). *Group processes and productivity*. New York: Academic Press.

Stempfle, J., & Badke-Schaub, P. (2005). Führungshandeln im Alltag: Ein Modell zur Analyse von Führungsprozessen [Leaders at work: A model for the analysis of leadership processes]. *Zeitschrift für Arbeits- und Organisationspsychologie, 49*, 92-101.

Stempfle, J., Hubner, O., & Badke-Schaub, P. (2001). A functional theory of task role distribution in work groups. *Group Processes Intergroup Relations, 4*(2), 138-159.

Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of Management Journal, 43*(2), 135-148.

Stockwell, D. C., Pollak, M. M., Turenne, W. M., Gibson, C. L., & Slonim, A. D. (2005). Physician team leadership affects clinical achievement in the intensive care unit (ICU). *Crit Care Med, 33*(12, Suppl.).

Stogdill, R. M. (1948). Personal factors associated with leadership: A survey of the literature. *The Journal of Psychology, 25*, 35-71.

Stogdill, R. M. (1963). *Manual for the Leadership Behaviour Development: Form 12*. Columbus: Ohio State University. Bureau of Business Research.

Stogdill, R. M. (1974). *Handbook of leadership: A survey of theory and research*. New York: Free Press.

Stout, R. J., Salas, E., & Carson, R. (1994). Individual task proficiency and team process behavior: what's important for team functioning? *Military Psychology, 6*(3), 177-192.

Sugrue, M., Seger, M., Kerridge, R., Sloane, D., & Deane, S. (1995). A prospective study of the performance of the trauma team leader. *The Journal of Trauma: Injury, Infection, and Critical Care, 38*(1), 79-82.

Sundstrom, E., De Meuse, K. P., & Futrell, D. (1990). Work teams. Applications and effectiveness. *American Psychologist, 45*(2), 120-133.

Sutera, P. T., & Smith, C. A. (1994). Asystole during laryngoscopy and tracheal intubation. *Journal of Cardothorac Vascular Anesthesia, 8*, 79-80.

Tannenbaum, S., Salas, E., & Cannon-Bowers, J. A. (1996). Promoting team effectiveness. In M. A. West (Ed.), *Handbook of work group psychology* (pp. 503-529). Chichester, UK: John Wiley & Sons.

Tannenbaum, S. I., Beard, R. L., & Salas, E. (1992). Team building and its influence on team effectiveness: An examination of conceptual and empirical developments. In K. Kelley (Ed.), *Issues, theory, and research in industrial/organizational psychology* (Vol. 82, pp. 117-153). Amsterdam: Elsevier Science.

Tannenbaum, S. J., Smith-Jentsch, K. A., & Behson, S. J. (1998). Training team leaders to facilitate team learning and performance. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and*

team training (pp. 247-270). Washington DC: American Psychological Association

Tesluk, P., Mathieu, J. E., Zaccaro, S. J., & Marks, M. A. (1997). Task aggregation issues in the analysis of team performance. In M. T. Brannick, E. Salas & C. Prince (Eds.), *Team performance assessment and measurement* (pp. 197-224). Mahwah, NJ: Lawrence Erlbaum.

Thilo, J. L. (2005). Leadership in the ASC Opportunity and responsibility. *Journal of Ambulatory Surgery, 12*, 11-14.

Tschan, F., Semmer, N. K., Gautschi, D., Hunziker, P., Spychiger, M., & Marsch, S. U. (2006). Leading to recovery: Group performance and coordinative activities in medical emergency driven groups. *Human Performance, 19*, 277-304.

Undre, S., Healey, A. N., Darzi, A., & Vincent, C. A. (2006a). Observational assessment of surgical teamwork: A feasibility study. *World Journal of Surgery, 30*(10), 1774-1783.

Undre, S., Sevdalis, N., Healey, A. N., Darzi, S. A., & Vincent, C. A. (2006b). Teamwork in the operating theatre: Cohesion or confusion? *Journal of Evaluation in Clinical Practice, 12*(2), 182-189.

Van de Ven, A. H., Delbecq, A. L., & Koenig, R. J. (1976). Determinants of coordination modes within organizations. *American Sociological Review, 41*, 322-338.

Vroom, V. H. (2000). Leadership and the decision-making process. *Organizational Dynamics, 28*(4), 82-94.

Vroom, V. H., & Jago, A. G. (1973). *Leadership and decision making*. Pittsburgh: University of Pittsburgh Press.

Vroom, V. H., & Jago, A. G. (1988). *The new leadership: Managing participation in organizations.* Upper Saddle River, NJ: Prentice Hall.

Wageman, R. (2001). How leaders foster self-managing team effectiveness. *Organization Science, 12*(5), 559-577.

Waisel, D. B. (2005). Developing social capital in the operating room. *Anesthesiology, 103*, 1305-1310.

Waller, M. J. (1999). The timing of adaptive group responses to nonroutine events. *Academy of Management Journal, 42*, 127-137.

Wang, J., Winship, S., & Russell, G. (1998). Induction of anaesthesia with sevoflurance and low-dose remifentanil: Asystole following laryngoscopy. *British Journal of Anaesthesia, 81*(994-995).

Weick, K. E. (1990). The vulnerable system: An analysis of the Tenerife air disaster. *Journal of Management, 16*, 571-593.

Weick, K. E. (2002). The reduction of medical errors through mindful interdependence. In M. M. Rosenthal & K. M. Sutcliffe (Eds.), *Medical error: What do we know? What do we do?* (pp. 177-199). San Francisco: Jossey-Bass.

Weinger, M. B., Herndon, O. W., Zornow, M. H., Paulus, M. P., Gaba, D. M., & Dallen, L. T. (1994). An objective methodology for task analysis and workload assessment in anesthesia providers. *Anesthesiology 80*, 77-92.

Weinger, M. B., & Slagle, J. (2002). Human factors research in anesthesia patient safety: Techniques to elucidate factors affecting clinical task performance and decision making. *Journal of the American Medical Informatics Association, 9*(6), 58-63.

Weinger, M. B., Slagle, J., Jain, S., & Ordonez, N. (2003). Retrospective data collection and analytical techniques for patient safety studies. *Journal of Biomedical Informatics, 36*, 106-119.

West, M. A., Borrill, C. S., Dawson, J. F., Shapiro, D. A., & Haward, B. (2003). Leadership clarity and team innovation in health care. *The Leadership Quarterly, 14*, 393-411.

Wetzel, C. M., Kneebone, R. L., Woloshynowych, M., Moorthy, K., & Kidd, J. (2006). The effects of stress on surgical performance. *The American Journal of Surgery, 191*, 5-10.

