Communication as a sign of adaptation to a complex system: The case of robotic surgery

Anne-Sophie Nyssen & Adélaide Blavier

Department of Cognitive Ergonomics, University of Liège, Belgium

Introduction

As investigations of medical accidents have revealed, communication is one of the factors that is most frequently associated with accidents. For instance, in anesthesia 25% of deaths are due to inadequate communication, which represents 39 % of reported medical errors (Arbous et al. 2001, Kluger et al. 2000). But, surprisingly, communication has not received much attention from researchers. Better training, better techniques, and better standards of equipment have been recommended in order to improve the patient's safety, but not much effort has been spent on communication training and tools, even though health care practitioners designate ”improving communication” as an important corrective strategy (Kluger et al. op. cit.)

During the past decade or so, there have been two important developments in medical care relevant to the study of communication in hospital:

i) the increased specialization of medical sciences, which has increased the division and distribution of tasks among experts from different disciplines and, thus, the need for coordination and communication between healthcare providers. Today, a patient will very seldom visit only one hospital department and furthermore rarely sees only one physician during their stay. Multiple departments and professional skills are brought together in order to provide health services, but also to provide uninterrupted care around the clock. This specialization requires more and more information to be exchanged between departments as well as between individual operators who work cooperatively in hospitals in order to coordinate interventions both in time and space. Hospitals themselves have even become specialized, so that a patient may have to go to several hospitals and institutions to be properly taken care of (Nyssen 2006). This obviously raises the communication challenge at the inter-organization level.

ii) the development and introduction of new computer-based technology in hospitals, that requires practitioners to communicate with computers, introduces new forms of media and more distance between the operators and their tasks, as well as between task performers themselves. During the past decade, the healthcare system has seen the introduction of more and more sophisticated technological devices and automated systems. Our fascination for the benefits of such technology has often obscured the fact that technology creates new demands for communication, it changes the way information is exchanged, introduces new media layers into the system, adds complexity, and creates new demands for cooperation. This perverse effect of technology was depicted by Bainbridge (1987) for automated systems as the irony of automation. It is largely due to the fact that the design still completely cut off from the environment of use as we, and other researchers such as Woods, have shown in various complex systems (Nyssen 2004, Cook & Woods 1996, Woods & Hollnagel 2006).

The aviation industry has attempted to reduce the problems of cooperation between humans and automation by *organizing* both human-machine and human-human communication, using a straightforward and predefined division and distribution of tasks (e.g. Pilot Flying and Pilot Non Flying), a codification and standardization of the communication language, a principle of systematic verbalization of main intentions, perceptions and actions (call-outs), a principle of systematic cross-checking of actions and understandings, and mandatory training of so-called “non technical skills” (Crew Resource Management). But some problems of communication obviously remain, as we can see with the case of the Sharm-el-Seikh accident (Egypt, January 4 2004), in which the crew failed to share a proper understanding of the autopilot status.

These difficulties faced in addressing cooperation needs might be grounded in the dominant tendency to use an analytical approach to solve a complex, non linear problem. The analytical approach attempts to explain a system through division and simplification. For example, an operation is dismantled into a series of tasks to be performed, cooperation is described as a series of mutual constraints (e.g., synchronization, input, output) between these tasks, and communication boils down to the information exchange between task performers which is needed to satisfy the constraints. The science of complex systems, however, addresses problems differently. What characterizes a system as complex is not the mere number of its component parts but the heterogeneity of the component parts and their relations among them, leading to a potentially unanticipated and autonomous outcome, namely an emergence. Particularly, the ability of a complex system to adapt itself to its environment and to maintain this adaptation to some extend against internal changes (e.g. new equipment, new people) as well as external changes (environmental), can be seen as an emergent property. In this approach, communication flows are seen as a manifestation of the adaptation work (Piaget 1967, Le Moigne 1999, Maturana & Varela 1980, 1987, constructivism). In most circumstances, the act of communication represents our best attempt to adapt to a specific situation.

The view taken in our research is that analyzing communication will reveal the adaptation strategies and the limits of the adaptation of the "system", taken here as the interaction between the surgeon, the assistant, and the robot. In this sense, our work is in accordance with new approaches to the safety of social-complex systems that have recently been explored under the name of resilience that looks for adaptation capacity instead of breakdowns and accident models. We shall discuss this new approach in the light of the constructivism perspective, in particular, the increasing focus on the emergent adaptive capacity of complex system through continual interaction with their environment.

