HANDBOOK
OF
SOFT SKILLS
TRAINING
USING
VIRTUAL REALITY
AND
SERIOUS GAMES
FOR
SURGICAL TEAMS
IN THE
OPERATING ROOM

S4Game Consortium

HANDBOOK OF SOFT SKILLS TRAINING USING VIRTUAL REALITY AND SERIOUS GAMES FOR SURGICAL TEAMS IN THE OPERATING ROOM

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LIST OF ABBREVIATIONS

ANTS	Anaesthetists' Non-technical Skills
CT	Computerized Tomography
CVET	Continuous Vocational Education and Training
DODAR	Diagnosis, Option, Decision, Assign the task, and Review
EBSTAF	Edinburgh Basic Surgical Training Assessment Form
ECG	Electrocardiogram
HMD	Head mounted display
ICN	International Council of Nurses
ICT	Information and Communication Technology
IOM	Institute of Medicine
ITS	Intelligent Tutorial System
MERSQI	Medical Education Research Study Quality Instrument
MSF	Multisource Feedback
NDM	Naturalistic Decision-Making
NOTECHS	Oxford Nontechnical Skills System
NOTSS	Nontechnical Skills for Surgeons
OODA	Observe, Orient, Decide and Act
OR	Operating Room
OSATS	Objective Structured Assessment of Technical Skills
OTAS	Observational Teamwork Assessment for Surgery
PBA	Procedure-Based Assessment
PGY	Postgraduate Year
RPD	Recognition-primed decision making
RCSE	The Royal College of Surgeons of England
RNAO	Registered Nurses' Association of Ontario
RPD	Recognition-Primed Decision
SG	Serious Games
SLAM	Stop, Look, Assess and Manage
SPLINTS	Scrub Practitioners' List of Intraoperative Non-technical Skills
TDG	Tactical Decision Games
VR	Virtual Reality
WHO	World Health Organization

INTRODUCTION

It has been quite a long time since surgeons do not operate on their own. Surgeons have become a team player rather than only "a pair of good hands". Joint efforts of different health professionals, such surgeons, nurses, anaesthesiologists and orderlies, are essential to obtain the best results for the patient. Therefore, just technical skills are no longer enough in a surgical training programme. It is necessary to also bear in mind that the non-technical or soft skills are also key on the surgical performance.

Non-technical skills (NTS) or soft skills, terms that will be used indistinctly in this handbook, are interpersonal (e.g. communication, teamwork, leadership), cognitive (e.g. decision making, situation awareness) and personal resource (e.g. coping with stress and fatigue) (Flin *et al.*, 2008). They have been proved important in a wide range of high-risk work environments, such as aviation, industry or military. In these domains, information might be fragmented, in situations with sudden changes, where time pressure might be intense, and errors might even have mortal consequences.

The human factor plays an essential role and it must be acknowledged the existence of human bias and limitations in terms of attentional resources, memory capacity or situation awareness. So even the most expert and best-trained professional might make mistakes. In this regard, the "Swiss cheese model" (Reason, 2000) is a well-known model in risk analysis and management. In this model, each layer represents a barrier or safety measure, while holes represent errors and mistakes on them. When a set of holes align through the different layers, then an accident occurs **(Figure 1).**
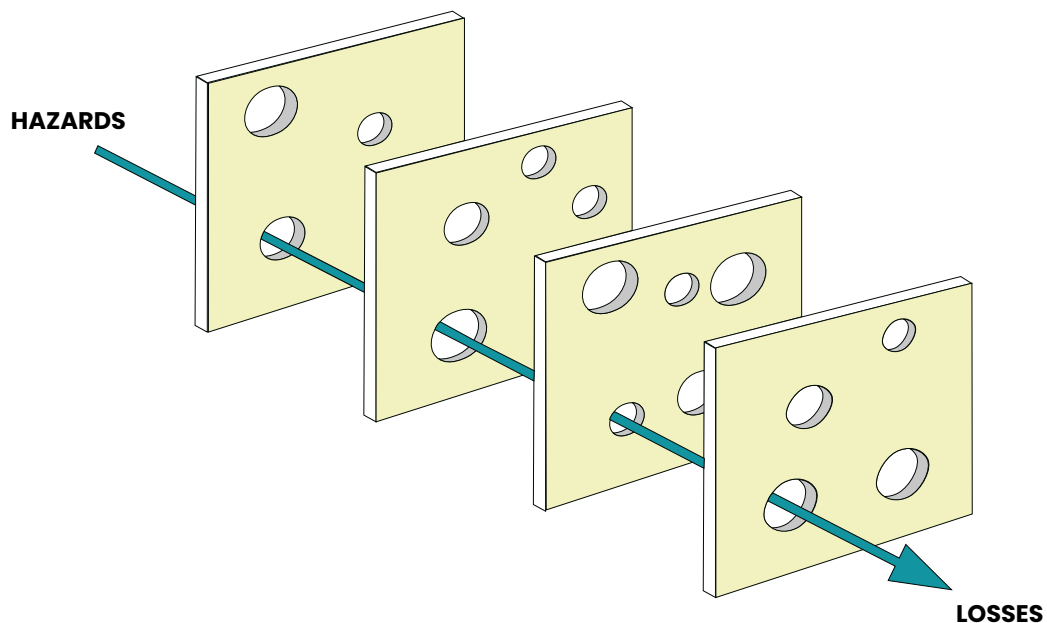
Figure 1. *Swiss cheese model. Source: Jesús Usón Minimally Invasive Surgery Centre.*

Many adverse events in an operating room (OR) occur due to human errors, which better training in soft skills can potentially prevent, resulting in a reduction of patient morbidity and mortality (Siu *et al.,* 2016). Current methods for soft skills training are e-courses, e-games or seminars at Continuous Vocational Education and Training (CVET) schools, using best practices, discussions, consultations, model situations or case studies. This training in surgery has not been standardized yet and still presents room for improvement and development of training tools and methods (Ounounou *et al.,* 2019). Thus, CVET of surgical team members in soft skills is still a must. Besides, new technologies for training, such as virtual reality and serious gaming, are still not widely used for surgical training and more particularly for soft skills training.

Virtual reality (VR) is a disruptive technology with great social impact, which offers visual and audio immersion using a head-mounted display that shows 3D images, so senses are artificially stimulated and deceived to accept another reality. The applications of VR go beyond the entertainment industry and can be applied in very disparate fields such as military, healthcare, construction or education. In surgery, these head-mounted displays have been used for image guidance and augmented reality, data display, communication, and education/training (Rahman *et al.,* 2019).

Serious games (SG) are games with educational goals that provide learners with an innovative, entertaining way of learning; helping them to understand complex problems and train multiple circumstances in several fields. SG also provide safe mechanisms for CVET in healthcare (Gentry *et al.,* 2019). Teachers acknowledge their great potential and are willing to use them. Besides, the improvement of the underlying technology increases the use of SG. Surgical training has already benefited from SG, for the acquisition of psychomotor skills, by applying gamification concepts while using regular simulators (Kerfoot and Kissane, 2014), or addressing team working (Kreutzer *et al.,* 2016). In comparison to expensive simulators or OR costs, SG provide a relatively cheap, safe environment with a wide variety of cases for health professionals in general (Wang *et al.,* 2016) and surgical skills training in particular (Graafland *et al.,* 2012).

Therefore, the aim of this handbook is to assist CVET teachers, trainers and their institutions to organize training activities on soft skills for surgical teams, so the main target groups are health professionals working in the OR: surgeons, nurses and anaesthetists, who want to improve their soft skills.
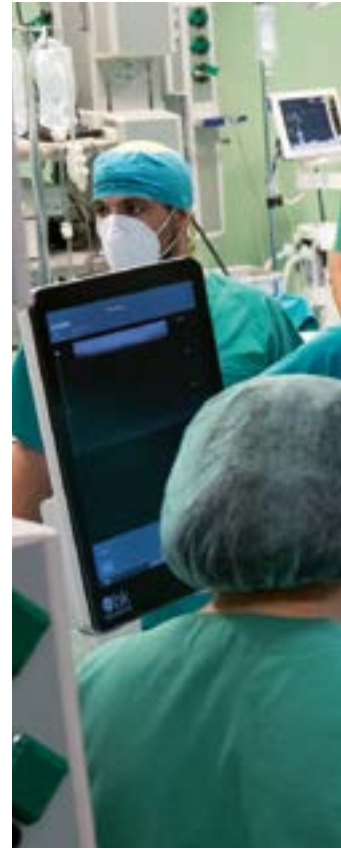
This handbook is structured in two parts. Part I is focused on establishing the methodological guidelines for soft skills training for surgical teams using VR and SG. It starts with a contextualization of the three main pillars: 1) the surgical team, 2) the soft skills and 3) VR and SG for training. Afterwards, each skill is addressed in a section, focusing on their particular theoretical concepts and using examples to bring the reader closer to the surgical reality.

The second part is eminently practical. It gathers 10 practical cases to train soft skills using SG and VR. Each case is fully described, together with the necessary resources. It is intended that any CVET teacher, trainer or mentor might use these cases to train soft skills in their institutions.

Contents presented in this handbook are not universal truth, therefore some readers might agree while others might disagree on the training methods and proposed activities. Even though, the global message remains out of the question: soft skills must be trained to improve the work of the surgical team, which eventually will lead to a better patient outcome and increased patient safety.

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PART

1. THE SURGICAL TEAM

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ROLES IN THE SURGICAL TEAM

Personnel of the operating room are: members of the surgical team and members of the anaesthesia.

Surgical team can be divided into sterile (scrubbed) personnel: surgeon, assistant surgeon, scrub nurse and non-sterile, non-scrubbed circulating nurse.

Surgeon: responsible for leading and performing the intervention.

Surgeon has the one person's responsibility for the whole surgery. Thus, for setting up the indication of the operation, for choosing the optimal time of operation, for carrying out the operation accepting the professional rules of surgery, for managing the early postoperative complications (bleeding, wound healing disturbances, anastomosis, insufficiency, etc.) and for the necessary surgical corrections at a later time (e.g. for scheduled multi-stage serial surgical intervention).

Surgeon is a specialist in a given field of surgery, who carries out the interventions with great responsibility, according to his/her best knowledge and according to the rules of the profession (guidelines of surgical college of specialists). He/she also has to fulfill the requirements of the Health law and do his/her work with the utmost care and diligence.

The attending doctor can also be a specialist-in-training, who can perform an operation only under supervision of a specialist. All important decisions regarding the patient, beginning from the hospital admittance until the discharge of the patient must be discussed with the specialist and the specialist has to give his/her opinion.

The operation is a teamwork, so at the end of the operation, the surgeon says thank for the work of the participants, and it is the correct thing that the assistants says thanks for the participation and thus for learning opportunities. It is important to note that despite the fact that the participants of an operation are working together as one team, there is no democracy in the operating room!

Only the person who carries the responsibility has the competence of decision-making and the right of giving commands (especially in critical situations). In the context of the operation, this person is the surgeon. Anaesthesiologist can also take over the command: for example, he/she can suspend the operation if the patient has to be resuscitated on the operating table.

Assistant surgeon: assists the chief surgeon during the procedure.

The assistant surgeon is a direct aid to the surgeon. He/she is usually a specialist or a specialist-in-training. If it is expected during the operation that a frozen section specimen will be sent for histological examination, the first assistant will check before the operation with the institution, who will examine the sample (e.g. pathology), and fills the required formulas. During the procedure the first assistant stands usually opposite to the surgeon during the whole operation. He/She performs all of the most basic surgical duties, allowing the surgeon to focus on the highly technical procedures. He/She has the following tasks: grasping and holding the tissues when the surgeon is preparing, knotting a ligation, or removing the haemostatic forceps after ligation, holding the thread when an anastomosis is made, etc.

These technical tasks have to be made in such a way that he/she helps the surgeon, but his/her hands should not disturb him/her. Surgeon can allow the experienced first assistant to perform certain phases of the operation (e.g. opening and/or closing the abdominal cavity).

Assisting for operations serves the young specialists-in-training to learn a procedure. Apart from learning the technical details, he/she also can gain experience in observing decision making in certain situations. Assistant surgeon at the end of operation has to fill up a formula for each removed tissue sample and another one for bacteriological culture. He/she also writes the personal data of the patient and names of the operating team, type of operation in the documentation of operations. In various departments the documentation can be regulated otherwise. Documentation of operation is the task of the surgeon.

In a great intervention second assistant is also necessary. The second assistant introduces a urinary bladder catheter before scrubbing (if it is necessary at the given operation). After scrubbing he/she disinfects the area of operation and with the help of the scrub nurse, he/she covers the operating field with sterile drapes.

Figure 1.1. *Position of staff during a pelvic surgery. Source: Semmelweis University*

During the procedure, the main task of the second assistant is to provide an optimal exposure (holding the retractors) and handling the suction device. Before moving the retractors he/she has to ask for the permission of the surgeon, he/she should not change the position of retractors arbitrarily. Usually he/she stands beside the surgeon, but usually he/she can see the least of the operation (especially if the surgical field lies deep). The medical students usually have the role of second assistant, if they are participating in operations. Although holding the retractors can be a boring task, it is an important possibility of learning and following the decision making.

In pelvic surgery, the surgeon and the scrub nurse stand on the left side of the patient, opposite the first and second assistant and the anaesthesiologist stands in the background **(Figure 1.1)**.

Scrub nurse: in charge of managing the instrument table and providing surgeons with the tools.

Before scrubbing, he/she checks the cleanliness of the operating room, and also controls that all materials, tools, appliances that are necessary for the planned intervention are available. Thereafter he/she is scrubbed in; he/she opens or asks someone to open the Schimmelbusch boxes, which are placed on the stands and checks the indicator strips, which show the validity of sterility. If the contents of the boxes are sterile, then he/she takes out an surgical gown and with the help of the circulating nurse, he/she puts it on. He/she puts on sterile gloves and covers the large table of instruments with sterile sheets. Thereafter he/she opens the basic tray of instruments or operation-set and takes out the sterile sheets and towels, which will serve for surgical draping: creating an aseptic area for operation, the so called sterile field. He/she also prepares dressing materials, gowns, etc. With the help of the circulating nurse he/she receives the single use sterile materials (e.g. suture materials, surgical gloves, etc.). When an operation is carried out in local anaesthesia, he/she prepares the appropriate drugs, revises their contents and expiration time! He/she covers the Sonnenburg table with sterile sheets. He/she organises all the instruments which can be found on the table according to the local habits.

In the meantime, he/she gives the necessary instruments for the assistant surgeon (sponge holder, sterilised cup or bowl, sponges).

Then he/she gives sterile gowns and gloves for all the participants of the operation with help of the circulating nurse.

There is a traditional, unwritten rule of taking the sterile gowns: surgeon, first assistant and second assistant. All members of the operating team and the scrub nurse are covering the operating field with sterile sheets and towels. In certain types of surgery (e.g. thyroid gland operations, when the sterile draping is put on from the direction of the chin), the sterile sheets can be fixed to the skin of the patient with a stitch. In such a case all the instruments (needle holder, needle, and scissors) used for the skin fixation cannot be regarded as sterile any longer, so it is not allowed to use them any longer and they have to be removed.

The scrub nurse continuously keeps on eye on each member of the operating team and he/she is monitoring the process and appropriate execution of scrubbing, disinfection, putting on sterile gowns, draping.

Particular attention is paid to the less experienced persons (e.g. scrubbing nurses in training, medical residents) and all those, who are only occasionally involved in surgical procedures (e.g. medical students).

The scrub nurse covers the large table for instruments with sterile sheet. All those instruments and materials which might be necessary occasionally for an operation are placed on this table. Then the Sonnenburg- table is pushed close to the patient (usually from the direction of the patient's feet). At this time all the members of operation took up their position around the operating table.

TASKS OF THE SCRUB NURSE DURING THE OPERATION:

1   **MAINTAINING OF ASEPSIS:**

CLICK ON THE NUMBER TO SEE CONTENT

2   **PROVIDING INSTRUMENTS:**

CLICK ON THE NUMBER TO SEE CONTENT

3   **INDEPENDENT PROFESSIONAL RESPONSIBILITY:**

CLICK ON THE NUMBER TO SEE CONTENT

The place of the operating staff and the main equipments in the OR is shown in the picture **Figure 1.2**.

1. Operating table	7. Hospital orderly	13. Kick bucket
2. Surgeon	8. Operation field	14. Diathermy
3. First assistant	9. Sonnenburg table	15. Anaesthesia screen
4. Second assistant	10. Back table for instruments	16. Anaesthesia machine
5. Scrub nurse	11. Shimmelbusch boxes	17. Table for anaesthesia
6. Anaesthesiologist and the assistant	12. Suction device	
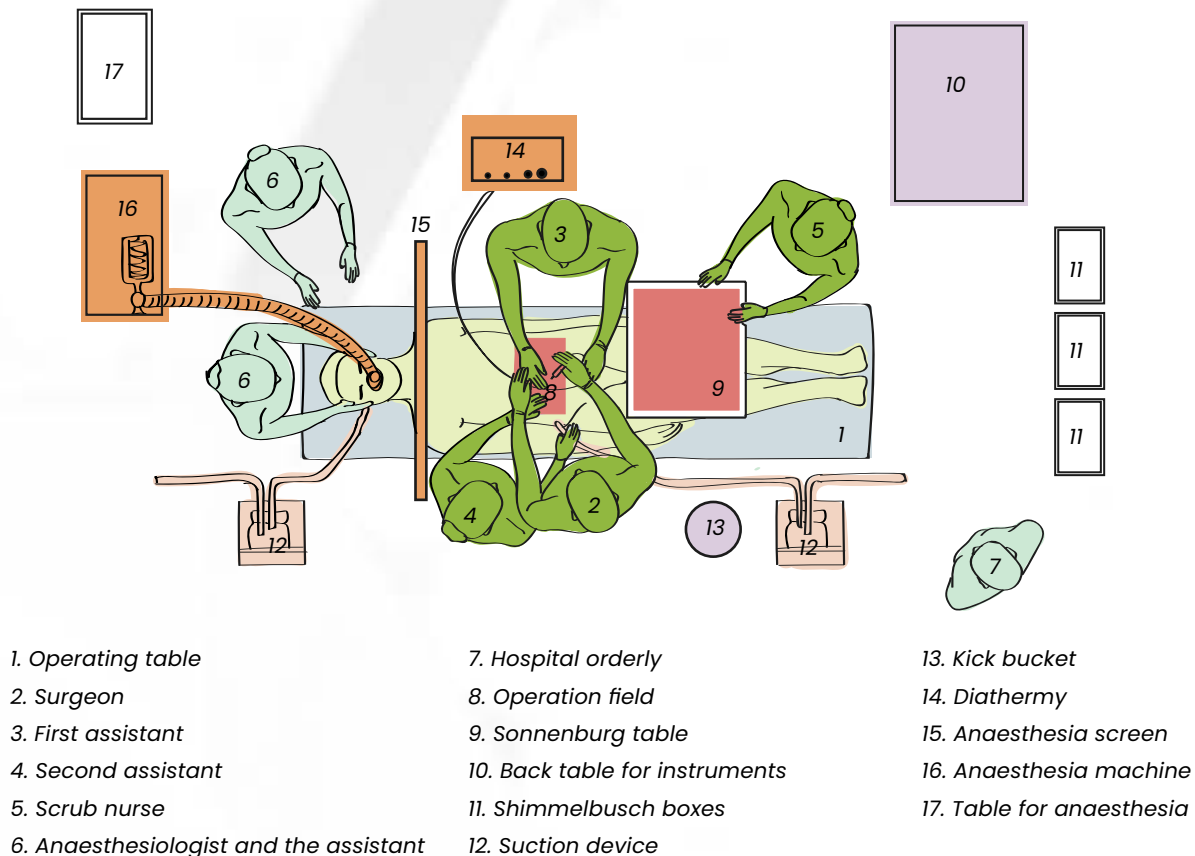
Figure 1.2. *Location of operating staff and equipment in the OR (Wéber et al., 2015).*

Circulating nurse or hospital orderly: managing and implementing activities outside the sterile field.

The circulating nurse has many tasks before the operation: he/she has to shave the area of operation of the patient, who was already transported into the operating room. He/she lays the patient on the operating table, places the extremities of the patient in stable position. He/she also puts the instrument table cushions on the operating table and mounts the inactive electrode of the diathermy on the patient. He/she also takes in or all necessary devices, which might be used during the given operation.

During the preparatory work, he/she helps in gowning of the already scrubbed nurse and the other members of the operating team.

He/she assists in introducing catheter in the urinary bladder. After the operating field has been disinfected, he/she takes the used tools and materials. He/she opens and gives the necessary single use materials and the individually wrapped instruments to the scrubbing nurse. The circulating nurse opens the wrapping of the instrument so that he/she touches only the outer surface and the scrub nurse opens the inner sterile wrapping. This rule applies to all double wrapped items, whether they have been manufactured so or they were packed in the central sterilizing unit.

The circulating nurse turns on the adequate devices (e.g. central suction system), equipment (e.g. operating lights) and connects the cables (e.g. active electrode of the electric knife) and tubes (e.g. sterile manual part of suction device). During the operation he/she gives the required fluids (e.g. sterile physiological saline or Betadine for rinsing) and materials (suture materials, textiles). If it is necessary, he/she changes position of the patient during the operation.

Figure 1.3. *Anaesthesiologist and an anaesthesiologist assistant with the anaesthesia machine in the background. Source: Semmelweis University.*

He/she handles the telephones in the operating room. He/she answers the calls, gets and forwards messages, and makes the necessary calls as well. According to local habits, he/she collects and counts the used textile (swabs, surgical sponge) and instruments, which were thrown in the kick bucket. At the end of the operation he/she checks the number of counted instruments and swabs with the scrubbing nurse. He/she secures the transport of the patient from the operating suite. He/she puts the removed tissues, which have to be sent for pathological, histological examination into formalin. He/she cleans the used instruments. The responsibility of unintentionally retained foreign bodies applies to all members of the operating team.

Members of the anaesthesia teams are: specialist of anaesthesia and assistant anaesthesiologist **(Figure 1.3)**.

Anaesthesiologist: responsible for inducing the anaesthesia and checking the vital signs of the patient during the procedure.

Anaesthesiologist or anaesthetist is a specialised physician, who is the head of the team that is performing local or general anaesthesia. The task of the anaesthesiologist is the relief or alleviation of pain of the patient during and after surgery and monitoring the patient's vital parameters and maintaining the adequate function of the vital physiological functions of the patient. The anaesthetist is also an expert of the intensive therapy, so he/she has experience in the care of the critically ill patients who are treated on the intensive care units. An important task is ensuring adequate pain relief for patients in the immediate postoperative period.

The role of anaesthesiologists has broadened during the last decades. They have to assess the patients before the surgical procedure, in order to identify high-risk patients and optimize their state during the procedure. Before the operation the anaesthesiologist reviews the results of preoperative examination, clarify the preoperative fasting: fluid and food intake (when did the patent eat and drink before the operation?).

He/she gives instructions to the patient, when and what is allowed to drink before operation. The anaesthesiologist informs the patient about the suggested method and process of anaesthesia. He/she decides how should the patient take his regular medication and prescribes the drugs for premedication.

The anaesthesiologist and the assistant of the anaesthesiologist receives the patient either in the preparation area of the operating block or in the operating room. They check the identity of the patient and put in an intravenous line (either in a peripheral or in a central vein). They give infusion and place and connect all the instruments (electrocardiogram –ECG–, blood pressure monitor, pulse oximeter, etc.), which are crucial for the monitoring of the patient during the operation.

The anaesthesia team tries to solve the anxiety of the patient who is still awake by talking continuously. When the patient notices the human atmosphere and presence of experts in the operating room, his/her anxiety usually decreases.

As a result of an appropriate general anaesthesia, the patient does not feel pain, he/she does not remember the operation, but in a short time after the end of the intervention his/her consciousness returns, he/she can swallow, talk, and he/she is able to move his/her limbs.

Thereafter according to the extent ("size") of the operation and the general condition of the patient, the anaesthetist decides whether the patient has to be observed in the recovery room, on the ward or in the intensive care unit. He/she accompanies the patient to the adequate location, hands over to the specialised personnel of the given unit, gives the most important information about the operation, the anaesthesia and the postoperative period and gives instructions about fluid replacement and medication of the patient.

Anaesthesia assistant: Anaesthesiologist assistants are highly skilled professionals who work under the direction of anaesthesiologists as part of anaesthesia care team. The anaesthesiologist assistant's responsibilities include:

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NEED FOR SOFT SKILLS TRAINING FOR THE SURGICAL TEAM

The high-level skill and excellent manual ability of the members of the team is self-explanatory. However, for an intervention not only technical, but soft skills are also necessary. Operative intervention requires special intellectual skills of all members of the surgical team and they have a special importance in the security of patient.

Unexpected events may often happen in the OR. In most cases these are not caused by technical failure, but human default. Non-technical knowledge, i.e. the appropriate intellectual skills, is the assurance of patient's security.

Survey of the operative activities shows that failures of communication in the surgical team or wrong decision lead frequently to malpractice (Green *et al.*, 2017, Newell *et al.*, 2015, Weller *et al.*, 2014). At the same time intellectual skill is an integral part of the ability of a surgeon with great experience.

The term "never events" got into the medical literature at around the turn of the millennium. This means avoidable events that are related to medical activity and that cause serious damage to the patient's health. They prolong the patient's hospital stay and/or their treatment requires further intervention that might cause inconveniences. They cause significant emotional or mental harm and are also harmful for the patient's working ability and quality of life, and in most serious instances they lead to death.

Nowadays in the United States, where the standard of medical care is among the highest, there is an annual incidence of about 50.000 – 100.000 hospital deaths that are the consequence of otherwise preventable iatrogenic failures. This figure means that it is the 8th most frequent cause of deaths. This is more than death rate in car accidents, breast cancer and AIDS. Investigations show that mistakes made in surgical interventions lead in 6,5% to patient's death. According to 2012 data in the USA in every week there are 20 inappropriately performed surgical interventions, 20 times wrong site surgery; i.e. the operation is not done on the affected site, and 39 times per week foreign body (e.g. textile, instrument) is left in the patient. Typically, these events occur mostly in hospitals with large patient turnover (Brennan *et al.*, 1991, Kohn *et al.*, 2000).

In health care, "error" or "mistake" may have consequences on human life. For this reason, the World Health Organization (WHO) established a simple procedure that helps to prevent a substantial part of surgical errors. Safe surgery saves life - this is propagated by the WHO. This program recommends the introduction of surgical safety checklists. This consists of three distinct phases. The items of this list must be read aloud by a member of the staff.

1   **PHASE ONE:** *"Before induction of anaesthesia"*. The patient is awake, at least the anaesthetist and a scrubbing nurse are present. Check:

CLICK ON THE NUMBER TO SEE CONTENT

2   **PHASE TWO** *"Before skin incision"*. This must be read aloud in the presence of the whole staff (surgeons, anaesthetists, scrubbing and circulating nurses):

CLICK ON THE NUMBER TO SEE CONTENT

3   **THIRD PHASE.** *"The end of the operation – before the patient leaves the operating room"*. This check is conducted by the nursing staff, before the patient and the surgical team leaves the operating room. Nurse verbally confirms the following:

CLICK ON THE NUMBER TO SEE CONTENT

The answers given to these questions are recorded in a list and put it in the patient's notes. In each individual country there may be further questions, depending on the particularities of the country.

The value of the recommended safety check list is showed by the fact that in a review (English *et al.*, 2018) made in eight hospitals in different parts of the world in 4000 patients for 2 years the hospital mortality rate decreased by 50%! In a recent review in the US the number of patients who died in hospital was reduced with 50.000 ever since the introduction of the safety check list, and by this way 12 billion dollars were saved. In a meta-analysis published in 2012 (Fudicka *et al.*, 2012) the data of 20 clinical studies are published; these data give evidence of the value of the check list. They also note, that apart from providing a safer control, the check list improves the communication between the members of the surgical team and improves the culture of "safety attitude".

2. SOFT SKILLS INCLUDED IN THE HANDBOOK

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Currently, soft skills are crucial in various areas. Unfortunately, with their growing importance, their training and practising is not emphasised correspondingly. King, Anson, & Kahanov (2019) conducted a research proving that service-learning increased professionalism, career skills, empathy, as well as community awareness. This was done among medical students who were able to more efficiently use and apply their knowledge which was moreover relevant to the given environment. Hayes, Bussey, & Graham (2019) emphasise that situated and experiential learning are under-researched. Their study highlights that the tacit knowledge, its implication and recognition is beneficial in supporting the soft skills and critical thinking skills in particular. Knowledge and skills within not only academic, but also medical curricula should be continuously developed and mastered. Vaughan (2017) recommends apprenticeship for development of both soft skills and vocational identities. He emphasises that the apprenticeship which is applied in the healthcare lead to overcoming of personal and professional challenges moves the 'vocational thresholds', i.e. the capabilities within the

particular area. The role of mentors, teachers and leaders is significant as well (Vaughan, 2017). Vaughan (2017) speaks about the importance of apprenticeship which provides the field-specific and learnable soft skills and dispositions needed for proficiency increase of any team role. The soft skills analysed within this chapter comprise teamwork, decision making, situation awareness, leadership and communication and interaction.

SITUATION AWARENESS

The development and the maintenance of the dynamic situation awareness and the risks represent the activity based on gathering information from multiple sources from the task environment, understanding and interpreting the information meaning and the use of it to think ahead about what may happen consequently. The whole process includes the following steps:

- Gathering information.
- Understanding information and risk status (using mental models and memory).
- Anticipating future state/developments.

Gathering information, which is also crucial for the decision-making process, consists of gathering all the essential information available in the given context and situation. Within this step, it is important to consider the sources of the information well and to separate the facts which are completely substantiated facts and the facts based, to a lesser or greater extent, on assumptions (Endsley, 2015).

Understanding information and risk status follows after gathering information. The team members should evaluate the information well and draw conclusions based on the follow-ups. Information can be risky in terms of possible misinformation and misunderstanding. This can occur both consciously and unconsciously. The conscious devaluation of the information happens when the information source devalues the information or manipulates with it somehow. The unconscious devaluation of information is primarily related to the mental model and memory of an individual (Stout, Cannon, & Bowers, 2017). The person who passes the information on can act in good faith that all the information he/she gives us is true, but he/she can only pass on a fragment or parts of the facts that can be greatly distorted. The mental model represents the representation of the surrounding world, which is associated with the perception and observation of reality by a person. A model, which at the outset may lack important aspects, is then stored in memory, where the information may be further degraded before it is transmitted (Holcombe & Kezar, 2018).

Anticipating future state means predicting future events. This ability depends not only on knowledge of current information, but also on considerable experience, complex perception of the problem, as well as on intuition. It is a soft skill that requires a significant amount of heuristics and can only be assumed by a professional or knowledgeable employee (Taylor *et al.*, 2016).

DECISION MAKING

Decision making includes the skills for diagnosing the situation and reaching a judgement in order to choose an appropriate course of action.

Decision making is a process that allows to solve problems optimally. Each decision-making process should consist of several steps, for instance:

- Identify the problem.
- Gather information.
- Identify alternatives.
- Weigh the evidence.
- Choose among alternatives.
- Take action.
- Review the final decision.

Particular problems might occur during the decision-making process. The first pitfall concerns the amount of information. This can include two extremes - if there is too much or too little. If there is a lot of information about the problem, it can cause confusion or misunderstanding. An important part of the decision-making problem might be omitted due to the overload of information. On the other hand, with the insufficient information might lead to impossibility to make the optimal decision, because all the necessary aspects that influence or determine the decision and its consequences are not known and available (Garg, 2017).

Another difficulty of decision making may be the misunderstanding of the nature of the problem. This is especially the case when the cause of the problem or all aspects that are affected by the situation are not determined appropriately. For this reason, it is crucial to devote enough time to the problem identification and its influential factors and interconnections.

Even if all the steps are taken correctly, all relevant information is obtained, and all the criteria are considered, the outcome of the decision may not lead to the expected effects. Therefore, it is important to evaluate the expected result objectively and to analyse its effectiveness after the implementation of the decision (Hargraves *et al.*, 2019).

It is also crucial to take into account the specifics of the particular case. A different approach should be applied when there is a decision problem that needs to be resolved as soon as possible, compared to a problem that can be solved in the longer term. The consequences of potential bad decision should be considered as well. The bad decision might just lead to the postponement of the deadline or a slight increase in costs. Nevertheless, this can result in the consequences influencing the operation of the whole company, or in the case of health care patient's life.

TEAMWORK

Teamwork contains skills for working in a team context to ensure that the team has an acceptable shared picture of the situation and can complete tasks effectively. The needed skills cover co-ordination, co-operation and conflict resolution. Nevertheless, the teamwork comprise for example understanding of member's own role within the team, coordination of tasks, considering and helping others, negotiating and resolving conflicts.

There are a lot of theories about team roles, distribution and placement. This issue has a significant impact on the functioning of the team, its performance and satisfaction of all members. Mathieu *et al.* (2015) define several roles. These include organiser (acts to structure what the team is doing), doer (willingly takes on work and gets things done), challenger (pushes the team to explore all aspects of a situation), innovator (regularly generates new and creative ideas and strategies), team builder (helps to establish norms, supports decisions and keeps a positive work atmosphere) and last but not least connector (bridges and connects the team with other subjects) (Tohidi *et al.*, 2017).