White, S. S., Mueller-Hanson, R. A., Dorsey, D. W., Pulakos, E. D., Wisecarver, M. M., Deagle, E. A., et al. (2005). *Developing Adaptive Proficiency in Special Forces Officers* (ARI Research Report No. 1831). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Wiener, E. L., Kanki, B. G., & Helmreich, R. L. (1993). *Cockpit resource mangement*. San Diego, CA: Academic Press.

Wittenbaum, G. M., Hollingshead, A. B., Paulus, P. B., Hirokawa, R. Y., Ancona, D. G., Peterson, R. S., et al. (2004). The functional perspective as a lens for understanding groups. *Small Group Research, 35*, 17-43.

Wittenbaum, G. M., & Stasser, G. (1996). Management of information in small groups. In J. L. Nye & A. M. Brower (Eds.), *What's social about social cognition?* (pp. 3-28). London: Sage.

Wittenbaum, G. M., Vaughan, S. I., & Stasser, G. (1998). Coordination in task-performing groups. In R. S. Tindale, L. Heath, J. Edwards, E. J. Posavac, F. B. Bryant, Y. Suarez-Balcazar, E. Henderson-King & J. Myers (Eds.), *Theory and research on small groups*. New York: Plenum Press.

Wong, L., Bliese, P., & McGurk, D. (2003). Military leadership: A context specific review. *The Leadership Quarterly, 14*(6), 657-692.

Xiao, Y., Hunter, W. A., Mackenzie, C. F., Jefferies, N. J., Horst, R. L., & Group, L. (1996). Task complexity in emergency medical care and its implications for team coordination. *Human Factors, 38*(4), 636-645.

Xiao, Y., Seagull, F. J., Mackenzie, C., Ziegert, J., & Klein, K. J. (2003a). Team communication patterns as measures of team processes: Exploring the effects of task urgency and shared team experience. *Proceedings of the Human Factors and Ergonomics Society 47th annual Meeting, Denver, CO* 1502-1506.

Xiao, Y., Seagull, F. J., Mackenzie, C. F., & Klein, K. (2004). Adaptive leadership in trauma resuscitation teams: A grounded theory approach to video analysis. *Cognition, Technology and Work, 6*, 158-164.

Xiao, Y., Seagull, F. J., Mackenzie, C. F., Klein, K., & Ziegert, J. (2002). Adaptation of team structure of trauma resuscitation teams. *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting, Baltimore, MD*, 569–573.

Xiao, Y., Seagull, J. F., Mackenzie, C., Ziegert, F., & Klein, J. (2003b). *Team communication patterns as measures of team processes: Exploring the effects of task urgency and shared team experience.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society 47th Annual Meeting, Denver, CO.

Yukl, G. (2006). *Leadership in Organizations* (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Yukl, G., & Van Fleet, D. D. (1992). Theory and Research on Leadership in Organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of Industrial*

and Organizational Psychology (2nd ed., Vol. 3, pp. 147-197). Palo Alto, CA: Consulting Psychologists Press.

Yule, S., Flin, R., Paterson-Brown, S., & Maran, N. (2006). Non-technical skills for surgeons in the operating room: A review of the literature. *Surgery, 139*(2), 140-149.

Yun, S., Faraj, S., & Henry, P. S., Jr. (2005). Contingent leadership and effectiveness of trauma resuscitation teams. *Journal of Applied Psychology, 90*(6), 1288-1296.

Yun, S., Samer, F., Xiao, Y., & Henry, P. S. (2003). Team leadership and coordination in trauma resuscitation. *Team-Based Organizing, 9*, 189-214.

Zaccaro, S. J. (2002). Organizational leadership and social intelligence. In R. E. Riggio, S. E. Murphy & F. J. Pirozzolo (Eds.), *Multiple intelligences and leadership* (pp. 29–54). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2001). Team leadership. *The Leadership Quarterly, 12*, 451-483.

Zala-Mezö, E., Künzle, B., Wacker, J., & Grote, G. (2004). Zusammenarbeit in Anästhesieteams aus Sicht der Teammitglieder [Cooperation in anesthesia teams as seen by team members]. *Zeitschrift für Arbeitswissenschaften, 58*(3), 199-207.

Zala-Mezö, E., Wacker, J., Künzle, B., Brüesch, M., & Grote, G. (2009). The influence of standardisation and taskload on team coordination patterns during anaesthesia inductions. *Quality and Safety in Health care, 18*(2), 127-130.

Ziegert, J., Klein, K., & Xiao, Y. (2001). Team leadership: A review and extension of existing theory through a qualitative study of trauma teams. In C. L. Pearce & R. L. Tung (Eds.), *Academy of Management Meeting* (pp. 135-140). Washington, DC: Academy of Management.

Zingg, U., Zala-Mezoe, E., Kuenzle, B., Licht, A., Metzger, U., Grote, G., et al. (2008). Evaluation of critical incidents in general surgery. *British Journal of Surgery, 95*, 1420-1425.

6 Appendix

Appendix A: Contribution of authors to Articles 1, 2, and 3

- *Article 1:* Ensuring Patient Safety through Effective Leadership Behaviour: A Literature Review; Authors: Barbara Künzle, Michaela Kolbe, Gudela Grote
- *Article 2:* Substitutes for Leadership in Anaesthesia Teams and their Impact on Leadership Effectiveness; Authors: Barbara Künzle, Enikö Zala-Mezö, Michaela Kolbe, Johannes Wacker, Gudela Grote
- *Article 3:* Leadership in Anaesthesia Teams: the most effective Leadership is shared; Authors: Barbara Künzle, Enikö Zala-Mezö, Johannes Wacker, Michaela Kolbe, Gudela Grote

Table 6.1: Contribution of the authors to Articles 1, 2, and 3

	Article 1	**Article 2**	**Article 3**
Involved in the project context	BK[1], GG	BK, EZ, GG	BK, EZ, GG
Literature research	BK	BK	BK
Study design: development of model, research questions, hypothesis	BK, discussed with MK	BK, discussed with EZ	BK, discussed with EZ
Design of category system	BK	BK	BK
Data collection	BK	BK, EZ, with assistance of JW	BK, EZ, with assistance of JW
Data preparation	BK	BK	BK
Data analysis	BK	BK	BK
Writing of paper	BK	BK	BK
Proofreading	MK, GG	EZ, MK, GG, JW	EZ, MK, GG, JW

Note. [1]BK=Barbara Künzle, EZ=Enikö Zala-Mezö, GG=Gudela Grote, JW=Johannes Wacker, MK=Michaela Kolbe

Appendix B: Staff information and consent form

U Institut für Anästhesiologie, Universitätsspital Zürich – Professur für Arbeits- und Organisationspsychologie, ETH Zürich

MITARBEITERINFORMATION

Die Bedeutung adaptiven Koordinationsverhaltens für die Leistung von Anästhesieteams
Videobasierte arbeitspsychologische Feldstudie

Diese videobasierte Studie untersucht arbeitspsychologische Phänomene bei Anästhesie-Teams. Dafür werden sowohl Anästhesie-Simulationen als auch Anästhesieeinleitungen live aufgenommen. Die Aufnahmen werden nur mit dem Einverständnis aller Beteiligten (Mitarbeiter, Patienten) durchgeführt.

