**Leadership and teamwork in anesthesia – Making use of human factors to improve clinical performance**

Johannes Wacker a,*, Michaela Kolbe b

* Institute of Anesthesia and Intensive Care, Hirslanden Clinic, Witellikerstrasse 40, CH-8032 Zurich, Switzerland

b ETH Zurich, Department of Management, Technology, and Economics, Weinbergstrasse 56/58, CH-8092 Zurich, Switzerland

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**SUMMARY**

Intuitively and empirically, leadership and teamwork are essential for team performance, patient safety, and patient outcomes in anesthesia and perioperative care. Team members have different needs and priorities during dynamically changing perioperative conditions. Team leaders may require recommendations on leadership practices to ensure patient safety while maintaining efficient work flow. Current research supports the concept that little explicit leadership is usually required during standardized routine work, but active and even directive leadership is important in unexpected, novel or stressful situations. Inviting and appreciating speaking up behaviour may further improve team performance. Team training and simulation methods can enhance teamwork and leadership behaviour. Future research will hopefully fill persisting knowledge gaps.

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1. Introduction

Anesthetics are typically provided by professional teams. Anesthesia teams function according to different models in various countries and healthcare systems. Intuitively and empirically, good teamwork within the team and with other healthcare professionals is essential for optimal patient care. Yet, individual team members may have different views on good teamwork, and may have differing needs during rapidly changing perioperative conditions.1-3

The current trend of increasing production pressure4 in perioperative care can further strain the working conditions in this demanding work environment. Responsible professionals may thus have to take active leadership more often to counterbalance adverse effects of this pressure on patient safety and on effective team performance.5-6 Numerous strategies for improving perioperative patient safety have been recommended,7 but they can only work if clinicians manage to practice them under real world conditions. Leadership within teams and institutions is one important force to promote patient safety.8 Hence, practicing anesthesiologists need well-founded recommendations about how to best realize leadership and active support of teamwork.

In this article, we review the scientific evidence for the benefits of specific leadership patterns and co-ordination behaviours in anesthesia. Taking the anesthesiologist’s perspective, we survey the use of human factors-based methods to improve clinical anesthetic and perioperative patient outcomes. We review the evidence for the effectiveness of team training interventions to foster specific leadership behaviours aiming at developing anesthesia teams and their performance. We also describe areas of uncertainty and further research needs.

Literature was searched using PubMed, Embase, Google Scholar, PsycINFO, and Web of Science™ Cited Reference Search.

2. General principles of leadership and co-ordination in teams

The study of the interrelationships between humans, the tools they use, and the environments in which they live and work has been termed “non-technical skills” or “human factors”.9,10 With respect to teamwork, leadership and co-ordination within and between teams are important human factors. What exactly constitutes good teamwork varies to some degree with regard to team and task characteristics (e.g., task complexity, time pressure, standardization).11 However, research indicates that there are core
competencies constituting good teamwork. For example, the “Big Five” model suggests that teamwork requires five competencies: team leadership, mutual performance monitoring, backup behaviour, adaptability, and team orientation. These five competencies require the support of co-ordinating mechanisms such as shared mental models, closed-looped communication, and mutual trust. A more recent approach suggests that the growing number of more dynamic, ad-hoc teams and multiple team memberships requires “teaming”, that is the ability to quickly set the stage for working well in any team. Core teaming processes are speaking up, collaboration, experimentation, and reflection. Particularly, the importance of speaking up as a central teamwork competence is being more and more acknowledged.

By speaking up, team members may contribute important information to the team as a whole and thus enable the team to learn from and prevent further mistakes. Since speaking up requires the crossing of many personal and interpersonal hurdles (e.g., fear of repercussions), it seems to require explicit invitation and appreciation - a certain form of leadership called leader inclusiveness. Both speaking up and leader inclusiveness are very explicit forms of co-ordination. Explicit and implicit co-ordination can be conceptually distinguished: Explicit co-ordination uses overt communication - for example, in novel situations. In contrast, implicit co-ordination by tacit agreement requires a common understanding of the situation, and is best used for the management of standardized routine tasks. Standardization as such can even substitute leadership in certain situations.