Coordination of tasks, both within the team and with other entities, is critical to ensure the appropriate function of the team. Each task must have a clear and specific goal with set deadline. Moreover, this goal must be achievable. The task is then assigned to a particular member, who is responsible for fulfilling it and transmitting information in case of a problem. The employee assigned to the task must have sufficient skills and authority to complete the task. Task coordination then takes place in several lines and at different levels. At the highest level, it involves communicating with the organisation's strategic elements/organisational units. The task should be consistent with the intention. It is also necessary to coordinate tasks within one project or tasks with the same goal. Related to this, the coordination of tasks between individual teams, which differs in the need of team managers or their coordinators to communicate, represent another important issue. The last coordination is the coordination of the task itself and its current status (Owen, Hickey, & Douglas, 2009).

The ability to be substitutable in the team is another important aspect. The team must be able to represent each team member, at least to some extent. It is also important for cooperation and for the team to always have a member who is able to help a colleague at least partially to solve a problem with more time than originally determined (Ramaswamy *et al.*, 2017).

Regarding conflict resolution and discussions, the team leader must ensure that all team members respect the basic rules of communication.

COMMUNICATION AND INTERACTION

The communication skills ensure the transmission and reception of information, thoughts and feelings. These are verbal, i.e. spoken or written, and non-verbal activities, which include, for example, body language. These capabilities can be divided into the following categories:

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LEADERSHIP

Leadership includes the activities like leading the team and providing directions, demonstrating high standards of clinical practice and care, and being considerate about the needs of individual team members. Leadership as well as supervision imply the need to possess and develop the skills for managing, directing, monitoring, and supporting a team in order to accomplish tasks for set targets.

Every capable leader should have the leadership skills including the delegation, communication, authority, proper use of feedback, fairness and positive motivation. The delegation means the opportunity

to provide employees some extent of self-sufficiency. They get the opportunity to express their opinions, participate in decision making and at the same time have the responsibility. The employees feel important under such leadership and at the same time, the managers express the confidence in them. This provides considerable motivation and increases efficiency (Harms *et al.*, 2017).

Another, probably the most important tool for a leader, is communication. From the manager-employee perspective, three levels of communication can be defined. The first is listening, where the supervisor let the employee express his/her opinion, respond to an issue without pressure on the worker. The next level consists of the leader's effort to understand the employee's perspective. The last level is crucial. It is represented by the approach of the leader who treats the employee as an equal partner (Vu, 2016).

Another part of communication: feedback is also very important. It is also related to the reward schemes. Appropriate appraisal as well as criticism should be delivered sensitively and efficiently. Criticism is, of course, essential for increasing efficiency and improving work processes, but poor criticism usually paralyses and demotivates its receiver. Therefore, it is important that the worker can defend and justify himself or herself (Mitchell & Reiter-Palmon, 2017). Ibrahim *et al.* (2018) exemplify the problem-based learning as a tool for support the knowledge and soft skills acquisition.

In order to be effective and to keep positive atmosphere at the workplace, every leader should be fair to all his subordinates. He/she should treat each employee equally, in case of conflict or problem, listen to all parties and be able to acknowledge his/her own mistake.

The last "duty" of the leader should be motivation. The manager should create a pleasant work environment that is optimistic and energetic. The leader might be supported by developing the strengths of his/her subordinates as well as being himself or herself effective and positive. Moreover, the goals he/she sets could be challenging, but have to be always realistic (Harms *et al.*, 2017).

TRADITIONAL TEACHING METHODS FOR SOFT SKILLS

There are currently different approaches that can be used to teach soft skills in any field. It is up to the trainer to select the most convenient under his/her methodological approach:

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In surgery, most common modalities have been recently reviewed by Ounounou *et al.* (2019). In this case, high fidelity simulation outstands over low fidelity simulation, didactic teaching and crisis resource management. These modalities are combined with different assessment methods, mainly NOTSS scoring system and NOTECHS scale (the reader is referred to section 4 for further information on assessment methods).

3. USE OF VIRTUAL REALITY AND SERIOUS GAMES FOR SOFT SKILLS

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STATE OF ART OF VIRTUAL REALITY

Virtual reality (VR) is a technology that, although it is not a new technology (its first developments date back to 1960), is in full swing and is settled in the general consumer market.

It is a computer technology that aims to simulate an environment, either real or imaginary, and translocates the user inside. This user will have a physical presence within that environment, being able to interact with it. Virtual reality tries to create complete sensory experiences.

The main features of virtual reality are:

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Virtual reality devices have reached the general consumer. Since 2012, in which Palmer Luckey developed and financed through Crowdfunding his Oculus Rift, obtaining more than 10 times what was required in its collection (2.4 million dollars) (Engadget, 2004), the number of devices has grown rapidly. This has been possible thanks to a decrease in the development costs of the devices and the force generated by their demand and expectations of the general public.

There can be considered two types of technology in the use of VR today. The first is more advanced and complete:

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Figure 3.1 shows a comparison among several devices that are currently on the market that belong to the first type of VR devices.

PRODUCT	OCULUST QUEST	NINTENDO LABO VR KIT	SONY PLAY-STATION VR	HTC VIVE	OCULUS GO	OCULUS RIFT S	HCT VIVE COSMOS	LENOVO MIRAGE SOLO WITH DAYDREAM
	$399.00	$79.99	$276.99	Best Price	$199.00	$399.00	$699.99	$299.00
BEST FOR	VR Newbies and Gamers	Nintendo Switch Owners	PlayStation 4 Owners	Stream Gamers	Curious VR Newbies	PC VR Users	Dedicated PC VR Fans	Google Daydream Users
HEADSET TYPE	Standalone	Mobile	Tethered	Tethered	Standalone	Tethered	Tethered	Standalone
CONNEC-TIONS	None	None	HDMI, USB 2.0	HDMI, USB 3.0	None	DisplayPort, USB 3.0	DisplayPort, USB 3.0	None
RESOLUTIONS	1,444 by 1,600 (per eye)	1,280 by 720 (total)	960 by 1,080 (per eye)	1,080 by 1,200 (per eye)	1,280 by 1,440 (per eye)	1,280 by 1,440 (per eye)	1,440 by 1,700 (per eye)	1,280 by 1,440 (per eye)
REFRESH RATE (HZ)	72	60	120	90	72	80	90	75
MOTION TRACKING	6DOF	3DOF	6DOF	6DOF	3DOF	6DOF	6DOF	6DOF (3DOF control-ler)
CONTROLS	Oculus Touch	Joy-Cons	DualShock 4, PlayStation Move	HTC Vive motion con-trollers	Oculus Go Controller	Oculus Touch	HTC Vive Cos-mos motion controllers	Daydream Controller
HARDWARE PLATFORM	Android	Nintendo Switch	PlayStation 4	PC	Android	PC	PC	Android
SOFTWARE PLATFORM	Oculus	Nintendo Labo	PlayStation 4	Steam VR	Oculus	Oculus	Steam VR	Google Daydream

Figure 3.1. *VR Headsets of 2019 (Pcmag, 2019).*

This technology has evolved exponentially in recent years, with 2019 being an important year which has been a inflection point. The cause of this milestone is the release of different virtual reality glasses of high resolution and immersion capacity, completely wireless and with a lower and affordable price for the general public.

These VR headsets can be used in turn with a series of devices that enhance experiences. Leap Motion is a motion sensor capable of capturing gestures made with the user's hands. This achieves an interaction between the user and virtual reality making possible a new user experience different from the traditional one, through the keyboard and mouse. Another of the advances are the VR walkers. They are similar to gymnastics walking belts, which allow users to move safely and freely in any direction, which facilitates 360 º movements. The most widespread platform is Virtuix Omnique, which has a concave shape where users' feet rest and where they slide as they walk. User movements can be limited by a safety harness with which to avoid any accident **(Figure 3.2)**.

Figure 3.2. *Virtuix Omni Platform. (www.vituix.com).*

STATE OF ART OF SERIOUS GAMES

A "serious game" is defined as that game which purpose is different from entertainment. Serious games are intended to simulate a real environment or event of any field and offer the user an interaction or reception of information through it.

Following the above definition, serious games can be distinguished from video games in that the main objective is not entertainment. This causes conflict for some authors (Jantke, 2010; Michaud, 2008; Ritterfeld *et al.*, 2009). These sources determine that the term "serious" comes from the role of the game of bringing experiences to the user, be it a message, information, knowledge, skills or general content; that is exposed to an environment that shows information through such experience or know-how, but that should not be removed from the definition of the first term: "game".

A game is considered as the union of three components: experience, multimedia and entertainment, as shown in **Figure 3.3**.
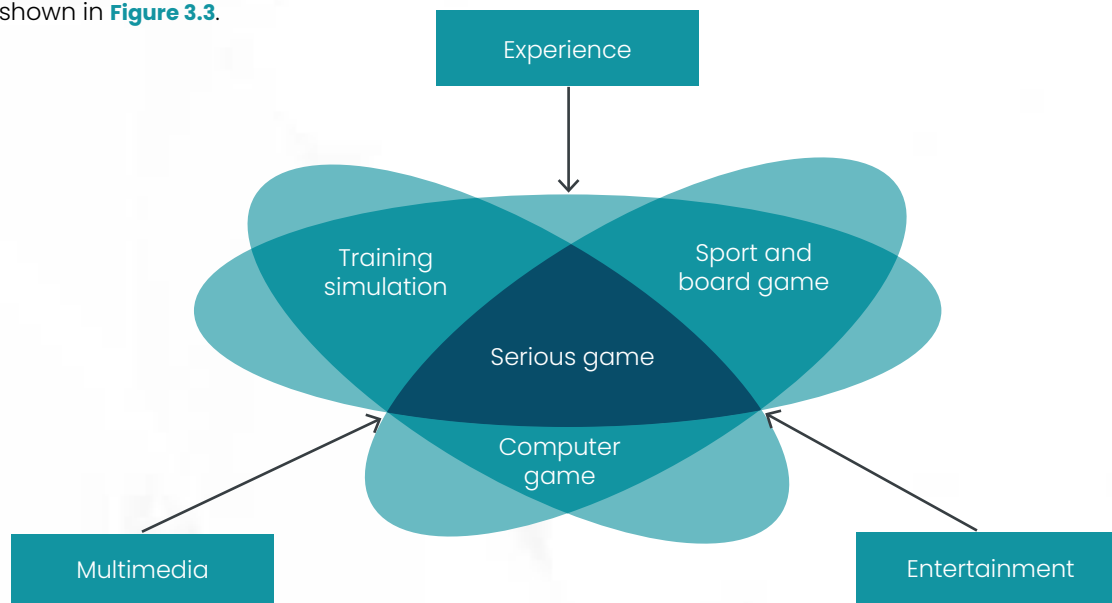
Figure 3.3. *Serious game components.*

Modern learning theories suggest that learning is most effective when it is active, experimental, problem-based and provides the user with an immediate response (Boyle *et al.*, 2011). Although experience is the fundamental pillar of serious games, it is therefore necessary to rely on multimedia and entertainment to be really effective.

Through serious games, students can develop soft skills, such as analytical skills, strategic thinking, decision making and communication (Susi *et al.*, 2007). It is also possible to use a multi-player game, with which to train teamwork competitions (Prensky, 2003).

It is worth noticed that the number of serious games published in the last 10 years has been multiplied by four (Michaud, 2010; Laamarti *et al.*, 2014).

Serious games have wide application in the field of medical training, where they are mainly related to the acquisition of theoretical knowledge and skills training (Asociación Española de Empresas Productoras y Desarrolladoras de Videojuegos y Software de Entretenimiento, 2015). They have great potential because they allow you to gain experience in risk-free environments (Akl *et al.*, 2013) for both medical staff and patients. In addition, because serious games have a global audience, they can contribute to transforming the traditional education of health professions.

The following is a summary of 3 systematic reviews carried out between 2016 and 2019 by different authors, whose purpose is to evaluate the effectiveness of serious games in the field of health compared to traditional learning.

In (Wang *et al.*, 2016), 42 articles of serious games applied in the field of health are identified and studied among more than 3,737 publications of serious games from different sectors. These serious games focus on health fields as different as geriatrics, nursing, radiography or neurology, among others. The study shows that most of the serious games reviewed (79%) propose to evaluate the "player" learning process. However, in most cases they do so in a lacking methodological approach and without a good evaluation design.

In a more recent study, Gorbanev *et al.* (2018) reduce to 21 the number of articles found on serious games or gamified applications in the field of health from a total of 494 identified publications. Of these studies, 16 are focused on knowledge and skills and the remaining 5 on satisfaction, attitudes, perceptions or opinions. For the most part, these studies used quantitative tools, such as surveys, and qualitative, as open-ended questions for the evaluation of learning. However, only 28.5% of the instruments had evidence of internal validity. Despite these methodological limitations, the statistical analyses used are correct (90.4% of cases) and measured objectively 76.1% of the time. This article concludes that serious games evaluated should be used as complementary tools of ordinary training. According to the Medical Education Research Study Quality Instrument (MERSQI) scale, it is not ensured that serious games are effective to a large extent despite the authors claiming that they are very useful pedagogical tools. Its effectiveness will depend on the quality, robustness and the good design of the educational game and the evaluation system.

In the revision by Gentry *et al.* (2019) 30 studies of a total of 30,532 citations are evaluated. 15 of the reviewed works compare educational games versus traditional learning, the results being inconsistent and generally with poor quality studies. However, the results of this research show that serious games can generate more knowledge, skills and satisfaction compared to traditional education.

BENEFITS OF USING VIRTUAL REALITY AND SERIOUS GAMES FOR SOFT SKILLS TRAINING

The characteristics described the previous section show VR as a tool with great potential in the world of Serious Games, and in particular for the training of soft skills. It has enough capacity to represent simulation environments for medical training in a virtual environment.

Virtual reality can be applied in two different ways in all fields and more specifically in the training of soft skills in the field of health:

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Figure 3.4. *360º Camera y Mobile VR from Samsung.*

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Figure 3.5. *CCMIJU professional experiencing VR.*

Both methods present virtual reality as a provider of unique experience, which justifies its use for training soft skills in the field of health (Ruiz-Parra *et al.*, 2009; Flanagan *et al.*, 2004; Pugh and Salud, 2007; McLaughlin *et al.*, 2002; Ypinazar and Magolis, 2006):

CLICK ON THE ICON TO SEE CONTENT

The measurements that can be made in the serious game of soft skills in health with virtual reality can be either technical or feedback for the user. As for technical, we mean automatic and objective measurements that the software automatically performs, for example:

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Those that are performed for the user come from certain psycho-pedagogical studies that try to evaluate non-technical skills. This feedback can be generated automatically through the software through a set of rules, or by a professional who analyses (either in real time or later) how the player has acted and what dialogue choices he/she has selected.

An important decision that should be evaluated is to offer feedback only at the end of the game session or interrupt the game when deemed necessary to give an evaluation.

In (Hays *et al.*, 2013), it is studied whether the course of the game should be interrupted to give feedback to the user. One way to increase the pedagogical value is to use an intelligent tutorial system (ITS) to provide feedback during the game. Some researchers have expressed concern about the fact that, because feedback from an ITS is often extrinsic (that is, it operates outside the main game mechanics), it alters the players' sense of presence. As a result, learning can be involuntarily hindered due to this ITS.

LIMITATIONS OF VIRTUAL REALITY AND SERIOUS GAMES

Among the disadvantages that are found when using virtual reality for this type of serious games are:

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The research carried out during this project must answer these questions, giving a result that allows users of virtual reality to recognize verbal language in other characters and people effectively.

4. TRADITIONAL ASSESSMENT METHODS FOR SOFT SKILLS TRAINING IN SURGERY

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In the field of surgery, it is well known the existence of technical skills assessments such as Procedure-Based Assessment (PBA) and Objective Structured Assessment of Technical Skills (OSATS) to measure procedural competence. Similarly, assessment tools can also be used to scrutinise the generic soft skills (interpersonal, cognitive and personal resource skills) which complement those technical skills. Several assessment tools have been developed to evaluate trainee nontechnical performance (Whittaker *et al.*, 2015). **Table 4.1** gathers the skills assessed in each tool, which are briefly described below.

ASSESSMENT TOOL	COMMUNICATION & INTERACTION	TEAMWORK	DECISION MAKING	SITUATION AWARENESS	LEADERSHIP	OTHERS
OTAS	x			x	x	cooperation, coordination, team monitoring
NOTSS	x	x	x	x	x	
NOTECHS		x	x	x	x	management, cooperation, problem-solving
ANTS		x	x	x		task management
MSF	x	x				clinical care, good medical practice, learning & teaching
EBSTAF	x	x				knowledge, clinical skills, technical skills
SPLINTS	x	x		x		task management

Table 4.1. *Summary of soft skills assessment methods.*

Observational Teamwork Assessment for Surgery (OTAS)

OTAS (Healey *et al.*, 2006, 2004) places the focus on the surgical team, for which communication, cooperation, coordination, shared leadership, and team monitoring and situation awareness are evaluated. The surgical procedure is divided into preoperative, intraoperative, and postoperative phases, which are also divided into 3 stages each. The team is observed, and the five previously mentioned skills are evaluated using 7-point Likert scales and generic checklist. Construct (Sevdalis *et al.*, 2009) and content (Hull *et al.*, 2011) validity of OTAS have been demonstrated, but observers require an intense training.

Non-technical Skills for Surgeons (NOTSS)

In NOTSS (Yule *et al.*, 2006), individuals are independently assessed on situation awareness, decision-making, communication and teamwork, and leadership. For each of these skills, three aspects are identified and assessed in a 4-point numeric scale. NOTSS have been extensively validated (Beard *et al.*, 2011, Crossley *et al.*, 2011), showing its value as a practical assessment tool.

Oxford Nontechnical Skills System (NOTECHS)

Originated for the aviation industry, NOTECHS can be also used in the OR (Mishra *et al.*, 2009). Although the surgical team is observed as a group, participants are individually assessed in terms of leadership and management, teamwork and cooperation, problem-solving and decision-making, and situation awareness. Each participant is scored using a 4-point numeric scale to afterwards obtain a summation of scores per subteam (surgical, anaesthetic and nursing teams), for which

a list of modifiers, both positive and negative, have been defined. Concurrent, convergent, face, content, and construct validity have been provided together with the NOTECHS definition (Mishra *et al.*, 2009).

Anaesthetists' Non-technical Skills (ANTS)

Differently to the tools exposed until now, ANTS (Fletcher *et al.*, 2003) is focused on assessing the role of anaesthetists within the surgical team. Based on NOTECHS, 15 items must be assessed on a 5-point numeric scale and related to four categories: task management, team-working, situation awareness, and decision-making; obtaining a summary score for each of them. Its content validity is also showed.

Multisource Feedback (MSF)

In this case, MSF (Violato *et al.*, 2003) presents a broader scope and is used to review the overall performance of clinicians in the National Health Service. Feedback on performance and professional behaviour (clinical care, good medical practice, learning & teaching, and teamwork & communication). Self-nominated colleagues and patients should complete structured questionnaires on a 3-point qualitative scale. Content and face validity (Violato *et al.*, 2003), as well as concurrent validity (Yang *et al.*, 2011) have been demonstrated.

Edinburgh Basic Surgical Training Assessment Form (EBSTAF)

The EBSTAF (Paisley *et al.*, 2001) focuses on the assessment of surgeon's skills, comprising a list of 70 tasks divided into five aspects: communication, knowledge, clinical skills, teamwork, and technical skills. Items in the form must be scored in a 3-point Likert scale and the form is evaluated by a range

of assessors with different profiles. Construct (Paisley *et al.*, 2001) and concurrent (Driscoll *et al.*, 2003) validity have already been analysed.

Scrub Practitioners' List of Intraoperative Non-technical Skills (SPLINTS)

SPLINTS (Mitchell *et al.*, 2013) has been designed to assess the scrub practitioners (including nurse, technician and operating department practitioner). It assesses skills on three categories: communication & teamwork, situation awareness, and task management, each of them with three underlying elements. Items must be scored in a 4-point Likert scale. Although content validity has been established (Mitchell *et al.*, 2013), further research is needed.
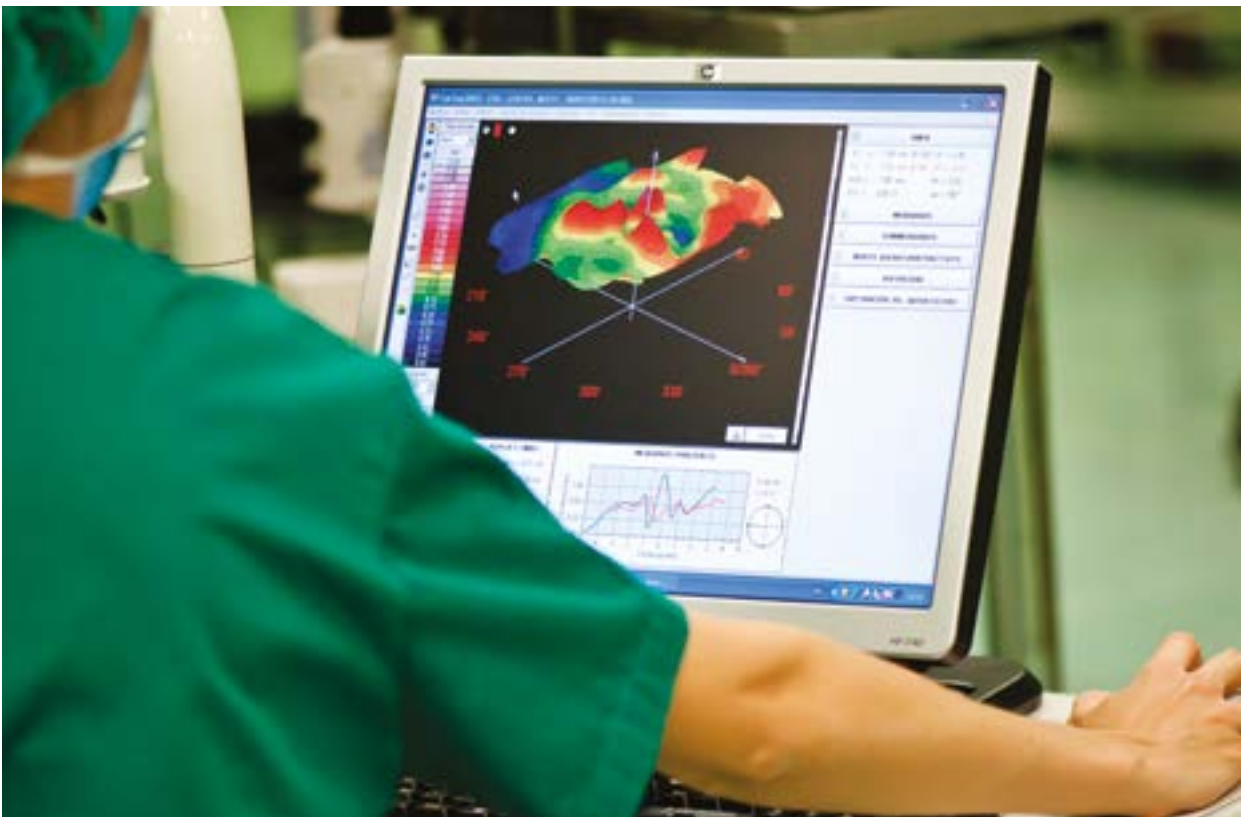
5. SITUATION AWARENESS

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THEORETICAL INTRODUCTION

During the 80s, situation awareness was mainly focused on individual performance of professionals. In this sense, Endsley initially defined the concept in the following terms:

"Situational awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future". (Endsley, 1988)

However, some years later other researchers expanded the idea to the team performance considering a collaborative approach of the concept:

"The shared understanding of a situation among team members at one point in time" (Salas *et al.*, 1995)

Later studies included other complex interaction models that include technological devices, such as surgical robots, smart surgical tools and surgical equipment in general, and its manipulation by humans.

"Activated knowledge for a specific task within a system….[and] the use of appropriate knowledge (held by individuals, captured by devices, etc.) which relates to the state of the environment and the changes as the situation develops" (Stanton et al., 2006).

Situation awareness model

The classical Endsley model (Endsley, 1995) is one of the most commonly used and the most cited one (Stanton *et al.*, 2017). It defines three ascending levels of situation awareness: *perception, comprehension and projection* **(Figure 5.1)**, and it has been recently reviewed (Endsley, 2015) to refuse some criticisms that support the development of other alternative models.

The first level to achieve situation awareness is to perceive the status, attributes, and dynamics of the relevant elements in the environment. In our field, each member of the surgical team should perceive all elements present in the OR: the patient, the equipment (monitors, instruments, anaesthetic tower, etc.), and the rest of the staff. It is also essential to compile information about their status, attributes, and dynamics: are the monitors on? Are the instruments sterile? Is there any obstacle that might hinder the movements of the circulating nurse? Comprehension of the current situation constitutes the second level. Based on the information from level 1, it is possible to make a holistic picture of the environment. In the OR, the surgeon must compile information from different sources to establish the patient status. In this situation, a resident might be capable of reaching the same level 1 in situation awareness as an experienced surgeon but might not be able to also integrate that information to comprehend the situation. Lastly, to reach level three

Level 3
Projection of future status

Level 2
Comprehension of current situation

Level 1
Perception of elements in current situation
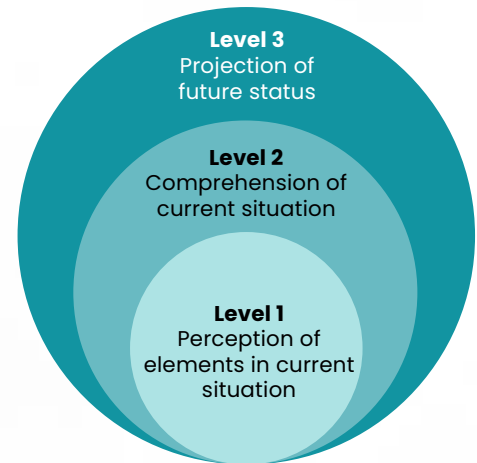
Figure 5.1. *Levels of Situation Awareness according to the Endsley Model (Endsley, 1995).*

it is necessary to project the future actions that will occur in the environment at least in the near term, based on the information from the two previous levels. For instance, in a laparoscopic procedure, the surgeon, based on the perceived elements and comprehended situation, must detect future complications that would make necessary to convert to open surgery.

As for a team, Endsley in his model also explain that situation awareness might be represented as a Venn diagram. Each member in the surgical team has a set of information for situation awareness related to his/her role, although some overlap might occur between two or more of them **(Figure 5.2)**. Therefore, team situation awareness might be considered as to the extent in which all members have the necessary situation awareness required for his/her responsibilities based not on the individual situation awareness but in a surgical team situation awareness, where all soft skills are also involved **(Figure 5.3)**. If the anaesthetist is aware of the patient vital signs but the surgeons does not, the overall situation awareness of the team is deficient, and performance might be compromised.

Based on the Endsley Model, other models have been defined, such as the distributed situation awareness (Stanton *et al.,* 2006). More recently, a casual model of situation awareness has been proposed using Bayesian Networks to represent the knowledge (declarative model) and some simple attributes to predict behaviours (behavioural model) (McAnally *et al.,* 2018).

Figure 5.2. *Team Situation Awareness.*
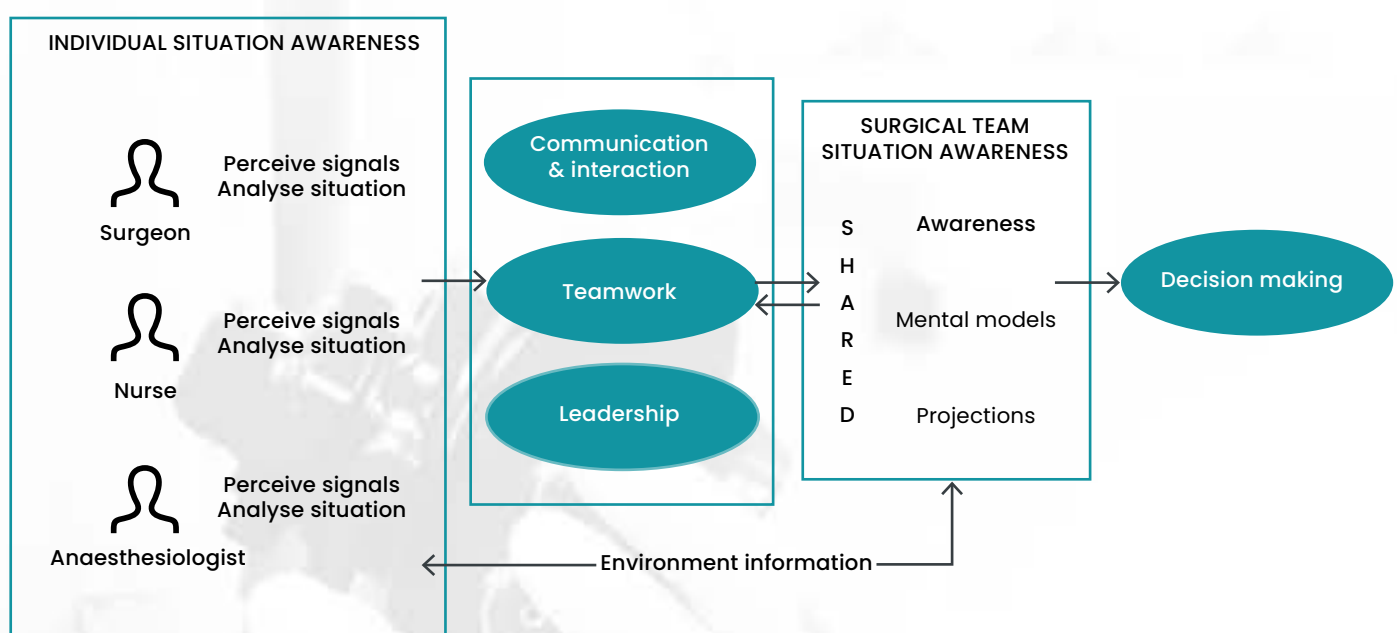
Figure 5.3. *Surgical Team Situation Awareness.*

SPATIAL AWARENESS (WHERE)	TEMPORAL AWARENESS (WHEN)
Understand location in the space and relationship between components. *Example*: (surgeon) correctly placing trocars in the abdomen for a laparoscopic procedure. (scrub nurse) correctly placing of surgical instrument and other material. (circulating nurse) organizing the location of surgical team and equipment.	Understand dynamics of process, sequences of events or time implications. *Example*: (anaesthesiologist) knowing the time left for the surgery to manage patient sedation.
RESPONSIBILITY AWARENESS (WHO)	IDENTITY AWARENESS (WHAT)
Knowledge about who is in charge for what. *Example*: (nurse) knowing who is checking that all necessary surgical instruments are on the table and in condition to be used (well ensembled and sterile)?	Recognise threats and/or operating system variables. *Example*: (surgeon) recognizing anatomical variations that might compromise patient security or highly impact the regular surgical procedure.

Table 5. 1. *Domains of situation awareness adapted from Panayiotou Charalambous (2017).*

Situation awareness domains

Harwood *et al.* (1988) described four domains of situation awareness, related to where, when, who and what. Later, Panayiotou Charalambous (2017) applied them in the case of performing a surgical procedure. **Table 5.1** shows these four domains, together with a set of examples in the surgical field, considering the different surgical team members.

The human brain and information processing

Once the models and domains related to situation awareness are clear, a brief introduction to how the human brain processes the information is needed to understand the high importance of human senses during the perception stage (level 1) and the cognitive processes for the comprehension and projection stages (level 2 and 3). Three types of memory can be defined:

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Situation awareness can be considered such as key first stage of decision-making that will be detailed in the next chapter. In the same way, a strong relationship with other soft skills such as teamworking and team communication were analysed by Graafland *et al.* (2014) **(Figure 5.4)**.
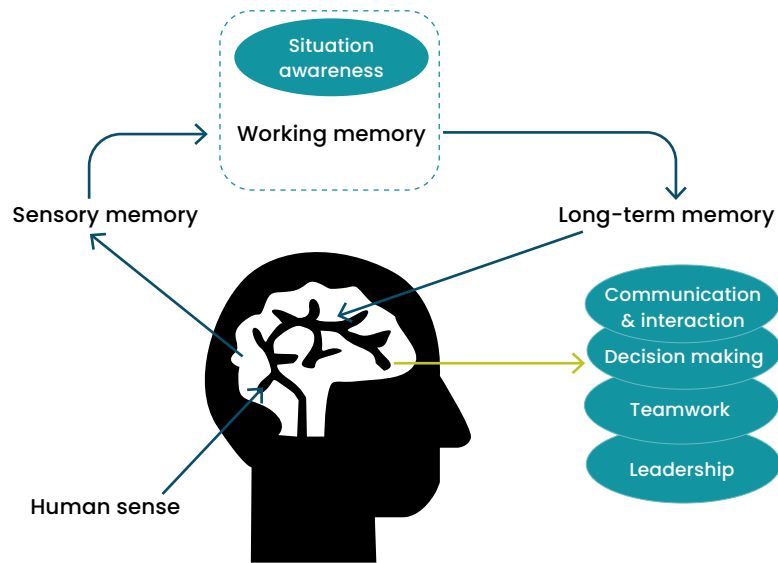
Figure 5.4. *The memory and the situation awareness relationship.*

CONTEXTUAL INFORMATION

A surgical team composed of a general surgeon, a 5-PGY resident, a scrub nurse and anaesthesiologist are performing a laparoscopic cholecystectomy. The resident has previously trained in animal models and simulators the requested basic skills as well as the full procedure, as well as observed several interventions before. Similarly, the nurse has wide experience in this type of interventions thanks to a 20-years career. In this occasion, the resident is entitled to carry out the procedure under the supervision of the general surgeon.