This new approach requires analyzing situations where the capacity of adaptation of the system is engaged to face changes in order to capture markers of adaptation in real time.

In this chapter, we examine how the introduction of the robotic system in the operating room creates new patterns of communication between surgeons and how the analysis of the communication reveals surgeons' adaptation strategies in addition to the limits of their adaptation to the technology. As a result, we will be able to better assist developers to design ongoing adaptation and, thus, to design communication tools.

Robotic / Laparoscopy Surgery and Communication environment

Robotic surgery and laparoscopic procedures provide a good system to support a study on communication, adaptation, and new technology.

There have been a number of technological advances in surgery, and laparoscopy is certainly one of them. There is little doubt that laparoscopy represents a definite progress in patient's treatment. However, there are a number of important drawbacks. For instance, the fact that long instruments are used through an opening (trocar) in the abdominal wall limits the surgeon's degrees of freedom to 4: in and out, rotation around the axis, up and down and from medial to lateral. Robotic surgery has been designed to improve the process of Laparoscopy or Minimal Invasive Surgery (MIS). The system allows for: 1) the restoration of the degrees of freedom that were lost, thanks to an intra-abdominal articulation of the surgical tools, 2) three-dimensional visualization of the operative field in the same direction as the working direction, 3) modulation of motion amplitude by stabilizing or by downscaling and 4) remote control surgery. Because of these improvements, surgical tasks can be performed with greater accuracy (Hubens et al. 2003; Marescaux et al. 2002; Cadière et al., 2000; Pasticier et al., 2001; Carpentier et al., 1999).

Laparoscopy procedures typically involve the simultaneous use of three or more instruments (e.g. laparoscope, probe or gripper and shears or other cutting tools). Because of this, at least one tool must be operated by an assistant. The assistant's task is often limited to static functions of holding the instrument and managing the camera.

In classical laparoscopy, the assistant and the surgeon are face to face, and they use the same 2D representation of the surgical field to tailor the task.

In robotic surgery, the surgeon is seated in front of the console at a distant point, looking at an enlarged three-dimensional binocular display on the surgical field while manipulating handles that transmit the electronic signals to the computer that transfer the exact same motions to the robotic arms. Robotic surgery can be performed at distant locations. However, within the actual technological system, the surgeon is still in the same operating room as the patient. The computer-generated electrical impulses are transmitted by a 10-meter long cable that controls the three articulated “robot” arms. Disposable laparoscopic articulated instruments are attached to the distal part of two of these arms. The third arm carries an endoscope with dual optical channels, one for each of the surgeon’s eyes, which allows a true binocular depth perception (stereoscopy). The assistant is next to the patient, holding one or two instruments and looking at a 2-D display of the surgical field.

[Insert fig.1 here- landscape]

Communication as a sign of adaptation

Every act of communication, both verbal and non verbal, can be considered as an adaptive process analogous to biological evolution. Adaptation is the process of adjusting the mental structures and the behavior to cope with the environment. Because so much of the adaptation processes in real time within the health care system are still verbal communication, the analysis of language becomes an important paradigm in order to study the adaptational capacities of a system. It is not the object of this chapter to review the literature concerning whether or not the structure of language determines the structure of thought as several researchers have maintained. However, when activities are distributed across space such as in surgery, the language used by task performers is almost certainly going to serve to organize resources to fit with the environmental constraints. The idea of language as an instrument of development of cognition, and thus serving adaptation, is central to Piaget's theories (1967, 1995). Adaptation, in this constructivism framework, is achieved through agent-environment interactions via the conjunction of two processes: (a) the assimilation of new experiences into existing structures, and (b) the accommodation of these structures, i.e. adaptation of existing ones and/or the creation of new ones. The latter, learning through accommodation, occurs for the purpose of 'conceptual equilibration' and the elimination of perturbations. Some cognitive researches have also examined the relationship between communication, regular interaction and adaptation. When practitioners repeatedly work together, a reduction of verbal information exchanges is observed as practitioners get to know each other. Information taken directly from the work field replaces the verbal exchanges. Indeed, any regular action, parameter or alarm takes on the character of the "initiator" of verbal communication (Savoyant & Leplat 1983; Pavard 1994; Nyssen & Javaux 1996). Other studies (i.e. Bressole et al. 1994) have examined the relationship between communication and non routine situations in complex systems: the greater the trouble, the greater are the demands for information centered on the task across the members of the team.

