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Invited Editorial

Teamwork, Communication, Formula-One Racing and the Outcomes of Cardiac Surgery

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Abstract: Most cardiac units achieve excellent results today, but the risk of cardiac surgery is still relatively high, and avoidable harm is common. The story of the Green Lane Cardiothoracic Unit provides an exemplar of excellence, but also illustrates the challenges associated with changes over time and with increases in the size of a unit and the complexity of practice today. The ultimate aim of cardiac surgery should be the best outcomes for (often very sick) patients rather than an undue focus on the prevention of error or adverse events. Measurement is fundamental to improving quality in health care, and the framework of structure, process, and outcome is helpful in considering how best to achieve this. A combination of outcomes (including some indicators of important morbidity) with key measures of process is advocated. There is substantial evidence that failures in teamwork and communication contribute to inefficiency and avoidable harm in cardiac surgery. Minor events are as important as major ones. Six approaches to improving teamwork (and hence outcomes) in cardiac surgery are suggested. These are: 1) subspecialize and replace tribes with teams; 2) sort out the leadership while flattening the gradients of authority; 3) introduce explicit training in effective communication; 4) use checklists, briefings, and debriefings and engage in the process; 5) promote a culture of respect alongside a commitment to excellence and a focus on patients; 6) focus on the performance of the team, not on individuals. **Keywords:** outcomes, cardiopulmonary bypass. *JECT. 2014;46:7–14*

The Green Lane Cardiothoracic Unit (CTSU) was established by Brian Barratt-Boyes, a charismatic and demanding leader, knighted in 1971 and (with John Kirklin) coauthor of the seminal text book *Cardiac Surgery* in 1986. The CTSU was built on a small, highly subspecialized team with a commitment to consultant-led practice at all hours and a culture of excellence. Great emphasis was placed on research, evidence, and outcomes, and the unit's results were closely monitored and regularly published (1). For many years, the unit undertook vascular surgery as well as cardiac and thoracic surgery, and pediatric cardiac surgery was integrated into the adult unit. The unit developed a pre-eminent national and international reputation in the late 1960s and the 1970s through its pioneering work in the use of homografts for aortic valve surgery and deep hypothermic arrest for the repair of congenital heart defects and through its world-leading outcomes. In the early days, the team was small and every anesthesiologist, surgeon, and perfusionist participated in most aspects of the work, including the postoperative intensive care of patients. They were supported by cardiologists, nurses, technicians, and others who worked exclusively within the unit or at least in close association with it. People worked very long hours and the unit's "lore" includes many stories of missed attendances at important family occasions (even childbirths), reflecting a strong commitment to the team as well as to patients.

Gradually progress has wrought change, accentuated by a physical relocation from a relatively small, somewhat specialist hospital to a much larger institution. Pediatric cardiac surgery is now provided in a separate part of the

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hospital complex by a substantially separate group of practitioners. Intensive care is provided by a group of doctors who, formally or informally, have substantially specialized in intensive care. There is still some overlap between these intensivists and the cardiac anesthesiologists with some individuals practicing as both, but the overlap is incomplete, and there is now a separate department of cardiac intensive care.

Thus, there has been an evolution from a relatively small and tightly knit team to a much larger group, still loosely identifiable as a team but with more dispersed leadership and a greater sense of division into separate "tribes." In line with the approach widely adopted in New Zealand, some surgeons, perfusionists, and anesthesiologists within the unit have always conducted private practice in a nearby institution in parallel to their (part-time) public hospital commitments. This has tended to result in very tight teams within the private setting but has also had some influence (probably good and bad) on the culture of the public hospital.

Outcomes have steadily improved (as they have in most units around the world) and are still excellent by international standards, but claims to world-leading results would be harder to sustain now than in earlier days.

Teamwork is self-evidently essential for successful cardiac surgery. In the early days of the Green Lane CTSU, effective teamwork flowed from the many hours spent together by a relatively small group of practitioners who knew each other well and understood each other's mutual expertise, skills, and expectations. Today, with a larger group and more disparate roles, there is a place for considering explicit initiatives to promote successful teamwork and communication. Institutions differ in their approaches and case mix, but the underlying principles are similar everywhere.