After creation of pneumoperitoneum and placement of the trocars, the general surgeon assists the resident by grasping the fundus of the gallbladder. To dissect the gallbladder pedicle in Calot's triangle, the resident is so deeply focused on the technical process to release the cystic artery and the cystic duct, that pays no attention to the explanations that the surgeons gives about the haptic perception during the laparoscopic technique as well as the information on different visual cues to correctly identify the anatomical structures. Since the gallbladder is retracted in a superior rather than a lateral direction, the resident misidentifies the cystic duct as it is quite aligned with the common bile duct. At the same time that the resident is manoeuvring, the general surgeon, the nurse and the anaesthesiologist are talking about the next scheduled intervention, complaining about the tight schedule in the OR, so nobody realizes the unexpected biliary leakage when the duct is cut. The procedure continues, the patient is recovered and sent to the room for post-operative follow-up.

The day after the procedure, the patient starts to feel bad and following jaundice and fever. An urgent open intervention is performed and the damage in the common bile duct is found.

This example is based on the work of Dekker and Hugh (2008), who analysed the reasons behind bile duct injury during laparoscopic surgery, also among experienced surgeons. In 86% of patients, the injury was due to duct misidentification. Main factors in it were underestimation of risk, cue ambiguity and visual misperception ('seeing what you believe' rather than believing what you see).

KEY CONCEPTS

In this section several concepts are presented for a better comprehension of the situational awareness skill, mainly focusing our efforts on a collaborative approach that reflects the needs of the surgical team.

Shared mental model

Mental models are internal representations of the world particular to each human. These models are usually referred to systems, so they describe, explain, and predict the behaviour of such system. When applied to teams, the system under exploration of these models is the team itself. Therefore, shared mental models can be defined as:

"Knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and, in turn, coordinate their actions and adapt their behaviour to demands of the task and other team members" (Jonker *et al.*, 2010)

Therefore, situation awareness in the OR should not rely solely on one individual member, but should be shared across the team, in order to assure a safe and efficient surgical performance for the patient.

Distributed situation awareness

Hutchins (1995) introduced the concept of distributed cognition, that refers to a global vision of the situation integrating the information processed by both team members and technological systems. Based on this concept, distributed situation awareness places the focus on the system, considering not only the human and the technological agents, but also the way in which they interact (Stanton *et al.*, 2006; Stanton, 2015). The distributed situation awareness theory establishes a set of propositions, among them:

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Later, several authors contributed with specific analysis of this concept applied to clinical disciplines, such as anaesthesia (Fioratou *et al.*, 2010) or patient flow management (Alhauder *et al.*, 2018).

Inattentional blindness

Although it may seem amazing, our brain has an incredible ability to concentrate when it focuses on performing a specific task. This feature sometimes derives in a paradoxical phenomenon where an object/situation that is within our visual frame, keep it out of our visual attention, so we do not see it although it was there. Hence, the idea of inattentional blindness emphasises the importance of focussed attention and the fact that sometimes we 'just look but do not see'. Accidents might happen when the inattentional blindness filters important information, so it never reaches our consciousness (Grissinger, 2012)

Influence of distraction, workload and other factors on situation awareness

Distraction can have either internal (pressure or anxiety) or external (events in the environment) causes, but in all, it leads to a reduced situation awareness. Similarly, if the cognitive workload is higher than the amount of work that an individual is able to manage at a certain point, situation awareness can also be compromised. There are several factors that might compromise and reduce situation awareness , which we can group into:

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These factors might negatively affect the situation awareness of the individual or the team: either the capacity for attending new information is reduced or the new information surpass the individual resources. Ideally, the working situation should be that in which the surgical team member has some spare attention capacity to attend sudden peaks of information.

Enhancing situation awareness

Some strategies and techniques have been used to train the situational awareness skill both at individual and shared levels (Panayiotou Charalambous, 2017). **Table 5.2**

During "self-talk" or "thinking ahead", the surgeon comments out loud the critical steps, explaining what he/she is doing to the rest of the team and what actions should be taken, increasing shared situation awareness. Another strategy might be the closed loop communication, by repeating messages so it is confirmed that they have been understood or that the action is being performed. Overhearing conversations might help to coordinate activities or anticipate unexpected events (Gillespie *et al.*, 2013).

The OODA loop concept (Nomikos, 2018) proposes four consequent functions: **O**bserve, **O**rient, **D**ecide and **A**ct, so it is highly related to decision making processes. Similarly, the SLAM technique proposes four steps to develop a culture of situation awareness (Nomikos, 2018):

- **S**top. Engage your mind and think on the task to accomplish: Is it a new task? Has it changed? Do I feel comfortable with it? Do I need training?
- **L**ook. Before, during and after the task, observe the environment: Are there potential hazards? What should be done with them?
- **A**ssess. Evaluate the effect of the hazards on you, on the team, on the equipment, on the patient… Do we need anything else to safely perform the task?
- **M**anage the problem if it arises. How can we be better prepared for this in the future?

Besides, it is possible to establish some recommendations and advices to maintain situation awareness or to reduce the risks associated to a low situation awareness:

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TYPE OF SITUATION AWARENESS	TRAINING TECHNIQUE	DESCRIPTION
Individual	SLAM	Stop, Look, Assess, and Manage
	OODA	Observe, Orient, Decide and Act
Shared	Self-talk or thinking ahead	Explain out loud the steps
	Closed loop communication	Repeat messages
	Overhearing conversations	Listen to other conversations in the OR

Table 5.2. *Summary of techniques for enhancing situation awareness.*

VISUAL ABSTRACT
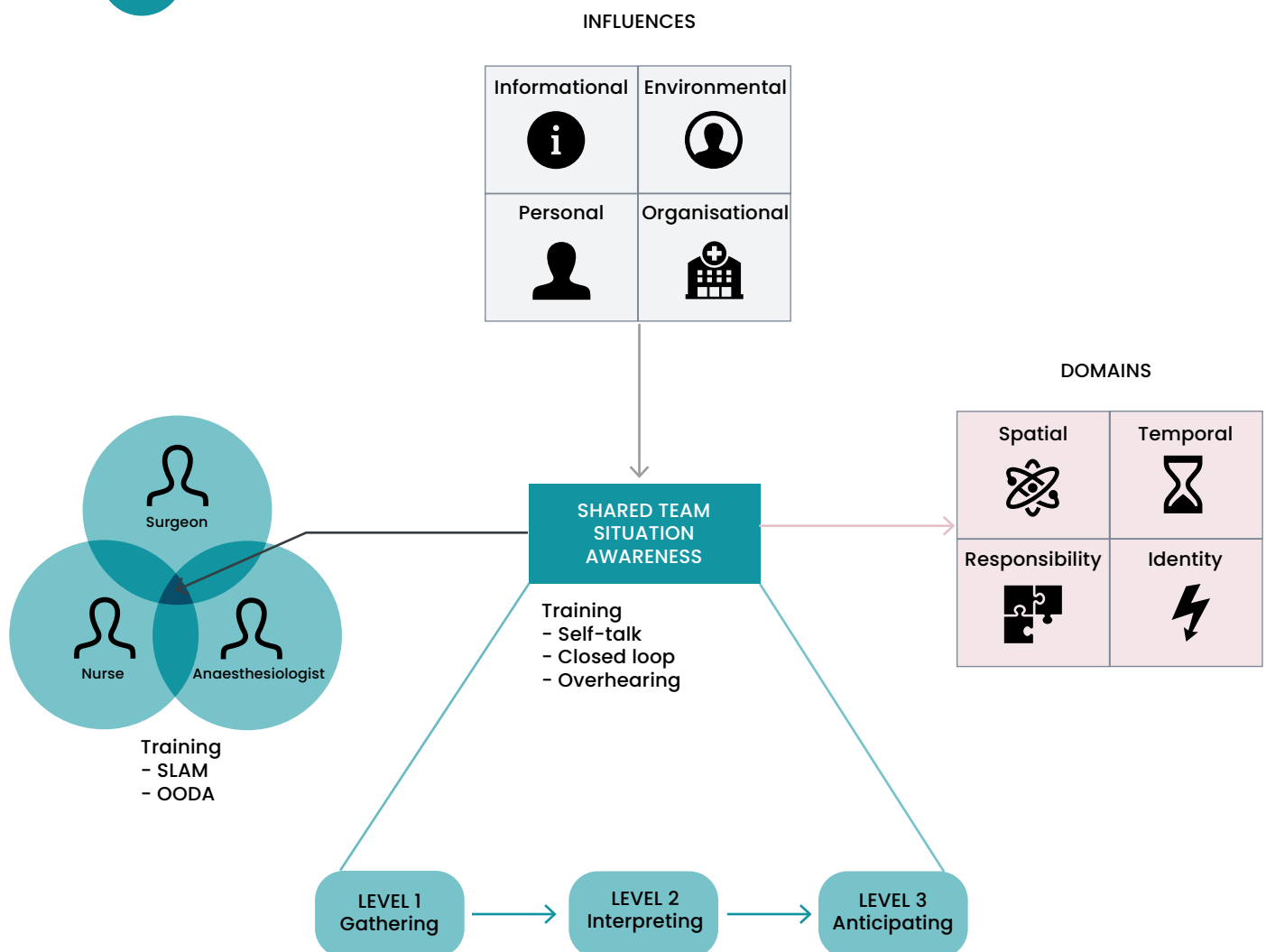
Figure 5.5. *Concepts of this chapter.*

EXAMPLE IN PRACTICE

We are again in the OR, with the same surgical team presented in section of contextual information: general surgeon, resident, scrub nurse and anaesthesiologist. In this case, just the patient differs, but the situation remains. It is a busy day with tight schedule in the OR, so the senior staff complains while the resident is performing the intervention under the supervision of the general surgeon. The resident knows by heart the normal anatomy of involved in the laparoscopic cholecystectomy. The resident matches the mental map of the 'normal' biliary tree to the patient's anatomy, missing that the duct that appears to merge with the infundibulum of the gall bladder is the right hepatic duct rather than the cystic duct. What would be the consequences if the general surgeon is not aware of the possible mistake while he/she is involved in the conversation with the scrub? Could the resident avoid the eventual error by a better understanding of the actual anatomy? What could be improved in this situation if the resident follows the "thinking ahead" technique?

SUMMARY

Situation awareness is key in a critical environment such as an OR, where subtle cues might have a great impact on the result of the actions. In this chapter we have described the fundamentals of the situation awareness model by Endsley, which can be applied not only at individual but also at team level. We have also explained the four domains of situation awareness, comprising spatial, temporal, responsibility and identity awareness, to then move forward to the relationship with the different types of memory and key concepts related to situation awareness, such as shared mental models, inattentional blindness or the factor that might compromise situation awareness. We also describe some techniques to improve both the individual and shared situation awareness. Finally, **Table 5.3** gathers a set of learning objectives and possible evaluation approaches for situation awareness in the OR, which can be used for creation of training activities.

LEARNING OBJECTIVES	EVALUATION
» To differentiate individual situation awareness from shared situations awareness. » To identify the three levels of situation awareness. » To recognize the four domains of situation awareness. » To recognize factors that influence the situation awareness.	» Identify moments within a succession of events where situation awareness might be compromised. » Select options that result in a better shared situation awareness (assessment checklist).

Table 5.3. *Learning objectives and evaluation for situation awareness.*

6. DECISION MAKING

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THEORETICAL INTRODUCTION

Making decisions often cause serious problems in the everyday life. People must make several decisions per day ranging from trivial issues (e.g. what to have for breakfast) up to important decisions that determines one's own or others life. Before decision, some people search for more information or ask suggestions from elderly people, others decide to listen their feelings. Whatever mechanism is used to make decisions, they have severe impact in our future.

The word "decision" originated from the Latin word "decisio" which means "to cut from". The verb "to decide" means "to come to a conclusion" or "to pass a resolution". Trewatha & Newport (1982) defines decision-making process as follows: *"Decision-making involves the selection of a course of action from among two or more possible alternatives in order to arrive at a solution for a given problem".*

Frequently, a lot of time is consumed while decision is taken, and it cannot be taken suddenly. A considered decision maker should follow the next six steps (Flin *et al.*, 2008):

1. Situation assessment - Defining the problem
2. Gathering information and collecting data
3. Developing and weighing the options
4. Choosing best possible option
5. Plan and execute
6. Outcome review

In surgery, doctors face a constant need for making decisions (in the OR, on the ward, bedside, in emergency situations) and often fast and immediate actions are needed. On the other hand, sometimes a deliberate decision is demanded where all factors should be carefully considered. Our decisions can be influenced by our profession, our relationship with colleagues and with patients, our performance and also the patient's outcome (Charalamborus, 2017).

Modern surgery requires that the whole surgical team make decisions according to their personal expertise. Studies mainly focusing on the background of the surgeon's and anaesthetist's decision-making skills in the operating room, especially in the intra-operative phase of surgery. However, scrub nurses are also key members of the team, who works directly with the surgeon and the assistant surgeons during the operation (Mitchel&Flin, 2008).

The traditional roles of the scrub nurse include ensuring that they are correctly 'scrubbed up', preparation of the instruments, trolleys and sterile supplies needed for the surgery, maintaining a sterile environment, providing skilled assistance to the surgeon during the operation, and performing the swab/instrument count at the end of the procedure. In the last decade the responsibilities of scrub nurse become the subject of debates because their duties and responsibilities have changed over the years (Taylor *et al.*, 2000).

While scrub nurses are involved into the intra-operative problem solving as a member of the surgical team, at the same time they cannot take part in decision-making process during surgery. This is because the surgeon has all the responsibility in the operating room, thus the surgeon makes the final decision all the time (Mitchel&Flin., 2008).

According to the literature, decision-making strategies of scrub nurses – including leadership skills – in the OR are rarely investigated, because it is not their main role in the surgical team. Generally, senior scrub nurses make decisions in nursing questions, organizing the whole team of nurses in the OR or in special cases an experienced scrub nurse trains a trainee or helps the work of an inexperienced young surgeon. Nursing soft skills are studied in other areas of healthcare like critical care or emergency departments (Bucknall *et al.*, 2003, Cesna *et al.*, 2004. Flin *et al.*, 2007, Nembhard *et al.*, 2006).

Anaesthesiologists and scrub nurses have managerial decisions in the OR. They are organizing the patient replacement; thus, they determine when surgeries should begin. From an economical point of view, scrub nurses are responsible for the proper operation of the OR, like performing all scheduled cases, reducing over-utilized OR time, reducing patient and surgeon waiting times and satisfying personal priorities (Dexter *et al.*, 2007).

The most important role of a well-organized anaesthesia team is the individual work in different ORs. A timely starts and brief times for patient awakening, turnover, and patient entrance to positioning are the basis of a well-organized surgical team. Wasting time can cause stress and disorders in communication, thus pulls back teamwork (Dexter *et al.*, 2007, Vitez *et al.*, 1998).

During the everyday surgical practice, patients should not be left out of the decision process. Generally, several therapies are available to treat the patient's disease (different types of surgery, no surgery, conservative therapy, endoscopy, etc.) and if none of these treatments is superior when weighing the benefits and possible harms, a treatment dilemma exists. Moreover, surgical techniques and its complications are not reversible, thus patient have to deal with potential harmful consequences (Barry *et al.*, 2012; de Mik *et al.*, 2018).

This chapter summarizes the background of decision making from surgical perspective. Surgery is a high-risk working environment, where real-time decisions made by front-line staff. Their decisions have a great impact, even being lethal if the decision is wrong. Examining how experienced surgeons decide in real situations have recently begun to be investigated. Several different methods and influencing factors of decision making are outlined, followed by practical suggestions for improving and assessing decision making skills.

The background of surgical decisions

Nowadays, surgical curricula are moving away from the traditional Halstedian apprenticeship model towards to a more formal, structured and mainly competency-based approach. On the early 2000s, doctor's weekly working hours have been regulated in all over the world by legislation directed at health and safety considerations for both doctors and patients. The reduction of work schedules and duty hours resulted on less time spent in the operating room, decreased exposure to clinical situations and also in the required number of operations (Poulose *et al.*, 2005). The loss of experience in decision making, both in the operating room and on the wards, needs to be compensated by improved training by expert surgical trainers and structured, competency-based practice in simulated environments (Flin *et al.*, 2007).

Surgical blocks and wards are risky environment where surgeons must make decisions under time pressured and unexpected

conditions. In emergency cases, unforeseen situations require new decisions or even changing the normal way of intervention. Surgeons often make individual decisions or consult with colleagues and make collective decisions with patients and relatives. They must either decide in the spot, within tight deadlines or they may have ample time for consideration (Hall *et al.*, 2003).

Naturalistic decision making

Classical (rational/normative) decision theory – developed by economists and business analysts - deals with selecting the optimal solution based on mathematical formulas for choosing between possibilities. However, these derived methods are too complex and impractical in time consuming situations and risky environments (Conolly *et al.*, 2000).

In emergency work situations, instead of making an optimal or perfect decision, reaching a satisfactory solution to gain control of a problem is often the main priority. In the early 1990s, researchers have begun to investigate the professionals' decision-making techniques in their normal environment, where decisions have to be made quickly under high risk and accuracy. Hence, naturalistic decision making (NDM) has emerged, where psychologists studied expert decision makers (firefighters, pilots, surgeons, militarists) in operational environment (Flin *et al.*, 1997; Lipshitz *et al.*, 2001).

NDM researchers aim to describe how experts make decisions in conditions of high uncertainty, inadequate information, shifting goals, high time pressures and risk, usually working in teams and subject to organisational constraints. These are all conditions experienced in the operating room, and it is likely that surgeons use similar cognitive techniques to make decisions during operations. This naturalistic approach has also been applied to other fields of medicine where uncertainty, suboptimality and value-based judgements are common (e.g. emergency units) (Flin *et al.*, 2008; Falzer, 2004; Zsambok *et al.*, 1997).

Model of decision making

In high risk work environments, a continuous cycle of monitoring is required. The model of dynamic decision making consists of three main levels:

- to assess the situation,
- taking appropriate actions,
- re-evaluating the results.

The model is adapted from a research with pilots and also well applied to surgery. The model shows the two-stage process of decision making:

1   **SITUATION ASSESSMENT.**

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2   **USAGE OF A DECISION-MAKING METHOD FOR CHOOSING THE APPROPRIATE ACTION.**

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| ANALYTICAL | RULE-BASED | INTUITIVE |

Low risk, enough time

High risk, less time

Figure 6.1. *Decision-making techniques depending on the level of risk and the available time.*

Recognition-primed decision making (RPD)

This decision-making technique relies on remembering the responses to previous situation of the same type. The solution quickly recalled from the long-term memory or a personal/observed technique used in a previous case with a similar situation. In this method, choosing a course of action is likely to be experienced as an automatic process, with little conscious deliberation. It is used mainly in situations where decision needed under uncertainty with quick action to prevent a catastrophic outcome. This method is used by experts working with routine cases, especially under high time pressures, and it may be reasonably resistant to the effects of stress. It is unlikely to be used by novices, as by definition they have limited domain experience and thus possess fewer memories of relevant events (Klein, 1993; Flin *et al.*, 2007).

Rule-based decision making

The rule-based method involves identifying the encountered situation and looking up a manual to apply onto the particular case. In medicine, it means the usage of an evidence base reference or the implementation of guidelines from an established authority. This process requires more mental effort than RPD. The decision maker is continuously searching his/her memory to recall the matching rule, or physically consulting a procedures manual/checklist to find the given response. Rule-based decision making is mainly used by novices who learn standard procedures for frequent or high-risk situations. With practice, this becomes automatic and the rule can be retrieved from memory with little conscious effort compared to recognition primed technique. Over-reliance on rule-based decision making may cause a degree of skill decay. It is not sure, if an unfamiliar situation arises and no guideline exists, a novice decision maker will be able to find an appropriate action to solve the problem (Flin *et al.*, 2007).

Analytical decision making

The decision maker investigates a number of actions and compares them simultaneously to determine the best one that the situation requires. Comparing options is often also called rational choice decision making. Several statistical and mathematical formulas give possibilities to help the selection of the optimal choice (e.g. Bayesian modelling), however the analytical comparison requires enough time and huge mental efforts to make correct decisions.

Creative decision making

An unfamiliar case indicates a brainstorming under high time pressure environments and requires a novel action to solve the problem. This technique in surgery mainly used in extremely high-risk situations without any logical alternatives by experienced experts. (Flin *et al.,* 2007.)

Table 6.1 summarizes the advantages and disadvantages of the different decision-making techniques.

DECISION MAKING TECHNIQUE	ADVANTAGES	DISADVANTAGES
Intuitive	» Rapid » Requires conscious thought » Useful in routine if applied by experts » Resistant to stress » Provide satisfactory	» Requires experienced user » Difficult to justify » Can encourage to support one model, rather than considering evidence that may not support that model
Rule-based	» Appropriate for novices » Rapid, if the rule learnt » Give a pool of determined actions by experts » Not necessary to know the background of each steps » Easy to justify the next step	» Time-consuming » Usually not written » If interrupts, easy to skip steps » Rule/guideline may be inaccurate » Wrong guideline may be selected » Not improve skills
Analytical	» Compares all possibilities » Justified » May chose the optimal solution	» Requires time » Difficult in distracting environment » Can be affected by stress » Can cause cognitive overload
Creative	» Solving unfamiliar problems » Helps innovation	» Time-consuming » Untested » Difficult under stress » Difficult to justify

Table 6.1. *Comparison of advantages and disadvantages of decision-making techniques.*

Factors influencing decision making

Understanding the factors that influence decision-making process is important to understand how decisions are made. Several factors influence decision making, like past experience, cognitive biases, age and individual differences, belief in personal relevance, and an escalation of commitment, influence what choices people make. Factors that influence the process may impact the outcomes (Dietrich, 2010).

Positive decisions increase satisfactory, which help people to make decisions quickly and with ease. Heuristics serve as a framework in which satisfactory decisions are made quickly and with ease. Many types of heuristics have been improved to explain the decision-making process; their main aim is to reduce the effort they need to expend in making decisions and heuristics offer individuals a general guide to follow, thereby reducing the effort they must disburse. Together, heuristics and factors influencing decision making are a significant aspect of critical thinking (West *et al.*, 2008; Shah *et al.*, 2008).

Future decisions mainly based on past experiences however are not necessarily the best decisions. If a decision had positive results, people are more likely to decide in a similar way in a similar situation. On the other hand, people are afraid of repeating past mistakes, thus rather than examining the background of negative outcomes, successful people investigate the current possibilities without any regard of past experiences (Juliusson *et al.*, 2005).

Research has indicated that age, socioeconomic status, and cognitive abilities influence decision making. A significant difference certified in decision making across age; that is, as cognitive functions decline as a result of age, decision making performance may decline as well. In addition, older people may be more overconfident regarding their ability to make decisions, which fits to the situation. Finally, with respect to age, there is evidence to support the notion that older adults prefer fewer choices than younger adults (de Bruin *et al.*, 2007; Reed *et al.*, 2008).

Heuristics are general decision-making strategies people use that are based on little information, yet very often correct; heuristics are mental short cuts that reduce the cognitive burden associated with decision making Heuristics reduce work in decision making in several ways. Heuristics offer the user the ability to scrutinize few signals and/or alternative choices in decision making. In addition, heuristics diminish the work of retrieving and storing information in memory; streamlining the decision-making process by reducing the amount of integrated information necessary in making the choice or passing judgment (Shah *et al.*, 2008; Dietrich, 2010).

As a cognitive skill, decision making is also depending on the following factors:

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If time and mental effort are required to assess a situation, decision-making process may be vulnerable. The two main factor of decreasing decision-making ability are the stress and the fatigue.

Stress may influence decision-making abilities both positively (information process) and negatively (over selective attention, decreased memory capacity, retrieval from long term memory). Among the four main decision-making techniques, stress affects the analytical and creative methods the most, because they use actively use cognitive resources. RPD as a method that is relatively light on cognitive processing, is less affected by stress **(Figure 6.2)** (Flin *et al.*, 2008; Orasanau *et al.*, 1997).

Decreasing cognitive effort

Decreasing effects of stress

Creative   Analytical   Rule-based   RPD

Increasing cognitive effort

Increasing effects of stress
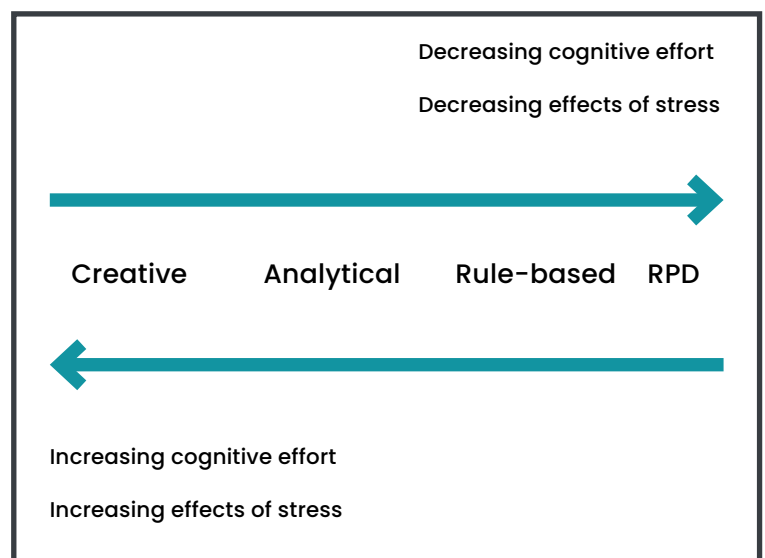
Figure 6.2. *Effects of stress on decision making.*

Another common factor that can influence decision making is fatigue. Only one night of sleeping loss can cause impair flexibility, decrease perseveration and the adaptation to updated situations.

In workplace environment decision, makers are faced with

multiple, conflicting factors that can influence the decision-making process. Recognising and accepting these contradictions could help to understand ourselves and improve our decision making. Leung *et al.* (2012) categorized these factors into three groups:

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Assessment of decision-making skills

Assessing cognitive skills sometimes poses a challenge to the researchers and trainers. Generally, decision-making skills are carried out in non-operating conditions by written or oral examination. Situational judgement questionnaires and methods present a case study and offers several alternative answers. This test investigates how candidates decide among the possible options comparing with the answers of experts of the exact case. Psychometric questionnaires also give possibilities to assess soft skill, however it reveals nothing specially of decision-making skills (Flin *et al.*, 2007; Motowidlo *et al.*, 1990).

Simulators and Tactical Decision Games (TDG) offer an objective and entertaining approach to assess decision-making skills. These ICT-based serious games have special scenarios with avatars of the surgical team and simulates real cases from the everyday surgical practice. Subjective observation of the cognitive part of the performance may be used, but it is not always practical, except if more trainees play at the same time, because through teamwork skills decision making behaviours may also be assessed.

Oxford Non-technical Skills System (NOTECHS)

Originally, NOTECHS is developed during the 1990s to assess the soft skills of cabin crew members. While operating staff also working as a team and surgery is also a high-risk environment NOTECHS adapted to understand the influence of behaviour on outcome in the OR. Decision-making process is individually assessed in a 4-point numeric scale to afterwards obtain a summation of scores per sub-team (surgical, anaesthetic and nursing teams) for which a list of modifiers, both positive and negative, have been defined (Mishra *et al.*, 2009).

A Modified Room Team Non-Technical Skills Scoring System (Oxford-NOTECHS II.)

15 years after the NOTECHS released, a need appeared for clearer difference between levels of performance within the normal range. To facilitate differentiation, a modified Oxford-NOTECHS II. scale have been improved in 2014. The new system uses an eight-point scale instead of four-point scale to measure each soft skill and default rating of six for each element. The main aim of this development was to improve scalability, enabling a richer understanding on the impact of each soft skill, including decision-making skills (Robertson *et al.*, 2014).

Miller's Pyramid

Traditionally, the model has been used to match assessment methods to the competency being tested. In the pyramid, the lower two levels only test cognition (or knowledge) and this is the area where inexperienced trainees (or novices) usually sit: for example, they either 'know' something about a surgical examination or they 'know how' to do a surgical examination. The upper two levels test behaviour: can they apply what they know into practise? Going back to the previous example: can they 'show' how to do a surgical examination or do they actually 'do' a surgical examination in practise? (Miller, 1990) **(Figure 6.3)**.
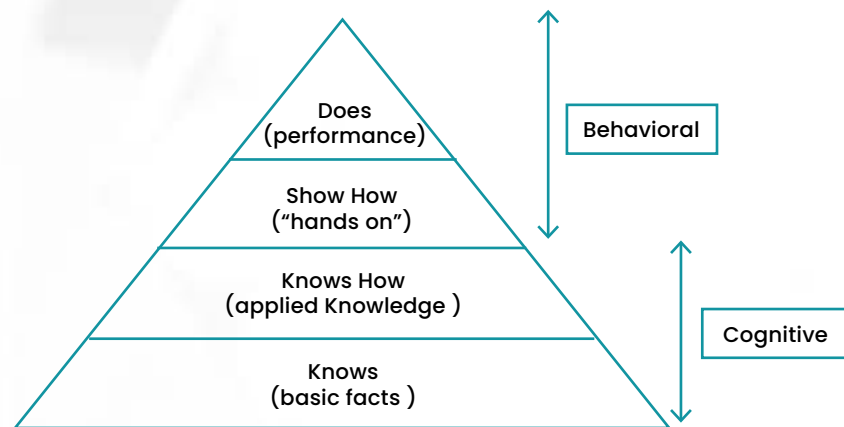
Figure 6.3. *Miller's pyramid (Miller, 1990).*

Training of decision-making skills

Classic method of training of decision-making skills is based on choice methods. While these methods are very effective in theoretical environment, in high-risk and stressed working environment tend to be irrelevant to assess the necessary skills (Klein, 1998).

To better memorize the necessary steps, several sequence or acronyms are used by experts in aviation. The best-known acronym is DODAR used by British Airways:

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This technique allows decision makers to follow a "guideline" and avoid missing steps during the process. However, in stressful environment, under time pressure it could be very difficult to follow (Flinn *et al.*, 2007; Walters, 2002).

Tactical decision games (TDG) are computer-based approaches to improve professional group's soft skill, especially decision-making skills. TDG contains small simulated scenarios and usually 4 to 10 participants are presented in a session, whom are asked to assign roles of the surgical team. Scenarios presents a case of real surgical problem and give information to help the decision, however important

information may be missing or misleading, or ambiguous information may be contained. The time is limited in each decision to simulate the real time-consuming situations and increase the stress factor. After each scenario, a brief discussion organized by a facilitator to analyse the similarities and differences of actions (Flin *et al.*, 2007.)

Story telling is a natural and ancient method of improving soft skills. In several workplaces (e.g. pilots, police officers, military officers, surgeons, nurses, etc.) "war stories" are the most interesting and exciting way of exchange of expertise. This happens in canteens, during lunch or after work and significant learning in this occupation is achieved by this way of experience sharing. According to Flin *et al.* (2007): *"Experienced professionals store these anecdotal accounts and use them to enrich their own memorised patterns of significant event for their work settings"*. Storytelling helps novices to understand better the background of situations and make sense of events.

After making a decision

After a decision is made, people may experience a variety of reactions. Different outcomes may result different feelings like regret or satisfaction, however all may influence our upcoming decisions.

Interestingly, regret shapes better the decision-making process. Regret, feelings of disappointment or dissatisfaction with a choice made is one potential outcome of decision making. Anticipated regret is the belief that the decision is the result of inaction. Anticipated regret may prompt behaviour; that is, when a person indicates they will not do something, such as take the pills, nonetheless they do to avoid regret. Once the decision is made and if the impact of the decision is regret, it will impact future decisions (Abraham *et al.*, 2003).

People feel regret in accordance with how the decision was made; regret may be dependent on the number of options that were available during the decision-making process; and how varied the options were may impact how regret is experienced after the decision was made. People feel remorse because they feel they were able to make a better choice by looking at more information, previously disregarded, and carefully weighing the pros and cons of each choice. In addition, regret is magnified when individuals revisit the other available options and considering what satisfaction the other option would have brought them. Interestingly, people who are dissatisfied with their decision feel obligated to embrace the decision, as a means to reducing anxiety regarding the quality of the decision (Sagi *et al.*, 2007).

Individuals may also experience satisfaction with their decisions. Satisfaction means how pleased the decision maker is with the outcome of the decision. Evaluating the positive and negative aspects of choices is also an interesting decision-making strategy (Botti *et al.*, 2004).