Based on the above arguments, three important points can be noted. First, the environment provides feedback, which is the raw material for adaptation. Simple systems tend to have very straightforward feedback, where it often easy and instantaneous to see the result of an action. Complex systems may have less adequate feedback. The deployment of technology has increased the complexity of communication from non verbal to verbal, and to complex symbolic patterns. Additionally, introducing media and a distance between the agent and the process to control can delay and/or result in loosing feedback information. In laparoscopy surgery, the surgeon looses direct contact with the surgical site. S/he looses tactile feedback and performs operations with only sensory input from the video picture. As the robotic system is introduced in the OR, s/he looses proprioceptive feedback in addition to loosing a face to face feedback communication channel.

Secondly, communication is a dynamic feedback process which, in turn, affects the communicators. As we shall see, because the assistant and the surgeon have often prior knowledge and experience with the task, the assistant can anticipate the next movement or instrument that the surgeon needs in a routine task and non verbal communication can be very efficient (e.g., when the surgeon makes a hand signal to indicate to stop the movement or when s/he looks at the assistant to verify the receipt of an implicit request).

Third, in this dynamic perspective, short term adaptation feedback strategies that are exclusively based on verbal communication can be highly resource-consuming for the practitioners over time and, thus, may lead to long term inadequate adaptation.

Each of these points will be dealt with in our working hypotheses.

- In the case of adaptation, it is hypothesized that the environment provides good feedback that supports the system to carry the task. Within our framework that views communication as an adaptive process, the following can be expected with the introduction of a robot system:
    - in the short term, new patterns of communication that reveal adaptation strategies
    - with training and regular interactions, a reduction of communication that reveals the dynamic nature of the adaptation process
- In the case of lack of or inappropriate adaptation, the environment provides inadequate feedback resulting in increasing and maintaining the verbal communication to compensate for the weakness of feedback from the new environment.

Experimental study and communication analysis

We carried out three studies to examine our hypotheses:

1) First, we compared surgical operations that were performed with a robotic system compared with classical laparoscopy. In the two conditions (robotic and classical laparoscopy), the surgical procedures and the team members were identical. They were experts in the use of classical laparoscopy (>100 interventions) and were familiar with the use of a robotic system (> 2

interventions). We chose two types of surgical procedures (digestive and urology surgery) because it is possible to perform them with either classical laparoscopy or with a robotic system.

We observed 5 cholecystectomy (digestive) with the robotic system and 4 with classical laparoscopy, and 7 prostatectomy (urology) with the robotic system and 4 with classical laparoscopy.

The robotic system used in our study was the Da Vinci robotic system (Intuitive Surgical, Mountain View, CE, USA) as shown in Figure1.

2) Secondly, we compared routine and non routine operations: conversion from robot surgery to classical surgery.

3) Thirdly, we compared teams with different levels of expertise during gynecology surgery with a robotic system. We compared three teams with different levels of expertise who successively performed two tubular reanastomosis of 36 Fallopian tubes: 1) both the surgeon and the assistant were experts with a robotic system (>50 operations with a robotic system), 2), the surgeon was an expert while the assistant was a novice with a robotic system (<10 operations with a robotic system); 3) the surgeon and the assistant were novices with a robotic system (<10 operations with a robotic system).

In the three studies, we recorded all the verbal communication between the surgeon and the assistant. We analyzed their content and identified six categories. We also measured the duration of the intervention, as this is an important performance criterion for surgeons.

The six types of communication were:

- Verbal demands concerning the orientation and localization of organs.
- Verbal demands concerning the manipulation of instruments and/or organs.
- Explicit clarification concerning strategies, plans and procedures.
- Orders referring to tasks such as cutting, changing instruments, and cleaning the camera.
- Explicit confirmation of detection or action.

- Other communications referring to state of stress or relaxation.

For each category, we measured the number of acts of communication, while taking into account the duration of the surgery (ratio = number of acts of communication / time (in seconds) X 100). We used the Mann-Whitney *U* test to compare the two techniques: classical laparoscopy and robotic surgery, and the Kruskal-Wallis test to compare the three groups of surgeons (Novice-Novice, Expert-Novice, Expert-Expert) and to measure the impact of expertise on communication.