Die vorliegende Information beinhaltet ausführliche Angaben zur Studie. Bitte nehmen Sie sich ausreichend Zeit, um diese Information und die angefügte Einverständniserklärung aufmerksam durchzulesen. Stellen Sie dem Prüfarzt oder dem Studienteam alle Fragen, die Sie eventuell dazu haben. Falls Sie mit einer Teilnahme einverstanden sind und Ihre Einwilligung zur Verwendung und Weitergabe von Informationen zu Ihrer Person geben, bitten wir Sie, die Einverständniserklärung zu unterschreiben.

1. Warum wird diese Studie durchgeführt?
Mit dieser Studie wird ein möglicher Zusammenhang zwischen der Art des Koordinationsverhaltens in Anästhesieteams und bestimmten Leistungskriterien dieser Teams wissenschaftlich untersucht. Dazu werden Videoaufnahmen während Anästhesiesimulationen oder Anästhesieeinleitungen aufgenommen, welche einerseits die Analyse des Koordinationsverhaltens (wie arbeiten die Teammitglieder zusammen) ermöglichen und andererseits erlauben, die auch sonst routinemässig erfassten Daten des Patienten (Blutdruck, Beatmungswerte etc.) zu erfassen. Damit kann beispielsweise die Reaktionszeit nach bestimmten Änderungen der Werte und andere Leistungskriterien des Teams beurteilt werden. Die arbeitspsychologische Auswertung der Videos ergibt eine Analyse des Koordinationsverhaltens. Schliesslich werden die erfassten Daten daraufhin untersucht, ob die Art der Koordination im Team die genannten Leistungskriterien beeinflussen oder nicht.

2. Wer sollte an dieser Studie nicht teilnehmen?
Um die Leistungen der Anästhesieteams vergleichen zu können, werden vergleichbare Verhältnisse bei den Anästhesieeinleitungen ausgesucht. Deshalb werden für diese Studie Patienten ausgewählt, welche eine Vollnarkose erhalten und welche sich planmässigen Operationen unterziehen. Patienten mit schweren Grunderkrankungen werden nicht in die Studie eingeschlossen, da solche Narkoseeinleitung meist zusätzliche Massnahmen beinhalten, die den Ablauf weniger gut vergleichbar machen. Um die Teams genügend vergleichbar zu halten, können als Mitarbeiter nur Assistenzärzte, Oberärzte oder leitende Ärzte und Anästhesiepflegepersonal resp. Anästhesiepersonal in Ausbildung sowie Operationspflegende eingeschlossen werden. Mitarbeiter, welche nicht zu den genannten Berufsgruppen gehören oder über weniger als 3 Monate praktische Berufserfahrung in Anästhesie verfügen, können nicht in die Studie eingeschlossen werden. Wenn Sie Bedenken irgendwelcher Art haben, bitten wir Sie, diese mit dem Studienarzt zu besprechen. Nur Mitarbeiter, welche mit den Studienzielen einverstanden sind und zu einer Teilnahme ihr schriftliches Einverständnis nach genügender Aufklärung gegeben haben, werden in die Studie eingeschlossen.

3. Was wird von mir verlangt? Welche Anforderungen werden an mich gestellt?
Die Teilnahme bedeutet für Sie lediglich einen organisatorischen und zeitlichen Aufwand und Ihr Einverständnis hinsichtlich des Datenschutzes. Der Ablauf ist wie folgt:
Information vor der Anästhesiesimulation oder Anästhesieeinleitung
- Erklärung der Studie und Einholen des Einverständnisses zur Studienteilnahme
- Aufnahme von Daten bezüglich Berufserfahrung und Zusammenarbeit mit anderen Teammitgliedern

Anästhesiesimulation oder Anästhesieeinleitung
- Video-Aufnahme der ganzen Simulation oder Anästhesieeinleitung von der Ankunft des/der Patienten/in im Einleitungsraum bis zum Weitertransport in den Operationssaal. Dabei werden auch die oben genannten, sowieso für jede Narkose erhobenen Daten aufgenommen. Für die Studie werden keine zusätzlichen Messungen am Patienten vorgenommen und die Anästhesie erfolgt völlig unabhängig von der Studie nach den üblichen Kriterien.

Ergänzend zu den Videoaufnahmen werden nach vorheriger Abmachung in einzelnen Fällen Interviews durchgeführt oder die Mitarbeiter um das Ausfüllen eines kurzen Fragebogens gebeten.

4. Was ist über den untersuchten Zusammenhang in der Teamkoordination bereits bekannt?
Über Teamkoordination sind in anderen Studien verschiedene Beobachtungen gemacht worden. Beispielsweise kann sich ein Team sogenannt „implizit" koordinieren, wenn in bestimmten Situationen jeder weiss was der andere tun wird, der Ablauf also in einer quasi „standardisierten" Phase ist. Dabei muss nicht viel gesprochen werden, man arbeitet sozusagen „Hand in Hand". Wenn nun ein Arbeitsschritt erfolgt, der nicht derart standardisiert ist, kann nicht mehr ohne weiteres „implizit" koordiniert werden. Dies ist in der Medizin häufig der Fall, da Patienten auf bestimmte medizinische Massnahmen individuell und unterschiedlich reagieren. Ein Team koordiniert sich dann eher „explizit", das heisst, das weitere gemeinsame Vorgehen wird besprochen; allenfalls werden auch Führungsmassnahmen angewendet, indem ein erfahreneres Teammitglied die anderen anleitet und das Vorgehen so koordiniert. In vielen Situationen ist die Koordination allerdings gemischt, manchmal werden auch rasche Wechsel nötig.
In einer vorgängigen Studie konnten wir feststellen, dass während Anästhesieeinleitungen in eher standardisierten Situationen eher implizit koordiniert wird, wie oben beschrieben; allerdings blieb dabei unklar, wie allfällige Wechsel in der Koordinationsform zustande kommen und welche Auswirkungen sie haben. Diese Studie konzentriert sich nun auf solche Wechsel und ihre Auswirkungen. Erkenntnisse könnten genutzt werden, um durch bestimmt Massnahmen die Leistung der Teams noch weiter zu erhöhen und damit die Arbeitsqualität zu verbessern.