If younger and older adults use this strategy at the same time in the same question, older adults tend to list more positive and fewer negative aspects of each choice, and older adults register more satisfaction with their choices when they use this evaluative strategy. One interesting
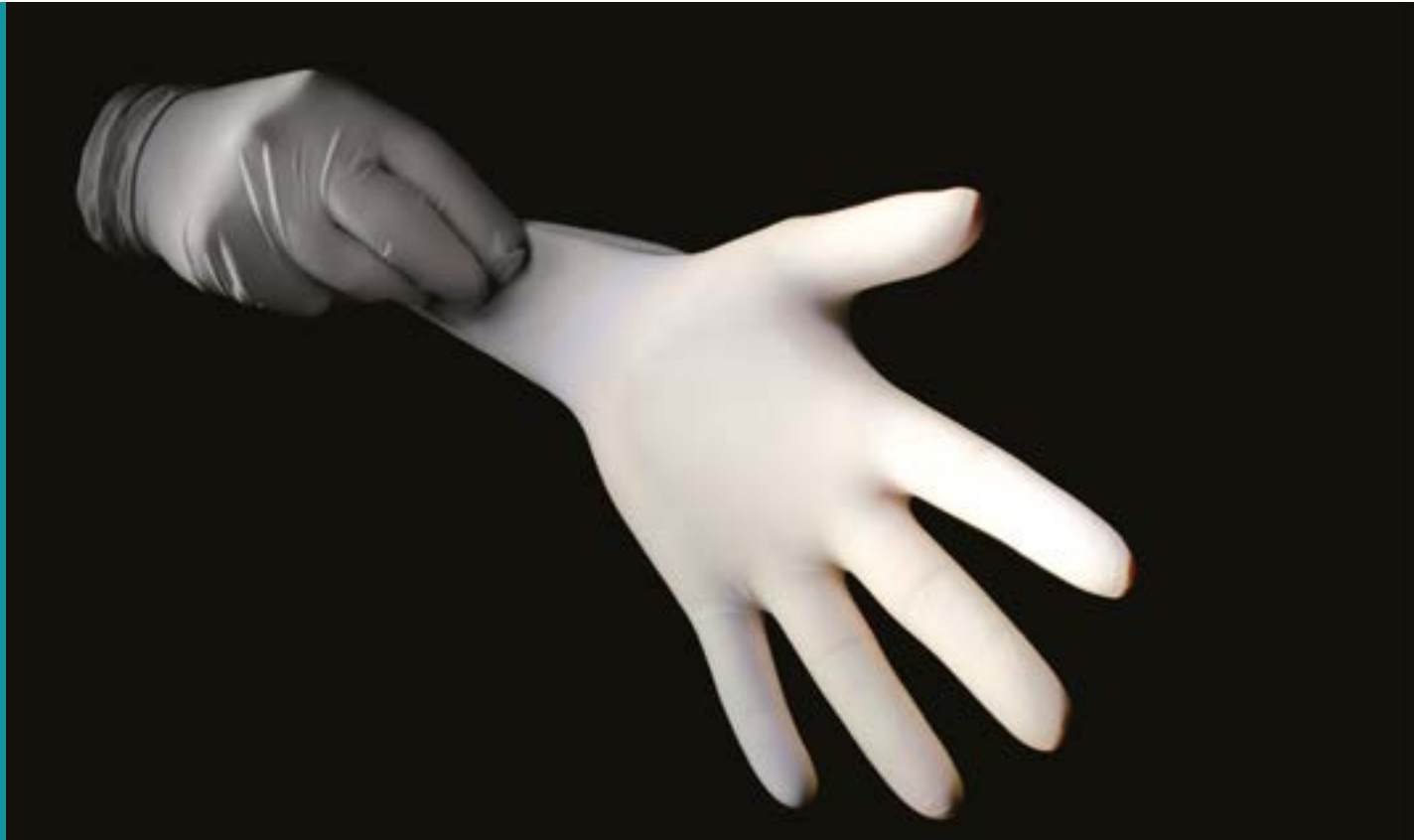
finding was that when people did not evaluate the options by listing the positive and negative features, there is no age difference in satisfaction (Kim *et al.*, 2008).

Besides past decisions, satisfaction or regret, future decision-making strategy is depending on the reversibility factor. The opportunity that people change their minds is significant to individual's satisfaction, while this ability decreases the satisfactory factor of their decision (Gilbert *et al.*, 2002).

CONTEXTUAL INFORMATION

Managing acute appendicitis

In a surgery department of a city hospital, two operating rooms (OR) and two surgical teams are working during the night shift. The surgical team consists of 3 general surgeons (a specialist – chief and 2 residents – PGY 4 and 5), an anaesthesiologist, 4 nurses with three different functions (2 instrumentalist/1 circulating/1 anaesthesia). Another specialist is "on call" duty at home.

In OR "A" an open laparotomy is performed by the surgeon with the older resident (PGY 5) as first assistant. The anaesthesiologist with the anaesthesia nurse, a circulating and an instrumentalist nurse are also present at this OR. The younger resident (PGY 4) is on the ward.

At 11 pm, 35-year-old male patient arrived at the surgery department with abdominal pain, nausea, and low-grade fever. Pain started in the mid-abdominal region 2 days ago and is now in the right lower quadrant of the abdomen. The pain was sharp and steady in nature and aggravated by coughing. The

younger resident examined the patient and physical examination reveals a low-grade fever (38,4ºC), pain on palpation at right lower quadrant. No diabetes mellitus, hypertension or any other chronic disease or blood transfusion present in the patient's history. No allergies and do not take medicines. The abdomen is soft and lax, no organomegaly, right iliac fossa tenderness. McBurney and psoas signs are positive. The resident took blood sample for laboratory and the patient has leucocytosis (11,800/microlitre).

The young doctor first impression is appendicitis, however several diseases may mimic the same symptoms, such as testicular torsion, urinary tract infection, right side ureteric colic or Crohn's disease. The differential diagnosis based on the following symptoms:

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According to the lab findings, the positivity of physical examinations sings and the resident's previous experience, he/she has the impression of appendicitis. The resident doctor discusses the case with the surgeon who decided to have surgery immediately. Here the resident used the rule-based decision-making techniques.

Appendicitis is the acute inflammation of the vermiform appendix. Typically presents as acute abdominal pain starting in the mid-abdomen and later localizing to the right lower quadrant. Associated with fever, anorexia, nausea, vomiting, and elevation of the neutrophil count. In patients with acute peritonitis, appendectomy should be performed without delay. Complications of acute appendicitis occur in 4% to 6% of patients and include gangrene with subsequent perforation or intra-abdominal abscess.

Thus, the resident was faced with the following issues to be resolved:

T

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The resident calls the OR to ask the surgical team about the possibilities. The specialist stated that the previous surgery (in room "A") would not be completed within 2 hours, however the appendectomy should be performed as soon as possible. The surgical specialist suggests to the resident to call the other specialist at home, to join the surgery as soon as possible.

According to the anaesthetist, the patient is eligible for laparoscopic intervention (age, cardiovascular status, etc.) and also the patient will have better outcome. The two specialists used the recognition-primed decision (RPD) making technique.

According to the responsible shift nurse, an instrumentalist nurse can join to the whole appendectomy, however only one nurse can be provided for circulating and anaesthetics issues. Here the creative decision-making technique is used.

After the call with the duty team, the solution is found. The resident calls the specialist at home to join him/her and help to perform laparoscopic appendectomy, then he/she begins to prepare the patient for immediate surgery. Parallelly an instrumentalist nurse starts to prepare the room "B" for surgery.

The anaesthesiologist in room "A" adapts to this situation and indicates the general anaesthesia in room "B" (during this

period the anaesthetist nurse observe the surgery in room "A"), than the anaesthesiologist goes back to room "A" and the anaesthesia nurse leave room "A" and accumulate the functions of circulating and anaesthesia works in room "B".

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Finally, after inducting pneumoperitoneum and entering the abdomen, no perforation or complication found, laparoscopic appendectomy is successfully performed. After surgery the patient got antibiotics and non-steroidal anti-inflammatory drugs for 3 days intravenously.

KEY CONCEPTS

Dynamic decision making is a two-stage process, assessing and diagnosing the situation, and then choosing one or more decision making methods to select a course of action. Correct identification of the situation is essential to solve the problem. Pilots make more decision errors by way of misidentifying the situation and applying the stipulated procedure than they do in correctly identifying the situation, but then taking the wrong actions (Orasanau *et al.*, 1997). Dynamic decision makers will typically switch between the different decision-making methods (intuition, rules, analysis, creative) depending on the available time, routine and situation demands. (Hamond, 1988). Crosskerry (2005) compared the intuitive and analytical methods with clinical decision making, *"the trick is in matching the appropriate cognitive activity to the particular task"*.

Some form of fusion of the different types of decision making may also probably take place, depending on context (e.g., elective vs emergency, familiarity of the procedure, predictability of events). In the case of a sudden bleeding, the first intuitive decision will be to secure haemostasis by achieving proximal and distal control, and thus create time to assess the situation and to identify the available options. Experienced surgeons are using more the intuitive, pattern-matching techniques than trainees, who will have to make more analytical comparisons of optional courses of action for a given problem (Flin *et al.*, 2007).

Regardless the selected method of decision making, it is advisable that a review stage is included after implementation, to ensure that the chosen course of action resolves the problem as anticipated. Discussion of intraoperative decisions should be included during post-case debriefing, although this safety procedure seems to be used far less frequently in medicine than in other safety-critical professions (Flin *et al.*, 2007).

👁 VISUAL ABSTRACT

STAGE 1. ASSES THE SITUATION
(What's the problem?)

Influences

| Risk-low | Risk-high |
| Time-ample | Time-limited |

STAGE 2. MAKE A DECISION
(What shall I do?)

Creative   Analytical   Rule-based   Intuitive

Select a course of action

Implement a course of action

F E E D B A C K
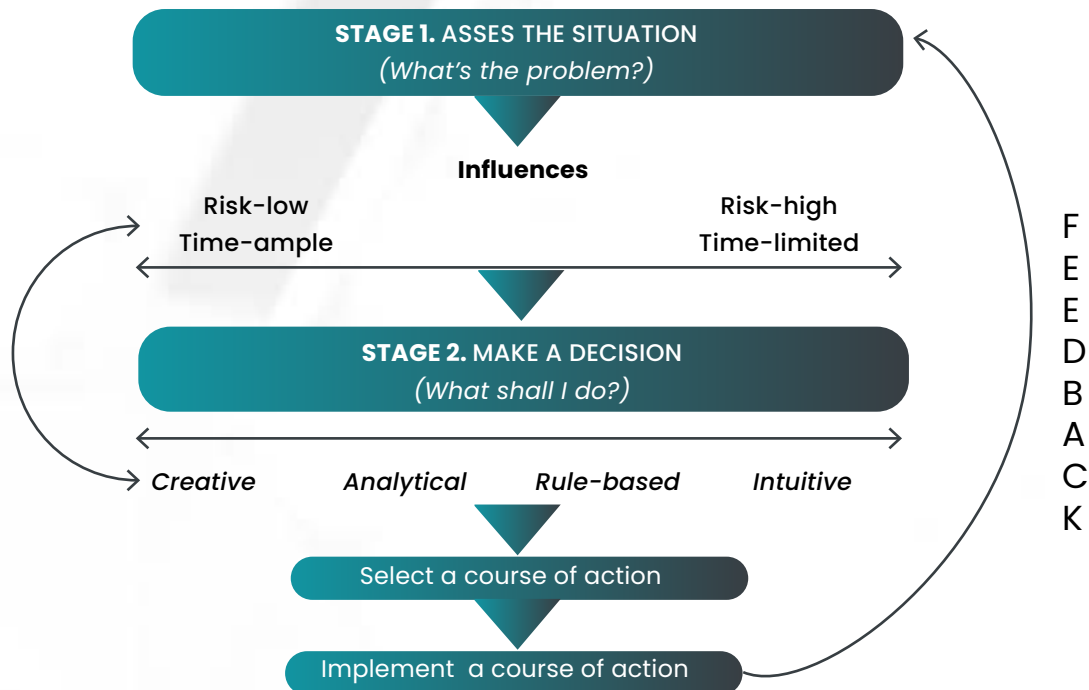
Figure 6.4. *Model of decision making after (Flin et al., 2008).*

🔗 EXAMPLE IN PRACTICE

Small bowel lesion during open abdominal hernia repair

A 57-year-old male was presented on surgical ambulance with 6-month history of a painless irreducible lump in the abdomen. He had a long history of constipation but no recent change in his bowel habit, nausea, vomiting, or pain. The patient's medical history included hypertension treated with ACE-inhibitors, hypercholesterolaemia treated with statins, Type 2 diabetes treated with metformin and diet and deep vein thrombosis for which he was on enoxaparin. He had no known allergies.

On assessment the patient appeared well, his vital signs were stable, and his abdomen was soft and tender. A child's head large lump was in his right anterior abdominal wall and was tender and irreducible. The patient signed light abdominal pain when coughing, exercising or bending over. The patient's inflammatory markers and renal and liver function tests were within normal limits.

An ultrasound scan showed hernia a size of a child's head measuring 14.6 x 26.9 cm on the right abdominal wall **(Figure 6.5)**.

Abdominal CT reported a right abdominal hernia measuring 15.5 × 30.0 cm, containing fluid, fat, and a small bowel junction.

Figure 6.5. *Patient with a 30 cm diameter of abdominal hernia.*

Surgical decisions:

- Is it an emergency case?
- What type of surgical method is needed? Open or laparoscopic abdominal hernia repair should be performed?
- Surgical indication – absolute, vital or relative?
- If open hernia repair: direct suture or implantation of the mesh?
- Implantation of the mesh: what type of mesh do we use?
- Implantation of the mesh: small bowel lesion during the laparotomy?
- Continue surgery: significantly increased risk of implant infection?
- Give up the reconstruction of the abdominal wall: e.g. discomfort, etc.?
- Risk of recurrence in the scar?
- Risk of recurrence on the abdomen?
- Advising weight loss to the patient?
- Diet restrictions?

Anaesthesiologic decisions:

- Are there anaesthesiologic risk factors?
- Laparoscopic technique is an appropriate choice for the patient?
- Cardiac risk of laparoscopic technique?
- Is the patient anaesthetically suited for surgery?
- Surgery can be postponed until the patient is cardiologically fit for laparoscopic surgery?
- Whether the patient gains laparoscopic technique?

Nurse decisions:

- If the surgical indication is absolute, when the patient is introduced into the schedule?
- Will he be placed on the recovery service?
- What type of instruments are needed to this surgery?
- What type of hernia meshes are available? Which one is suitable for the patient?
- Is there enough large size to cover the abdominal wall deficiency?

SUMMARY

Decision making during surgery, particularly in emergency cases, is a key element in clinical practice that merits better preparation than is currently delivered. Current techniques in surgical training allow little opportunity for reflection, and perhaps there is now place for a more careful scrutiny of surgeons' cognition, using the naturalistic decision research methods.

Investigating decision-making techniques on the surgical team's level (surgeon, anaesthesiologist, scrub nurse) is a major challenge, because for centuries the surgeon has all the responsibilities in the operating room. Anaesthesiologists may have an influence on the timing and invasiveness of surgery depending on the patient's cardiovascular status, however only in vital cases they may make decisions related to the patient's outcome. Nurses (scrub-, circulating-, anaesthesia nurse) may have only suggestions during surgery, only in few cases may have significant impact on surgery or patient outcome, e.g an instrument missing or there is problem during swab counting.

Decision making is triggered by a change of the working environment followed by situation awareness, selecting a course of action and finally revise the effect of our decision. Four main decision-making methods were described: intuitive, rule-based, analytical and creative. The choice of decision-making methods depends on the previous experiences of the decision maker and the situational constraints (stress, fatigue, age, etc.). Techniques are being developed to enhance situation awareness and decision-making skills using low-fidelity methods and these could be easily adapted for surgeons. Decision training is based on strengthening the situation assessment skills with the help of different low- and high-fidelity simulators, which has large impacts also in assessing decision making skills. Besides, situational judgement questionnaires or interviews may help assessing the surgical team's performance.

In other high-risk professions (e.g. aviation, military), where situation awareness and decision making are regarded as critical skills, which are addressed explicitly in basic training. Surgical teams also could profit from decision training to be more effective. If clinical decision making is to be valued as highly as technical skills, then a better understanding of surgeons' cognitive skills must accrue, so that the processes can be studied, and reconstituted as a skill that can be applied by the practising surgeon. This learning must be applied with a sense of expediency, given the rapidly changing educational environment for future cadres of surgical specialties.

(Table 6.2.) shows the main learning objectives which highlight some of the most important competencies and skills related to decision making in the operating room.

LEARNING OBJECTIVES	EVALUATION
» To recognize the level of competencies	» Select the right method for make appropriate decision
» To identify the decision-making techniques used so far	» Sequentially choose at least one method that may influence the decision-making techniques
» To analyse the changes of the environment	» Select options that result in adequate decision-making processes (assessment checklist)
» To determine the problem to be solved	
» To recall the main decision-making methods	
» To utilize the proper technique and react	
» To revise the effect of the decision	

Table 6.2. *Learning objectives and evaluation for decision making.*

7. TEAMWORK

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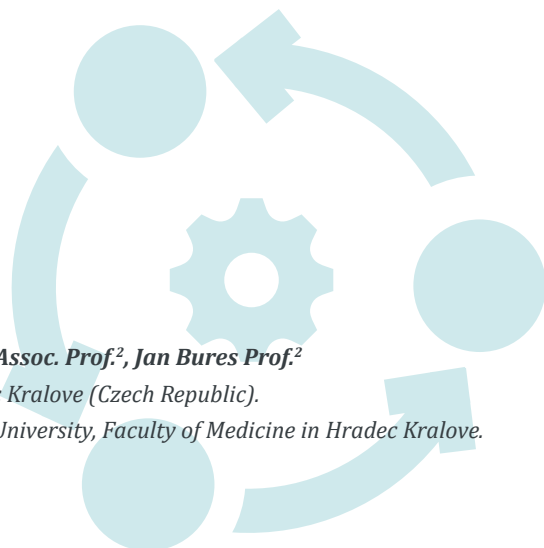
Teamwork represents one of the most important skills in relation to reliable and efficient course of action during the everyday situations not only in hospitals, but everywhere else. This soft skill should be practised and trained especially during the critical situations when every second matters. Antonacci *et al.* (2018) highly value the process mapping, especially for the purposes of healthcare quality improvement. The process mapping can support the improvement of teamwork. It allows to gather a shared understanding of the reality, identify improvement opportunities, involve stakeholders, define the goals, follow the progress, support learning, and increase empathy (Antonacci *et al.*, 2018). Moreover, they outline the factors helping the successful implementation of the improvement initiatives which comprise of training, soft skills, comprehensible visual representation, etc. The before-mentioned should be implemented in teamwork as well.

⚡ THEORETICAL INTRODUCTION

The first important step is to determine the terminology and characterise the concept of team and group. The team is created from a small number of people ideally complementing each other and usually sharing a common goal. It is important that each team member contributes with his/her knowledge, efforts and attitudes. The real team, in contrast to the classic working group, is made up of people who trust each other and work together. They fulfil the aims and particular tasks within them with the appropriate responsibility. The working team is a specific type of working group.

Team and teamwork can be considered as the organisational tools of contemporary management. These are based on roles that teach particular skills to several people at the same time. The team and its members are linked by synergistic interaction. In healthcare, there is a need to create effective and quality teams (Payne, 2007). The prosperity of workplaces or departments depends on staff, when doctors and other staff work together to create harmonious workplaces. In order to maintain continuity, rules or tasks must be clearly defined in the units. The established and unwritten rules streamline the work process and thus contribute to the satisfaction of the entire staff and patients.

The main motto for any team is "Together we will achieve more". The word TEAM can be seen as an abbreviation for keywords **(Figure 7.1)**:

T ogether

E verybody

A chieves

M ore
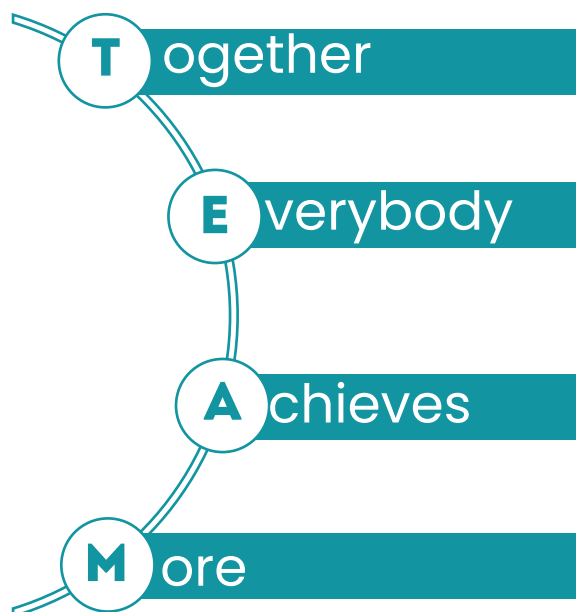
Figure 7.1. *Acronym for team.*

The definitions of the team are:

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Basic characteristics of the team comprise (Graves, 2017):

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The roles in the team

There are many interpretations and conceptualisations of the roles within teams. The basic division was done by the British researcher Meredith Belbin. His categorisation comprises the cognitive, affective and behavioural roles. Within these categories, the below mentioned roles are included (Belbin, 2010).

COGNITIVE ROLES

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AFFECTIVE ROLES

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BEHAVIOURAL ROLES

CLICK ON THE TITLE TO SEE CONTENT

The roles can be also generally divided according to the Schindler's classification (Schindler, 1957):

α	β	γ	ω
active member informal leader	special prerequisites for carrying out an activity	let herself/himself lead high representation in teams	edge position

Table 7.1. *Schindler's classification.*

In addition to this division, there are also negative and destructive roles. For example, deserter, rabid, authoritarian.

A manager in any industry including the health care is responsible for the proper functioning and success of his team. Every good manager uses, sometimes even without realising it, different styles of leadership at work. There are four basic styles of subordinate leadership **(Table 7.2)** . These styles need to be used alternately to increase the efficiency.

DELEGATION	PARTICIPATORY	TRANSACTIONAL	COMMAND
» subordinates want and can work. » the highest maturity of the team.	» subordinates do not want, but can work.	» subordinates want, but cannot.	» subordinates do not want or know. » the lowest maturity of the team.

Table 7.2. *Basic styles of subordinate leadership.*

A typical feature of a team leader is respect for team members. Deciding with humility and delegating powers and responsibilities represent the required skills. On the other hand, the solo leader is bad. The governance is virtually unlimited and such leader has the feeling of unlimited or complete freedom. He/she makes decisions without interest and respect for other members (Cobb, 2012).

Creating a team

Team creation can be approached from different perspectives. A sense of belongingness is very important and sometimes critical. Members should do their utmost to achieve the team goal. The individual should prefer the word "we" over the "I" approach (Moxon, 1993). This approach is called interpersonal. Another way of forming a team is to determine roles. It is based on the need to divide the roles that are performed in the team and to create the roles that need to be represented or supplemented for ensuring the efficiency. Members of the team must be able to share their values with others. A precise formulation of the tasks that each role is in charge of is necessary. The last important option for creating a team is to accomplish a task with a given goal. It is necessary to know what task the team is facing and then select the members who are able to complete the task by their expertise. Therefore, the expertise is in the first place. For all approaches, the disadvantages should be taken into account. The drawback when professionals in the domain area, whose personal qualities complicate their cooperation with other members, come together on one task. Properly composed team significantly influences its success (Bayley, 2007).

Team efficiency

Effective collaboration does not always occur when a team is formed, roles are split, and the goals and rules are set. Despite the fact that everyone takes the task for themselves and is willing to participate in it with interest and commitment, it does not mean that fatigue, insecurity, dislike, disappointment and other unpleasant feelings do not appear during the work. If any of these moments occur, members need to be motivated or rewarded. Sometimes, it is enough to support people with an encouraging word or

praise their work. It is necessary to ensure that the team stays in a good mood and does not start to disintegrate. The relationships in long-term teams need to be maintained to be stable. Often, therefore, the organisation organises team building session in diverse forms. Trips can be exemplified as one of them. During trips, the relationships are cemented (Mathieu, 2015). There is room for clarification of some problems. The friendly teams can also organise regularly informal meetings. The initiative ideally comes from one of the members. This informal meeting is a certain signal that the team has belongingness.

Effective team characteristics:

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The Situation Awareness Global Assessment Technique (SAGAT) represents a method providing the possibility to objectively measure the situation awareness, team performance, task performance and patient safety during a team simulation (Coolen, Draaisma, & Loeffen, 2019; Hultin *et al.*, 2019). It includes the clinical assessment and decision making which all further influence the team effectiveness. It provides the feedback for healthcare professionals who can develop their technical and teamwork skills based on the SAGAT results (Coolen, Draaisma, & Loeffen, 2019).

The areas of team effectiveness are determined as follows:

- time to goal achievement
- consensus on primary problem
- diagnosis
- task prioritisation
- leadership
- teamwork satisfaction (Coolen, Draaisma, & Loeffen, 2019)

Communication

A key part of each team is successful communication between individual co-workers. In the health sector, communication has many specificities, mainly due to the occurrence of stressful situations to which they are exposed (Rosen *et al.*, 2018). These situations are accompanied by feeling of fear and by emotions. The prevention of similar stressful situations is an effort to ensure effective communication. There are three types of communication:

- Internal communication - communication between co-workers at different levels.
- Communication with patients - communication of a health care professional or medical staff with a patient or family member.
- External communication - communication outside the medical facility, such as communication with authorities, insurance companies or media.

Especially in the health care, the non-verbal manifestations are is extremely. Except from other situations, this communication takes place between the patient and the healthcare professional. In this kind of communication, it is necessary to focus on attitude, movements, gestures, facial expression or voice tone. This might help to estimate the patient's internal condition. For the successful non-verbal communication, it is necessary to be able to control their own speeches and to try to orientate in the feelings of others. The consent, enthusiasm, surprise, but also disagreement or disinterest can be deduced from the speech and its context. The principle of good communication, both non-verbal and verbal, is a positive attitude with the counterpart and adapting speech according to the situation (Bártlová & Treflová, 2010).

Influences on the team

The quality of the individuals influences the team. If the team is made up of excellent experts, but they are individualists and do not have the ability to work together, then the team will not work well. Therefore, the personal character of an individual is also crucial. If the team is already composed of people who can work together, the next question arises. This comprise how they can communicate, to what extent they trust each other and rely on each other. Everyone desires success and recognition (Nelson, 2017). If a team member has the impression that his/her activity is not sufficiently valued or fails to identify him/herself with the team, the consequences on the whole team can occur. It may also happen that the worker feels that he/she is working below their level. Feeling, that they can do more, and they should work somewhere else might occur. A belief that all team members are not trying to do or not doing their best to accomplish the task can have negative impact on the team. There is a so-called Ringelmann effect, which mentions that when a rope is dragged by, for example, eight people, they do not even achieve four times the performance of individuals. This phenomenon is also referred to social laziness, for which there are many reasons such as **(Figure 7.2)**:

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Figure 7.2. *Reasons for social laziness.*

CONTEXTUAL INFORMATION

More often, the concept of interprofessional teams and practice is adopted in healthcare. Flood *et al.* (2019) claims that it is essential in pursuit to provide high quality, patient-centred and collaborative care. To reach the interprofessional attitude, the individuals should work on themselves and nurture their spirit. Then they should combine it within the interprofessional trainings. Liaw *et al.* (2019) mention the value added of team training programme based on the interprofessional rounds during which the shared mental models are developed. They proved that the interprofessional training including the cognitive tools, experiential learning and virtual simulations foster the shared mental models, and consequently improve the team performance together with the interprofessional attitudes and deliver the optimal clinical teamwork.

The interprofessional education including simulation-based and clinically-based interprofessional activities can be employed (Brack & Shields, 2019). These include for example shadowing and patient reviews which can be implemented in pursuit to develop the clinical skills and better understand the teamwork together with the roles and responsibilities (Brack & Shields, 2019). Paige *et al.* (2019) provide another proof of usefulness of simulation-based training of interprofessional teams. Key team-based attitudes and competences including behaviours

in the clinical environment might be improved not only in the transfer care area which they examined. Generally speaking, the interprofessional education facilitates and develops professionals in healthcare to work collaboratively.

Furthermore, it is recommended as well as useful to include the externals during the identification of the team composition and its work patterns. Not only the above-mentioned professionals, but also family members might be involved in the latter processes connected to both the patient's care team and to the operating one. The value of parents in such teams is described in case of paediatric practice by Baird, Ashland, & Rosenbluth (2019). Walter *et al.* (2019) mention the usefulness of this phenomena in case of seriously ill patient's families which meet with the medical team(s). This results in better decision making and improvement of team members' knowledge and attitudes. Furthermore, these interactions lead to the elimination of uncoordinated efforts and inefficiencies.

Peng *et al.* (2019) claim that effective teamwork and communication are crucial to patient outcomes. Ceccaldi *et al.* (2019) develop the latter emphasising that the technical skills and individual knowledge are not sufficient in any medical specialisation. Therefore, the teamwork should be developed and facilitated. Nevertheless, the objectivity should be ensured to eliminate the inherent biases (Peng *et al.*, 2019). For these purposes, the simulation is often used during fellowship trainings to improve the patient outcome. The implementation of the digital simulators, 3D printers and other tools can provide fruitful transmission of professional knowledge (Ceccaldi *et al.*, 2019). Tang *et al.* (2019) add to the teamwork also the electronic interprofessional communication and collaboration to cover the patient's needs more efficiently. Nevertheless, they emphasise that appropriate mix of technology support and non-technology factors is required to improve the teamwork. Zeltser & Nash (2019) mention that the efficient teamwork training in medicine can be inspired by the military and commercial aviation areas. The justification lies in covering the areas connected with the human factors such as team behaviour, leadership and communication.

Mastering these skills can reduce the medical errors and improve patient safety (Zelster & Nash, 2019).

Working in a healthcare facility is a collective work, the result of which is the joint effort of all team members. Each of them must know their task well and perform it reliably. In addition to doctors and nurses, there are also various specialists, surgical ambulances, hospital wards and helpers, etc. As a rule, the team should comprise permanent staff of the department (Slouka, 2017). In some cases, the difficulty of the work also requires other necessary specialists and inviting another members or teams.

The operation is usually led by the chief surgeon who performs the procedure. At the same time, he/she manages the surgical team and is responsible for the course of action and the result of the operation. He/she assigns duties to individual members. The assistants help the surgeon during the operation but also before it. Nurses perform tasks related to operation, such as preparation of materials, tools, sterilisation or maintenance of medical devices and equipment. They take care of the equipment, organise and manage the cleaning in their designated areas. Each member has precisely determined his/her work and the tasks to be performed.

The surgical team is one of the organisational units that continually takes care of the patient during the whole process. They start from preoperative examinations, continue during the surgery, and are active during postoperative care. The powers are delegated by the surgeon who performs the most difficult part of the work. He/she then manages the rest of the team for maximum efficiency. The surgeon has undergone a long training and has replaced many positions, so he can put him/herself into individual roles. First, they have to complete a medical school and other specialised trainings that usually last 5 years. Then they start as assistants to more experienced surgeons. Afterwards they move to the positions of surgeons under the supervision of more experienced surgeons. After gaining the above-mentioned experience, he/she becomes the chief surgeon him/herself. Based on their previously accumulated experience, they assemble their team and delegate work to their assistants (Bayley *et al.*, 2007).

The surgeons hold roles in several teams. The first one at the department, where they regularly visit, carry out check-ups, evaluate the patient's results and prepare the patients for surgery. Then they play an irreplaceable role as surgeons. They are surrounded by the surgical teams and their assistants who help from the preparation to the end of the surgery. A good assistant must anticipate the surgeon's mind processes and respond precisely to the surgeon's procedures. Here, harmony and interplay play an important role.

The main examples of the role distribution can be seen in two assistants. The first one stops a more active role. He/she is in the immediate vicinity of the chief surgeon who leads him. For example, the assistant performs masking, delimits the surgical field, captures the bleeding blood vessel and performs other operations according to the surgeon. The second assistant performs fewer active tasks. His/her responsibilities include lighting and its settings, disinfecting the operating room. Both of them have to follow precisely defined rules, which must be kept by all team members in order not to endanger the team and the patient. The examples of the main rules are: return unnecessary tools to the instrument table immediately, do not feed anything under the arm or behind your back or do not obstruct the view of the team leader (Baker *et al.*, 2016).

All employees of the healthcare facility should base the treatment of their patients on available professional theoretical knowledge gained through undergraduate and postgraduate studies. Basic not only surgical techniques represent an essential part of everyday practice in all fields. These skills are already taught to medical students through practical exercises. The importance of practical training is indisputable, but some cannot be obtained simply by studying the literature. For the training of individual techniques, it is desirable that the medical student theoretically master the principles (Gladkij, 2003). Surgery and similar medical disciplines are continually evolving and introducing new technologies that allow more efficient and gentle work. Therefore, new skills must be learned regularly and continuously by doctors and other workers. In surgery, practical skills and self-confidence are acquired through experience and practice (Hu & Liden, 2015).

KEY CONCEPTS

The key concepts of teamwork comprise the necessity of clearly set meaningful vision and purpose of conducted activities. The team structure as well as clearly set roles and responsibilities matter as well. Moreover, the efficient communication represent the crucial foundation of any team. The team members should be emphatic and able to consider current condition and limits of each other. The overall support is favourable and beneficial. Generally speaking, the ideal team should be flexible and agile in pursuit of being able to change the course of action according to changing conditions and situational context. This matters especially in the operating room where it is sometimes hard to estimate the development of the situation.

The decision-making processes might be done by all involved members or by the team leader depending on the situation. Nevertheless, it should be clearly assigned including the rules of delegation in critical situations. Important part of a teamwork include also the willingness to consider as well as to appreciate the outputs and achievements of the team. The feedback is a must and the team performance should be continuously monitored. This would stimulate the future motivation to develop the skills of team members and improve the performance of the whole team. On the other hand, if any issue appears, it should be solved and addressed. The lessons learned are ideally identified and best practices derived in order to eliminate or avoid similar situations in the future.