In the first part of this article, we discuss adverse events in health care and summarize the evidence supporting the concept that teamwork and communication influence outcomes. Initiatives to improve performance should be accompanied by measurement and we will consider how this might be done in the context of cardiac surgery. In the second part of the article, we outline the elements of teamwork and outline six approaches to improving teamwork and communication in cardiac surgery.

PART 1: TEAMWORK, COMMUNICATION, AND THE OUTCOMES OF CARDIAC SURGERY

Error and Preventable Harm in Health Care

Today it is widely accepted that too many patients suffer harm as an unintended consequence of their health care (2,3). Much of this harm is avoidable and attributable to error. Cardiothoracic surgery is no exception: it is self-evidently associated with substantial risk (4), and in a study involving retrospective review of charts in hospitals in Colorado and Utah, the rate of preventable adverse events was higher than average for coronary artery bypass graft and cardiac valve surgery (3).

Things may go wrong at any point in a patient's pathway from primary care through the wards, operating rooms, intensive care, and back again. In the United Kingdom, a report from the National Reporting and Learning System database showed that of 4828 incidents involving cardiac surgical patients, 21% occurred in the operating room (OR) and 79% outside the OR. Harm resulted in 23% of the OR and 34% of the non-OR incidents (5).

It is all too easy to develop an excessive focus on the reduction of error or on the Hippocratic mantra "primum non nocere" (first, do no harm). The drawback of this is that most healthcare services today have limited resources and heavy loads of very sick patients requiring treatment, often urgently. Doing nothing, or investing excessively in safety at the expense of productivity, may mean fewer patients are harmed by health care, but it will often also mean that some die untreated, whereas others remain too sick to enjoy a worthwhile quality of life. Quality in health care depends not only on safety, but also timeliness, efficiency, efficacy, equitability, and patient-centeredness (represented by the acronym STEEEP) (6). The ultimate objective should not be to avoid error or harm at all costs, but rather to achieve the best outcomes for the greatest number of sick patients. For the avoidance of doubt, a reasonable emphasis on avoiding error and reducing harm is of course a necessary part of achieving this objective, but, in the context of allocating limited resources, there is likely to be an optimal level of investment in error prevention beyond which the net effect on outcome may be negative. It does seem that most healthcare systems today invest relatively lightly in safety initiatives, so this point may be moot in contemporary practice.

The Institute of Healthcare Improvement (IHI) has introduced the concept of a "Triple Aim" (7) (New Zealand has adopted a modification of this emphasizing value for the available resource rather than cost reduction per se [8].). The Triple Aim involves the simultaneous pursuit of three objectives: improving the health of the population; enhancing the patient experience of care (including quality, access, and reliability); and reducing, or at least controlling, the per-capita cost of care.

This expresses at the highest level the objectives of any healthcare system and by implication of any part of such a system.

Quality Improvement and the Importance of Measurement

Drawing from the experience of advances in anesthesia safety, Lucian Leape (9) has asserted that undue insistence

on evidence and measurement can be counterproductive and that there are some things that should be done simply because they make sense. Nevertheless, there is a strong belief that measurement is essential for effective improvement in health care (10,11).

Donabedian (10) has outlined a simple framework for the measurement of quality in health care that has become widely accepted. The framework emphasizes three domains: structure; process; and outcome.

Structure is relatively easy to measure, but there is an obvious attraction in focusing on outcome. For many interventions, and in many fields of health care, it turns out that this can be very expensive and perhaps impractical. For example, medication error features prominently in almost every study of harm arising from health care, and cardiac anesthesia and perfusion involve the administration of large numbers of drugs, so this seems likely to be a fruitful area for improvement. However, finding a reliable way to count and quantify adverse drug events (ADEs) is not easy. Identifying drug administration or prescription errors is even more difficult.