5. Wie lange werde ich an der Studie teilnehmen?
Diese Studie dauert voraussichtlich insgesamt etwa eineinhalb bis zwei Jahre. Die Datenerfassung dauert voraussichtlich einige Monate mit Beginn ca. März 2005 und Ende ca. Oktober 2006. Die zeitliche Beteiligung eines Mitarbeiters oder einer Mitarbeiterin beschränkt sich auf das Aufklärungsgespräch und die Videoaufnahme der Anästhesieeinleitung, sowie allfällige zusätzliche Interviews resp. Frgabögen. Videoaufnahmen können von den darauf aufgenommenen Teilnehmern auf Wunsch eingesehen werden, es werden aus logistischen und datenschützerischen Gründen aber keine Kopien angefertigt.

6. Wie viele andere Personen werden an der Studie teilnehmen?
Es werden ungefähr 30-50 Patienten und entsprechend viele Anästhesieteam-Mitglieder an der Studie teilnehmen, wobei eine Mehrfachteilnahme möglich ist.

7. Welche unerwünschten Effekte können im Rahmen dieser Studie auftreten?
Es sind keine spezifischen unerwünschten Effekte zu erwarten, da in dieser Studie keine Substanzen oder Verfahren getestet werden. Es wird lediglich der sowieso geplante Anästhesieeinleitungs-Ablauf gefilmt und die sowieso erhobenen Daten für die Studie erfasst. Die Videos können nur von den Studienmitarbeitern eingesehen werden und werden nach Abschluss des ganzen Studienprojektes vernichtet, ausser wenn mit den aufgenommenen Teilnehmern etwas anderes schriftlich vereinbart wurde (z.B. Videos zu Demonstrationswecken). Falls zufälligerweise ein strafrechtlich relevantes Ereignis auf den Videos aufgenommen wird, darf das Videomaterial nicht wie oben beschrieben vernichtet werden, sondern muss aus rechtlichen Gründen als potentielles Beweismaterial aufbewahrt werden. Die für die Studie verwendeten geräte (Kamera, Aufzeichnungsanlage etc.) sind vom Technischen Dienst des Universitätsspitals auf ihre elektrische Sicherheit geprüft worden.

8. Wer deckt Schäden, die ich gegebenenfalls im Rahmen des klinischen Versuchs erleide?
Alle Teilnehmer sind im Rahmen der Versicherung für Klinische Versuche ds Universitätsspitals und der Universität Zürich („Zürich"-Versicherungs-Gesellschaft) bis zu einem maximalen Betrag von 3'000'000.- Fr. pro Schadenereignis gedeckt.

9. Welchen Nutzen kann ich erwarten, wenn ich an der Studie teilnehme?
Es ergibt sich kein unmittelbarer Nutzen für die Teilnehmer. Grundsätzlich tragen Sie durch die Teilnahme aber dazu bei, dass allenfalls nutzbringende Erkenntnisse über arbeitspsychologische Zusammenhänge gewonnen werden können.

12. Welche Daten und Information zu meiner Person werden vom Prüfarzt erhoben?
Falls Sie sich entscheiden, an dieser Studie teilzunehmen, werden der Prüfarzt oder Studien-Mitarbeiter von Ihnen Daten und Information zu Ihrer Person einholen. Diese personenbezogenen Daten können Namen, Adresse, Telefonnummer, Geburtsdatum, Angaben über Ihre Ausbildung, Berufserfahrung oder andere personenbezogene Angaben zum Arbeitsumfeld umfassen. Die erhobenen Daten können auch folgende Information umfassen: Videoaufnahmen, Interviews, Fragebögen.

13. An wen werden der Prüfarzt und die Studienmitarbeiter diese Informationen weitergeben und was geschieht mit dieser Information?
Die Videos und studienrelevanten Daten werden unter allen Kautelen des Datenschutzes gesammelt und sind nur den Mitarbeitern der Studie zugänglich. Diese sind Mitarbeiter des Instituts für Anästhesiologie, Universitätsspital Zürich, oder des Instituts für Arbeitspsychologie, ETH Zürich. Videoaufnahmen können von den darauf aufgenommenen Teilnehmern auf Wunsch eingesehen werden, es werden aus logistischen und datenschützerischen Gründen aber keine Kopien asugehändigt.
Informationen aus dieser Studie werden nicht dazu verwendet, Sie als Adressat für Marketing- oder Werbematerial zu identifizieren. Die Ergebnisse der Studie könnten auch in medizinischen Fachzeitschriften veröffentlicht werden. Sie können jedoch in keiner solchen Publikation identifiziert werden, ausser Sie willigen explizit dazu ein (z.B. Bildmaterial). Sämtliche Daten unterliegen den Bestimmungen des Datenschutzes sowie des Berufsgeheimnisses.

14. Werde ich Informationen über meine Person aus dieser Studie erhalten?
Videoaufnahmen können von den darauf aufgenommenen Teilnehmern auf Wunsch eingesehen werden, es werden aber keine Kopien ausgehändigt. Nach Abschluss der Studie können Sie zudem schriftlich von Ihrem Prüfarzt Einsicht in die über Sie erhobenen Daten verlangen. Ebenso werden Sie auf Anfrage über allfällige resulierende Publikationen informiert. Bitte kontaktieren Sie den verantwortlichen Prüfarzt Dr. Johannes Wacker. Sofern vom Gesetz oder ethischen Richtlinien nicht anders vorgeschrieben, kann Ihnen der Prüfarzt Einsicht in Ihre Daten gewähren und Sie können Korrekturen von allfälligen Fehlern verlangen.

15. Werde ich für meine Teilnahme an der Studie bezahlt?
Nein, eine Entschädigung ist nicht vorgesehen.

16. An wen muss ich mich wenden, wenn ich Fragen habe?
Fragen zu Ihren Rechten als Studienteilnehmer oder zur Studie richten Sie bitte an den Prüfarzt: Dr. Johannes Wacker, Institut für Anästhesiologie, Universitätsspital Zürich, Rämistr.100, 8091 Zürich; Tel: 01 255 59 87.

17. Kann ich mich weigern, an der Studie teilzunehmen?
Ja. Ihre Mitwirkung bei dieser Studie ist freiwillig. Sie haben die Möglichkeit, die Teilnahme an dieser Studie abzulehnen bzw. diese zu jedem Zeitpunkt zu beenden, ohne Ihren Entscheid zu begründen. Es werden Ihnen daraus keinerlei Nachteile oder ein Ausfall von Rechten entstehen, auf die Sie normalerweise einen Anspruch haben.