Results

Communication as a feedback adaptive process

The average duration of the intervention was significantly longer ($p<0.05$) with the robotic system (cholecystectomy: 82.59±27.37; prostatectomy: 221.39±58.79) than with classical laparoscopic (cholecystectomy: 31.85±9.64; prostatectomy: 95.74±11.53).

Figure 2 shows that the introduction of the robotic system created a new pattern of communication. Our results show that not only was there more acts of communication with the robotic system, but also that different types of communication between the surgeon and the assistant were used. This pattern of results was similar for the two types of surgery.

Following our hypothesis, the increase of communication acts observed in the robotic system suggests that a portion of useful feedback is not provided by the robotic system anymore, and that the surgeon attempts to compensate this weakness of the system via verbal communication acts.

The significant increase in the number of communication acts ($p<0.05$) referring to orientation, manipulation, order and confirmation within the robot system suggests that a breakdown occurs in the collaboration between the surgeon and the assistant. The surgeon works alone and continually needs to ask the assistant about the orientation and the placement of the instrument (which is manipulated by the assistant) in order to facilitate the identification of the organs. Explicit demands, order, and confirmation are needed because the system configuration impedes face to face communication and prevents the assistant from anticipating the expected course of the surgeon's actions. Additionally, by introducing a distance between the surgeon and the patient, the robot configuration creates a new requirement for collaboration when s/he needs proprioceptive feedback, as illustrated in the following example of communication.

Example of interaction:

Surgeon at the consol: "could you tell me if you are touching something here, because I see a particularity "

Assistant surgeon near the patient: "yes, I am touching something hard - it is a bone".

[Insert fig.2 here- landscape]

Communication as a sign of trouble

We observed two conversions: 1 in urology from a robotic surgery to open surgery and 1 in digestive surgery from robotic surgery to classical laparoscopy surgery.

As uncertainty increases during the case due to progression from expected to unexpected variability, initial procedures that are operationalized through preparatory configuration become irrelevant. In this case, conversion becomes imperative and may require the use of procedures that are not practiced by the surgeon anymore as it was the case for prostatectomy in open surgery.

Each of these conversions is associated with an increased number of verbal communications (see fig.3). These communications concerned explicit clarification of strategies (replanning) and expectations concerning orientation and manipulations. We also observed less communication that referred to confirmation. During a crisis, the surgeon acts and does not take the time to verify the receipt of his action or request.

[Insert fig.3 here- landscape]

Communication as a dynamic process

Our results show that the number of acts of communication is reduced with repeated experience: from the first operation to the second operation of Fallopian tube anastomosis, but also with the degree of expertise of the team with the robotic system (see fig. 4).

The duration of the intervention was significantly different ($p<0.05$) according to the surgeon's expertise level: interventions are longer with novice surgeons (58.37±5.66) than with an expert at the console (32.67±10.46) and with two experts (25.85±8.66).

Detailed analysis of communication showed that the number of communication acts referring to orientation, manipulation and strategies was significantly reduced ($p<0.05$) when both surgeons were experts. Not surprisingly, the number of acts of communication referring to order and confirmation was significantly greater when an expert was present. In the contrary, the reduced number of acts of communication referring to orders and confirmation when both surgeons were novices attests to the absence of organization and structure that the surgeons have to compensate through more communication on ongoing action control (manipulation and strategies).

[Insert fig.4 here- landscape]

Discussion

Based on our results, it is clear that a robotic environment changes the feedback loop and that verbal communication used by surgeons is a feedback-adaptive process to compensate the feedback information absent in the robotic environment. Verbal demands concerning manipulation, orientation, confirmation, and orders attest to the fact that the surgeons need information in order to carry out their task, identify the organs, and control their action. Indeed, the patterns of communication reveal the needs for feedback and, thus, the defeating aspects of feedback from the robotic system.

Our results also show that both the number of communication acts and the type of communication evolves with the agent-robot environment interactions. The fact that there are regular interactions between the surgeon and the assistant creates implicit communication and reduces the need for explicit communication and furthermore suggests successful adaptation to the environment. However, our results also indicate that the surgeon's emergent adaptive learning response is achieved more readily through interacting with the classical laparoscopy system than with the robotic system. By introducing a distance between the surgeon and the assistant, the robotic system prevents face to face communication, which normally serves as a critical feedback for this adaptive process. Instead, the robotic system requires greater attention and continual efforts to communicate during even routine surgical procedures. However, as mentioned earlier, when complications occur, increased verbal communication is required to clarify plans and expectations in order to enable coordinated actions between the surgeon and the assistant.