3. How leadership, teamwork and co-ordination influence patient outcomes

According to many observational studies, human factors have a significant impact on perioperative patient outcomes. One study assessed how surgeons and nursing staff perceived safety culture, the quality of teamwork, and communication in bariatric surgery. The rate of surgical complications was actually associated with the perceived safety culture.

Surgical errors are then more often related to teams rather than to one single person: two or more clinicians were involved in over 70% of surgical errors leading to adverse events. Communication breakdowns were the second most cited factor contributing to errors after inexperience and lack of surgical competence. Even if formal briefings are instituted to facilitate communication within and between teams, the factual quality of communication is not warranted. A recent study presented a system of preoperative weekly interdisciplinary meetings of senior staff from surgery, anesthesia, radiology, oncology, and nursing, to ensure shared understanding of the surgical plans and risks of elective cases. Despite these meetings, mutual critical information (surgical difficulty and estimated blood loss; anesthetic monitoring) was lacking or inaccurate in 15–20% of cases. Resulting deviations from preoperative surgical or anesthetic plan were frequently due to organizational and team-related events, and were independently associated with adverse clinical events.

In accordance with this report, risk-adjusted morbidity correlated with levels of communication and collaboration in surgical teams in a large multicentre survey of surgical staff. More generally, a recent systematic review of studies mainly from perioperative settings concluded that team processes actually do influence clinical team performance as well as actual patient outcomes according to some investigations.

The following narrows the focus from the perioperative to the anesthetic setting. Direct availability of the physician anesthesiologist and other team factors were related to better patient outcomes in a large Dutch multicentre case-control study. Postoperative mortality and coma was significantly lower if the anesthesiologist was directly available (by intercom, instead of indirectly, e.g. by telephone or beeper) and did not change during anesthesia, if a full-time working anesthetic nurse was present, and if two persons attended the emergence. Furthermore, team factors such as changing team composition and care transitions have been proposed to explain a surprising finding from a large database analysis: Anesthetic adverse events were four times higher in patients operated in the late afternoon as compared to 7 AM in the morning. These assumed negative effects contrast with findings suggesting positive effects of team factors. Advantages of teamwork in anesthesia have been recognized decades ago. In the US, different models of anesthesia delivery are in use (anesthesiologist-only practice; nurse anesthetist-only practice (often under direction of the operating, licensed physician); anesthesia care team practice; hybrid practices).

According to research into anesthesia-related morbidity and mortality, physician directed practice models of anesthesia delivery were found superior to nurse-anesthetist only practices, but the best patient outcomes were documented for anesthetics delivered by anesthesiology care teams under the medical direction of physicians. Anesthesia care teams have strengths that may explain some of these findings: Diverse talents and observational skills are combined to make appropriate care decisions, and during medical crises, physicians are rapidly available.

4. The dynamic nature of anesthesia teams

Teamwork in anesthesia is strongly affected by the properties of the operating room environment. In a field with inherently high risks, different professional groups are working closely together, but often with conflicting priorities and differing interpersonal relationships. Anesthesia professionals frequently experience routine changes, but also non-routine events and occasionally more severe events, many of which are unpredictable. Decision making interrelates with the resulting actions due to rapid physiological responses of the patients, and unforeseen surgical events. External influences are constantly present, such as time pressure to use the OR efficiently, and institutional norms.

Additional responsibilities also interfere quite often with the clinical core tasks of anesthesia professionals. Because of on-call duties for in-hospital emergency or pain services, beeper or pager calls may interrupt the clinical work. Indeed, interruptions and distractions have been identified as a frequent source of disturbance with mostly negative influence on patient management. Postoperative issues of patients transferred to the postanesthesia care unit or to the ward sometimes may cause the physician anesthesiologist to leave the OR, and to delegate clinical tasks to anesthesia nurses, residents or to anesthesiologist assistants. Work flow in anesthesia is therefore often fragmented, team composition variable, and leadership is mostly occurring in short-lived ad-hoc teams. Anesthetic teamwork typically happens in a work environment characterized by intense dynamism, time pressure, and uncertainty about substantial risks.