18. Kann man mich auffordern, die Studie vorzeitig zu beenden?
Ja. Die Studie kann aus unterschiedlichen Gründen zu jedem Zeitpunkt unterbrochen werden, namentlich wenn die Anästhesieeinleitung den vorgesehenen Rahmen wesentlich überschreitet oder massgebliche Rahmenumstände nicht mehr gegeben sind. Falls die Studie vorzeitig beendet wird, verlieren Sie dadurch keine Rechte, die Ihnen zustünden.

19. Wenn ich aus der klinischen Studie ausscheide, was geschieht dann mit den Video-Aufnahme und den Informationen über meine Person?
Wenn Sie freiwillig aus der Studie ausscheiden oder wenn die Studie vorzeitig abgebrochen wird, können der Prüfarzt und die Studienmitarbeiter alle Informationen und Daten über Ihre Person, die bereits vor Ihrem Ausscheiden aus der Studie erhoben wurden, weiter für die in dieser Information beschriebenen Zwecke verwenden.

20. Kann ich an der klinischen Studie teilnehmen, wenn ich diese Einverständniserklärung nicht unterschreibe?
Nein. Wenn Sie diese Einverständniserklärung nicht unterschreiben, können Sie an der Studie nicht teilnehmen. Sie erhalten ein unterzeichnetes Exemplar dieser Einverständniserklärung.

Institut für Anästhesiologie, Universitätsspital Zürich – Professur für Arbeits- und Organisationspsychologie, ETH Zürich

Schriftliche Einverständniserklärung des Mitarbeiters zur Teilnahme an einer klinischen Studie

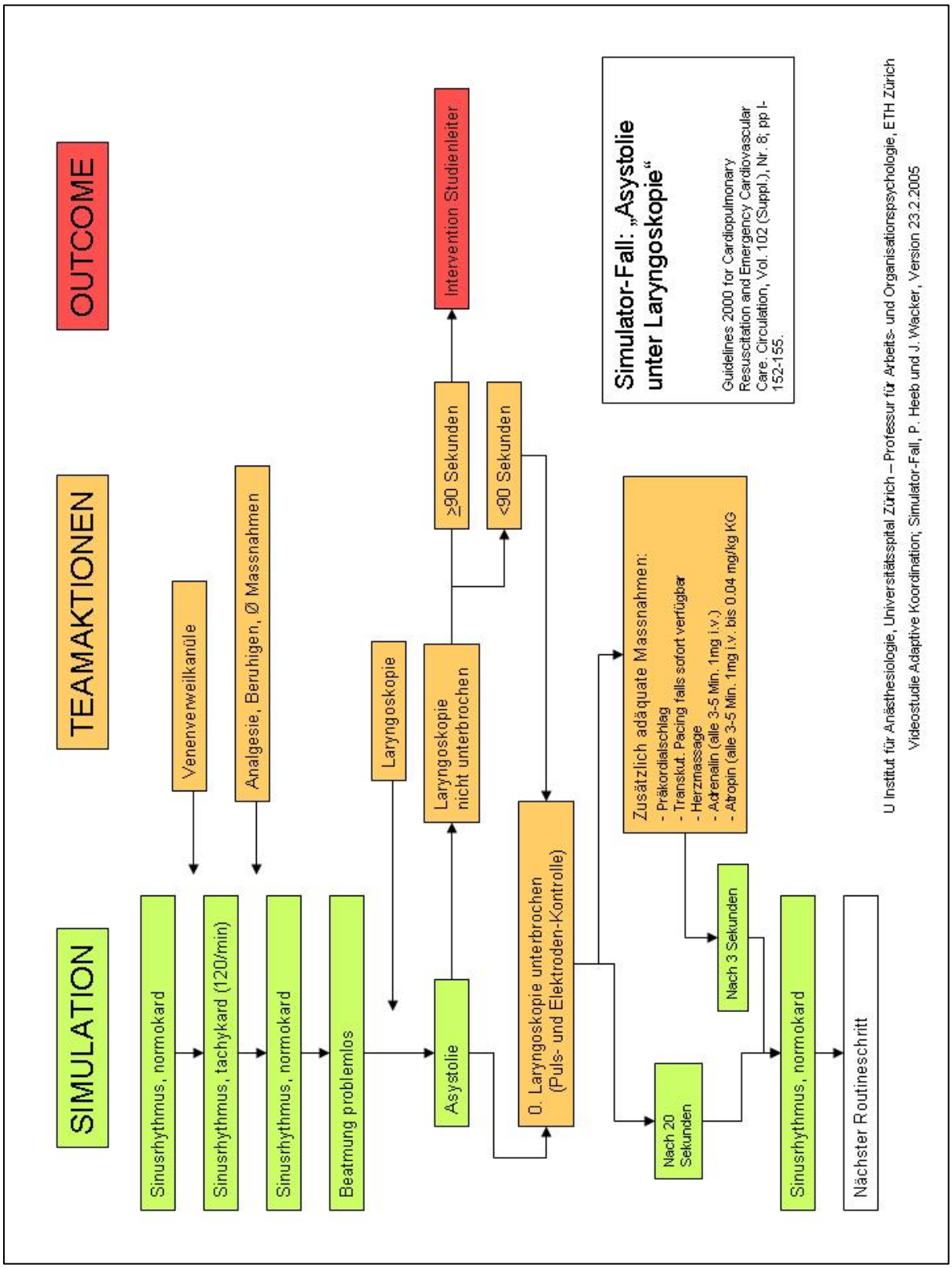
- ***Bitte lesen Sie dieses Formular sorgfältig durch.***
- ***Bitte fragen Sie, wenn Sie etwas nicht verstehen oder wissen möchten.***

KEK-Nummer der Studie: _____	
Titel der Studie: Die Bedeutung adaptiven Koordinationsverhaltens für die Leistung von Anästhesieteams	
Ort der Studie: Institut für Anästhesiologie, Universitätsspital Zürich	
Prüfarzt Name und Vorname:	
Mitarbeiter Name und Vorname, Funktion:	
Geburtsdatum: (fakultativ)	Geschlecht: (fakultativ)