Within the healthcare, the teamwork represents a very important soft skill, because most of the tasks and activities require more people involved. Usually, every process necessitate the participation of various actors. In case of surgery, these include a surgeon, an assistant doctor, an anaesthesiologist, nurses, cleaning staff and other relevant parties. Nevertheless, the stakeholders are much wider. Not only the families of patients, but also entities influencing healthcare institutions such as pharmacies, ministries, governments, etc. are important and impacted by the efficiency of the teamwork performance.

VISUAL ABSTRACT

Figure 7. 3 graphically illustrates the main parts that describe the concept teamwork. Each of these parts is an integral part without which teamwork would not be effective and efficient.
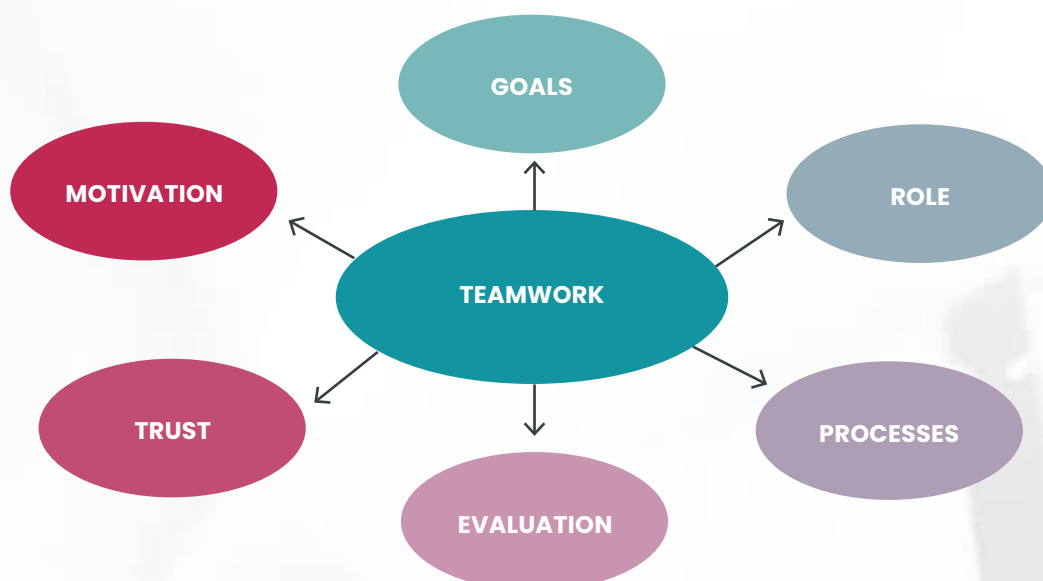
Figure 7.3. *Main parts of teamwork.*

🔗 EXAMPLE IN PRACTICE

The organisation uses the teamwork and team-building together with their tools to support the effectiveness of different departments and teams. Work in healthcare is based on working in teams because teams can better use their organisational potential. This is also linked to more functional and integrated strategy. The team-building principles drive the creation of harmonious, more efficient and productive environment and outputs. The main effort is to create and unite the team. Exploiting the capacity of all members to achieve their goals is maximised (Burford, 2012).

There are various forms of team-building. The most common distinction is the team spirit programme, fun programme and team-building programme. The team spirit programme serves as a suitable bonding agent for starting groups. The recommended activities are focused more on relaxation and ice-breaking. A common example is the game of bowling. Fun programme is focused on non-traditional experiences. These rewards are a frequent form of remuneration from the employer. These activities are primarily used to cement the team and to promote loyalty. The last programme is an organised event with a clear goal. The goal is to eliminate the problems the team has and gain confidence. Each game should be followed by the analysis, feedback from all participants on how they performed. The consequences and follow-ups should be derived every time.

There are also a lot of teamwork techniques. They are suitable for finding new ideas, for creative assessment and for decision-making techniques. Finding, revealing and developing ideas should be an integral activity of the team. It is important that the team finds new solutions to problems, other alternatives to the problem, or suggestions for improvement.

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SUMMARY

This chapter covers various topics related to the teamwork. Firstly, the basic terms and concepts are described as well as introduced. The context is also provided to comprehensibly understand the discussed issues. The practical implications for individuals as well as whole teams are stressed and outlined to provide the inspiration and practical advice for the stakeholders. Second, the tools and options for improving the efficiency are provided. Nevertheless, each practitioner should consider various conditions at his/her workplace. These will specify the use of the mentioned concepts and approaches.

LEARNING OBJECTIVES	EVALUATION
» To recognise the principles and potential of teamwork » To define the roles of individual team members » To estimate the newly established team functioning » To differentiate various types of leadership » To establish main indicators for teamwork efficiency evaluation » To reconstruct the previous situations and to prevent the mistakes according to the analysis	» Appropriately define a role-based team structure. » Select proper type of communication under specific circumstances. » Suitably motivate and coordinate team members in pursuit of reaching the goals. » Regularly provide feedback to all team members.

Table 6.2. *Learning objectives and evaluation for teamwork.*

8. COMMUNICATION AND INTERACTION

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Viral Studios. Badajoz (Spain).
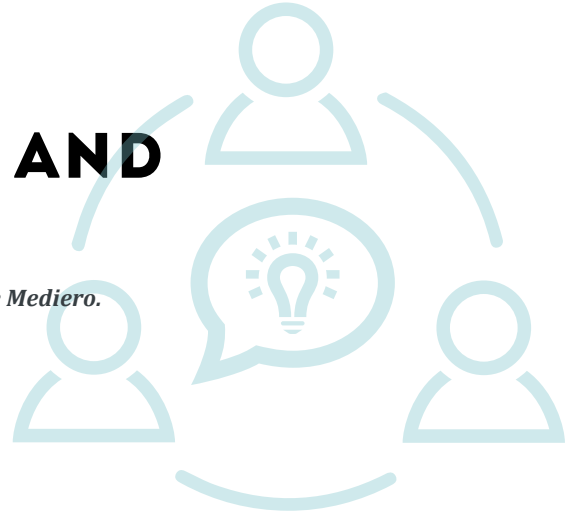
THEORETICAL INTRODUCTION

Communication, as understood in this study, includes all the mechanisms involved in the transmission of information. Any of these factors, which can contribute to improving the effectiveness of a work team, is framed within four basic questions: what, how, why and who *(Flin et al., 2008)*.

The continuous advances in the communication systems have had a fundamental impact on how the information is transmitted, which does not mean that these changes have not affected the other factors as well. Not surprisingly, many authors have anticipated the sociological and anthropological changes that are closely linked to the new information and knowledge technologies. In this sense, the aphorism "the medium is the message" (Marshall McLuhan, 1964) is perhaps the best summary of the enormous importance of the new forms we use to communicate.

Virtual environments as new spaces for communication are framed within a historical trend in which the speed of communications has been progressively increasing. This fact has allowed the interactive possibilities of human beings to have increased following this trend, once the ability to transmit information in real time from anywhere in the world has been achieved.

In the case of virtual reality, the sensory barriers that until now allowed us to distinguish between physical ("pentasensory") and telematic ("bisensory") environments are overcome, just as Javier Echeverría faced in his studies on the so-called Third Environment *(Echeverría, 1999)*.

Overcoming bisensory in virtual environments, especially the most immersive, is therefore the key to the development of soft skills that are raised in this handbook and that contribute significantly to the performance of work teams *(Royal College of Surgeon of England, 2014)*.

Models of communication

Taking into account all the technological possibilities of our time, we distinguish three communication models that represent in some ways three historical stages.

Linear model of communication

The linear communication model is a unidirectional process in which a sender intentionally transmits a message to a receiver (Ellis & McClintock, 1990).

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Interactive model of communication

In the interactive or interactive communication model, communication is a process in which participants alternate positions as sender and receiver and generate meaning by sending messages and receiving feedback within specific physical and psychological contexts (Schramm, 1997).

Transaction model of communication

In the transaction model the context becomes more meaningful, which gives meaning to the communication itself. Communicators indiscriminately adopt the role of sender or receiver in a more dynamic relationship than in previous models.

This model, although based on the work of Barnlund (1970), is closely linked to the virtual environment paradigm as a communication space.

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Project-based learning is also closely related to this communication model, since all participants are subject to the evolution of a common outcome on which most of the messages are centred around.

Communication modes

Other than the communication models, it is necessary to distinguish several types of communication that are mainly determined by the channels used. This way, we could establish a first difference between oral communication and written communication.

Within the oral communication, it is also worth noting the importance of non-verbal language, which acquires special importance when the communication channels overcome the bisensory barrier. Based on the communication studies carried out by Mehrabian in the late 1960s, in an oral language the amount of attention the recipient pays to the components of the sender's message can be divided into:

- ‣ WORDS..7%
- ‣ TONE..38%
- ‣ OTHER NON-VERBAL CLUES......................55%

However, in a transaction model adapted to all the technical possibilities of a context such as that of a virtual environment, several types of communication are involved that should be compared to assess its scope **(Table 8.1)**.

Any of them can become an appropriate resource for the needs of the communicators involved in a virtual team experience, so that programming and planning acquire special importance for media

SPOKEN COMMUNICATION	NON-VERBAL COMMUNICATION
» Social and functional.	» Is a major signal of emotional state.
» Helps to build relationships.	» Complements the information that is said.
» Language and timing are very important.	» Can be ambiguous and open to misinterpretation.
» It is very important how the information is said.	» Serves to discern if someone is lying.
» The content is often insufficient.	
WRITTEN COMMUNICATION	REMOTE COMMUNICATION
» Is regularly used in the workplace.	» Can increase the performance of work teams.
» The content can be extensive and neat.	» Lack of mutual awareness of contextual aspects.
» Must be clear, accurate and informative.	» Takes more time than in on-site conversations.
» Space is not shared and there is no physical contact.	» Allows multicronic conversations.
» Can be synchronous but is usually asynchronous.	

Table 8.1. *Comparative table of different communication modes.*

optimization. In that sense, it is also possible to distinguish between synchronous and multicronic communications, another of the differential properties that Javier Echeverría (1999) establishes between the so-called three environments.

Conditioning factors of communication

Communication processes (Castells, 2006) depend on the following factors:

- Issuer characteristics
- Receiver features
- Sender and receiver characteristics in the context of the process
- Technology used in communication

The barriers to communication can be classified based on this distinction, with the implicit characteristics of the sender and receiver being the ones that present the greatest difficulty of analysis because they are located in a more subjective environment. However, the characteristics that allow the sender and receiver to be identified with a specific role within the context of communication do respond to objective criteria that can be framed within the role plays used in medical education, which contribute to overcoming the communication barriers that are related to these characteristics (*Baile and Blatner, 2014*).

The assignment of roles according to the capabilities of the communicators and the adaptation of the interactive mechanics to these capabilities is essential for overcoming barriers that we might consider internal: own language, culture, motivation, expectations, past experience, prejudices, moods, hearing ability, voice level, etc.

On the other hand, there are other types of barriers that are related to external aspects of communicators. In this category the importance lies in the media or communication channel itself, that is, in "the material process through which signals are produced, transmitted, received and interpreted" (Castells, 2008). In this sense it should be remembered that the term "communication" refers etymologically to "what becomes common." From this generic meaning, all the characteristics of the communication spaces, whether physical or virtual, acquire a communicative sense that goes beyond the mere transmission of information: any element used in the design of that space can be a tool for improvement of the conditions in the communication process, but it can also become a barrier in itself.

CONTEXTS OF THE COMMUNICATION SPACE

The communication space, with all the factors that determine it, is the immediate context in which the communication process takes place. Following the transaction model, this space becomes an environment that feeds on other contexts. In this way the conditions of the medium are part of the interactive process.

Historical Context

The state prior to the communication process marks a starting point that has to be analysed in relation to all its conditions. In an editable context, that is, a context that can be defined by certain parameters, it is possible to accumulate the historical experience of different agents. However, as we said before, the communication space becomes a unique context if it responds to the real characteristics of the communicators. In this sense, the historical context of the same communication process, and its continuous analysis, are decisive for the subsequent development of improvements.

In the development of role-playing games, the sequence of the historical stages of the process becomes especially important in relation to the strategies followed and, especially, in relation to the challenges that are proposed successively depending on the results obtained **(Figure 8.1)**.

Stage	Strategy
Stage 1: preparation	Instructor plans the session
Stage 2: creating safety	Cofidentiality statement Framing the exercise
Stage 3: promoting spontaneity/ group building	Warm-up
Stage 4: choosing role plays	Learning work in dyads
Stage 5: setting up the role-play	Creating characters. Doubling
Stage 6: conducting the role-play	Demostration. Role-Reversal
Stage 7: group processing	Sharing. Debriefing

Figure 8.1. *Stages of role-play enactment (Baile & Blatner, 2014).*

Psychological Context

The psychological context can also be analysed when some of the soft skills addressed by the work team are closely related to it. In this case it is necessary to have evaluable indicators that allow a correct design of the communication process - from the assignment of roles to the adaptation of the communication space - and with an evaluation of the results of the process that allows to determine the scope of training in the original psychological contexts and, where appropriate, the negative aspects of the process.

Cultural Context

Cultural aspects are perhaps the least quantifiable, although their impact may be key in the development of any communication process. The heterogeneity of the working groups is in any case an added value, as long as there is an accurate previous analysis regarding all the needs that the integration of different cultural contexts demands.

Social Context

On the other hand, the social context responds to aspects that in most cases interfere with a correct interpretation of the communication space. That is to say, the social context must be an external element to the assignment of roles, since part of the virtual experiences must favour the simulation of different scenarios that do not have a direct correlation with the starting social reality.

However, psychological, cultural and social contexts play a very important role in the communicative process, which should be taken into account. If we look at Bronfenbrenner Ecological Theory **(figure 8.2)** we will understand more clearly that the communication space is determined by the sum of the intrinsic contexts in each of the communicators **(figure 8.3)**.
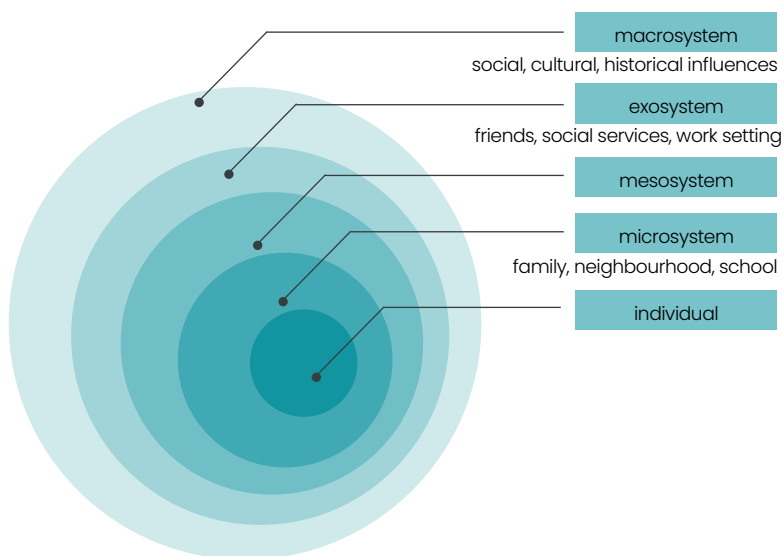
Figure 8.2. *Bronfenbrenner's ecological systems theory (Bronfenbrenner, 1979).*
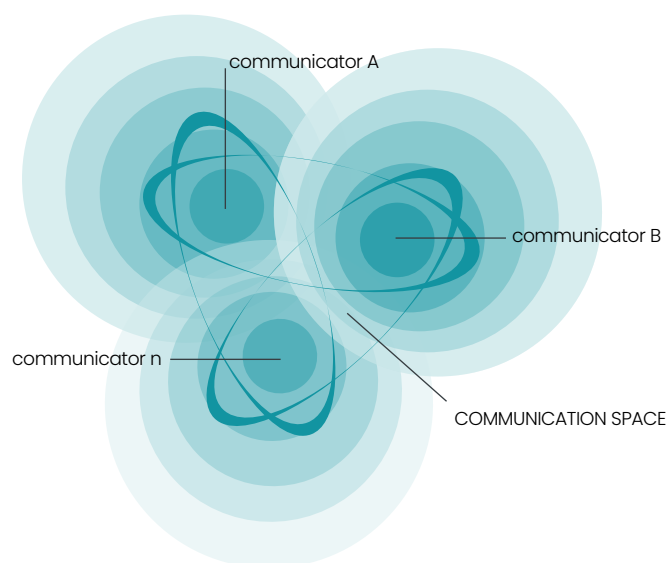
Figure 8.3. *Influences of individual contexts in the communication space according to ecological theory.*

Physical Context

Although a virtual environment cannot be considered as a physical context itself, all the elements that comprise it are a representation of physical spaces whose characteristics are intended to simulate until reaching an immersion that allows it to be equated with a real physical context.

However, a virtual physical context responds to different topological relationships. Following another of the differential properties that Javier Echeverría (1999) establishes between the three environments of humanity, a telematic space is based on reticularity, as opposed to the recintuality of physical spaces. Although a virtual environment participates in both concepts, it cannot be ignored that its communicative characteristics allow us to establish a more distant relationship with respect to physical representations. Thus, it is necessary to establish a clear difference between the physical context from the recintuality of the real spaces in which the communicators are located, and the topological context from the reticularity of the communication space, which although it represents concrete physical realities offers tools to overcome any physical barrier.

KEY CONCEPTS

Communication protocol

The communication protocol, based on successive experiences of other work groups, is a key element in the coordination and planning of communications. In this case it is necessary to establish a linear model, preferably with written communication, in which basic guidelines are marked that are sufficiently clear and concise so that all communicators can easily interpret the interactive mechanics of the communication process.

An example of how the protocol determines the forms of communication between the members of a work team is found in flight crews. In virtual simulations, a hierarchy is established in the roles that mark the meaning of all communications, including presentations among members.

Verbal language and non-verbal language

The words and tone used to communicate belong to two different areas in the communication process. The tone is mainly associated with oral communication and usually occurs synchronously. On the other hand, words can be transmitted through different communication channels and in a multicronic way, which allows greater prior reflection and less dependence on individual contexts.

In a flight simulation, most of the messages that are transmitted to the rest of the crew use an aseptic tone, except in cases of emergencies or defaults, where the tone of voice used can be decisive in the reaction of other team members.

Alternative communication channels

When communication channels established primarily by the protocol have deficiencies in the transmission of information, whether due to problems in the medium itself or due to problems associated with communicators, alternative forms of communication are foreseen. In the same way, when the tone used or the formulation of a question generate adverse responses, it is necessary to adapt the form of our message and repeat it to try to redirect the communication.

This is a common case in flight communications, not in vain in the training of communication skills, one of the main learning objectives is the ability to adapt to adverse situations through the reformulation of messages.

Question reformulation

Similarly, the recipient must have participation mechanisms that allow him to warn of the need for repetition or reformulation of the messages received. In the event that one of the communicators is unaware of any

of the terms used, he must assess whether such ignorance requires the request for more information and to what extent that fact may hinder work in the communication space.

Receipt confirmation

In each of the transmissions, taken in isolation, there must be some mechanism to ensure that the message has reached the receiver. To allow greater communication fluency and the optimization of the times used, the communication space itself incorporates these mechanisms. In the case of a flight simulation, the control panel, to which all communicators located in the flight cabin have access, clearly states the status of communications and transmission errors can be detected in it.

Signage

In interactive communication within the same communication space, any element within the reach of communicators can be used to transmit a certain message. In order to be able to choose the appropriate signals at all times, it is necessary to have a thorough knowledge of all available means of communication, as well as the role they play in the communication protocol. The effectiveness of the signals, as with the acoustic alarm signals, is demonstrated after analysing the communication processes and experiencing different solutions for the transmission of the same message.

Empathy

Empathy towards other communicators is especially important in medical communications. It is not necessary to know the psychological, social or cultural context of another communicator to express empathy towards him. However, it is necessary to point out certain advantages and disadvantages that empathy usually entails. In any case, knowledge of the individual contexts, as well as the main characteristics of the communication space, serve to maximize the advantages and lessen the effect of the inconveniences **(Table 8.2)**.

ADVANTAGES	DISADVANTAGES
» Helps strengthen our interpersonal relationships. » Serves to give hope in times of despair. » Helps us better understand the personal problems of colleagues and patients.	» Sometimes causes psychological overload and stress. » In some cases it leads to false expectations. » Leads us to obtain a lot of information that may be irrelevant for the case.

Table 8.2. *Advantages and disadvantages of empathy in medical situations.*

Emergency communication

To assess the importance of communication in the case of emergencies, it is necessary to return to a different context than medical communications.

When a flight simulation crew member detects a serious problem, he uses the instructions in the communication protocol to act accordingly. This protocol, being based on previous experiences of other communication processes, can guarantee a high probability of communication effectiveness. However, it is the perception of the communication space, understood as the sum of all the contexts integrated in it, which offers the communicator most of the information he needs to act in case of emergency or to communicate an urgency. Therefore, the communicator's skills, based on his/her own experience, may be more decisive in this type of communications than the historical context and the experiences that have served to develop the communication protocol.

VISUAL ABSTRACT

Psychological Context   Cultural Context   Social Context

communicator A
communicator B   communicator N

Key concepts
specified in the experience   Types of communication

Communication protocol   Spoken communication
Communication urgency   Written communication
Etc.   Non-verbal communication
                                Remote communication

communication space
(co-creation of meaning)

Physical Context

Interactive model

Transaction model of communication

Linear model

Historical Context

Figure 8.4. *Concept of this chapter.*

EXAMPLE IN PRACTICE

A paradigmatic example of the communication and co-creation space, within the transaction model, is the chess board.

Following this model, an interactive game based on chess for training and development of soft skills related to communication in a virtual environment is proposed. Instead of limiting the game to only two communicators, two teams of six components are established. Each of the participants will be assigned a certain type of pieces, as if it were a role or as if these pieces were their avatars within the game. The players, who have to communicate with each other to carry out any movement, are not necessarily located in the same physical space, since they have devices that allow them to participate telematically, both to move their pieces and to transmit written messages to the rest of the your equipment (remote communication).

The main issues that arise in the face of this approach are the following:

What previous orders are established among team members?

What type of communication is used between team members during game development?

What importance is given in decision-making to players who have more experience?

If players are given freedom of movement, how do emergency situations communicate with other players?

The solution to these questions involves the definition of a communication protocol that includes the most appropriate interactive mechanics in each case. Next we develop its main items.

Information hierarchy

To optimize the full potential of the equipment, it is necessary to use communication channels that facilitate the transmission of information by all its components, but it is essential to classify the information to prevent the most superfluous messages from hindering the transmission of the most important.

First of all there must be a previous approach, preferably in writing, in which the main guidelines are defined. Secondly, there must be interactive instruments for decision making, whether agreed or simply consulted. Finally, there must be an emergency communication channel, that is, a mechanism to transmit relevant information at decisive moments.

Shared alternatives

The communication space represented by the chess board is placed in a higher order than the situation models shared by the members of the same team to test possible movements. Similarly, in a surgical intervention we would distinguish the operation itself from the virtual models we use to share solutions with the rest of the team.

The shared situation models are themselves a communication channel, but it can also be a testing ground in which each player can check the viability of their proposals before being transmitted to the rest of the team.

Adaptations and modifications

The original plans, the result of previous work by the team, can be altered during the development of the game. Faced with an unexpected situation, the communication protocol must clearly establish the mechanisms available to the team in order to alter the initial approach.

Alternative decisions are subject to what happens on the board, which then functions as a true communication space. However, in highly hierarchical work teams it is necessary to have an alternative communication space in which solutions are studied before making final decisions.

Free interactivity

In an open communication system, all players are allowed to intervene freely. In this case, the board itself functions as a true communication space, since it becomes a space for experimentation for all participants. Although the result is more impulsive, and does not take advantage of the potential of the team, it allows a more faithful simulation of critical situations. That is, it contributes to the training of soft skills related to overcoming stress or the ability of participants to take the initiative in an emergency.

Remote communication management

Regardless of the communication system, it is necessary to define each and every one of the communication devices available to the team. In this case, the physical context of each of the participants plays a key role.

When all players are placed in the same physical space, problem and error management can be carried out in the communication space itself. When one of the players participates telematically, it is necessary to monitor a management space that serves as a remote communication channel. However, the different communication channels will be subject to the degree of participation of the players and the type of communication that is considered most appropriate in each case.

Communication mode choice

In order to determine the type of communication that is most efficient, we start from the following classification.

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In summary, the communication protocol necessary to optimize the work of each team will depend largely on the correct allocation of communication channels. All decisions will be the result of a coordinated communication work whose success will be closely linked to individual and collective capacity, but most decisions will be conditioned by the interactive mechanisms established by the protocol.

In the design of the communication protocol it is essential to establish a clear distinction between synchronous communications and communications that can be transmitted through multicronic channels, that is, channels that allow the analysis of messages and proposals before being transmitted to a co-creation space in the That decisions are irreversible.

SUMMARY

Interactive communication responds to a compendium of learning dynamics based on instrumentalism (Dewey, 1938). The communication protocol, although designed as a structure, is another instrument of the communication process and as such is subject to modifications. Similarly, the communication space is an instrument that adapts according to the results of different communication experiences.

In the learning process all the elements of the communication space, including the communicators themselves, are the object of study. A detailed analysis of the errors and achievements of each communicative experience can be key to understanding the needs of subsequent development. In any case, the study and evaluation of the processes must be oriented following the guidelines of the following learning objectives.

LEARNING OBJECTIVES	EVALUATION
» Interpret the communication protocol correctly. » Follow the guidelines of the role assigned by the protocol. » Identify the category to which each of the information belongs. » Use the appropriate communication channels. » Contribute to the development and improvement of the communication space.	» Relate each role to its function in the communication. » Follow the established sequence and alter it if necessary. » Choose the right time to convey a specific message. » Choose the right way to convey a specific message. » Alternative proposals and results of its implementation.

Table 8.3. *Learning objectives and evaluation for communication and interaction.*

9. LEADERSHIP

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Polytechnic Institute of Portalegre. Portalegre (Portugal).
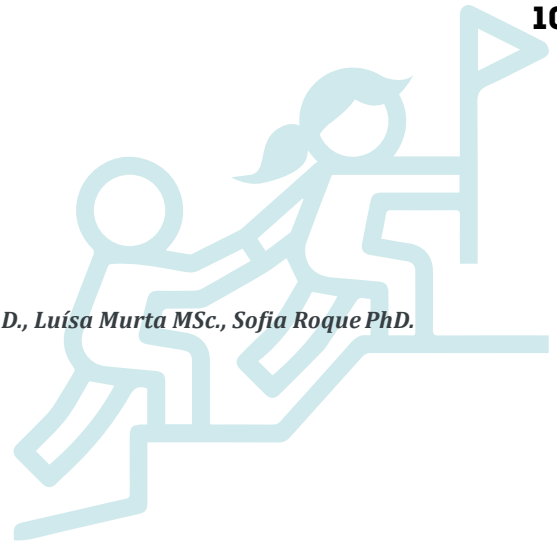
THEORETICAL INTRODUCTION

Leadership is an essential soft skill (Agha, Fowler & Sevdalis, 2015) of health professionals, regardless of the practice's specialty or environment. These professionals have the responsibility to contribute for achieving the results of their profession, of patients and organizations. The development of leadership skills needs to be an integral part of their learning and training as a facilitating vehicle for health system management and transformations.

Health is a challenging context in which the quality and safety of care is seen by most countries as a priority, requiring policies that address not only health interventions but also the economic and social context of the country. Thus, integrated governance plays a key role in the sustainability of global health systems, where the clinical, business, financial, information and risk management focus are aligned. This gives greater accountability and the need for communication between different levels of management, which should be based on strategic cooperation models, precisely and concisely delimiting the relationship between different sectors (Fernandes, 2014).

However, it is well known that globalization, competition, workforce diversity, information and technology explosion, as well as economic and social disruption are current global trends that lead health systems to constant change with efforts in their adaptation and management (International Council of Nurses [ICN], 2006). Leadership plays a key role as a key element in making change happen **(Figure 9.1)**. Health systems are placed in highly complex scenarios requiring more human and technological resources, generating risks, uncertainties and insecurities that may be responsible for causing adverse events and errors in patient care.

It is up to the national governance of each health system to rethink its clinical governance in order to safeguard the quality standards of health care, and according to the Portuguese National Health Plan, it should have as its fundamental pillars: the involvement of all elements of the health team; the recognition of the value of each member of the health team for the quality of care; and finally, the team's joint work in identifying outbreaks in need of improvement and in finding solutions. Such designs will patent the change needed for a healthy work environment, where the integration of skills and competencies of all team members aims for the best outcomes for patients while achieving continuous improvement of care.

Quality assumes an imperative importance in health care and over time, it has contributed to changes in organizational cultures, aiming the excellence and safety of care provided. However, we know that the environment of professional practice can be enhanced or constrained by the strategies adopted by policy makers, management or even leaders, influencing patient outcomes. Nevertheless, what is a healthy practice environment? According to the *World Health Organization* [WHO] (2010), it is the one that promises the continuous improvement of safety, health and welfare of professionals and sustainability of the workplace.
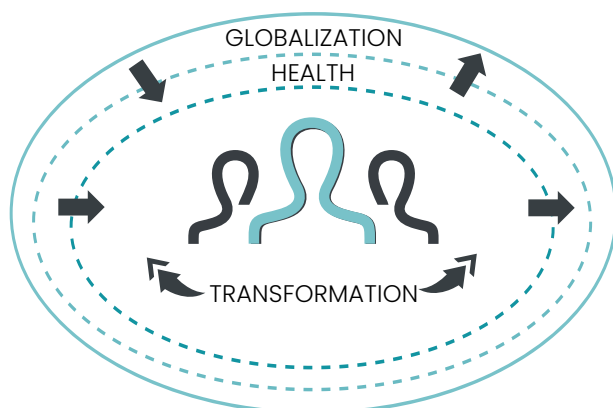
Figure 9.1. *Leadership as a key element.*
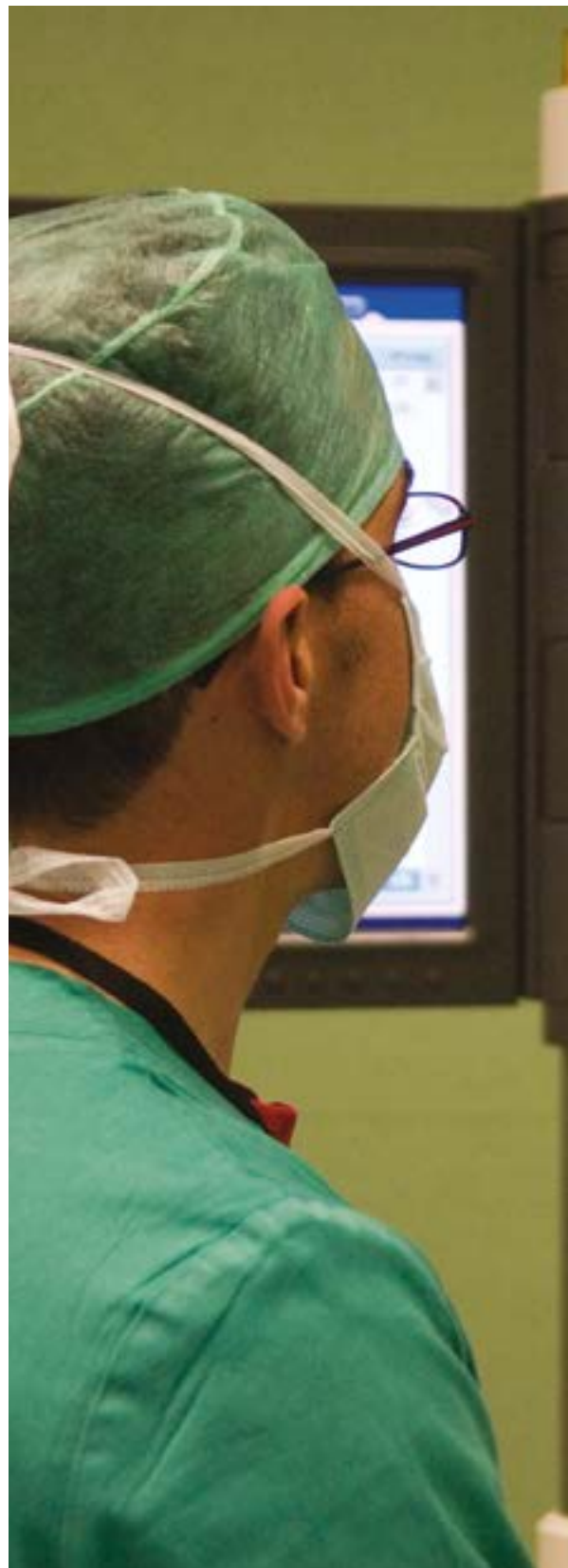
Several studies in different areas of health have been developed demonstrating the influence of the environment on the care provided. However, this concept is well developed, applied and studied in nursing, as it has been investigated for a long time. Its origin is quite old, since the time of *Florence Nightingale*, which was able to demonstrate the importance of the environment in the recovery of patients, being relaunched later with the Magnet hospital movement, which was the developer of the improvement of nursing practice environments worldwide carried out by different investigations.

It becomes particularly visible with the publication of the book *Keeping Patients Safe*: *Transforming the Work Environment* by the *Institute of Medicine* [IOM] in 2004, being again boosted in 2007 with the International Day of Nursing and assumed in 2009 by the *Joint Commission* as one of the criteria to be met in the accreditation process of health facilities. The environment construct of nursing practice, by Lake (2002), although more recent ones exist, such as the *Essentials of magnetism instrument*, is the most used internationally in relation to the RN4Cast's internationally recognized project, which illustrates what happens to the quality of care and nursing outcomes when different aspects of the teams are changed.