These results reveal the value of verbal communication as a sign of adaptation or difficulty with adaptation of socio-technical systems. Indeed, our studies suggest that verbal communication can be seen as an adaptive feedback process that allows the agents to maintain an adequate performance level, minimizing the defeating feedback from the technical system. This adaptive response of the system is triggered by the environmental change (the change of the technical system) but emerges and evolves through agent-environment interactions. Thus, it is compatible with Piaget's constructivist view of adaptation: driven by the need to fit environmental constraints and emerging through interaction with the environment.

The concept of adaptation is also central to newer research on resilience engineering that views safety of complex systems as a system property that emerges from agent-environment interactions. In psychology, the term "resilience" is used to designate the human ability to survive after a significant trauma that has destroyed his/her equilibrium (Bowlby 1973, Cyrulnik 2003). We will therefore utilize the term resilience to designate the system’s ability to recover from a change that destroys the system’s structure.

We have discussed that the conversion cases represent a fundamental breakdown for the system, yet we have also seen how the surgeons, and not the robot, have mechanisms for recovering from the situation before it affects the patient by replanning the cases into classical surgery. This means that the system’s capacity for resilience resides in the human part rather than in the technical part of the system. Indeed, adaptation emerges through the history of different agent-environment coupling over time (open surgery, classical laparoscopic surgery, robotic surgery) that enhances the agent’s autonomy towards the variability from the environment. This is similar to Maturana and Varela ‘s work on the biology of cognition and autopoiesis (Maturana & Varela, 1980, 1987). According to Maturana and Varela (1980), living systems are not at all the same as machines made by humans. Machines, including robots, are allopoietic. The organization of an allopoietic machine is given in terms of a concatenation of processes independent of the organization of the machine. Thus, the changes that an allopoietic machine goes through are necessarily subordinated to something different from itself. In contrast, a living system is truly autonomous in the sense that it is an autopoietic machine whose continual interactions between components and environment, their transformations and destruction regenerates and maintains the system to be viable, in an emergent fashion, driven by the need to fit with environmental variability constraints. The result will be what Varela has called “a history of mutual congruent structural changes”.

Although recent work from Joint Cognitive systems engineering discusses issues like autonomy, resilience, variability and adaptation, much prevention effort is still spent on control mechanisms and how to anticipate breakdown. However, from our point of view, attempting to predict and control the breakdown sterilizes the new approach developed above. The results captured in this chapter support the idea that studying both the behavior of the system and the communication process provides markers of the system‘s adaptation and inadequate adaptation and, in turn, will help to develop adaptive technology that enhances coupling between agents and their environment.

References

Amalberti R. (1996). La conduite des systèmes à risques.Paris : Presses Universitaires de France

Arbous, M. S., Grobbee, D. E., van Kleef, J. W., de Lange, J. J., Spoormans, H. H. A. J. M., Touw, P., Werner, F. M., & Meursing, A. E. E. (2001). Mortality associated with anaesthesia: a qualitative analysis to identify risk factors. Anaesthesia. 56(12): 1141-1153.

Bainbridge L. (1987). “The ironies of automation,” in New technology and human error, J. Rasmussen, K. Duncan and J. Leplat Eds. London: Wiley, 271-283.

Bowlby J. (1973). Attachment and loss. Vol 2 : Separation. New-York : Basic Books.

Bressolle MC, Decortis F., Pavard B., Salembier P. (1996).Traitement cognitif et organisationnel des micro-incidents dans le domaine du contrôle aérien : analyse des boucles de régulation formelles et informelles. In : G. De Terssac, E. Friedberg (Eds.), *Coopération et conception.* Octares, Toulouse, p. 267-288, 1996.

Cadière, G.B., Himpens, J., Germay, O., Lupinc, N., Degueldre, M., Vandromme, J., Izizaw, & Bruyns J. (2000). Chirurgie laparoscopique par robot : Faisabilité. A propos de 78 cas. Le Journal de Coelio-Chirurgie, 33, 42-48.