- Ich wurde vom unterzeichnenden Arzt mündlich und schriftlich über die Ziele, den Ablauf der Studie (Videoaufnahme der Anästhesieeinleitung, dabei keinerlei Veränderung oder Eingriff in den normalen Ablauf; oder Videoaufnahme der Anästhesiesimulation) informiert, insbesondere auch darüber, dass ausser Aspekten des Datenschutzes (Studienpersonal sichtet das Videomaterial und die Daten zur Studienauswertung unter strikter Wahrung der Vertraulichkeit) keine weiteren Vor- und Nachteile oder spezifische Risiken bestehen.
- Ich habe die zur oben genannten Studie abgegebene schriftliche Mitarbeiterinformation vom 3.3.2005 gelesen und verstanden. Ich bin mit den darin genannten Studienzielen und den Umständen der Studie einverstanden. Meine Fragen im Zusammenhang mit der Teilnahme an dieser Studie sind mir zufriedenstellend beantwortet worden. Ich kann die schriftliche Mitarbeiterinformation behalten und erhalte eine Kopie meiner schriftlichen Einverständniserklärung.
- Ich bin darüber informiert, dass alle Teilnehmer im Rahmen der Versicherung für Klinische Versuche des Universitätsspitals und der Universität Zürich („Zürich"-Versicherungs-Gesellschaft) bis zu einem maximalen Betrag von 3'000'000.- Fr. pro Schadenereignis versichert sind.
- Ich hatte genügend Zeit, um meine Entscheidung zu treffen.
- Ich bin einverstanden, dass die zuständigen Fachleute des Studienauftraggebers, der Behörden und der Ethikkommissionen zu Prüf- und Kontrollzwecken in meine Originaldaten Einsicht nehmen dürfen, jedoch unter strikter Einhaltung der Vertraulichkeit.
- Ich nehme an dieser Studie freiwillig teil. Ich kann jederzeit und ohne Angabe von Gründen meine Zustimmung zur Teilnahme widerrufen, ohne dass mir deshalb Nachteile entstehen.

Ort, Datum	Unterschrift des Mitarbeiters
Ort, Datum	Unterschrift des Prüfarztes

Appendix C: Simulator case



Appendix D: Category system

Kodierungsanleitung

1. Allgemein

Die Aufnahme soll nach folgendem Kodierschema kodiert werden. Wenn kein Führungsverhalten (Punkt 2.1 und 2.2) kodierbar ist, sollen die Kategorien zur Erfassung des übrigen Informationsflusses kodiert werden (Punkt 3). Relationen (wer spricht zu wem) sollen immer parallel kodiert werden (vgl. Punkt 4). Ausserdem sollen die Phasen parallel kodiert werden (Punkt 5). Neben den Kodierungen sollen für jede Aufnahme auch allgemeine Eindrücke bezüglich der Teamarbeit sowie spezielle, erwähnenswerte Eindrücke notiert werden.

2. Kategorien zur Erfassung des Führungsverhaltens

2.1 Fachlich-inhaltliche Führungsebene (Inhaltsorientierung)

Die fachliche Führung bezieht sich auf fachlich-inhaltliche Anforderungen, die an das System gestellt werden. Führungsperson ist Ideenträger und Aufgabenspezialist. Diese Dimension umfasst Äusserungen im Zusammenhang mit einer inhaltlichen oder thematischen Auseinandersetzung mit einem Problem oder Handlungsablauf. Es geht um den inhaltlichen Umgang mit Ergebnissen und Prozessen, nicht um die Strukturierung eines Arbeitsprozesses.

Kategorie	Beobachtbares Verhalten	Erläuterung	Beispiel
Informationssammlung	Information request	Inhaltsorientierte Fragen mit Ziel, den gleichen Wissensstand wie die anderen zu haben. Aufgabenbezogene Informationen, die nötig sind, um das Ziel zu erreichen. Kodierungshinweis: Nicht kodiert wird z.B. AP zu AA: wie viel soll ich ihm geben? (Ablaufsteuerung oder Kommunikation, je nach Situation)	AA fragt AP: „Haben wir Atropin in der Nähe?“ (Vorausdenken, mögliche Strategien überlegen) AP fragt AA: „Hast du gute Sicht? Bringst du den Tubus gut rein?“ AA fragt AP: „Ist es 1%iges, das du ihm spritzt?“
Mitteilung	Informationsvermittlung	Inhaltsorientierte Informationen zur Schaffung eines gemeinsamen mentalen Modells, damit die anderen Teammitglieder den gleichen Wissensstand haben. Aufgabenbezogene Informationen, die nötig sind, um das Ziel zu erreichen. Kodierungshinweis: Frage, die bei der Kodierung zu stellen ist: benötigt die andere Person die Information?	Informationen über den Zustand des Patienten, z.B. „der Patient lässt sich gut beatmen“ Wenn eine Strategie oder Entscheidung bekannt gegeben wird, z.B.: „Ich gebe dir den 4er Spachtel.“
Problemlösung	Benennung des Problems	Ziel: gemeinsames Problemverständnis schaffen Kodierungshinweis: Benennung des Problems nur im Zusammenhang mit Problemdefinition kodieren, also wenn es wirklich um den Inhalt, Findung eines Problems geht und im Anschluss Ursache und Lösung gesucht wird.	AA zu AP: „CO2 funktioniert nicht.“ AA zu AP: „Es kommt kein Sauerstoff, ich glaube, da ist ein Leck.“

Kategorie	Beobachtbares Verhalten	Erläuterung	Beispiel
	Problemanalyse, Suche nach Ursachen	Tritt immer nach einem Problem auf, es wird aktiv nach Ursache gesucht.	AP fragt Patienten: „Sind Sie Raucher?“ Begründungen wieso Bradykardie, z.B. AA zu AP: „Bradykardie stört mich nicht weiters, das könnte vom Fenta kommen.“ AA fragt Patrick bei Bradykardie: „Sieht der Patient sportlich aus?“
	Klärung von Zielen	Im Anschluss an ein Problem werden wenn nötig neue Ziele gesetzt.	
	Definition von Lösungs-strategien, Lösungsentwicklung, Auswahl zwischen verschiedenen Lösungen, Entscheidungen treffen	Inhaltliche Vorschläge zur Problemlösung. Ideen generieren, die zur Lösungsfindung beitragen.	Wenn entschieden wird, ob OP weitergemacht oder abgebrochen wird Lösung nach einem Problem (vorher hat Diskussion statt gefunden)

2.2 Prozessorientiert-koordinative Führungsebene (Steuerungsorientierung)

Eine Führungsperson übernimmt verschiedene koordinative Aktivitäten; hier werden Interaktionen erfasst, die die Strukturierung und Steuerung des Arbeitsprozesses betreffen.