Positive associations between the practice environment and the quality of care provided, patient safety and safety culture have been found, but also adverse events with patients and incidents with health professionals assume negative associations (Roque, 2016) **(Figure 9.2)**. Although they are taught in nursing, we think they can be extrapolated into the health universe. All outcomes are the result of teamwork, which can only achieve high performance if it maintains high levels of engagement that will be promoted by the team leader .
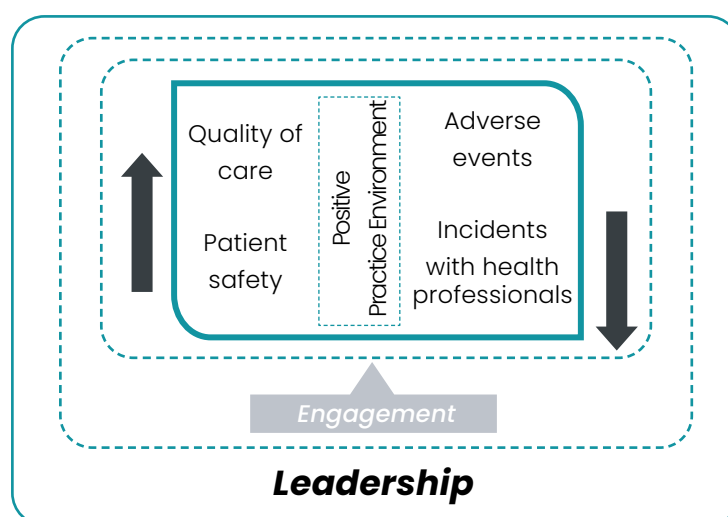
Figure 9.2. *Outcomes of good leadership (Adapted from Roque, 2016).*

Baumann (2007) and WHO (2010) have other perspective, the results in health professionals, highlighting the positive relationship of the practice environment with their health and well-being and, consequently, the quality, productivity and the value of care provided. However, practice environments are influenced by the characteristics of leadership (Balsanelli & Cunha, 2014), assuming it to be a central aspect in the quality and safety of care in health organizations (The Royal College of Surgeons of England [RCSE], 2014), being one of the top topics on the agenda of health professionals and policy makers.

A research conducted by the University of Toronto that analysed various health systems characterized by high performances, such as the United States, Sweden, England and Canada, have identified as a common element the focus of quality of care, combined with the development of health care leadership not only for individuals but also for leadership teams (Ham *et al.*, 2011). It is from this premise, as well as from the benchmark of the IOM report entitled *To err is human: Building a Safer Health System* (Kohn, Corrigan & Donaldson, 2000), which identifies the need to promote efficient care safety teams, that we considered the reflection on leadership pertinent as one of the fundamental and inseparable elements of the work of surgical teams in the operating rooms (Giddings & Williamson, 2007), which is a non-technical but facilitating ability to achieve shared goals through individual work and collective (Parker, Yule, Flin & McKinley, 2012).

However, what do we refer to when we talk about leadership? A wide range of definitions can be found in the literature. Nevertheless, the ability to influence each other and the ability to direct seem to be key elements to define *the leader*, varying in the practices to be applied. One of the most accepted definitions seems to be that of Kotter (1996) **(Figure 9.3)** where process management and leadership are at the core, that is, the core of its action will be process management with planning, financing, human and material resources, monitoring implementation and evaluation, as well as problem solving and re-planning if necessary. A distinctive prism
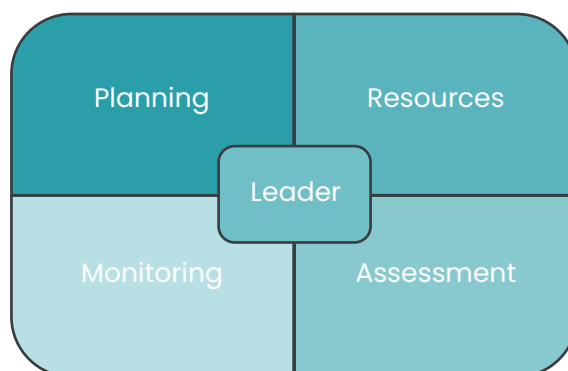
Figure 9.3. *Process management and leadership as a leader focus (Adapted from Kotter, 1996).*

of leadership is centred on the ability to lead others in the desired direction, motivating and keeping them motivated and even inspiring them to develop their skills.

We know, however, that surgical team leaders in the operating room, as well as other care settings, are integrated into other leadership teams within the organization, so they will have to lead their team in conjunction with the organization's greater interest, which requires some degree of autonomy for the function to be performed responsibly (Giddings & Williamson, 2007). This is completely transposable to those who assume leadership within the operating room, whose greatest interest will always be, as well as the organization, the quality and safety of patient care. Surgery is a complex joint procedure with multiple intervention by health professionals, and someone needs to lead to achieve the goals, where each member tends to know clearly his/her role and relies on the skills of other team members (Leach, Myrtle & Weaver, 2011), and the leader should promote and foster the building of trust.

The attribution of intraoperative leadership is difficult to find, usually it is the surgeon, so many of the literature focuses on this healthcare professional as a leader of the operating room team (Robertson, Dias, Yule & Smink, 2017; Parker *et al.*, 2012; Wakeman & Langham, 2018). However, in the study by Leach *et al.* (2011) both the circulating nurse and the surgeon were identified with leaders who influenced team performance, among surgeons, nurses, anaesthetists and surgical technicians.

The study by Bogdanovic, Perry, Guggenheim & Manser (2015) exploring coordination behaviours and adaptive coordination strategies, through a qualitative analysis of 33 semi-structured interviews with doctors and nurses from different specialties and hospitals, has identified a coordination based on management of tasks and information, as well as teaching and leadership. Furthermore, adaptive coordination strategies triggered by infrequent events such as intraoperative complications and different level of experience among operating room staff was another finding.

Leadership is assumed in this study as a special aspect of coordination that may vary depending on the intraoperative phases or events, considering that all team members are responsible for their tasks and can be considered a leader in their work area. A case of adaptive leadership to contingencies is described in the aforementioned article: indication of the surgeon to close, but the final material count had not yet been completed, clearly the person who is doing it will have to take the lead and stop the procedure. This case is obviously a situation of personal compromise, where injury to the patient is known if the procedure is not stopped. However, for those who identified the situation to act, they had to be previously involved in a team where the environment could support the development of knowledge and its integration, with openness for analysis and discussion.

Parker *et al.* (2012), analysing the specific leadership skills and behaviours associated with surgeon performance during surgery, specifically in 29 surgeries of 3 hospitals, identified 258 leadership behaviours during 63 hours of observation, which are classified according to complexity, using the *British United Provident Association's* schedule of procedures. The identified behaviours were guidance and support, communication and coordination, task management, resource management, direction and ability, standards maintenance and decision-making. Some more leadership behaviours were found when surgery was more complex, with guidance and support (33%), communication and coordination behaviours (20%) and task management (15%) being the more frequent.

The most identified results reflect the conceptualization of empowerment, which is grounded on capacitation through formal or informal systems allowing access to opportunities to learn and grow (guidance and support), access to information (communication), access to support (coordination) and access to resources (task management) needed to perform the activities. These are the core behaviours identified in the current literature for surgical leadership, which require specific skills, although there is no perfect model. Being identified by RCSE (2014), there are three key elements for surgical team leadership: setting and maintaining standards, supporting the others and dealing with the pressure. These elements must be supported by styles that will assertively adapt to the situation in order to complete the task with quality and safety.

The bibliographic findings are quite simply stated by the RCSE (2014) in the guide to best practice surgical leadership, referring that effective leadership of surgical teams, regardless of context, must be able to adapt style to the situation, be assertive, clearly define the roles of each element especially in critical situations, involve all elements in decision making, as well as incessantly promote the search for peer input. However, studies by the English National Health Service show that dysfunctional behaviour is promptly recognized by the team, but the search for input previously addressed is not always clear as the team may lack the skills or confidence to express its concerns (Giddings & Williamson, 2007), data corroborated by Siu, Maran & Paterson-Brown (2016), which confirm that bad leadership is highly correlated with intraoperative incidents, which could have happened in the case mentioned above.

Different studies have shown that good leadership leads to benefits in the results, whether organizational, professional or in patients, and on the other hand, poor leadership will have a cost that can be very high (Ham *et al.*, 2011) **(Figure 9.4)**.
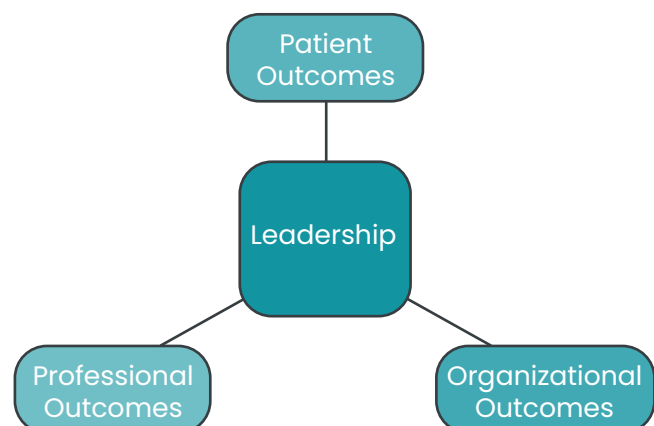
Figure 9.4. *Outcomes influenced by leadership (Adapted from Ham et al., 2011).*

CONTEXTUAL INFORMATION

In an Operating Room (Multipurpose), in the afternoon shift (16 to 24 hours) the detached team consists only of four elements – three nurses, with different functions (circulating / anaesthesia / instrumentalist), and an anaesthesiologist – team that should give response to surgical situations that may exist.

At the beginning of the shift in room A, a general surgery, which began in the previous shift, is underway. The surgery was prolonged (laparoscopic cholecystectomy). The team in room A consists of two general surgeons, an anaesthesiologist and three nurses (circulating / anaesthesia / instrumentalist).

At 16 hours the nursing team is replaced, and three nurses also compose the new one. The surgeons remain the same so as the anaesthesiologist. This new nursing team continues the surgery.

After 90 minutes the service phone rings. The nurse in charge answers and is informed by the obstetric surgeon that there is a pregnant woman in labour, who will have to undergo an urgent caesarean section, because the foetus is suffering. At this point, the nurse informs the surgical team in room A of this occurrence.

Surgical teams are confronted with the following reality:

> CLICK ON THE TITLE TO SEE CONTENT

All members of the surgical team (surgeons/anaesthesiologists/nurses) have their "roles" clearly defined, a responsibility to the patient and consequently, an opinion/position in terms of leadership in the decision to be taken.

The general surgeons in room A assume that this surgery should continue without interference, proposing that the nursing staff remain unchanged.

The obstetric surgeons in room B reinforce the urgency of obstetric surgery, which implies that both occur simultaneously, admitting the possibility of not having the support of an instrumentalist nurse.

The anaesthesiologist in room A agrees to adapt to this situation, being supported by a nurse who simultaneously assumes the duties of circulating nurse / anaesthesia.

Nurses show willingness to ensure the operation of both operating rooms.

After the dialogue with the surgical team, a consensus solution is found. The responsible shift nurse determines that two of the nurses will go to room B (circulating/anaesthesia) and, consequently, in room A only a nurse remains, who will accumulate the functions of circulating and anaesthesia, both rooms being without a nurse instrumentalist.

First, one nurse leaves room A (instrumentalist), who will prepare room B. When room B receives the emergency obstetric surgery, the second nurse leaves room A, leaving only one nurse, assuming the duties of circulating/anaesthesia. The nurses in room B assume the functions of circulating and anaesthesia.

Problem resolution:

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KEY CONCEPTS

Different theories of leadership have been applied and studied recently in the area of health, based on the applicability of transformational theory, which may also contribute to the creation of a healthy workplace. A healthy workplace (WHO, 2010) is one in which workers and managers collaborate to use a continual improvement process to protect and promote health, safety and well-being of all workers and the sustainability of the workplace by considering the following, based on identified needs:

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In most surgical procedures it is the surgeon who takes the lead in the operating room. However this type of behaviour should not be interpreted as an absolutist or dictatorial attitude, but rather a perfectly appropriate attitude which main purpose is to prevent the emergence of autocratic nature behaviours that, in the surgical context, may lead to an increase in errors during the performed procedures.

However, when the surgeon is engaged in performing procedures that require his full attention, the leadership of the surgical team may and should be assumed by another of its members, and this should be envisaged as a perfectly normal process resulting from the establishment and development of a culture of respect and mutual support within the surgical team, leading to a decisive contribute to increase safety in the operating room.

Effective leadership involves inevitably the promotion of a peaceful work environment and establishes processes that foster effective communication, enabling surgical team members to take a critical thinking and reflection posture that promotes appropriate action. It is important to stress the importance of giving special attention to potential risk situations within the surgical team, which can be listed using the IMSAFE acronym widely used in aviation, such as **I**llness, abusive consumption (**M**edication), **S**tress, **A**lcohol intake, **F**atigue, and psychological problems (**E**motion), such as depression (Wakeman & Langham Jr., 2018).

Indeed, some strategies used in the training of aviation pilots are now being introduced into the surgical context, emphasizing the importance of simulation, a long-valued training area for the development of surgical technical skills, in which currently there are also encompassing strategies for the training of soft skills, such as leadership, communication and teamwork. This design results from the evidence that training associated with attention to the human component is essential to reduce clinical error and increase the effectiveness of the surgical team thus promoting a healthy environment within the operating room.

In order to effectively contribute to a better practice in the surgical context, as in any other clinical practice, it is important that the leaders use transformational leadership practices to create and maintain healthy work environments. This way it will be possible to model values through action, open communication, visibility and using participatory decision-making, based on the following keys concepts: **Building trust relations; Create an empowerment-based work environment; Create an environment that supports knowledge development and integration; Lead and support change; Balance system complexities, by managing competing values and priorities** (Registered Nurses' Association of Ontario [RNAO], 2013).

Independently of whether these key concepts are associated with guidelines for the best practice in nursing leadership, it is considered that they can be transposed to all health professional groups of the surgical team, a methodological preliminary that is assumed in this handbook. This assumption is also founded in guidelines for the best practice in surgical leadership (RCSE, 2014), where attributes for good surgical leaders are indicated and can be considered as transversal to the key concepts defined above, namely the integrity, honesty (in an open and consistent way), accessibility, opening to challenges and feedback, decision capacity, self-awareness and mindfulness of their impact on others, and awareness in their own responses to stress.

Furthermore, some of the main features related to processes of operational leadership of surgical teams can also be associated in a transversal way, highlighting the functions normally assumed by the surgeon as a leader of these teams, namely while "conductor, elucidator, delegator, engagement facilitator, tone setter, being human, and safe space maker" (Stone *et al.*, 2017). This study emphasizes as the most relevant leadership functions elucidator and tone setter, advocating that in leadership processes behaviours as teaching, constructive criticism, explanation, relevance giving, constructive humour, compliments, reassurance and encouragement should be privileged, and behaviours as private criticism, negative criticism, frustration, destructive humour and conversation unrelated to the case should being avoided.

The effective results of proper leadership at the surgical team level may be evidenced by the behaviours and attitudes assumed by its members (followership), being especially contemplated in this interpretation aspects such as "integrity, responsibility, resilience, courage, respect, loyalty, discretion and ego management" (Watters, Smith, Tobin & Beasley, 2019). This article, published in the Royal Australasian College of Surgeons official journal, highlights the fact that relationships established between leaders and their followers are a complex process, being the success of leadership dependent on the ability of the leader to promote and preserve trust on their competence, performance and ability to achieve the desired outcomes.
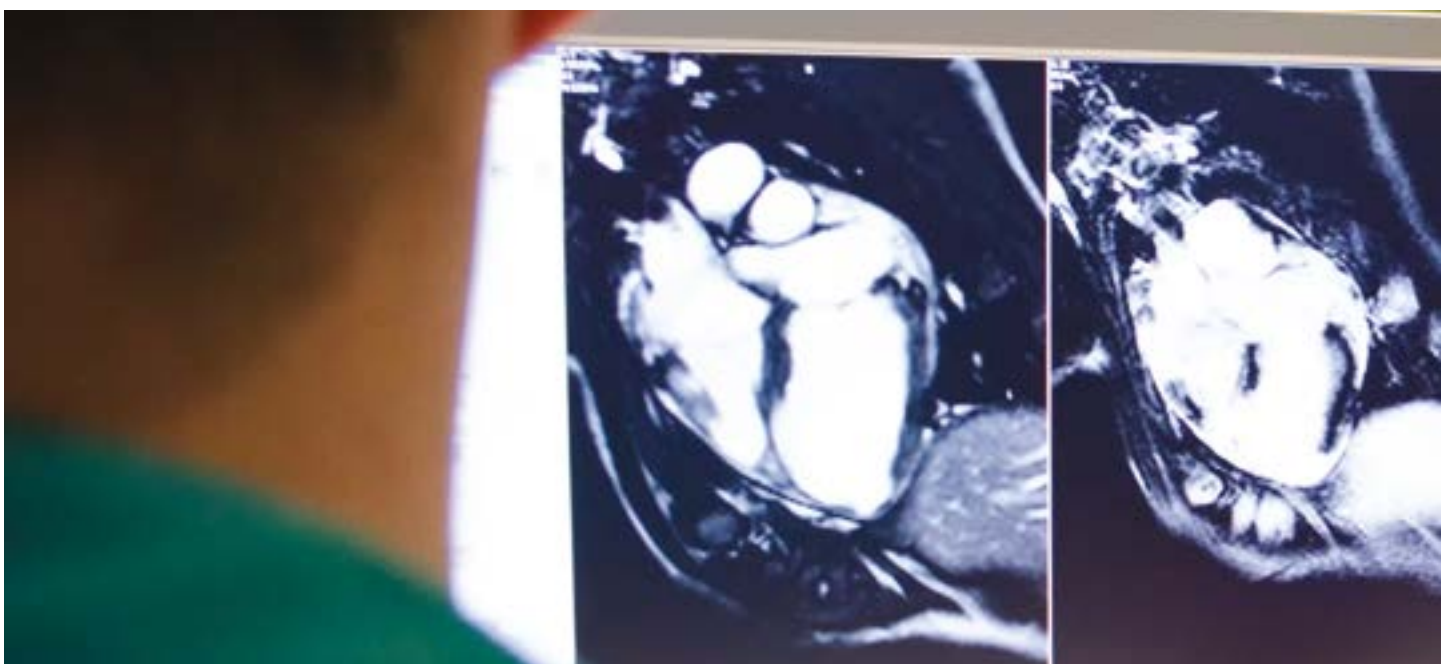
Building trust relations

Trust supports the interpersonal relationships established in clinical practice amongst health professionals (Laschinger, 2004, in RNAO, 2013), emerging from cognitive judgments regarding competence. Given the complexity of health systems, previously stated in the introduction of this chapter, relationships of trust facilitate constant adaptation to change (Guardia & Lima, 2019). It is also known the complexity and level of uncertainty that involves a surgical intervention, where changes of plans often happen, requiring proactive adaptation of the entire team on behalf of the patient.

Trust is a key concept for the leadership of the operating rooms' teams, acting as an engine for solving risk problems, requiring the engagement of all team members, promoting increased job satisfaction and organizational commitment (RNAO, 2013; RCSE, 2014; Wakeman & Langham Jr., 2018; Watters *et al.*, 2019). Given the importance of trust relationships, some practical strategies at individual, team, unit or organization level, to achieve them are presented in **Table 9.1**.

INDIVIDUAL STRATEGIES	TEAM, UNIT, ORGANIZATION STRATEGIES
» Understand what is expected from the leader. » Know well the work to be developed. » Listen to each leader's concerns and manage these at different levels of management. » Be "top-down" and "bottom-up" information vehicle. » Provide informal and ongoing positive feedback. » Develop skills in inter-professional practice and how to facilitate teamwork. » Support change initiatives by discussing projects with colleagues.	» Create a collective vision and value statement for the team by developing behavioural patterns to reflect that vision. » Make clear and accessible statements of roles and levels of responsibility. » Perform performance appraisal on a regular basis. » Formalize recognition of merit.

Table 9.1. *Building trust relations – Practical strategies (Adapted from RNAO, 2013).*

Create an empowerment-based work environment

The complexity and unpredictability of operating rooms require knowledge in order to be proactive. *Empowerment* assumes itself as a catalyst for good practice in the decision-making process as it allows power, freedom and information. Assertive and informed decision-making is crucial in intraoperative inter-occurrences approved for patient quality of care and safety. However, *empowerment* is inseparable from leadership because team capacity comes from the leaders, who must make the team feel capable of acting without hesitation in the commitment to good results.

An *empowerment*-based work environment promotes improved occupational mental health and work effectiveness / performance (RNAO, 2013; RCSE, 2014; Stone *et al.*, 2017; Wakeman & Langham Jr., 2018). Considering the importance, it assumes some practical strategies at individual, team, unit or organization level to achieve this goal are presented in **Table 9.2**.

INDIVIDUAL STRATEGIES	TEAM, UNIT, ORGANIZATION STRATEGIES
» Engage in continuous learning. » Question the status quo. » Ask yourself about success or failure. » Participate in setting a vision or collective purpose. » Share information and resources. » Build trust. » Create shared values. » Recognize contributions. » Seek broad feedback to understand how others perceive behaviour.	» Definition of formal and informal leadership roles. » Involvement of health professionals in patient care conferences. » Permit access to support programs and support groups after post-incident discussion. » Develop positive feedback programs.

Table 9.2. *Create an empowerment-based work environment – Practical strategies (Adapted from RNAO, 2013).*

Create an environment that supports knowledge development and integration

Patients are increasingly aware of their rights and require health professionals to provide better conditions and better quality of care. Knowledge is an indispensable resource of the organization to make actions more founded, efficient and effective. Knowledge is the combination of data and information that guides actions and decisions. Healthcare organizations are rich sources of data and information with the implicit ability to generate and access knowledge.

The much proclaimed knowledge management integrates not only the form of production, but also the storage, distribution and use of knowledge, a process that can be vital for professionals to achieve quick and assertive decision-making responses, for example in the course of the intraoperative process. A leader who promotes knowledge development and integration will be a leader who impulses knowledge sharing among team members, stimulating critical thinking where people continually learn together, by sharing individual expertise and building collective knowledge, aiming at patient's quality of care and safety, as well as the improvement of care in a future situation.

An environment that fosters knowledge development and integration leads to enhanced personal and professional growth of staff (RNAO, 2013; RCSE, 2014; Stone *et al.*, 2017; Wakeman & Langham Jr., 2018). Given the assumed importance, some practical strategies at individual, team, unit or organization level to achieve this purpose are presented in **Table 9.3**.

INDIVIDUAL STRATEGIES	TEAM, UNIT, ORGANIZATION STRATEGIES
» Show personal commitment to professional development. » Promote discussion of research articles, case studies and experimental studies. » Promote analysis of best practice guidelines and integrate them into leading clinical practice. » Discuss how to evaluate the practice with other colleagues and gather data for the evaluation. » Analyse and study care successes and failures.	» Develop quality improvement teams and committees. » Encourage knowledge sharing regularly. » Support continuing training. » Diagnose needs and develop training plans. » Establish annual training plans.

Table 9.3. *Create an environment that supports knowledge development and integration – Practical strategies (Adapted from RNAO, 2013).*

Lead and support change

Change can either be programmed or not. In what concerns the context under analysis, change is often unscheduled and requires rapid change, the leaders being the key to success, as they will be the promoters of replanning and implementation. However, we know that change causes discomfort (by the leave of everyone's comfort zone), and that discomfort should be less than the sum of dissatisfaction with the status quo, vision, sharing and team knowledge (ICN, 2006), so that the leader has the ability to lead and support change effectively, promoting team engagement in the change needed.

Leaders who have the ability to manage change properly providing team support will be responsible for higher-performing teams and lower absenteeism (RNAO, 2013; RCSE, 2014; Wakeman & Langham Jr., 2018; Watters *et al.*, 2019). In **Table 9.4**, some practical strategies at individual, team, unit or organization level that facilitate change management and support are presented.

INDIVIDUAL STRATEGIES	TEAM, UNIT, ORGANIZATION STRATEGIES
» Consider the health professional need for change and their involvement in the change process. » Create a team shared value chain. » Understand that acceptance of change varies from individual to individual, performing a stakeholder analysis to understand who can promote or inhibit. » Think about change and monitor it in a structured way, whether in human, financial and quality improvement resources.	» Involve health professionals in building change. » Share the vision and tactics of change in open forums and through technology. » Promote training offer of new skills. » Discuss similar initiatives that failed to identify what should be done differently.

Table 9.4. *Lead and support change – Practical strategies (Adapted from RNAO, 2013).*

Balance system complexities (managing competing values and priorities)

We have previously addressed the complexity of health systems, as well as the complexity of operating rooms, and have presented the results of the greatest complexity associated with leadership behaviour. It is necessary in the mentioned contexts that the management of leaders be efficient and effective regarding values and performances that can be used to embody conflicts. This way, the leader should bring forward all the resources needed to provide quality care and safely to patients and staff, and mobilize trust relationships and work environment based in empowerment, where general knowledge be integrated into the goal to achieve, and where sharing and discussion will define the change to be made through a collective decision making, while maintaining a high level of engagement.

An adequate and balanced decision will promote in the surgical team increased perceptions of their value and self-image (RNAO, 2013; RCSE, 2014; Stone *et al.*, 2017; Wakeman & Langham Jr., 2018; Watters *et al.*, 2019). Some practical strategies at individual, team, unit or organization level that promote the ability to balance complexity and value management and concurrent priority are described in **Table 9.5**.

INDIVIDUAL STRATEGIES	TEAM, UNIT, ORGANIZATION STRATEGIES
» Seek ethical frameworks to assist in clarification and decision making.	» Develop and maintain a philosophy and mission statement that values nursing and puts the patient first.
» Use proven scientific evidence to support decision making.	» Apply management models that encourage information sharing and decision making.
» Demonstrate and promote the link between nursing work environments and patient outcomes, including the impact of staffing levels.	» Establish forums to discuss ethical concerns, including formal and informal ethical aspects.
» Form alliances with like-minded groups and individuals.	» Develop whistleblowing policy.
» Analyse your own personal philosophy and vision values and beliefs of the organization before accepting the role of leader.	» Identify polarities in complex situations and map strategies to manage them.

Table 9.5. *Balance system complexities (managing competing values and priorities) – Practical strategies (Adapted from RNAO, 2013).*

◉ **VISUAL ABSTRACT**

| Leadership | ▶ | Practice Environment | ▶ | Quality and Safety of Care |

Health Professional Leaders

▼

Leadership practices to create / maintain healthy work environments

Building trust relations

Create an empowerment-based work environment

Create an environment that supports knowledge development and integration

Lead and support change

Balance system complexities (managing competing values and priorities)

Modelling values

Action

Open communication

Visibility

Participatory decision making

Figure 9.5. *Leadership (Adapted from Balsanelli & Cunha, 2014; RNAO, 2013; Roque, 2016).*

EXAMPLE IN PRACTICE

In an Operating Room (Multipurpose), the team that ensures the afternoon shift (16 to 24 hours) consists of an anaesthesiologist and three nurses who take over the functions of circulating, anaesthesia and instrumentalist.

In operating room A, an orthopaedic surgery (femoral locking due to femoral neck fracture) is scheduled, which will be performed by two orthopaedic surgeons. This operating room was properly prepared, with all the necessary material, and the patient was sedated and anaesthetized (spinal anaesthesia), with the entire surgical team (orthopaedic surgeons, anaesthesiologist and circulating nurses / anaesthesia / instrumentalist) prepared to begin the surgical procedure.

During the positioning of the image intensifier, the radiological equipment required to perform this surgery, the radiology technician responsible for operating this equipment accidentally collides with the articulated C-arm of the image intensifier on one of the operating room walls, in which a compressed air ramp was located, and breaks one of the valves causing a compressed air leak (pressure of 7 Bar). The occurrence makes impossible to perform the surgery in adequate conditions because it affects the normal functioning of the operating room.

In this situation, it was up to the responsible shift nurse to phone the Prevention Maintenance Service and, together with another nurse, to perform the procedures indicated by the Maintenance Service technician to try to solve the compressed air leak. They were not able to solve the problem.

It was then compulsory for the Prevention Maintenance Service technicians to go to the operating room to solve the leakage of compressed air. They informed that it would take at least 30 minutes to arrive and proceed to the necessary repair.

Although the surgical procedure had not yet begun, the patient was already sedated and anaesthetized (spinal anaesthesia), making it inevitable that the leader of the surgical team should take a decision, safeguarding the patient's best interests and after discussion with the rest of the surgical team they found different options that could be taken:

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The situation described would enable the training of leadership skills which inevitably and transversely would have to be associated with other soft skills, such as communication and interaction skills, situation awareness and decision making.

SUMMARY

In the operating room, technical skills have to be complemented by soft skills so that teamwork is facilitated, and assuming that the surgical team integrates different sub teams divided by professional classes. Based on recent scientific evidence, the importance of leadership as an essential and inseparable element of the surgery team and as a facilitating ability to reach shared goals through individual and collective work is presented.

Assuming that it will be difficult to create a set of scenarios that meet all real situations, such as a surgical context, it is contemplated that the use of experimental models that innovate this learning process can be a strategy. This can be effective in contributing to the acquisition of leadership skills, enabling learning with possible mistakes in a virtual reality environment, without any real consequences for the care of patients.

Leadership does not have to be an innate competence but can most often be developed through systematic processes involving elements such as personal and professional experience, associated with processes of reflection and oriented guidance. Indeed, there are not many born leaders, either in health or in any other areas, however the skills associated with developing leadership processes can be acquired through training activities that involve two distinct stages (Giddings & Williamson, 2007).

At an early stage, it is essential to promote the learning of key leadership concepts, along with the resources available to implement these processes. The next stage involves promoting the practical application of these key concepts, allowing their interaction and adjustment in situations that develop in more or less complex environments, in which it is essential to deal with different individuals and situations with some degree of unpredictability.

Assuming that non-technical skills such as self-awareness, self-discipline, persistence and empathy are extremely significant leadership traits that can be included within the scope of emotional intelligence, five domains for conducting leadership skills' training in a virtual reality environment are presented:

- Recognition of one's emotions;
- Effective management of one's emotions;
- Ability to self-motivation;
- Recognition and perception of the emotions of others;
- Effective relationship management (managing the emotions of others).

With the following learning objectives **(Table 9.6)**, we try to highlight some of the most common behaviours and attitudes related to the concept of leadership in the operating room, assuming as a principle that there are no perfect models and styles of standard use, because they are influenced by different context contingencies.

LEARNING OBJECTIVES	EVALUATION
» To recognize the different emotions.	» Select the right options for an effective leadership process.
» To manage the relationships effectively (managing the emotions).	» Sequentially choose 2 or more options that promote an effective leadership process.
» To delegate tasks, responsibilities and timelines appropriately.	» Select options that result in adequate leadership processes (assessment checklist).
» To manage efficaciously conflict situations.	
» To define the roles and responsibilities clearly (particularly in critical situations).	
» To utilize appropriate language to communicate effectively (openly, timely and respectfully).	

Table 9.6. *Learning objectives and evaluation for leadership.*

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11. GLOSSARY OF TERMS

A

• ***Anaesthesiologist*** - Responsible for inducing the anaesthesia and checking the vital signs of the patient during the procedure.

• ***Anaesthesiologist assistants*** - Highly skilled professionals who work under the direction of anaesthesiologists as part of anaesthesia care team.

• ***Analytical decision making*** - Different and alternative options identified and the preferable one is carefully selected.

• ***Appendicitis*** - Acute inflammation of the vermiform appendix.

• ***Assertiveness*** - Behaviour of achieving goals in a clear and honest way with respect to the rights and feelings of others.

• ***Assistant surgeon*** - He/she assists the chief surgeon during the procedure.

B

• ***Benefits of teamwork*** - Significant increase of productivity in areas where creative thinking is required for various tasks, high adaptability and operability (teamwork benefits include elimination of mistakes, increased reliability and better outcomes, mutual satisfaction of all stakeholders, higher patient's satisfaction, lower costs of treatment, better image of the hospital, etc.).

• ***Bidirectional communication*** - It implies that the sender transmits information to the receiver, who has the opportunity to respond to and, in turn, becomes the sender and transmits the information to the receiver, forming a closed feedback loop.

C

• ***Chief surgeon*** - Responsible for leading and performing the intervention.

• ***Circulating nurse or circulator*** - Responsible for managing and implementing activities outside the sterile field.

• ***Classical (rational/normative) decision theory*** - It was developed by economists and business analysts. It deals with selecting the optimal solution based on mathematical formulas for choosing between possibilities.

• ***Classical Endsley model*** - One of the most commonly used models. It defines three ascending levels of situation awareness: perception, comprehension and projection.

• ***Closed loop communication*** - Repeat messages.

• ***Communication*** - Exchange of information among the participants and the related context (this comprise using appropriate terminology).

• ***Conduit model treats communication*** - Defined process that occurs within an established social context, and in doing so limits our ability to appreciate other potentially more powerful social dynamics.

• ***Corrective comments*** - The receiver challenges or corrects the sender's message, e.g. questions or queries the initial statement to gain clarification.

- ***Creating a team*** - Elected team manager selects suitable candidates for his/her team, each candidate is assigned a role and his/her competences.
- ***Creative decision making*** - Faced with unusual problem, improvisation is necessary.
- ***Cultural context*** - One of the most obvious factors of communication, but it is also one of the most important. Culture relates to the beliefs and values of a group.