Carpentier, A., Loulmet, D., Aupecle, B., Berrebi, A., & Relland, J. (1999). Computer-assisted cardiac surgery. Lancet, 353(9150), 379-380.

Cook R., and D. Woods D. (1996). Adapting to new technology in the operating room,” Human Factors, 38, pp593-613.

Cyrulnik B. (2003). Les murmes des fantômes. Paris : Odile Jacobs.

Hatton F, Tiret L, Maujol L, N'Doye N, Vourc'h G, Desmonts JM, Otteni JC, Scherpereel P. (1983). Enquête épidémiologique sur les accidents d'anesthésie. Premiers résultats. Ann Fr Anesth Réanim 2: 331-86.

Hollnagel, E., Woods D., Leveson N. (2006). Resilience Engineering : Concepts and Precepts. Hampshire, England: Ashgate Publishing.

Hubens, G., Coveliers, H., Balliu, L., Ruppert, M., & Vaneerdeweg, W. (2003). A performance study comparing manual and robotically assisted laparoscopic surgery using the da Vinci system. Surgical Endoscopy, 17, 1595-1599.

Hutchins E. (1995). Cognition in the world. Massachustts : MIT.

Kluger, M. T., Tham, E. J., Coleman, N. A., Runciman, W. B., & Bullock, M. F. (2000). Inadequate pre-operative evaluation and preparation: a review of 197 reports from the Australian Incident Monitoring Study. Anaesthesia, 55(12):1173-1178.

Le Moigne JL.(1999). La modélisation des systèmes complexes. Paris:Dunod.

Marescaux, J., Leroy, J., Rubino, F., Smith, M., Vix, M., Simone, M., & Mutter, D. (2002). Transcontinental robot-assisted remote telesurgery: feasibility and potential applications. Annals of Surgery, 235(4), 487-492.

Maturana, Humberto R. and Varela, Francisco J. (1980). Autopoiesis and Cognition - The Realization of the Living. Dordrecht, The Netherlands: D. Reidel Publishing.

Maturana, Humberto R. and Varela, Francisco J. (1987). The Tree of Knowledge - The Biological Roots of Human Understanding. Shambhala, Boston, MA. NB: All page numbers refer to the revised edition of 1992.

Nyssen AS, Javaux D. (1996). Analysis of synchronization constraints and associated errors in collective work environments. Ergonomics, 39: 1249-1264.

Nyssen, AS (2004). Integrating Cognitive and Collective Aspects of Work in Evaluating Technology, IEEE Transactions on Systems, Man and Cybernetics, Part A : Systems and Humans, 6,743-749.

Nyssen A.S. (2006). Coordination in hospitals: organized or emergent process?, Cognition, Technology and Work, Pasticier, G., Rietbergen, J. B., Guillonneau, B., Fromont, G., Menon, M., & Vallancien, G. (2001). Robotically assisted laparoscopic radical prostatectomy: feasibility study in men. European Urology, 40(1), 70-74.

Pavard, B. (1994). Système coopératifs : de la modélisation à la coopération. Toulouse: Octares.

Piaget, J. (1967/1992). Biologie et connaissance. Lausanne: Delachaux et Niestlé. (Première édition : 1967, Paris: Gallimard).

Savoyant A. , Leplat J. (1983). Statut et fonction des communications dans l'activité des équipes de travail (Statut and function of the communications in the activities of the workteams). Psychol.fr.,28,3: 247-253

Samurçay, R. (1995). Conceptual models for training. In J.-M. Hoc, E. Hollnagel & C. Cacciabue (Éds.), Expertise and Technology: Cognition and Human-Computer Cooperation. Hillsdale, NJ: LEA, 104-124.

Woods D.n Hollnagel E. (2006). Joint Cognitive Systems: Patterns in Cognitive Systems Engineering. New-York : Talor&Francis.