Code	Beobachtbares Verhalten	Erläuterung	Beispiel
Rollenverteilung		Am Anfang der Narkose wird abgemacht, wer was macht, also wer welche Rolle übernimmt (dies ist längerfristig als nur Aufgabenverteilung, Rollenverteilung bestimmt die Tätigkeiten über längere Zeit hinweg)	AA zu AP: „Ich intubiere, du machst die Medikation.“

Code	Beobachtbares Verhalten	Erläuterung	Beispiel
Aufgabenzuweisung		Zuweisung einer Aufgabe, wer soll die Handlung ausführen	AA zu AP: „Gib 10mg Iso“
Entscheidung über Vorgehen	Klärung der Ausführungsart	Entscheidung wird getroffen, wie etwas durchgeführt wird (direkt am Ort des Geschehens, keine Diskussion um etwas, sondern es passiert unmittelbar) :	AA zu AP „Wir beatmen ohne Filter.“ AA zu AP: „wir machen mal Atropin parat, spritzen es aber noch nicht.“
	Aufzeigen von Wegen	Zeigen/Sagen, wie etwas gemacht wird (nicht einfach eine einfache Aufgabenzuweisung, sondern es muss ein Aufzeigen von Wegen enthalten sein). Zielorientiert (um unmittelbar eine Aufgabe zu bewältigen).	AA zu AP: „Am besten stichst du in diesem Winkel...“ AA zu AP: „Herz kräftig massieren.“ AP erklärt AA wie sie den Monitor einstellen muss.
Initiate an action		Initiieren von Handlungen ohne darum gebeten werden. Die Person möchte aber Zustimmung der Teammitglieder. Zeichen für aktives Mitdenken.	AP zu AA: „Möchtest du nochmals etwas Fentanyl?” AP zu AA: „Ich lass die Pumpe laufen, ok?“
Ablaufsteuerung	Bestimmung der Reihenfolge der Aktivitäten.	Information über den Start einer Aufgabe, Information darüber, wann etwas gemacht wird. Chirurgen rufen. Meilensteine setzen (jetzt geht’s los…). Entscheidung darüber, wann eine Handlung ausgeführt wird. Koordination von Geschwindigkeit und Rhythmus.	AA zu AP: „Warten wir bis die Frequenz schneller wird und dann wagen wir noch einen zweiten Anlauf.“ AP fragt AA, ob er schon präoxidieren könne. AA antwortet: „Nein, noch nicht, im schreibe zuerst noch die Werte auf.“

Code	Beobachtbares Verhalten	Erläuterung	Beispiel
	Planung der nächsten Schritte		AP zu AA: „Ich hole noch alles was fehlt.“ AA zu AA: „Wir müssen noch Magensonde legen und Chirurgen rufen.“
Ressourcenmanagement	Ressource Material und Personen	Beschaffung von zusätzlichen Geräten oder Personen. Wenn Hilfe geholt von sich aus bzw. wenn jemand beauftragt wird, Hilfe zu holen.	

3. Kodes zur Erfassung des übrigen Kommunikationsflusses (kein Führungsverhalten)

Kategorie	Erläuterung
Kommunikation mit dem Patienten	MA spricht mit Patienten, Zusatzkodierung (z.B. Kontrolle externer Faktoren) ist möglich,
Bestätigung	Jemand bestätigt Aussage/Frage des anderen, welches kein Führungsverhalten ist.
Plaudern	Wenn Teammitglieder über ein nicht aufgaben-relevantes Thema in kurzen, untrennbaren Sequenzen sprechen, auch über Freizeit o. ä.
Andere Kommunikation	Wenn kein Führungsverhalten, aber explizite Kommunikation, die keiner anderen Kategorie zugeordnet werden kann.
Keeping quiet - Gemeinsame Arbeitsprozesse	Teammitglieder sprechen nicht miteinander, aber führen eine gemeinsame Handlung aus. Nur kodieren, wenn wirklich beide Personen an einer Handlung arbeiten (z.B. Intubation). Nicht kodieren, wenn beide z.B. Monitoring machen (dann getrennte Arbeitsprozesse) Personen hier nur markieren, wenn einer etwas macht und der andere wartet.
Keeping quiet - Getrennte Arbeitsprozesse	Teammitglieder sprechen nicht miteinander, sie führen getrennte Handlungen aus. Hier können weitere Parallelkodes gebildet werden, wenn unterschiedliche Handlung offensichtlich ist oder wenn beide z.B. Monitorisieren
Wartezeit	Teammitglieder müssen warten, keine Aktivitäten oder wenn einer wartet und der andere führt etwas aus (ist z.B. draussen oder muss noch etwas fertig vorbereiten). Kann ein Parallelkode zu „Getrennte Arbeitsprozesse“ sein.

Kategorie	Erläuterung
Simulatoreffekt	Wenn Interaktion mit Problemen zu tun hat, die nur durch Simulator ausgelöst worden sind (z.B. Elektroden funktionieren nicht). Wenn Patrick oder Johannes sich an der Diskussion beteiligen. Witze über Simulator, über Puppe.
Unverständlich	Wenn Rücksprache mit anderem Kodierer nötig ist.

4. Kennzeichnung der Relationen

Wer spricht mit wem oder wer führt mit wem die Handlung aus, wer ist beteiligt. Alle möglichen Richtungen erfassen, Kode erstellen, sofern es ihn noch nicht gibt.

Kategorie	Erläuterung
AP	AP=Pflegefachperson
AA	AA = Assistenzarzt
OA	OA=Oberarzt
AA zu AP	
AP zu AA	
AA zu OA	
AP zu OA	
OA zu AA	
OA zu AP	
Andere	Bei Bedarf sollen andere Interaktionen gebildet werden
AA (…) geht raus	Parallelkode, wenn eine Person (kann beliebig ergänzt werden) den Raum verlässt.
AA (…) kommt rein	Parallelkode, wenn eine Person (kann beliebig ergänzt werden) wieder zurückkehrt.

5. Kennzeichnung der Phasen

Bei jeder Aufnahme müssen die Phasen nach folgendem Schema gekennzeichnet werden.

Kategorie	Start und Ende	Erläuterung
1. Preparation	Preparation Start	Patient wird in den Raum gefahren/Aufnahme startet
	Preparation End	Wenn erstes Mittel gespritzt wird
2. Medication/ Preintubation	Medication Start	Endpunkt der 1. Phase
	Medication End	Patient zeigt keine Muskelreaktion mehr; Start der Intubation („So, fangen wir an…“)
3. Intubation inkl. Asystolie	Intubation Start	Endpunkt der 2. Phase
	Intubation End	Asystolie ist gelöst, Sinusrythmus.

Weitere Anmerkungen:

- **Kodiereinheit:** Die Kodiereinheit stellt eine Sinneinheit dar. Eine neue Sinneinheit ist dann gegeben, wenn sich der Inhalt einer Aussage ändert. Häufig wird eine Kodiereinheit durch den Sprecherwechsel begrenzt.
- **Empfängerorientierte Kodierung:** Interaktion sollte so kodiert werden, wie sie beim Empfänger ankommt.