D

- ***Decision*** - Originated from the Latin word "decisio" which means "to cut from".
- ***Distributed cognition*** - Global vision of the situation integrating the information processed by both team members and technological systems.

E

- ***External motivation*** - Motivation by the external stimulus, for example the threat of punishment but also reward; external motivation can be of material origin - financial reward, or intangible - praise or appreciation (the motivation from the head of department, hospital management or the ministry of health are relevant).

G

- ***Group*** - The main difference from the concept of a team is that people do the job independently, work in an unlimited number of people and only depend on their coordination. Work of specialists in a lab can serve as an example. All employees have their own tasks, which do not have to be mutually dependent, when the lab is used by various company departments. They only need to coordinate activity to enable effective lab operations.

H

- ***Head mounted display (HMD) stand-alone*** - These helmets hinder the user's vision and display two screens (one for each eye) in which the visual information of the three-dimensional world is sent.
- ***Heuristics*** - General decision-making strategies people use that are based on little information, yet very often correct; heuristics are mental shortcuts that reduce the cognitive burden associated with decision making Heuristics reduce work in decision making in several ways.
- ***Historical context*** - It involves the expectation of the speaker and the audience in situations that happen regularly or have happened in the past.
- ***Informational comments*** - The receiver provides a non-evaluative response, e.g. provides an objective statement in response to the initial statement.

I

- ***Intelligent Tutorial System (ITS)*** - One way to increase the pedagogical value to provide feedback during the game.
- ***Internal motivation*** - Satisfying the needs of one's mind and interests, such as cognitive needs or self-realisation (the individual motivation to increase the personal expertise and contribute to the common goal serve as an example).

K

- ***Knowledge*** - Combination of data and information that guides actions and decisions.

L

- *Leadership* - The development of leadership skills needs to be an integral part of their learning and training as a facilitating vehicle for system management and transformations.
- *Long-term memory* - In this main memory store, all information learnt and acquired during our lifetime is stored, both personal memories of events (episodic memory) and knowledge (semantic memory).

M

- *Manager* - Responsible person for achieving the project goals, in charge of setting up the project team, and possessing freedom of choice, professional prowess and professional conduct (within the healthcare, the manager can be represented by the chief surgeon or the leader of the head of the medical concilium).
- *Mental model* - Representation of the surrounding world, which is associated with the perception and observation of reality by a person.
- *Miller's Pyramid* - Traditionally, the model has been used to match assessment methods to the competency being tested.
- *Mobile VR* - Helmets that use mobile phones to visualize three-dimensional worlds and uses its gyroscope to interact with the environment.
- *Motivation* - Set of factors leading to the streamlining of behaviour and action to achieve the goal.

N

- *Non-technical skills* - Interpersonal, cognitive and personal resources.
- *Non-verbal communication* - Communication without using words, the most often facial expressions, gestures, haptics, etc. (in the operating room, the gestures or similar activities matter).

O

- *OODA loop* - It proposes four consequent functions: Observe, Orient, Decide and Act, so it is highly related to decision making processes.
- *Overhearing conversations* - Listening to other conversations in the operating room.

P

- *Physical context* - It involves the actual location, the time of day, the lighting, noise level and related factors.
- *Psychological context* - Mood and emotions of the audience, as well as the speaker to a lesser extent.

R

- *Recognition-primed decision making (RPD)* - Solution is chosen based on the previously recognized pattern (previous experience).
- *Reinforcing comments* - The receiver acknowledges clear receipt of the message, e.g. checks understanding of the message.

- **Role in the team** - Specific function within team focused on behaviour not on personality, role allocation depends on individual abilities, strengths and weaknesses (specific tasks and responsibilities of a particular team member).

- **Rule-based decision making** - Applying recalled rules to the situation, this type of technique requires awareness of the rules and also knowledge to how to apply them.

S

- **Scrub nurse** - Responsible for managing the instrument table and providing surgeons with the tools.

- **Self-talk** - Explain out loud the steps.

- **Sensory memory** - This type of memory retains information from the human senses only for a brief period, before it is transferred to the working memory.

- **Serious games (SG)** - Games with educational goals that provide learners with an innovative, entertaining way of learning; helping them to understand complex problems and train multiple circumstances in several fields.

- **Simulators and Tactical Decision Games (TDG)** - Computer-based approaches to improve professional group's non-technical skill, especially decision-making skills.

- **Situational awareness** - Perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future.

- **SLAM technique** - It proposes four steps to develop a culture of situation awareness: Stop, Look, Assess and Manage.

- **Social construction approach** - It focuses on the ways in which team communication creates the very context in which people work.

- **Spoken communication** - Both social and functional. At a social level, it helps to build relationships and is instrumental in helping a team to carry out its task

- **Swiss cheese model** - Well-known model in risk analysis and management.

- **Synergic effect** - Creative connection of team members, mutual inspiration leads to increased performance of the whole team. Such cooperation results in the value added and worthier, and more reliable as well as relevant outcomes (if a patient is treated and examined by more experts in particular fields, their cooperation will lead to more efficient treatment setting than if the GP sets it).

T

- **Team** - Group of people working together with the common goal (team within healthcare can be represented by the staff present in the operating room when all the participants share the common goal of successful operation, i.e. saving patient's life or another beneficial activity).

- **Team efficiency** - This metric is low in the beginning after team establishment. It is important that the members create in addition to the given rules natural trust and team culture. Usually, the team efficiency should increase with time and might be measured in needed time and means to prepare the patient and the operating room for surgery, or in needed time and means for the surgery and its particular steps.

- **Team members** - Usually a limited number of people who depend on each other to achieve the common goal (team members in healthcare are represented by particular people, i.e. a surgeon, an anaesthesiologist or a nurse).

- **Teamwork** - Modern tool in organisations providing interplay, cooperation of individuals and creative solution of tasks (working in functioning teams provides the possibility to eliminate the mistakes and improve the performance).

- ***Thinking ahead technique*** - Explain out loud the steps.

U

- ***Unidirectional communication*** - The information or message that the sender wishes to transmit is encoded in words or other signals from the sender, which are then transmitted to one or more receivers, which then decode the information to identify the meaning.

V

- ***Verbal communication*** - Communication by word or writing (being clear, unambiguous and understandable is the most important).

- ***Virtual reality*** - Disruptive technology with great social impact, which offers visual and audio immersion using a head-mounted display that shows 3D images, so senses are artificially stimulated and deceived to accept another reality.

W

- ***Working memory*** - It is also known as short-term memory and the second memory store. Capacity of working memory is limited and estimated to be 7±2 pieces of information.

PART

TEACHING METHODS FOR SOFT SKILLS WITH VIRTUAL REALITY S4GAME

In part I, the traditional teaching methods for soft skills are gathered. In this part II, they are enhanced by using a virtual reality approach through the S4Game. Table 1 provides a summary of how the traditional approach can be transformed into a virtual reality approach using the S4Game.

TRADITIONAL APPROACH		VIRTUAL REALITY APPROACH
Best practices		The trainee watches an expert demo; therefore, the trainee witnesses a scene that goes correctly.
Discussion		Trainees are briefed before playing the virtual reality game, and once it is finished, they are debriefed.
Consultation		Trainees watch an expert demo, either in an individual or group session, and it is followed by a debriefing/questions session. Another possibility is to include FAQ within the game when scenes are played by avatars, not the trainee him/herself.
Situation-based training	Role reversal	The trainee plays the same situation twice, each time taking a different role.
	Presentation	This method is currently no applicable using the S4Game.
Case-studies	Interpretation	This method is currently no applicable using the S4Game.
	Individual exercises	The trainee is requested to complete a list of tasks in the right order in the game to collect points.
	Group exercises	Although this would be ideally recreated through a multiplayer game, this alternative is currently not supported in the S4Game. Alternatively, bots (automatic players) can play different roles in the group exercise.
	Review	The trainee is recorded while playing the S4Game (game point of view and optionally from outside as well) for displaying it on another training session. A possible alternative is to watch performance out of the virtual reality setting.
	Video training	
	Self-knowledge tests	The trainee plays the S4Game after completing a pre-test and should complete a post-test after the training session.
	Tests	The trainee is requested to assess a situation: the trainee witnesses a scene and afterwards is questioned about what happened.
	Practical training	The trainee plays a situation: the trainee is involved in the development of the scene and is requested to make decisions.
	Feedback	The S4Game provides explanations at the end of the training session on the performance.

Table 1. *Correspondence between traditional and virtual reality approaches for teaching soft skills.*

METHODOLOGY FOR PRACTICAL CASES

The methodology considers a few important aspects described below.

1

CLICK ON THE NUMBER TO SEE CONTENT

2

CLICK ON THE NUMBER TO SEE CONTENT

In the following post-its, all practical cases are specified, and their methodological emphasis and main focus is described.
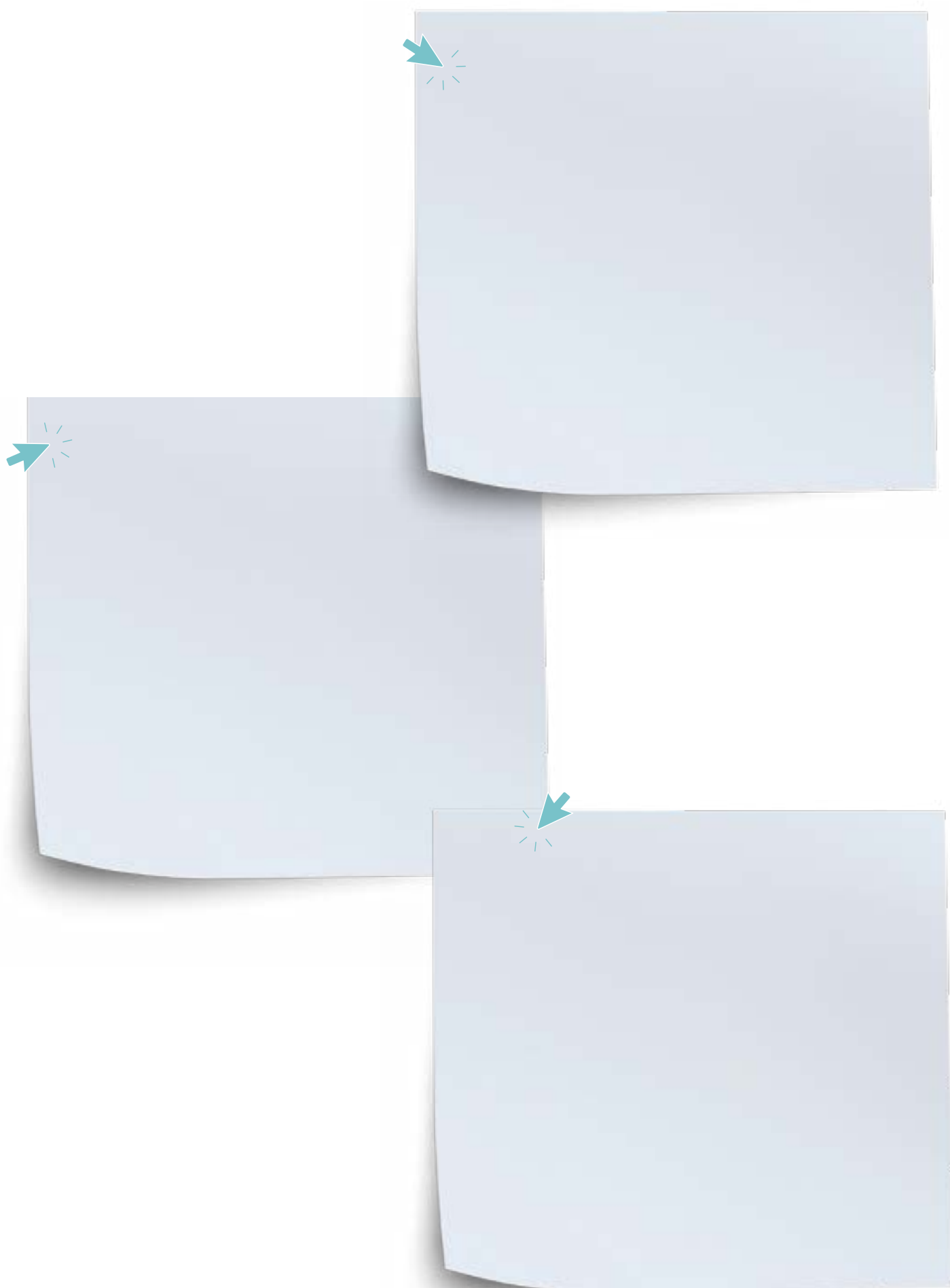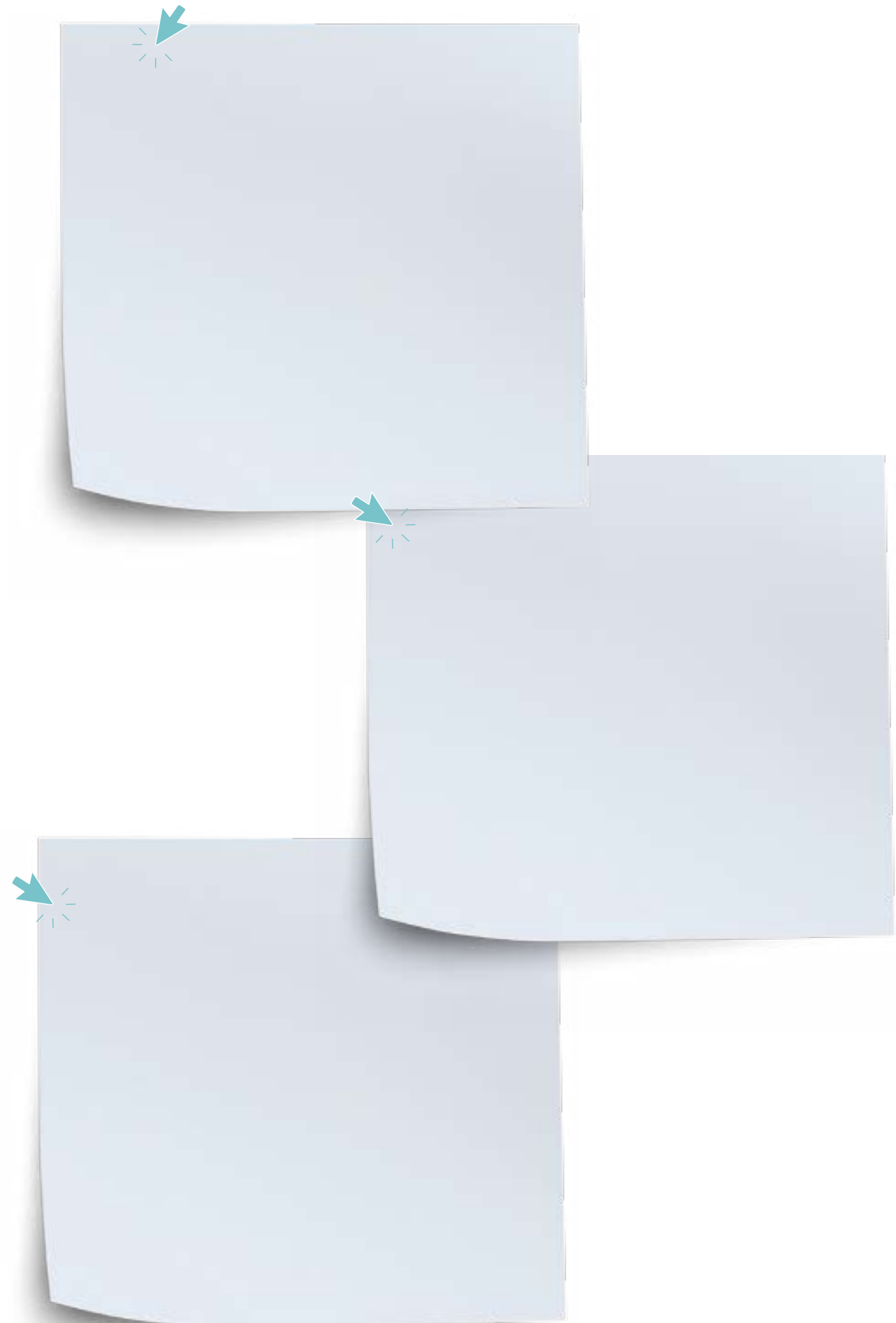
ASSESSMENT AND FEEDBACK

Within the S4Game scenes presented in the different practical cases, each question/decision node has, in general terms, four answers/options. These represent potential cases and possible reactions of the trainee going through the game. Every answer/option is assessed by particular points according to the appropriateness of the reaction. The final score is calculated from all the given answers. Then the results are converted to a table representing the knowledge of a trainee. He/she will get the feedback demonstrating their skills, acquired knowledge as well as personal characteristics (i.e. empathy, communication, estimation of situation and context, etc.). We describe next the outcomes corresponding to the final results and reflecting the game. The trainee should interpret it correctly and therefore, further instructions are outlined.

A   In case of reaching high amount of points, specifically **over 90%**, the trainee gets just the feedback including total amount of points and the overview of the questions together with the incorrect ones and their interpretation, justification and/or explanation. The repetition of the game is neither needed not required.

B   The results from **70% to 89%** represent the situation in which the trainee did relatively well, but there was significant number of questions which should have been answered more appropriately. In this case, the trainee will get the overview of the questions and correct answers. The reasoning will be provided as well. The repetition of the game is neither needed not required. Repetition of the game will be offered to the trainee as an option.

C   The trainees with the results **below 70% will** get just the score with no justification. The trainees will have to go through the game again until they reach at least 70 – 89 %. After this procedure, the detailed results with correct answers will appear. The aim is to make the trainee to realise that he/she did mistakes which could have been omitted.

The repetitive principle of the feedback form is focused on the improvement and better adoption of the appropriate reactions within the given situations. The justification is provided when needed to explain the trainee the value added in realising of what to focus on. He/she can then eliminate similar of the same mistakes in the future cases.

RESULTS	PERCENTAGE OF POINTS	OUTPUTS AND POSSIBILITIES
A	≥ 90%	Results with justification, possibility to continue to another game or to repeat it again.
B	70% – 89%	Results with justification, possibility to continue to another game or to repeat it again.
C	< 70%	Necessity to repeat the game, THEN results with justification, possibility to continue to another game or to repeat it again.

The total amount of points depends on each case. Within one case different total amount of points can be reached, because the trainee might go through the case varietally according to his/her choices.

After going through all the game and after getting the percentage including the correct and incorrect answers and decisions, the results will be discussed with the trainer. The trainee will receive the detailed justification of the correctness of the answers. Moreover, further steps will be derived according to the level and the experience of a trainee.

STRUCTURE OF CASES

The practical cases in this handbook are presented under the same structure, aimed at including the different elements and details that are necessary to put the case into practice. They are designed to be ideally carried out using the S4Game, but in some cases, they might also be implemented without it, as for example if they are implemented through a roleplay session. For this purpose, some tools, such as checklists are provided when deemed necessary.

Theoretical information

This section highlights the skills to be trained in the practical case, together with a brief introduction on its importance. Furthermore, learning objectives for the case and associated competences are also listed. These learning objectives are expressed in a trainee-centric manner, i.e., oriented towards what the trainee will do. They constitute observable behaviours which can be measured. They are formulated following the schema:

"The learning objective is to [Action Word] + [Knowledge, Skill or Ability]"

Timing for achieving these learning objectives is considered to be time playing the S4Game until a satisfactory amount of points are achieved.

The trainer who intend to adapt the practical case to the particular needs of his/her trainees and therefore needs to either modify or include more learning objectives is encouraged to follow this structure for the definition of the learning objectives.

Methodology and training approaches

If any particularization of the methodology and training approaches already presented in the previous sections is needed for a particular case, it will be detailed in this section.

Practical information

Further details on clinical aspects for contextualizing the practical case are provided in this section.

Resources

For each case, the resource section lists the characters, equipment and/or facilities that are necessary to be implemented in the virtual reality environment for a proper development of the case. Furthermore, any additional resource that might be necessary for a particular case is also listed in this section.

Since we are presenting practical cases using a serious game based on virtual reality, the use of standardized hardware and technically recommended software for this operation are suggested, namely:

- **Hardware:**
  - *Desktop / Portable Computer* (Intel i7 / SSD + HDD / 16GB RAM / Nvidia 1070GTX) or compatible.
  - *Virtual reality Glasses HTC VIVE PRO* (2880 X 1600 px) / HTC VIVE (2160 X 1200 px) or compatible.
- **Software:**
  - *S4Game* (Serious game – Virtual reality).

Assessment

Although general indications on the assessment are already given in general terms, assessment forms (either checklists or rating scales) are also provided in some practical cases, in the event that they are carried out without the S4Game.

CASE 1.

WRONG INFORMATION OF THE PATIENT

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THEORETICAL INFORMATION

Main Skill

Situation awareness

Secondary Skills

Teamwork

Communication and Interaction

In this practical case, situation awareness plays an essential role on detecting that the intervention will be done on the wrong site surgery. The classical Endsley model (Endsley, 1995, 2015) can be applied at its different levels by each of the team members, which, together with the rest of soft skills, will lead to a proper team situation awareness. Therefore, aspects related to the spatial, temporal, responsibility and identity awareness are necessary to solve the situation in a successful manner. The final aim of the case is to create a shared mental model between the surgical team, so patient security is not compromised.

Situation awareness in the operating room should begin well before the start of the surgical procedure itself, with the patient's first visit to the clinic. Thus, the patient's medical history should correctly reflect the patient's identity, diagnosis, prognosis and the surgical procedure to be performed. It is therefore very important that the information in a patient's medical record matches the procedure and the laterality, in cases where there may be errors due to this.

Due to the procedure itself or other external reasons, it may happen that the patient gets to the operating room without being seen beforehand by the surgeon who is going to operate him/her. This might increase the risk of error, so thoroughly check the clinical history is a must. Besides the surgeon, the nursing staff in charge must also make the appropriate checks on the medical history and detect any possible inconsistencies that should be brought to the attention of the surgeon in charge. Therefore, responsibility awareness is also key to identify errors on time and before they cause major consequences.

Related to spatial awareness, one of the most important aspects is marking the area to be operated on with indelible ink. Furthermore, any previous marks or stains that could lead to error should be previously checked and, if found, noted. The patient's cooperation may be necessary to check the laterality and the procedure, although this should always be checked against the medical history. The use of the surgeon's initials, in a widespread and well-known format, or a representative mark indicating the person who has made the marking, can help to locate the area to be operated on in a safe manner.

Misleading indications such as an "X" or the word "no" should be avoided, as it is always advisable to indicate the site/area to be operated on in an unambiguous manner. It is therefore recommended that the marking is made by the surgeon who is going to perform the surgery, or his/her immediate or closest assistants, provided that the surgeon checks it before starting the surgery.

In the case of wrong site surgery, the surgeon must safeguard the patient's best interests and maintain an honest and clear attitude towards the facts. This means that as soon as the error is noticed and

whenever possible, the surgeon should take whatever medical action is indicated to mitigate or at least lessen the effects of the error. If the surgeon notices the error during surgery, he/she should act depending on the type of anaesthesia used, as it plays a role in temporal awareness aspects:

- In the case of performing surgery under general anaesthesia the surgeon must perform the planned procedure at the correct site, unless there are medical reasons for not doing so; and in the event that the patient has previously consented to it, he/she must inform the family about what happened.
- In the case of local or regional anaesthesia and the patient being able to understand the information correctly, the surgeon must clearly explain what happened and advise on the course to follow.

In any case, the surgeon must answer sincerely to the patient's questions and perform or not the surgery according to the patient's wishes.

If the error is identified after surgery, the surgeon should inform the patient of what happened and, if possible, recommend a plan to correct the error as soon as possible. In any case, professionals should not forget that they are bound by the code of ethics defined by the competent national institution, which refers to ethical and legal standards. The express communication of episodes where problems and errors have appeared during surgery is very important, as the opposite case determines a greater future risk, beyond the ethical and legal considerations derived from the surgery.

The appearance of errors is the result of a series of accumulated errors from the consultation to the arrival of the patient in the operating room and are evidence of a clear lack of situation awareness, both at individual and team levels, missing shared mental model and poor communication between the members of the surgical team and with the patient.

Thus, the **learning objectives** of this practical case are:
- To differentiate between the three levels of situation awareness model.
- To recognize the different domains of situation awareness.
- To identify situations where inattentional blindness might occur.
- To anticipate possible errors that might result on patient damage.
- To recognize when a situation might go out of control through the perception of all the elements and people involved.
- To recognize the importance of paying attention to all aspects of a surgical procedure, even the ones that are not strictly surgical.
- To acquire the cognitive resources assisted through checklists to be able to work below the maximum workload to be supported.
- To recognize the implications of human errors in the planning and review of an intervention.
- To recognize the influence of the environment to maintain attention during a surgical procedure.

Furthermore, a set of associated competences can be defined:
- Ability to recognize the different levels of situation awareness model.
- Ability to use a revision and check system for keeping attention.
- Recognition of the different domains of situation awareness.
- Appropriate language utilization in the communication with the rest of the surgical team.

METHODOLOGY AND TRAINING APPROACHES

The situation presented in the previous section can be applied under different training approaches:

Best practice: in this case, the trainee should watch the recording of an expert playing the game to learn the best options and decisions (best practice).

Consultation: in this case, a best practice approach is complemented with an initial briefing and a posterior debriefing.

Test: theoretical questions on the situation awareness domains or the different levels of situation awareness should be included in the case.

Practical training: the trainee plays the scene and is requested to make decisions during the game.

Feedback: each decision of a trainee is scored during the game, the points achieved correspond to the correctness of the trainee's reactions and lead to various actions (repetition of the game, presentation of bad choices) after its end explaining the correct/recommended steps including the justification of the extent of appropriateness of the selected actions.

In any case, the trainee should be informed by the trainer regarding the learning objectives associated with the practical case.

PRACTICAL INFORMATION

A 50-years old female patient has been diagnosed with breast cancer. A multidisciplinary team discusses the best intervention based on the laboratory results, which found a malign lump on the right side as well as a benign one on the opposite side. Thus, within her treatment, a lymph node removal in her right armpit is scheduled. During this meeting, the surgeon mistakenly notes down the wrong side on the notes. These are lately typed up by the administrator, including the error, and the operation is scheduled.

The surgeon, due to a heavy workload during the previous days, could neither visit the patient the day before the intervention, nor review the patient's medical history in preparation for the operation.

The day of the operation, the patient is examined before the procedure, following the written notes, so a lump is found in the 'wrong' side. She is not asked at any time about pain or discomfort in the planned area for conformation. Although the WHO safe surgery checklist is undertaken pre-procedure, the imaging and histology results are not reviewed, relying only on the patient's records.

Once in the operating room, and right before starting the procedure, there was no verbal verification of the procedure and location by each team member, in order to ensure that everyone was aware of it. Although the mark indicating the location of the intervention was checked, it was done accordingly to the transcribed records without further checking, so it was considered correct. In this case, it would have been beneficial to further apply the "Dead Time" technique. A final check should be made before starting the intervention, in which the whole surgical team should be involved. Because of the procedure itself, this step should be supervised by a specific responsible person (circulating nurse) who does not necessarily have to be involved in the intervention itself. The aim is to develop an active check-up where all members discuss and become aware of the patient's situation, the technique to be performed, the conditions and the personnel involved. It can be used as an opportunity to discuss

possible complications that may arise during the surgery itself, and possible solutions to be considered. The technique highlights the importance of managing the slightest doubt that any member of the surgical team might have.

The procedure is successfully finished, but the error is found when the histological results on the node removed comes back as 'benign'. After this, a new intervention is rescheduled and the lymph node in the correct side is removed.

It seems effective to systematically double check laterality in those circumstances where this error may occur, just as the sex and identity of the patient should be checked in all interventions.

RESOURCES

To ensure that this serious game enables an approximation to real contexts where the present practical case is supposed to occur, the cases idealized in virtual reality should include the following elements:

- A standard operating room.
- A general surgeon who lead the intervention.
- An instrumentalist nurse.
- A circulating nurse.
- A member of the administrative staff.
- A female patient.

ASSESSMENT

Although the use of virtual reality in technical skills training has increased, the use of virtual reality systems in health education can still be considered recent, particularly in the field of soft skills. Despite the importance of defining evaluation processes for the outcomes from the use of virtual reality systems as training tools, this assessment currently continues to focus on evaluating the usability and acceptability of virtual reality simulation (Bracq, Michinov & Jannin, 2019) and not so much on the assessment through virtual reality, which is the novelty in S4Game.

However, the use of virtual reality implies some limitations in terms of the assessment possibilities, which, for the moment, must be focused on the virtual reality elements presented and with which the trainee can interact.

When surgeons, because of their daily work, are forced to face particularly stressful situations, such as a rarely performed surgical intervention, a patient in a critical health status or a personal situation that affects them in a specific way, they may focus their thoughts on what worries or frightens them and ignore everything else. Thus, this tunnel vision can endanger their work and generate harmful consequences for the patient.

Traditionally, in psychology, this circumstance has been considered in people going through complex times marked by change and uncertainty and it makes use of situational awareness. This tool, now considered as a skill to enhance, tries to make us aware of what is happening around us, helping us to understand our surroundings, where we are, and the technical challenge we face when we are in an operating room.

Therefore, several levels of situational awareness are established:

- **Perception.** Situational awareness is based on knowledge of the situation in which we are immersed, through the processes of perception and attention. If we are not sufficiently attentive, we will not be able to grasp the big picture.
- **Evaluation.** It is necessary to process the information we are aware of to understand its meaning. We must evaluate and interpret it to be able to make sense of it. In many cases we make this assessment instantly and with little effort based on the recognition of key patterns, but in other cases, especially when the environment changes, we must make a continuous effort to understand the connections between people, places and/or events.
- **Decision-making.** We take note of our environment so that we can anticipate its trajectory and act accordingly. We imagine the most likely scenarios to make more effective decisions.

Thus, situational awareness is presented as an exercise that forces us to consider our surroundings, process that information based on our experience and knowledge, and make reasoned decisions according to each circumstance.

Situation awareness = Situation perception + Information evaluation + decision making

However, to develop truly effective situational awareness in stressful situations, each of these steps needs to be accompanied by a calm attitude and concentration. With training in this line, we can reduce stress to an acceptable level that allows us to broaden our perception, develop a broader perspective and develop a viable plan of action for each intervention.

Situational awareness, in the end, is the ability to accurately perceive what is happening on the operating table, at any given moment, but also in the operating room. It is about being able to perceive all the elements in the given context, in a given time and space. But it is also about understanding what is involved in the activity we are doing and projecting the consequences in the near future.

It is a dynamic cognitive process, individual but directly influenced by the people with whom we are in the operating room, which must focus on maintaining concentration and anticipating critical or unforeseen events. All staff present in the operating room should be aware of the situation that is unfolding there, anticipating what may happen based on their expertise.

So far, most authors support that soft skills should be assessed in a context that allows integrating their assessment with the assessment of technical skills in a realistic environment. They therefore speak of "total assessment" of the performance of the surgical team which should not be confused with performance assessment. However, this approach would imply having safe surgical environments (in a training centre specialised in simulation, or the use of experimental models) and the whole surgical team being evaluated at the same time, as a whole. Alternatively, the S4Game aims to offer another objective tool capable of training soft skills and their evaluation. In a simple way, the evaluation of the practical case can be done based on a checklist, complemented by other tools developed in the virtual reality environment.

It has been shown that the lack of transmission of critical information to team members during surgery diminishes the perception of what is being done and compromises shared, or common, situational awareness. Therefore, establishing a pre-intervention dialogue regarding the clinical decisions made by team members in that context can significantly improve the conduct of surgery.

Strategies used to convey decisions that enhance situational awareness include the use of self-diagnosis, active listening, checklist checking and risk analysis. In contrast, behaviours that compromise a surgical team's situational awareness are often related to tunnel vision and loss of situational awareness, as well as lack of concentration and poor communication among surgical team members.

In **(table 1)**, a possible checklist is presented.

Verifies the understanding of the surgical team regarding the actions to be performed.	YES	NO
Checks that all members of the surgical team recognise each other and are aware of each other's role.	YES	NO
The clinical history and pre-anaesthetic assessment of the patient has been verified.	YES	NO
Diagnostic tests, including radiology and laboratory tests, if appropriate, have been reviewed.	YES	NO
Considers the estimated duration of the surgical procedure	YES	NO
Reviews the surgeon's previous marks and notes on the patient's skin (including location and/or area to be operated on).	YES	NO
The marks and annotations have been made prior to entering the operating room with the patient awake and with the patient's cooperation.	YES	NO
Checks that there are no marks or tattoos that could lead to error at the time of surgery. Or, where applicable, they have been indicated in a reliable manner.	YES	NO
It has been verified with the entire surgical team: ❑ The procedure to be performed. ❑ The possible complications. ❑ The necessary equipment. ❑ Measures to be taken in the event of an incident.	YES YES YES YES	NO NO NO NO
During the verification phase with the surgical team, attention has been maintained even when there has been an incident or interruption.	YES	NO
Specifically: ❑ The identity of the patient has been confirmed. ❑ The side and location of the intervention have been confirmed. ❑ The entire team is aware of the procedure to be performed. ❑ The correct position of the patient has been checked.	YES YES YES YES	NO NO NO NO
After the intervention, any incidents have been noted down.	YES	NO
Any problems in communication or in the transfer of orders have been considered.	YES	NO
Different points of view on the surgical procedure have been collected.	YES	NO
The occurrence of errors due to lack of attention and situation awareness by all members of the surgical team has been checked.	YES	NO
When an incident has occurred, appropriate action has been taken to correct possible errors.	YES	NO

Table 1. *Checklist for case 1 (Adapted from Mishra, Catchpole & McCulloch, 2009 - NOTECHS).*

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NOTES

CASE 2.