5. Adaptive leadership and co-ordination improve anesthesia team performance

This dynamic work environment and rapidly changing tasks interact with the typical patterns of teamwork and co-ordination in anesthesia teams. In contrast to some other professional teams, anesthesia teams seem to prefer implicit co-ordination with little leadership during routine work flow. Implicit co-ordination is less time-consumming than explicit co-ordination. Hence, such routine phases can be used to optimize efficiency of the work
without compromising safety.24,40,41 A common understanding of what has to be accomplished together, and how, is necessary for successful implicit co-ordination.24,42,43 Such “shared mental models”44 may be based on shared knowledge from professional training or on institutional rules and standards,40 and sometimes on tacit knowledge.45 If these mental models differ however, implicit co-ordination may be less effective or even risky. Hence, more explicit co-ordination is needed in complex situations with increasing co-ordination requirements.40 This may explain to some extent why time requirements tend to increase disproportionately in clinical situations with unexpectedly or suddenly accelerating complexity, as for instance intraoperative cardiac arrest, or simply an unforeseen change in the OR schedule. Explicit co-ordination, e.g. by directive leadership, may then help to bundle team activities irrespective of pre-existing shared mental models, and to concentrate them on task execution, and eventually, e.g. by a team debriefing, rearrange mental models of the team members. In accordance with these principles, more explicit co-ordination and leadership behaviour were found in anesthesia teams during less standardized phases of anesthetics,24 and anesthesia staff stated in interviews to prefer active leadership during critical situations and emergencies.46

However, the perioperative clinical environment is seldom purely “routine” or “emergency.” This precludes oversimplified rules for leadership and team co-ordination. Unexpected events are common even in routine anesthesia cases,47,48 and challenge teams to shift rapidly between co-ordination forms. Intraoperative cardiac arrest is a rare event and would usually trigger a cardiopulmonary resuscitation (CPR) alarm. Other anesthesia events however occur in a broad range of severity levels. Hence, the leadership and co-ordination rules for resuscitation may not be valid for the management of all types of unexpected events in anesthesia. Anesthesiologists must often tailor their co-ordination activities individually according to the severity of an event. For example, sudden massive surgical bleeding with severe hemorrhagic shock may trigger a resuscitation alarm, while moderate bleeding may increase workload, but can usually be managed without the help of a dedicated resuscitation team. The ability of teams to promptly adapt their co-ordination pattern to a new situation (e.g., to an unforeseen event) has been termed adaptive co-ordination and was found to be related to better rater-based team performance in a clinical observational study.20

Anesthesia teams that adapted co-ordination promptly after a simulated critical event by increasing their information management achieved faster decisions on how to proceed.31 During the management of simulated malignant hyperthermia, those anesthesia teams performed better that exhibited more situation assessment and less task distribution, and that were less likely to split up in subcrews.46 Small differences in task characteristics may actually have important implications for co-ordination: Easily diagnosed problems that demand fast action require more action co-ordination (e.g., cardiac arrest), whereas more difficult to diagnose problems require more information co-ordination (e.g., malignant hyperthermia).11,21 Explicit co-ordination in the form of speaking up of anesthesia nurses was found to be positively related to technical team performance during simulated inductions of general anesthesia.25 With respect to leadership, simulation studies showed that teams performed better when their members shared leadership,28 adapted co-ordination activities45,51,54 more readily after simulated events and used more leadership during less standardized situations and less leadership during routine situations.26

In summary, these empirical findings highlight that anesthesia teams are well advised to use leadership and co-ordination mechanisms for managing the uncertainties involved in their tasks and current team structure (see Table 1). The importance of balancing stability and flexibility to deal with uncertainty is being more and more discussed in the broader context of risk management.16

6. Encouraging evidence for the benefits of team training on patient outcomes

In view of limited healthcare resources, team training interventions to improve leadership skills and teamwork should be assessed as carefully as any other healthcare intervention in terms of their effectiveness for improving patient outcomes, their potential direct and indirect undesired effects, and their cost-effectiveness. Yet team training interventions are relatively complex and pose methodological challenges for rigorous scientific examination.54

Nevertheless, the evidence for the effectiveness of team training and other safety interventions for improving patient safety was comprehensively reviewed a short time ago.57 This extensive analysis was supported by the U.S. Department of Health & Human Services’ Agency for Healthcare Research and Quality (AHRQ). Based on the results, an expert panel encouraged both team training and simulation training for adoption in healthcare.56 Despite expected implementation difficulties, this recommendation was based on balancing moderate scientific evidence with low evidence for harm and moderate costs.57 Most of the analyzed studies examined multidisciplinary acute care teams, and focused on team outcomes such as communication, situational awareness, leadership, role clarity, and co-ordination.57,58