Trigger Tools as a Means of Monitoring Outcome

In the early 1990s Classen et al. (12) described a computerized method of using triggers, or flags, to identify patients in whom an ADE was likely; a subsequent review of the relevant charts could then establish whether or not an ADE had actually occurred. This proved much more efficient than traditional approaches based on the review of large numbers of randomly selected charts (13,14) but required appropriate electronic record systems. The IHI subsequently developed an ADE trigger tool that could be used on the basis of a manual inspection of relatively small samples of charts (15). For example, the use of naloxone suggests the possibility of an opioid overdose, and the use of vitamin K suggests the possibility of a warfarin overdose. A key point about the trigger tool approach is that no effort is expended on the question of preventability or error. The aim is to reduce harm, and the assumption is that an overall reduction of harm will reflect a reduction in those events that are preventable. The ADE trigger tool has been adopted quite widely but still requires considerable resource and has some limitations. Other trigger tools, including a global trigger tool, are also available.

Mortality Statistics

Cardiac surgery is unusual in that even routine cases are associated with relatively high rates of mortality. This has led to a well-established culture of monitoring and reporting mortality statistics, often corrected for known risk factors. For example, Kang et al. (16) have described an application of this approach to quality assurance in congenital heart surgery.

The Society for Cardiothoracic Surgery in Great Britain & Ireland (SCTS: www.scts.org accessed January 22, 2014) reports mortality data for indicator cardiac procedures in the public domain. These data are supplemented with information on case volumes and some indication of case mix. National averages are provided, and funnel plots are used to indicate acceptable limits of performance. Some hospitals now provide links on their web sites to this sort of information for individual surgeons (see for example www.uhsm.nhs.uk/cardio/Pages/surgeons.aspx; accessed January 21, 2014).This approach is, in our opinion, too narrow and places too much emphasis on individual practitioners from one subset of the overall cardiac team. We return to this point in the second part of the article.

Why Process Should Be Measured as Well as Outcome

In New Zealand, the Health Quality and Safety Commission has introduced quality and safety markers for three important aspects of quality in health care: falls, hospital-associated infections, and surgical harm. A marker for medication safety is expected later this year. All of these areas are of relevance to cardiac surgery.

Each marker contains two parts: a measure of process and an indicator measure of outcome. For example, one marker addresses hand hygiene. The process marker is the percentage of practitioners that comply with all of the World Health Organization's (WHO's) five moments of hand hygiene (17). The outcome measure is the incidence of *Staphylococcus aureus* bacteremia.

This approach is predicated on the idea that it is more reasonable to set targets for process indicators than for outcome indicators. There is no particular reason why one hospital should find it more difficult than another to achieve a high level of compliance with a process. On the other hand, many factors contribute to outcomes. Nevertheless, it pays to include some measure of outcome for two reasons: to give a clear message about the primary purpose of focusing on the particular process; and to reduce the likelihood of gaming.

The use of an indicator of outcome is simpler and less costly than trying to measure all relevant components of outcome. Thus, for falls, the outcome measure is the number of patients sustaining a hip fracture from a fall while in the hospital. Obviously other forms of injury also occur: fractures of arms, skulls, and so forth. However, hip fractures are common and give a good indication of the overall picture.

In cardiac surgery, the Society of Thoracic Surgeons in the United States has adopted a broader approach than the SCTS. A three-star system is used to rate participating groups or institutions on a combination of outcome and process measures for certain indicator procedures. The outcome measures include mortality, reoperation, stroke, kidney failure, infection of the chest wound, and prolonged ventilation. Process measures include the use

of at least one internal mammary artery and the perioperative prescription of certain important medications.

This approach has much to commend it and also provides a sensible approach to monitoring efforts to improve safety. The outcome measures provide a good indication of the things that are likely to matter to patients. Reducing error and thereby improving safety is one necessary element in achieving excellent outcomes, so an ongoing emphasis on error reduction is appropriate in everyday practice. There is of course good reason to monitor or investigate specific aspects of practice as well, and in this regard, trigger tools and the quality and safety markers also have a role to play. The balance lies in finding a reasonable mix of measures to provide adequate information without becoming too onerous or expensive. The focus on optimizing outcomes for the available resource should not be forgotten.