Appendix E: Team member work experience

Institut für Anästhesiologie, Universitätsspital Zürich – Professur für Arbeits- und Organisationspsychologie, ETH Zürich

Fragebogen Teammitglieder: Befindlichkeit und Zusammenarbeit

Name:.....Vorname.....Funktion.....

Datum:.....Name Patient.....Studienlaufnummer (Fall):.....

	Weniger als 6 Monate	6- 18 Monate	18-36 Monate	3-6 Jahre	Mehr als 6 Jahre
Seit wann arbeiten Sie im Universitätsspital in Ihrer jetzigen Position?	❑	❑	❑	❑	❑

	Nie	Ab und zu	Regel-mässig	häufig	Fast immer
Wie oft haben Sie mit der Pflegeperson zusammengearbeitet?	❑	❑	❑	❑	❑
Wie oft haben Sie mit der/dem Assistenzärztin/Assistenzarzt zusammengearbeitet?	❑	❑	❑	❑	❑
Wie oft haben Sie mit der/dem Oberärztin/Oberarzt zusammengearbeitet?	❑	❑	❑	❑	❑

	Nie	Ab und zu	Regel-mässig	häufig	Fast immer
Haben Sie mit jemandem vom Team auch privat Kontakt?	❑	❑	❑	❑	❑
AP	❑	❑	❑	❑	❑
AA	❑	❑	❑	❑	❑
OA	❑	❑	❑	❑	❑

	Seit heute	Seit gestern	Seit ein paar Tagen
Seit wann wissen Sie, dass Sie bei der Operation dabei sein werden?	❑	❑	❑
Seit wann wissen Sie, aus welchen Personen das Team bestehen wird?	❑	❑	❑

	Ja	Nein
Waren Sie bei der Prämedikation dabei?	❑	❑

	Ich fühle mich krank				Ich fühle mich völlig gesund
Wie geht es Ihnen gesundheitlich?	❑	❑	❑	❑	❑

	Ich fühle mich erschöpft				Ich bin völlig ausgeruht
Wie müde fühlen Sie sich?	❑	❑	❑	❑	❑

	Ich bin emotional stark belastet				Ich bin völlig ausgeglichen
Wie ist Ihr emotionaler Zustand?	❑	❑	❑	❑	❑

Please note that only the first four questions concerning team member work experience were used for the analysis reported in Article 2 and 3.

Appendix F: Curriculum Vitae

Name: Barbara Künzle Haake

Date of Birth: May 14, 1977

Place of Birth: Appenzell, Switzerland

Education and Professional Experience

2004 - 2008	ETH Zurich, Organization Work and Technology Group Research and teaching assistant
1998 - 2004	Studies in psychology at the University of Zurich Licentiate in psychology
1996 - 1998	Gymnasium in Appenzell
1993 - 1996	Commercial college in Fribourg FR
1984 - 1993	Primary and high school in Gais AR

Publications

Research Papers under Review and Revision

Künzle, B., Kolbe, M., Grote, G. (under revision). Ensuring patient safety through effective leadership: A literature review. *Safety Science.*

Künzle, B., Zala-Mezö, E., Kolbe, M., Wacker, J., Grote, G. (under review). Substitutes for Leadership in Anaesthesia Teams and their Impact on Leadership Effectiveness. *European Journal of Work and Organizational Psychology.*

Künzle, B., Zala-Mezö, E., Wacker, J., Kolbe, M., Grote, G. (under review). Leadership in anaesthesia teams: the most effective leadership is shared. *Quality and Safety in Health Care.*

Journal articles

Zala-Mezö Enikö, Wacker Johannes, Künzle Barbara, Brüesch Martin, Grote Gudela (in press): The influence of standardisation and task load on team coordination patterns during anaesthesia inductions. *Quality and Safety in Health Care.*

Zingg Urs, Zala-Mezö Enikö et al. (in press): Evaluation of critical incidents in general surgery. *British Journal of Surgery.*

Zala-Mezö, E., Künzle, B., Wacker, J., & Grote, G. (2004). Zusammenarbeit in Anästhesieteams aus Sicht der Teammitglieder. *Zeitschrift für Arbeitswissenschaft; Themenheft: Arbeitswissenschaft im Krankenhaus,* 58 (3), 199-208

Articles in conference proceedings

Künzle, B., Xiao, Y., Mackenzie, C., Seagull, F.J., Grissom, T., Sisley, A., Dutton, R. (2007). Development of an Instrument for Assessing Trauma Team Performance. *Proceedings of the Human Factors and Ergonomic Society Annual Conference,* Baltimore, October 1-5.

Chapters in books

Künzle, B., Xiao, Y., Miller, A., Mackenzie, C. (in preparation). Observational tools for teamwork evaluation. In E. Patterson & J. Miller (Eds.), *Macrocognition Metrics and Scenarios: Design and Evaluation for Real-World Teams.* Guy Loft, Ashgate Publishing.

Conferences

Presentations

Künzle, B., Zala-Mezö, E., Kolbe, M., Wacker, J. & Grote, G. (2008, July). The most effective leadership is shared: An empirical analysis of the impact of shared leadership on team effectiveness in Swiss anaesthesia teams. Paper presented at the XXIX International Congress of Psychology. Berlin, Germany.

Künzle, B., Kolbe, M., Zala-Mezö, E., Grote, G. & Wacker, J. (2007, December). Leadership in anaesthesia teams. Paper presented at the Workshop Assessment Methods of Coordination Processes. Goettingen, Germany.

Künzle, B., Grote, G., Zala-Mezö., E., Wacker, J. (2007, May). Adaptive leadership in Anesthesia teams. Paper presented at the 12th European Congress on Work and Organizational Psychology, Stockholm.

Künzle, B., Grote, G., Zala-Mezö., E. (2006, July). Adaptive leadership processes in Anesthesia teams. Paper presented at the 26th International Congress of Applied Psychology, Athens, Greece.

Posters

Künzle, B., Zala-Mezö., E., Grote, G., Wacker, J. (2007, September). Leadership in Anesthesia teams. Poster presented at the 10th Congress of the Swiss Society of Psychology, Zurich.

Künzle, B., Grote, G., Zala-Mezö., E., Wacker, J. (2007, September). Wie können Anästhesieteams effektiv geführt werden? Poster presented at the Tagung Patientensicherheit Schweiz: Aktivitäten – Stolpersteine – Perspektiven, Bern, Switzerland.

Künzle, B., Grote, G., Zala-Mezö., E., Wacker, J. (2007, January). Adaptive leadership processes in Anesthesia teams. Poster presented at the 7th Annual International Meeting on Simulation in Healthcare, Lake Buena Vista FL, USA.