Importantly, impact of defined team training interventions on relevant patient outcomes was also found.57 A reduction in mortality has been associated with the Veteran’s Affairs Medical Team-Training, and significant decreases in medication and transfusion errors were related to the TeamSTEPPS® intervention.57,59 Furthermore, team training for the cardiac operating room has been advised as a formal class I level B recommendation.60

The comprehensive review cited above also encouraged simulation training to improve patient safety for adoption in healthcare.56 This recommendation is based on balancing moderate to high scientific evidence with moderate costs, potential of binding healthcare resources, and expected implementation issues.61 Among evaluation studies focusing on patient outcomes (e.g., in obstetrics, or cardiopulmonary resuscitation), most were not conducted in anesthesia, or studying simulation of specific techniques or outcomes.57 One study used hybrid debriefing techniques successfully in simulation-based team training. This technique was associated with significantly improved psychological safety and leader inclusiveness after the intervention.62 Another investigation found that senior cardiac anesthesia residents who had attended simulation-based weaning training including technical and nontechnical skills training instead of traditional interactive seminars performed better when clinically weaning their patients from cardiopulmonary bypass.63 Actual patient outcomes were not evaluated in this study.57

Overall, there is a considerable body of evidence for general benefits of team training and simulation training to improve leadership and teamwork. Regarding their practical implementation in anesthesia and perioperative care, some limitations should be considered. Due to the complexity of these interventions, many studies examining team training and simulation training are of low or moderate scientific quality, focus mainly on surrogate outcomes rather than actual patient outcomes, and only a few have been conducted in anesthesia or perioperative settings. Validity for the clinical setting should therefore be carefully verified before adopting individual interventions.57
Table 1

<table>
<thead>
<tr>
<th>Work phases and special situations</th>
<th>Recommended leadership practice</th>
<th>Description</th>
<th>Strengths (S) and weaknesses (W) of practice</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine - low task load(^{1,9})</td>
<td>“Low leadership”, monitoring, implicit coordination, individual work following standards.</td>
<td>Let professionals do their best according to their knowledge and to well-known standards. (^{1,46})</td>
<td>S: speed, no unnecessary time loss or delay, efficiency.</td>
<td>Routine anesthesia induction, no events</td>
</tr>
<tr>
<td>Routine - high task load(^{10})</td>
<td>Implicit coordination may be supplemented by explicit coordination and “heedful interrelating” in more complex high task load situations. (^{25})</td>
<td>Despite standardization of single tasks, complexity of high task load may require more explicit coordination. (^{12})</td>
<td>S: Maintenance of 1. safety and 2. work flow during high task load phases.</td>
<td>Standardized, but demanding patient positioning (e.g., prone position)</td>
</tr>
<tr>
<td>Unexpected events - minor events - low standardization</td>
<td>Explicit, interactive coordination: Re-adjust team mental models.</td>
<td>In ambiguous situations, re-adjust common understanding.</td>
<td>S: Adjusting team mental models, largely maintaining work flow.</td>
<td>Minor hypotension; minor surgical bleeding</td>
</tr>
<tr>
<td>Unexpected events - minor events - initiation of response(^{19})</td>
<td>Explicit leadership (^{24,45,46}), establish leadership structure; call for help; set medical priorities; “delegate and regulate”(^{10}); integrate new members, and pass leadership if needed; allow team to speak up.</td>
<td>Due to time pressure, directive leadership using clear commands focuses team on event. Call for help using cardiopulmonary resuscitation (CPR) alarm if needed.</td>
<td>S: Focus on initiation of specific event management.</td>
<td>Cannot ventilate; cardiac arrest; anaphylactic shock; massive hemorrhage</td>
</tr>
<tr>
<td>Unexpected events - serious events - maintenance of response(^{10})</td>
<td>Explicit leadership (^{25}) and coordination: maintain medical priorities and global perspective; closed-loop communication; avoid undue focus on secondary tasks.</td>
<td>Directive leadership, explicit coordination; if needed, “stepping back” and directly advising team members: “delegate and regulate”. (^{61})</td>
<td>S: Focus on maintenance of specific event management, re-establishing of team mental models.</td>
<td>Cannot ventilate; cardiac arrest; anaphylactic shock; massive hemorrhage</td>
</tr>
<tr>
<td>Briefing, debriefing</td>
<td>Facilitating, re-establishing shared mental model, (^{60}) allow for team learning. (^{38})</td>
<td>Establish or re-establish common “team mental models”. Before routine (^{46}) and non-routine tasks, after unexpected or adverse events.</td>
<td>S: Creating or readjusting shared mental models.</td>
<td>Brief team update, discussion and task assignment before difficult intubation Debriefing after adverse event Disregard of hand hygiene, or checks, or other safety rules</td>
</tr>
<tr>
<td>Responding to violations of safety rules(^{44})</td>
<td>General rule: systematic observation of practice, continuous dialogue within team. (^{49,103})</td>
<td>Violations cannot be completely eliminated. Sometimes, disciplinary action may be needed(^{104}); exploring reasons will allow for team learning.</td>
<td>S: Implementation of evidence-based safety rules where possible.</td>
<td>W: Effect of different approaches (tolerant vs. punitive) not well understood. (^{105})</td>
</tr>
<tr>
<td>Handover(^{8})</td>
<td>Using explicit leadership, support accomplishment of formalized handover. (^{101,70})</td>
<td>Handover including clear responsibility, checklists, defined sequence and contents, and allowing speak up.</td>
<td>S: Formalized handover may cause less information loss. (^{2,10})</td>
<td>Postoperative handover of surgical patients to ICU</td>
</tr>
</tbody>
</table>