Evidence that Teamwork and Communication Matter in Cardiac Surgery

Any unit achieving acceptable results for cardiac and thoracic surgery must already have skilled staff and reasonable teamwork. Nevertheless, there may be room for improvement.

In the context of health care generally, many studies have identified failures in teamwork and communication as common factors in the genesis of adverse events in health care (18,19). Several studies have produced similar findings in the context of managing patients with cardiac disease (20). A key theme that emerges is that minor events, taken collectively, are as important as major ones (21–23). Recently Wahr (24) has led the development of an evidence-based scientific statement on the importance of teamwork for patient safety in the cardiac operating room.

The Flawless Operative Cardiovascular Unified Systems (FOCUS) project is an important initiative being undertaken by the Society of Cardiovascular Anesthesiologists. The aim is harm-free cardiac surgery. Early findings emphasize the importance of a culture in which staff feel able to speak up if they see something that might be going wrong and of teamwork and communication (25,26). Moreover, there is evidence that teamwork and communication in health care can be improved (27). Improving teamwork is an explicit objective of the WHO Surgical Safety Checklist (the Checklist) (28–30).

Variation and Teamwork

Variation in healthcare practice should be predicated on differences in patients, but instead, it often reflects differences in the belief and culture of different institutions or individual practitioners (31–33). A key point about variation in practice within an institution is that it makes teamwork more difficult; standardization of practice has been pivotal in improving the safety of aviation and other high reliability enterprises, and it is well overdue in health care.

PART 2: FORMULA-ONE RACING, RED DOGS, AND THE GREEN LANE WAY

Many years ago, a visiting resident to Green Lane from the United States first said "Red dog!" when he meant "Let's go onto bypass." The phrase stuck, at least for some practitioners of that era. Its adoption as an implicitly understood code reflected a well-developed approach to teamwork that may not have involved the jargon that is prevalent today but did follow many principles now being taught as new and innovative. For example, the "sterile cockpit" was normal when Alan F. Merry began his career: little idle chatter was allowed, and full attention on the task in hand was expected from everyone. Closed loop communication has always been expected for key procedures such as giving heparin or protamine. People did not need introductions because everyone knew each other. "The Green Lane Way" was understood by all, and there was considerable standardization, even down to the way patients' arms were tucked by their sides.

Transfer to the intensive care unit provides a great example of how much change has taken place. In those early days, it was done without any monitoring other than a finger on the pulse, and although there was handover to a nurse and a resident, the senior surgeon and anesthesiologist continued to be responsible for patient care so did not need to be given any new information at the point of transfer. More recently, the complexity of transferring highly monitored pediatric patients with numerous drug infusions and possibly other forms of therapy to the care of intensivists has prompted pediatric cardiac surgeon Marc de Leval and his team (in the United Kingdom) to seek the assistance of airline pilots and Formula-One racing teams to develop a more organized and standardized approach to hand over (34).

As indicated in the introduction, in this second part of the article, we outline the elements of teamwork and discuss six methods to improve the performance of teams in cardiac surgery.

IMPROVING THE PERFORMANCE OF TEAMS

Elements of Teamwork

On the basis of empirical evidence from various settings, Salas et al. (35) have proposed a model for teamwork, which includes five dimensions: team orientation, team leadership, mutual performance monitoring, backup behavior, and adaptability. These dimensions are underpinned by three coordinating factors: mutual trust; effective communication; and shared mental models within the team.

Method 1: Subspecialize and Replace Tribes with Teams

You cannot expect teamwork if people do not understand (and agree) that they belong to the team (36). In health care, teams tend to form for a particular purpose and then disband. Teams in cardiac surgery are often more stable than in many other parts of health care but still typically less stable than a hockey or basketball team. The skills and knowledge that are required to care for surgical patients come from different disciplines: surgery, anesthesia, perfusion, and nursing—supported by technical, administrative, and other staff, all of whom contribute in important ways. It is not usually possible, today, for a member of one group to take over and adequately perform the duties of a person from another. This is different from the present-day situation in an airplane cockpit where the pilot and copilot can do each other's work and where a single authority gradient applies.