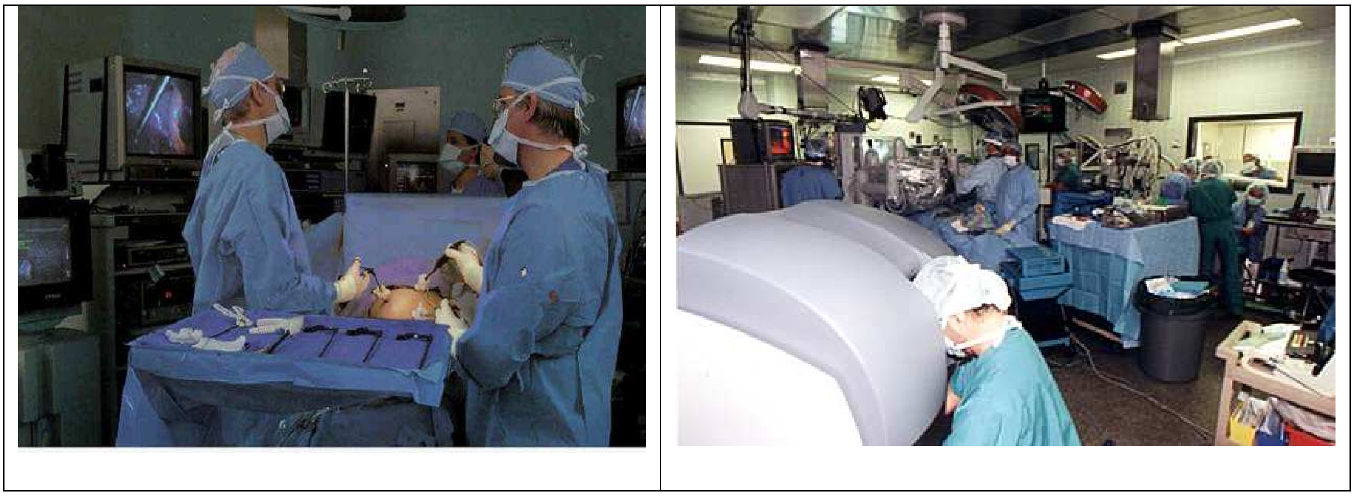
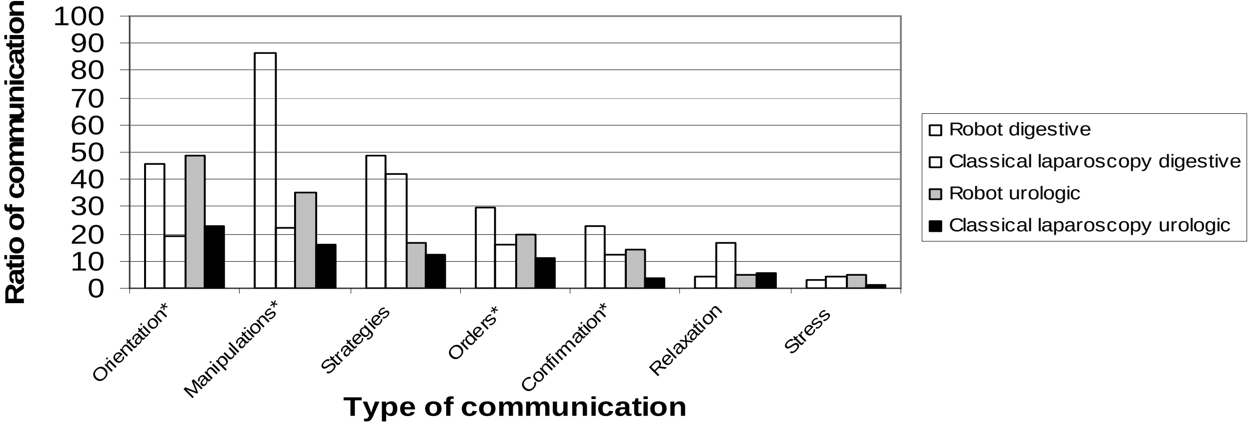


Fig. 1. Configuration of the operating theater in classical laparoscopy (left) and with the robotic system (right)

fig. 2. Communication during robotic and classical laparoscopy in digestive and urologic surgery



* Significant difference with $p<0.05$ (Mann-Whitney U test)