7. Recommendations for leadership and team co-ordination in clinical anesthesia

Teamwork and leadership are important for patient outcomes in anesthesia and perioperative care, and interventions to improve clinical performance have been evaluated as outlined above. Some of these practices have been specified for anesthesia and perioperative care. However, most evaluating studies have only moderate scientific quality, and interventions evaluated in other clinical settings may have limited validity. Nevertheless, some guidelines for leadership and teamwork in anesthesia are necessary for clinical practice. The recommendations summarized in Table 1 present a selection based on available evidence mainly from observational studies.

8. Challenges for future research

As outlined above, team factors are essential for clinical patient outcomes. The shortage of high quality studies examining the effectiveness of team training interventions to improve actual patient outcomes\(^{27}\) such as mortality, morbidity, and quality of life, is therefore a major drawback for perioperative patient safety. In an era of limited healthcare resources and increasing production pressure, \(^{4}\) safety practices may rapidly fall victim to cost constraints, if not based on solid scientific foundations. Equally, long-term effects of interventions with documented short-term effectiveness should be examined.\(^{27}\) The need for periodical retraining should be evaluated in consideration of often fragmented work of
short-lived teams,\textsuperscript{57} and of the patterns of personnel turnover. Furthermore, evidence inferred from other clinical fields and from other industries should be validated for the setting of anesthesia and perioperative care. Particular problems for future research include (a) the impact of production pressure\textsuperscript{4} on teamwork and team performance in short-lived teams, (b) the effectiveness of leadership practices to prevent or compensate negative effects such as substandard workarounds or violations,\textsuperscript{64} (c) how distractions and interruptions resulting from the dynamic perioperative work setting interact with team effectiveness and patient outcomes, (d) how team leaders and members can best address these distractions,\textsuperscript{15,67} and (e) which handover techniques are most effective to improve patient outcomes.\textsuperscript{66}

9. Conclusions

Teamwork, leadership, and co-ordination are essential for perioperative patient outcomes according to a multitude of observational investigations. Many interventions using team training and simulation methods have been designed to improve teamwork, team effectiveness and the resulting patient outcomes. Due to the complexity of such interventions, research evaluating their effectiveness for enhancing teamwork and improving patient outcomes is mostly of moderate scientific quality. The guiding recommendations on teamwork practices for team leaders which we present in this article are based on available empirical evidence. In essence, active and explicit leadership is most important in unexpected, novel situations or deviations, and leaders should “delegate and regulate” during stressful work phases, but less leadership is usually required during standardized, routine periods of work, when skilled staff prefer to work with high levels of autonomy. Team leaders can further improve team performance by inviting and appreciating speaking up behaviour by the team. Additional insights into effective team leadership in anesthesia and perioperative care may be expected from future research that will hopefully fill persistent knowledge gaps.

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Conflict of interest

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References