Health professionals typically train in silos: medical schools, nursing schools, and so on. Thus, the healthcare setting tends to promote a sense of "tribalism" in which a nurse or anesthesiologist may identify more with large departments of nursing or anesthesiology than with a cardiothoracic unit. This may lead to differences in priorities and in the way individuals communicate and view issues of leadership and teamwork (37,38). The extent to which tribalism of this type usurps the perception of belonging to a multidisciplinary team does vary. In the days of Sir Brian, the Green Lane CTSU had a very strong sense of identity. In part this may be because it was situated in a relatively small hospital. With the move to the much larger Auckland City Hospital, and with the other developments outlined previously, this has been at least slightly diluted.

One aspect of this question relates to the degree to which clinicians specialize in a particular field. For anesthesiologists and nurses, there is a tension between the flexibility provided by generalist staff and the advantages of subspecialization. However, in a field as complex and challenging as cardiac surgery, subspecialization is clearly an advantage for all concerned, both because it increases skills (transesophageal echocardiography is a clear example of this point), but also because it increases the time the team members spend together and therefore the effectiveness of teamwork. It is noteworthy that the 2001 report on the inquiry into pediatric cardiac surgery at the Bristol Royal Infirmary (39) supported the concept of patient-centered multidisciplinary teams.

Method 2: Sort Out the Leadership while Flattening the Gradients of Authority

Speaking up is pivotal to safety, and this may need the most junior person in the room to ask a question that might seem silly such as "Aren't we meant to be operating on the other side of this patient?" Steep authority gradients and a strongly hierarchical culture tend to inhibit speaking up, and so does tribalism because individuals may limit their perceived responsibility to the boundaries of their professional group's area of practice. At the same time, it does need to be clear who is in charge in relation to any particular decision.

Hospitals operate through various models of leadership, and there is often some degree of mistrust between the "tribes" of health care. The principle that the surgeon should automatically be the "captain of the ship" is no longer tenable. Today, every healthcare worker is held accountable for his or her actions, and as explained, skills are not necessarily interchangeable between groups. In the OR, leadership should alter depending on the decision in question. Bleakely (40) introduced the idea of democracy in healthcare teams, advocating open conversations and the encouragement of suggestions from other members of the team. However, making decisions in real time in the OR on the basis of a vote does not appeal, and the term "consultative" may be more appropriate. Each person's expertise needs to be respected, and all members of the team need the opportunity to comment and contribute, but if the matter is obviously anesthesia-related, the senior anesthesiologist should make the final call, and so on.

The overall leadership of a unit is a different matter, and a greater degree of democracy may well be effective in this context. A governance structure with representation from each professional subgroup working collectively under an agreed chairperson would seem to be ideal. This chairperson could come from any subgroup, particularly if a rotating fixed-term approach is adopted, so that change from group to group can be reasonably anticipated. A more traditional leadership model with an open-ended appointment of a designated leader (often a surgeon) would also be functional (as illustrated by Green Lane in Sir Brian's time), but perhaps harder to impose on groups that have become used to "tribal autonomy."

Surprisingly, a clear structure for overall governance is sometimes absent from cardiac and other surgical units and instead each discipline may tend to meet and make decisions in isolation from members of other disciplines. It seems to be a matter of common sense that a multidisciplinary committee should meet regularly (at least monthly, probably weekly), make explicit decisions about policy and strategy, and deal with problems as they arise. In this way standardized approaches to common problems could be developed and the mental models for policy, direction, and clinical care could become mutually agreed and therefore shared.

Method 3: Introduce Explicit Training in Effective Communication

The principles of effective communication include clarity, comprehensiveness, and the principle of confirming that messages have been received (i.e., "closing the loop").