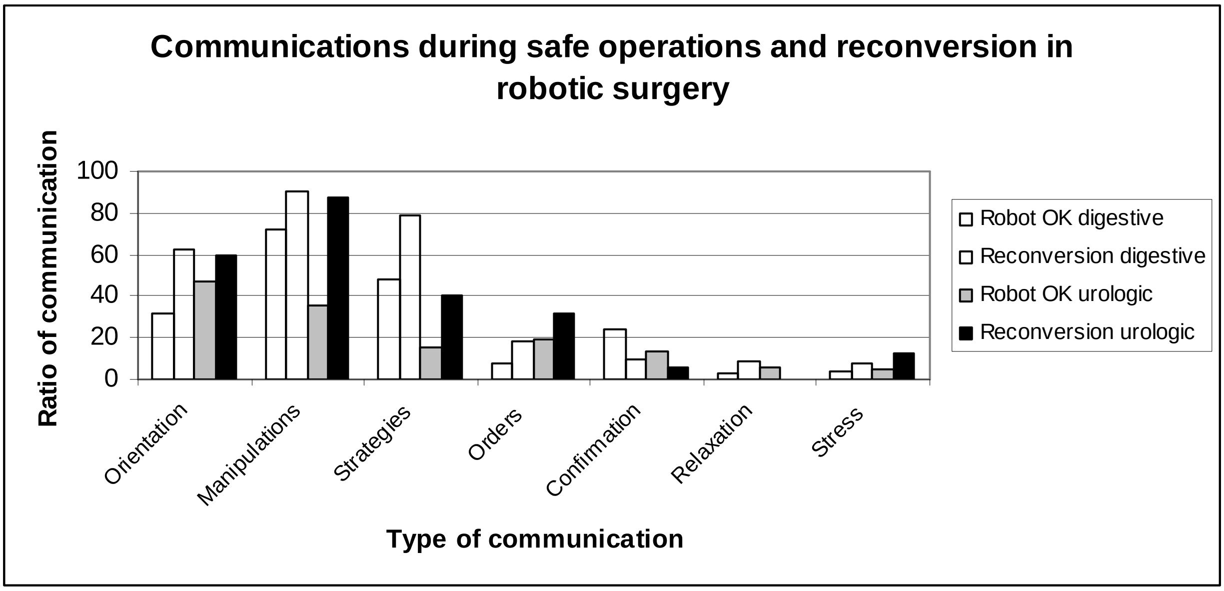


Fig.3. Communications during safe operations and reconversion in robotic surgery

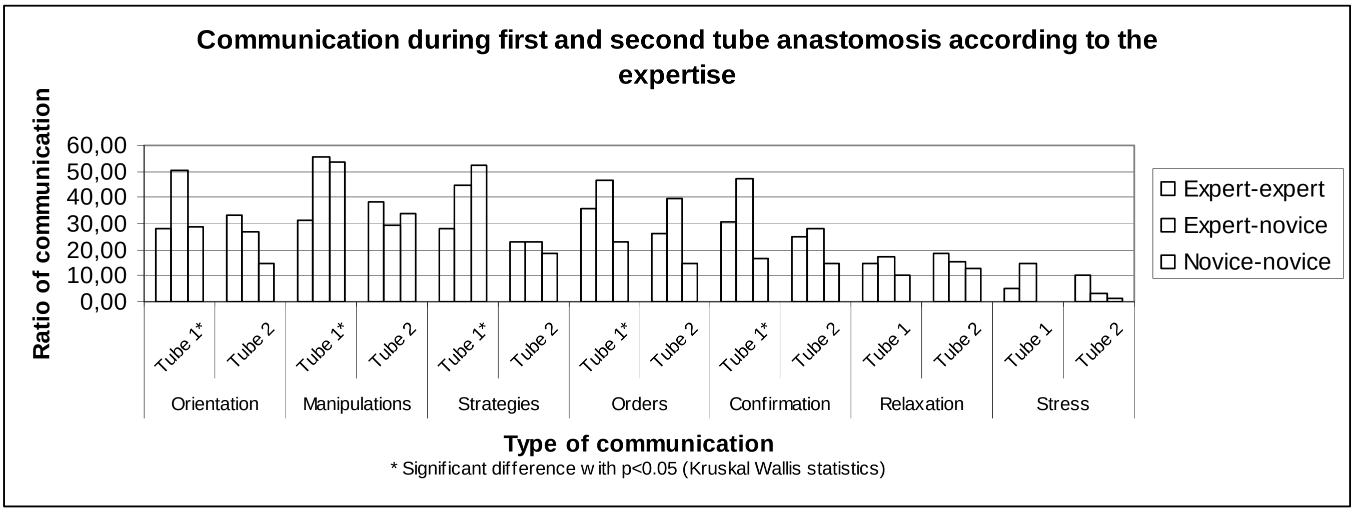


Fig.4 Communication during first and second tube anastomosis according to the expertise