Communication should be directed to named individuals and not to the room in general. It follows that people's names should be used, and this is also a matter of mutual respect. This is why introductions are a key element of the WHO Surgical Safety Checklist. It is helpful for names also to be written on a whiteboard. Graded assertiveness is a skill that facilitates speaking up in particular and effective communication in general. All of these skills can and should be taught; as with cannulating an aorta or intubating a trachea, it is unlikely that real proficiency will be achieved by simply expecting these skills to be acquired by some form of informal absorption (41).

Simulation is now an established method of teaching teamwork and communication in health care (42–46). In a recent study, simulation was used to improve the management of acute crises in cardiac surgery (47). Simulation is fairly costly, but drawing from the experience of airlines, it seems that its wider adoption by whole teams working together is overdue.

Method 4: Use Checklists, Briefings, and Debriefings. . .and Engage in the Process

The WHO Surgical Safety Checklist should be accepted as a standard of care (29,30,48,49), but its use will only be effective if all concerned engage fully in the process. Briefings at the beginning of every surgical list have huge potential to improve efficiency, set a positive and collegial tone, and avoid harm (29). Short debriefing sessions at the end of the day, to which all should contribute, can identify areas for improvement while reinforcing effective behaviors.

Method 5: Promote a Culture of Respect Alongside a Commitment to Excellence and a Focus on Patients

A particularly interesting study by Curry et al. (50) identified a commitment to excellence as a key element of achieving good outcomes for acute myocardial infarction. This is entirely aligned with the culture of Green Lane Hospital in the days of Sir Brian; for its day, the commitment to excellence was evident and exceptional. Within a culture of excellence there should also be a commitment to respect. Courtesy should not be negotiable. The basic assumption should be that everyone is skilled and knowledgeable and fully committed to working together to provide the best possible care for patients. If this proves to be untrue for a particular individual, the problem should be addressed formally rather than through verbal abuse or other forms of bullying. The latter approach is antithetical to the promotion of teamwork. In the study of Curry et al., the following illuminating comments were reported:

"We don't accept anything less than the very best."

"[Staff here have] a very, very strong work ethic. . . . If you didn't intend to work in a similar fashion, this isn't a good place for you. . . . They are very careful in their selection from the very beginning. Success breeds success. . . You have to fit into the culture."

Method 6: Focus on the Performance of the Team. . .Not on Individuals

There is a strong case for emphasizing and celebrating the performance of the team rather than of individuals within it. In this context, we are very much opposed to the public dissemination of individual surgeons' mortality data. The data provided by the SCTS are illustrative of one reason for this. There will always be differences between the mortality rates achieved by individual surgeons within a given unit. Funnel plots are used to make the point that most of these individuals' results lie within acceptable limits, but in fact surgeons with low numbers of cases might well have allegedly "acceptable" rates that would not be acceptable for surgeons with high caseloads. An informed patient might well feel that it would be preferable to choose one of the latter surgeons, but few systems would accommodate choice at that level. More importantly, these data discount the contribution of the other members of the team. It has been established that individual anesthesiologists can influence the outcomes of cardiac surgery (51,52), yet their results are seldom published. In fact, good outcomes depend on all members of the team working together, efficiently and effectively. The best way to promote this is surely to publicize the results of the unit as a whole in comparison with national averages or percentile data. This should be accompanied by internal (confidential) review of the results of individuals and an assurance to the public that all surgeons and anesthesiologists (and perhaps perfusionists) are functioning within the acceptable limits of the funnel plot. If all concerned were focused on improving the unit's results, then idiosyncratic behavior, predicated on the "hero" model and the (statistically impossible) belief by each person that he or she is (or at least should be) the best, could be replaced by a collective approach to excellence. In such an approach, practitioners would surely be more inclined to help each other with difficult cases and to address issues related to low volumes or poor performance from particular individuals. They would also be more inclined to feel comfortable with a level of transparency that is fair and appropriate.

CONCLUSION

The story of the Green Lane CTSU provides some interesting messages about excellence and teamwork. Results have improved around the world, but the risk of cardiac surgery is still considerable. Enhanced teamwork provides considerable potential for achieving better results, and there are probably few units today in which some aspect of teamwork could not be improved.

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