SUDDEN BLEEDING

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THEORETICAL INFORMATION

Main Skill

Decision making

Secondary Skills

Teamwork

Communication and Interaction

Many human factors including surgical procedures, transfusion practices, blood supply, and anaesthetic management are involved in the process that leads to haemorrhage developing into a critical situation.

Massive haemorrhage can be defined as follows (Hellstern *et al.*, 2002):

- blood loss exceeding circulating blood volume within a 24-hour period.
- blood loss of 50% of circulating blood volume within a 3-hour period.
- blood loss exceeding 150 ml/min, or (iv) blood loss that necessitates plasma and platelet transfusion.

Even with utmost care, bleeding may occur during surgery. The surgeon is the first who face with the changed condition during surgery. His/her main role is to realize and assess the situation, inform the team about the changes and lead team during the problem-solving process. The anaesthesiologist may reduce the rate of bleeding by applying various medications and supporting vital functions. The scrub nurse provides the surgical tools, swabs, ligatures to the surgeon to stop the bleeding, parallelly, the circulating nurse starts to organize blood supply if it is necessary.

Surgical problems include inappropriate judgments (27%), poorly developed skills (26%), delay of recognizing bleeding during endoscopic procedures (3%), and incorrect handling of surgical devices (3%). When critical events develop in the operating room, communication among the staff concerned is important to avoid exacerbation of critical conditions caused by haemorrhage and to minimize the adverse effects of massive haemorrhage on patients. However, communication between surgeons and anaesthesiologists seemed to be poor in 34% of the cases (Irita *et al.*, 2005).

If intraoperative haemorrhage seems to be critical, a state of emergency should immediately be declared to the operating room staff, the blood transfusion service staff, and blood bank staff in order to organize a systematic approach to the ongoing problem and keep all responsible staff working outside the operating room informed of events developing in the operating room. To rapidly deal with critical haemorrhage, not only cooperation between anaesthesiologists and surgeons but also linkage of operating rooms with blood transfusion services and a blood bank are important (Irita *et al.*, 2011).

Communication and organizational problems of blood supply included delayed delivery of blood products from blood banks to hospitals (9%), exhaustion of time by cross-matching (8%), shortage of manpower during nights or weekends (6%), delayed delivery of blood products from blood transfusion services to the operating room (4%), and exhaustion of time by irradiation in blood transfusion services (4%) can weaken team unity and increase dissatisfaction among team members. In Japan, the safe limit of time required for emergency delivery of blood products from blood banks to hospitals seemed to be between 30 and 45 min. Blood-type examination takes 9+/-7 min by manual procedures and 12+/-7 min by automatic procedures. Cross-matching takes 25+/-12 min by manual procedures and 29+/-10 min by automatic procedures (Kino *et al.*, 2009).

The main aim of this practical case is presenting the complexity of surgical decision making and demonstrating the following **competencies**:

> - To recognize your own decision-making strategy.
> - To realize new decision-making techniques.
> - To acquire new decision-making techniques.
> - To improve information gathering skills.
> - To develop communication skills under pressure.
> - To evaluate the results of our decision.

METHODOLOGY AND TRAINING APPROACHES

Assuming from the outset that the trainee already knows how to use S4Game and before starting this practical case (briefing), he should be informed by the trainer regarding the learning objectives associated with it.

The performance of the activities proposed in this practical case implies that the trainee follows a series of sequential activities', each one presented with 4 proposals for resolution, being only one of them the correct one. Marking the correct option, the trainee will proceed to the next activity, until the entire process is complete. The success of the Practical Case resolution will be assessed by the number of correct and incorrect options selected by the trainee throughout the proposed process.

After completing the practical case (debriefing) the trainee, with the supervision of the trainer, should reflect about it and carry out the consequent appreciation of the developed learning, using a checklist developed for this purpose.

PRACTICAL INFORMATION

In this practical case, we would like to present how quickly the surgical team has to make complex decisions. In order to stop a severe bleeding and save a patient's life, the surgeon have to make decisions and organize the surgical team members within seconds. A small mistake in teamwork or organization, the lack of accurate instructions can end up in the patient's life.

On an average day in a city hospital, an operating room is available for Caesarian section at the Gynaecology Department. The surgical team consists of a gynaecologist (chief surgeon) and a resident (PGY 5) as an assistant, an anaesthesiologist and a scrub nurse. Circulating nurse and anaesthesiologist assistant are split between another operating room.

32 years old woman is scheduled for caesarean section at the 39th week of pregnancy to deliver her baby. The pregnancy was physiological, the foetus corresponds to the week of gestation. The preoperative patient is conscious, oriented, afebrile, haemodynamically stable, with a regular auscultatory finding on the heart and lungs and without neurological outbreaks. Of the previous surgical procedures, there was a caesarean section in general anaesthesia without complications. The patient is negative for allergies. Preoperative laboratory analyses were in reference values. At the request of the patient, the anaesthetic technique was a general anaesthesia with endotracheal intubation.

At 9:30 general anaesthesia introduced in with propofol, then the patient is relaxed with succinylcholine and intubated without complications. The baby was taken at the usual time, not longer than 10 minutes after giving the medication, the Apgar score was 10/10. At 5 minutes later – during the closing of the abdomen - uterine atonia is realized and accompanied by severe bleeding.

The chief surgeon observed the abdomen and tried to discover the origin of the bleeding (observation). Then he/she informed the surgical team about the complication and the bleeding and asked the scrub nurse to call the circulating nurse to help. Parallelly, the scrub nurse provided the necessary instruments to stop the bleeding (recognition-primed decision-making technique). The surgeon consulted with the anaesthesiologist and the surgical team ordered blood from the blood bank and the anaesthesiologist tried to control the bleeding with vasoconstrictor medications. After the observation the gynaecologists s considered the possibilities and started to perform hysterectomy immediately (analytical decision-making technique). At that time, the patient was haemodynamically stable (TA 120/90 mmHg, HR about 90/min SpO2 99-100%, etCO2 3.3 kPa) and had two broad peripheral venous lines. The urinary catheter is routinely placed preoperatively.

While the surgeons were trying to save the mother's life, the anaesthesiologist called the anaesthesiologist assistant's attention so she could be ready if she needed it. Meanwhile, the anaesthesiologist ordered blood products (e.g. fresh frozen plasma, whole blood, erythrocytes) to make up for the lost volume. The anaesthesiologist continuously informed the surgeons about the patient's condition (rule-based decision-making technique).

Circulating nurse was constantly in this operating room, providing the necessary equipment to the scrub nurse and keeping in touch with the blood bank about the delivery of blood products (rule-based decision-making technique). Also, the circulating nurse informed the surgical team about the delivery.

Three hours later, the surgery finished. Despite of quickly and professionally performed hysterectomy, the patient lost about 5L of blood, which we estimated on the basis of an aspirator's mantle and the number of abdominal bloodstreams. Because of this, it received 2.5L whole blood, 1L concentrated erythrocytes and 1L fresh frozen plasma, with 5L crystalloidal solutions (sol. Hartman) and 500ml colloidal solutions (sol. Hetasorb 6%). At the end of the operation, the patient was relatively haemodynamically stable with the following vital parameters: tachycardia (HR 100/min), hypotension (TA 100/60 mmHg), SpO2 drops to 98%. After the procedure, the patient is transferred to the intensive care unit for observation.

As it can be seen, the tragic outcome can only be avoided by the awareness of the surgeon, continuous teamwork and communication between the team members. While the surgeon has the main responsibility, each team member have to follow each steps of surgery and be prepared for the next step. A good team member is constantly following the surgery and thinks ahead, e.g. the scrub nurse asks an instrument before the surgeon asks it to decrease the pressure of delay. This makes surgery smoother and reduces the stress caused by the time pressured environment.

Decision-making process:

> - **Surgeons**
>   - ‣ Is hysterectomy necessary?
>   - ‣ Is possible to save the patient's life without hysterectomy?
> - **Anaesthesiologist**
>   - ‣ Is blood transfusion needed?
>   - ‣ What type of blood products is necessary?
>   - ‣ How many products are needed?
>   - ‣ What type of medications may support the circulation?
> - **Nursing team**
>   - ‣ Are necessary instruments (type and pieces) available?
>   - ‣ Organizing papers of blood delivery.
>   - ‣ Contact with intensive care unit for place for the woman.

The practical case is based on the case report of Nenad Mladenovic. However, the story is fictional, any match with reality is a coincidence (Mladenovic, 2018).

RESOURCES

To ensure that this serious game enables an effective approximation to real contexts where the present practical case is supposed to occur, the idealized in virtual reality should include the following elements:

> - 1 standard operating room.
> - Obstetric surgery team – a surgeon and an assistant (resident PGY5).
> - Anaesthesia – one anaesthesiologist.
> - Nurse team – three nurses (circulating/anaesthesia/scrub).
> - Patient – one patient (caesarean patient).

ASSESSMENT

In this case, assessing the performance of the surgical team become a major challenge, because the pressure to make decisions in a very short time makes the first step of decision making more difficult. The included elements are:

> - Problem definition.
> - Diagnosis and option generation.
> - Risk assessment.
> - Option choice.

Similar aggravating factor is the personal emotions. According to research studies, emotion management is one of the major predictor factors of safety in the workplace, especially under stressful conditions. Using and recognizing coping strategies in stressful conditions may avoid from burnout or post-traumatic stress disorder (PTSD) (Ceschi *et al.,* 2019., Cicognani *et al.,* 2009.).

An effective decision-making technique depends on the demands of the situation, the supportive discussion, the experience of the surgical team and the outcome. After the case, we need to think carefully about what happened, the process of our decisions, and the influencing factors. It is important to identify the used decision-making technique and examine that it was an appropriate choice in the given situation. At the same time, we need to rethink which decision-making technique would be best suited to the situation and draw conclusions for the future.

The following questionnaire may help us to systematically analyse our decision-making process and help to identify the points to change **(Table 1)**. For each statement, mark the statement (Not at all/Rarely/Sometimes/Often/Very often) in the column that best describes the decision-making technique.

STATEMENT	NOT AT ALL	RARELLY	SOMETIMES	OFTEN	VERY OFTEN
I evaluate the risks associated with each alternative before making a decision.					
I try to determine the real issue before starting a decision-making process.					
I rely on my own experience to find potential solutions to a problem.					
I tend to have a strong "gut instinct" about problems, and I rely on it in decision-making.					
If I have doubts about my decision, I go back and recheck my assumptions and my process.					
I consider a variety of potential solutions before I make my decision.					
Before I communicate my decision, I create an implementation plan.					
When communicating my decision, I include my rationale and justification.					
I prefer to make decisions on my own, and then let other people know what I've decided.					
I determine the factors most important to the decision, and then use those factors to evaluate my choices.					

Table 1. *Questionnaire for case 2 (Adapted from www.mindtools.com).*

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NOTES

CASE 3.
INEXPERIENCED TEAM MEMBER REPEATING MISTAKES

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THEORETICAL INFORMATION

Main Skill

Teamwork

Secondary Skill

Communication and Interaction

The main aims of this practical case include the following knowledge, skills and abilities:

- to recognise the principles and potential of teamwork.
- to demonstrate the compensation of the team member's professional insufficiency.
- to recognise the threats of the incompetent behaviour of a team member.
- to practice the team communication skills.
- to use the empathy in the team communication.
- to predict the future malfunction of a team member.
- to judge the consequences of the inefficient teamwork.
- to estimate the newly established team functioning.
- to reconstruct the previous situations in pursuit to prevent the mistakes according to the analysis.

After completing this practical case, the trainee will reach the following knowledge, skills and abilities:

- overview of the critical parts of the endoscopy.
- learning how to identify and recognise the potential bottlenecks.
- getting used to prevent them and/or adequately solve them.

The practical case is focused on adequate behaviour within the team during the endoscopy. Each member has his/her role. The role should not clash and all team members should be aware of their role within particular phase of the case, i.e. everybody should try to ensure the flow of the case.

METHODOLOGY AND TRAINING APPROACHES

Interpersonal as well as communication and coordination skills are crucial. These can both support and accelerate the surgery or any other medical intervention, or these might prolong the course of action, confuse the involved participants or even worsen the health condition of the patient due to particular misunderstandings, incorrect procedures, conflicts, ambiguous situations or similar problems. In particular, the aforementioned issues are mostly connected with the interpersonal and communication skills. All soft skills can be partly trained, learned and practiced. For these purposes, the following case focuses on the inter-team communication. The skills how to behave and react are prevalent. Nevertheless, dealing with the internal problems within the team, the external disturbances and other issues should be managed as well. Therefore, these are emphasised in particular situations and decisional actions. The following methods are used in this case:

Consultation - watch the demo of the game and answers to arising questions from a trainee.

Role reversal - inexperienced team member x team leader - trainee will go through the game in both roles to see different perspectives (note: so far only two roles are described and prepared, the further can be developed in the future).

Review and video training - recording the behaviour of a trainee inside the game, observation of the activities and selected steps including the consequences arisen.

Practical training - going through the game, fulfilling the tasks, making decisions.

Feedback - each decision of a trainee is scored during the game, the points achieved correspond to the correctness of the trainee's reactions and lead to various actions (repetition of the game, presentation of bad choices) after its end explaining the correct/recommended steps including the justification of the extent of appropriateness of the selected actions.

PRACTICAL INFORMATION

The location of this case is the endoscopy room at the university centre. The integral part of the clinical practise within the endoscopy unit include the education and the on-the-job training of the inexperienced team members. Besides, some of the most complicated cases within the endoscopy practice are performed under the general anaesthesia which includes the presence of the anaesthesiologic team during the procedure. All members of both teams, the endoscopic and anaesthesiologic, should communicate efficiently in pursuit to ensure the smooth course of action. Therefore, ideally the staff should be harmonised as well as used to cooperate during the procedures. The case demonstrates the difficult therapeutical colonoscopy performed by the expert endoscopist, the endoscopist assistant and the inexperienced even though fully educated endoscopy nurse. The trained skill is mostly related to the teamwork, communication and interaction.

At the beginning, the patient is in a colonoscopy position (lying on his left side). The room is commonly equipped, see its plan below. The colonoscopy under general anaesthesia is performed.
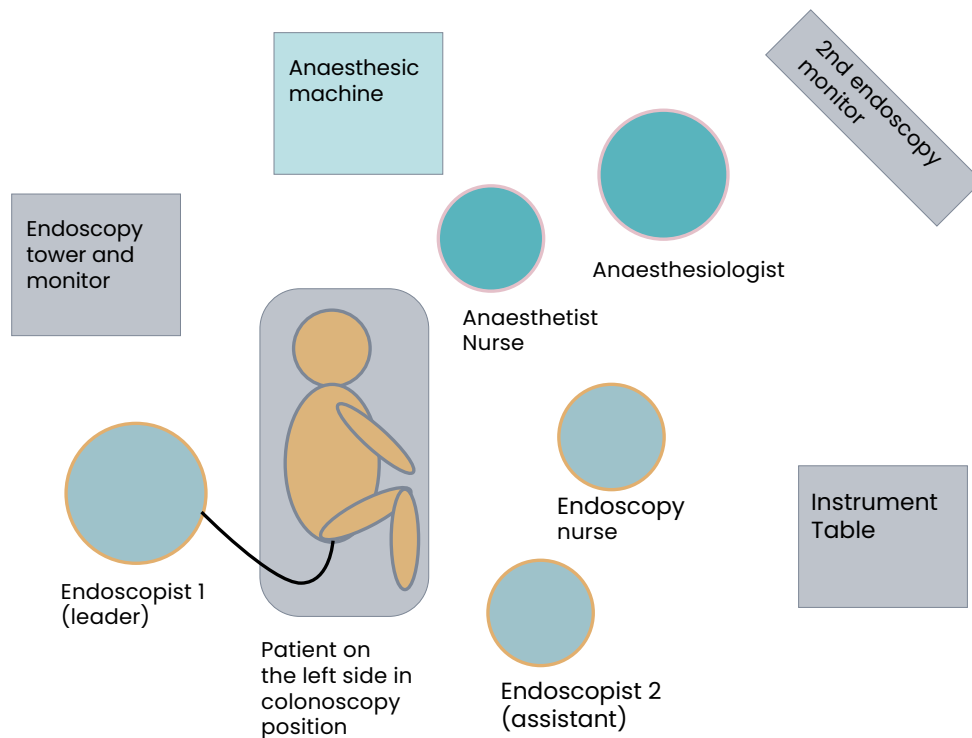
The team consisting of 5 members in 2 teams.

- • Endoscopy team responsible for the colonoscopy procedure:
  - ‣ Endoscopist 1 (leader endoscopist, tutor, leader of the team).
  - ‣ Endoscopist 2 (assistant, endoscopy fellow in training).
  - ‣ Endoscopy nurse.
- • Anaesthesia team responsible for general anaesthesia leading including:
  - ‣ Anaesthesiologist.
  - ‣ Anaesthetic nurse.

All team members are dressed according to the endoscopy room dress code (including the personal protective equipment): surgical mask, blue isolation gown, gloves, eye protection (googles), disposable hair cap, shoes.

The endoscopy starts. The first issue is that the endoscopy nurse is informed about breaking the dress code rules. She is not having the personal protective equipment. Afterwards, during the procedure, the nervous endoscopy nurse repeats the mistakes during assisting the head endoscopist, i.e. passing wrong tool, etc. Therefore, the conflict starts as she is not reacting correspondingly quickly as well as flexibly. The situation requires the further assistance of the experienced nurse. The rude comments about the situation of the other team members occur. Later, the secretary entering the room during the endoscopy is another external disturbing factor. The case demonstrates the interaction among the leader endoscopist, the assistant endoscopist, the endoscopy nurse and the anaesthesiologist. The aim is to teach the adequate reactions and actions to keep the quality of the endoscopy itself and to manage the communication and interaction among all participants.

RESOURCES

To ensure that this serious game enables an approximation to real contexts where the present practical case is supposed to occur, the scenarios idealised in virtual reality should include the following elements:

- Endoscopy room equipped with the endoscopy tower and monitor, instrument table as well as the second endoscopy monitor and the anaesthetic machine
- Team comprising two groups:
  - ‣ Endoscopy team responsible for the colonoscopy procedure:
    - ▫ Endoscopist 1 (leader endoscopist, tutor, leader of the team)
    - ▫ Endoscopist 2 (assistant, endoscopy fellow in training)
    - ▫ Endoscopy nurse
  - ‣ Anaesthesia team responsible for general anaesthesia:
    - ▫ Anaesthesiologist
    - ▫ Anaesthetic nurse
- Patient in colonoscopy position: procedure under the general anaesthesia, disabling communication with the patient within the case

Assuming that the trainee already knows how to use S4Game and before starting this practical case (briefing), he/she should be informed by the trainer regarding the learning objectives associated with it. Moreover, he/she should go through the practical situational description of the particular case to be prepared what to expect and in which context the case happens.

The course of action than follows particular development of the colonoscopy procedure within which the particular decisional situations occur. The trainee has to choose from the provided options. He/she has limited time for these decisions. The colonoscopy procedure itself from the medical point of view creates just the external conditions as well as situational determination whereas the emphasis is put on the interpersonal relations and the overall atmosphere among all the staff in the operating room. Therefore, just the soft skills are trained and practised.

Each decisional situation forwards the trainee to the new situation. The points are allocated to the trainee according to the correctness of his/her decision/answer. In case of running out of time or selecting just absolutely inappropriate option, the game might be quitted and the trainee will have to play it again. At the end of the game, the trainee is assessed (see above the full methodology of the total percentage and the corresponding categories of the outputs). The results imply the overall outputs for the trainee. Accordingly, the trainee gets the recommendation to continue to another case or to repeat the same case in pursuit to improve and get better result. Moreover, the debriefing with the trainer would be useful. The supervised and guided reflection of the mistakes and of the correct decisions should provide the value-added learning experience. This debriefing should lead to the adoption of the skills within the trainee's behaviour and consequently to the ability to apply the acquired knowledge in the real situations.

ASSESSMENT

The use of virtual reality for the educational purposes is worthy for both the hard and soft skills. The correct interpretation of the serious game is the integral part of the educational process. Therefore, the appropriate attention should be paid to it.

Within the game, two types of assessment are relevant as well as considered. The first one includes the feedback to the trainee. Whereas the second one is related to the evaluation of the benefits of the game itself, i.e. for the team, department or the whole hospital.

The feedback for the trainee is based on the multiple-choice answers which are assessed with different number of points allocation. These are derived based on the importance as well as correctness of the answers. Similarly, the time limit is allocated to all questions to evoke the time pressure during the medical intervention. The details of the feedback are provided in the Assessment and feedback section. Nevertheless, the feedback to the trainee is mostly provided in the end of the game. The trainee will see all questions including the correct answers and their choice as well. Both the justification and the explanation of the correct and incorrect answers will be available as well. This should ensure the appropriate outcomes and the value added to the trainee. Moreover, he/she will see the reasons and get the scope for their development and improvement of their knowledge/expertise. This should eliminate the mistake repetition in the future and enhance the 'digestion' of the appropriate course of action. The only exception will be represented by the questions within which the bad choice would lead to the fatal consequences. Therefore, the simple feedback in case of a fatal mistake is be provided immediately through 'game over' notification. The final results will be discussed during the debriefing activity with the trainer. Scoring also provide the possibility to compare the results among the medical students as well as the progress of a particular student him/herself.

The evaluation of the case might employ the Non-Technical Skills of Surgeons (NOTSS) system (Jung *et al.*, 2018). This methodology is considered as being valid, feasible and reliable. The checklist of the skills development and progress might be primarily measured within the following areas (Jung *et al.*, 2018; Crossley *et al.*, 2011; Sharma *et al.*, 2011):

> - Situation Awareness: The situation awareness assesses the understanding and interpretation of data collected from the environment (about patient, team, time, displays, equipment, etc.). These imply the preparedness of the trainee for the current as well as future course of action.
> - Decision Making: This skill corresponds with the ability to judge the situation and to choose the appropriate option about the further steps.
> - Communication & Teamwork: The communication together with the teamwork represent important skills and abilities to cooperate effectively, share the perception of the situation and complete the tasks as required and needed.
> - Leadership: Leading, guiding and directing all team members requires patience and experience. The leader should be able to consider individual needs of his/her colleagues.

After the case and after the initial feedback outputs, the trainee might fulfil the following table subjectively and see how it fits with his/her feelings and experience. The above-mentioned categories should be assessed on the scale from Poor to Good described below (NOTSS, 2021):

- Poor: Performance endangered or potentially endangered patient safety - remediation is needed
- Marginal: Performance implied particular concern - significant improvement is required
- Acceptable: Performance had a satisfactory standard - particular improvement is possible
- Good: Performance was of a high standard - best practice might be shared within the community

Except from the mentioned assessment options, the 'Not applicable' option is provided for the cases within which the element is not relevant or assessable.

	POOR	MARGINAL	ACCEPTABLE	GOOD	NOT APPLICABLE
SITUATION AWARENESS					
Gathering information					
Understanding information					
Projecting and anticipating future state					
DECISION MAKING					
Considering options					
Selecting and communicating option					
Implementing and reviewing decisions					
COMMUNICATION & TEAMWORK					
Exchanging information					
Establishing a shared understanding					
Co-ordinating team activities					
LEADERSHIP					
Setting and maintaining standards					
Supporting others					
Coping with pressure					

Table 1. *Checklist for Case 3 (Adapted from NOTSS, 2021).*

According to the assessment in the table, the trainee (ideally in cooperation with the trainer) might check the feedback and consider the further skills improvement including the need to focus on any issues and weaknesses identified. Thanks to these results, he/she might get the overview of the problematic skills. Then, it is easier to develop them in the desired way. The best effect is reached when the trainee does the assessment before and after the training using the serious games. The comparison of the results might show the training value added of the learning process as well as the progress of the individual, team and potentially the whole department or the hospital.

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NOTES

CASE 4.
BAD–TEMPERED MEMBER

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THEORETICAL INFORMATION

Main Skill
Communication and Interaction

Secondary Skill
Teamwork

Usually communication skills are an underestimated skills among members of the surgical team, however, it would require much more attention, as a significant proportion of surgical malpractice could be prevented through proper communication. In the last decade, collaboration in surgical teams has become to the forefront of interest, because of the impact of human factors on patient safety in the OR. It is a long–known fact, that the quality and efficacy of surgeries are affected by communication and teamwork success or failure. Next to clinical knowledge and technical skills, healthcare members need the knowledge of soft skills in their everyday practice. Surgical outcome and patient safety depends on the high quality communication and shared knowledge, which are challenging to accomplish due to the time pressure, the overload and the interdependence of surgery (Torring *et al.*, 2019.).

Improved communication skills promote effective teamwork, the better and sooner understanding of a clinical situation, it helps make better decisions in the operating room. Evidence-based communication trainings are applied in many departments to train healthcare professionals and improve surgical outcomes. These programs develop the communication skills and promotes the interdisciplinary collaboration between the surgical team and increases patient safety through human factors. However implementation of these programs often encounters multiple barriers - e.g. the open mindness of the team -, which can be more easily overcome if team members understand and accept the importance of communication skills (Østergaard *et al.*, 2011., Courtright *et al.*, 2011.).

Communication within teams is important to both the team's dynamic and developing professionalism. Surgical team is a diverse system, where different health care professions (surgery, anaesthesiology, and nursing) work together, sometimes supplemented with radiology or pathology staff. Despite appearances, there is no democracy in the operating room, the surgeon is responsible for everything in the OR. While hierarchy determines the team, interactions among surgical team members are not as

clearly structured as in high-intensity professions such as aviation, where communication protocols exist for most recurring scenarios. Different specialities and unclear team relations makes effective communication in the OR a challenge (Lingard *et al.*, 2002.).

The main aim of this practical case is presenting the complexity of communication between the surgical team members and demonstrating the following competencies:

- To contrast the models of communication.
- To use the appropriate communication channels.
- To evaluate the influence of the context in the communication.
- Understand the communication protocol correctly.
- Follow the guidelines of the role assigned by the protocol.
- Identify the category to which each of the information belongs.

PRACTICAL INFORMATION

Procedure related communication between the surgical team is called case-relevant communication, however if this communication is not necessary or relevant for the procedure (case-irrelevant communication), it is often cause communication problems. Any conversation which is irrelevant to the case or small talks related to other work besides the actual work (discussions about other surgeries, scheduling the following program in the OR), can be considered irrelevant. Moreover any other noises, like door opening and closing may affect the surgeon's concentration (Widmer *et al.*, 2018.).

This practical case presents, how wrong communication effects the patient outcome during some minutes. Performing surgery is a really complex work that requires high and continuous attention. However, interruptions and distractions that may threaten this concentration are frequently observed during surgeries.

During the night shift, a 29-year-old male arrived to the Emergency Department with a four-hour history of right lower quadrant (RLQ) abdominal pain. The pain originated in the umbilical region, radiating diffusely across the lower abdomen and subsequently localised to the RLQ. The pain was of sudden onset, sharp and colicky with progressing intensity. Analgesic was taken before presenting to emergency, which did not alleviate the pain. The pain was exacerbated by lifting the right leg and relieved by leaning forwards. Severity was rated nine on a scale of one to 10, with one being no pain and 10 being the most pain possible. This episode had not been preceded by previous abdominal pain, and he denied nausea or vomiting. He opened his bowels post-onset of the pain with no changes to the consistency of the stools and absence of blood or mucus. Past medical and surgical history was nil of note. The patient has no known drug allergies. There was no relevant family history. The patient did not smoke, reported alcohol consumption occasionally, and denied recreational drug use. Under observation, the patient was apyrexial with stable vital signs. The abdominal examination revealed a soft abdomen, tenderness on percussion, rebound tenderness in the right iliac fossa, and a positive psoas sign. He was not peritonitic and had a negative Rosving's sign and absent hernias. Based on the clinical presentation, a laparoscopic appendectomy was performed under general anaesthesia with the following ports: umbilical 10mm, left iliac fossa 5mm, suprapubic 5mm.

The surgical team consists of a surgeon and a resident (PGY 2) as an assistant, an anaesthesiologist and a scrub nurse. Circulating nurse is split between an other operating room. Exploration of the

abdomen went well without any complication and the surgeon started to prepare the inflamed appendix. However, the door of the operating room (OR) suddenly opened and the circulating nurse entered to the OR. The surgeon stopped for a moment, but some seconds later continued his/her work.

Without any apologies request, he/she urged the surgeon to immediately go to the director's office for a meeting. Firstly, the surgeon ignored the circulating nurse and continues the surgery. The scrub nurse answered to the circulating nurse that soon the surgeon finish the appendectomy and then call the director. The circulating nurse left the OR and informed the director about the answer of the surgeon.

The circulating nurse returned again in 5 minutes later and directly told to the surgeon that the director immediately wants to consult him/her about a patient's condition. The surgeon responded in the same way as before the scrub nurse, could not leave the patient here and the resident colleague could not yet take over the surgery. He will call the director back as soon as he/she can.

However, the circulating nurse did not leave the question to that extent and called on the surgeon to answer to the director because he/she didn't want to mediate further between them and would have a lunch break anyway. For this, the surgeon became angry and argued with the circulating nurse. During his/her arousal he does not concentrated enough on surgery and the tools used for preparation moved freely in the patient's abdomen and injured a vein. The bleeding was realized a half minute later by scrub nurse on the screen of the laparoscopic tower, when the surgical area was already so bloody that the origin of the bleeding could not be established.

The surgeon interrupted the discussion with the circulating nurse and said this is the result of his/her inappropriate attitude. Due to the debate and the complication that ensued, the surgeon was irritated, but took a deep breath and tried to concentrate on the situation. Quickly observed the abdomen and tried to discover the origin of the bleeding however it was too late for this. In 10 seconds, the surgeon informed the surgical team about the conversion of laparoscopic surgery into open surgery and asked the scrub nurse to prepare instruments for this. In 2 minutes, the surgeon started to open the abdomen and manually stop the bleeding. A half an hour later the bleeding was stopped, the appendix was removed and the patient was haemodynamically stable. After the procedure, the patient is transferred to the intensive care unit for observation.

As can be seen, inappropriate communication may lead to the tragic outcome, which can only be avoided by effective and continuous communication between team members, supportive environment and teamwork. During surgery, each team member should consider the interests of the patient and strive for proper communication. A good team member is constantly following the surgery and support the others, this makes surgery smoother and reduces the stress caused by the time pressured environment.

The practical case is based on the case report of Simran K. Longani. However the story is fictional, any match with reality is a coincidence (Simran *et al.,* 2019).

RESOURCES

Considering that it is a practical case using a serious game based on virtual reality, the use of standardized hardware and technically recommended software for this operation are suggested, namely:

- Hardware:
  ‣ Desktop / Portable Computer (Intel i7 / SSD + HDD / 16GB RAM / Nvidia 1070GTX) or compatible.
  ‣ Virtual reality Glasses HTC VIVE PRO (2880 X 1600 px) / HTC VIVE (2160 X 1200 px) or compatible.
- Software:
  ‣ S4Game (Serious game – Virtual reality).

Thus, to ensure that this serious game enables an effective approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

- 1 standard operating room with laparoscopic tower.
- General surgery team – a surgeon and an assistant (resident PGY2).
- Anaesthesia – one anaesthesiologist.
- Nurse team – three nurses (circulating/anaesthesia/scrub).
- Patient – one patient (male patient with abdominal pain).

Assuming from the outset that the trainee already knows how to use S4Game and before starting this Practical Case (briefing), he should be informed by the trainer regarding the learning objectives associated with it.

The performance of the activities proposed in this Practical Case implies that the trainee follows a series of sequential activities', each one presented with 4 proposals for resolution, being only one of them the correct one. Marking the correct option, the trainee will proceed to the next activity, until the entire process is complete. The success of the Practical Case resolution will be assessed by the number of correct and incorrect options selected by the trainee throughout the proposed process.

After completing the Practical Case (debriefing) the trainee, with the supervision of the trainer, should reflect about it and carry out the consequent appreciation of the developed learning, using a checklist developed for this purpose.

ASSESSMENT

To become an expert communicator a lot of practice and knowledge are needed. We need to be effective at all points in the communication process – from "sender" through to "receiver" – and find the right moment and form of communication that fits the situation and supports patient safety. As supported by case study, an improperly chosen form and timing of communication can even cost a patient's life.

The following questionnaire may help us to analyse our communication process and helps to identify the points to change (Table 1.). For each statement, mark in the column (Not at all/Rarely/Sometimes/Often/Very often) that best describes your communication skills.

STATEMENT	NOT AT ALL	RARELLY	SOMETIMES	OFTEN	VERY OFTEN
I try to anticipate and predict possible causes of confusion, and I deal with them up front.					
If I don't understand something, I tend to keep this to myself and figure it out later.					
I'm surprised to find that people haven't understood what I've said.					
I can tend to say what I think, without worrying about how the other person perceives it. I assume.					
When talking to people, I pay attention to their body language.					
Before I communicate, I think about what the person needs to know, and how best to convey it.					
I try to help people understand the underlying concepts behind the point I am discussing. This reduces misconceptions and increases understanding.					
I consider cultural barriers when planning my communications.					

Table 1. *Questionnaire for case 4 (Adapted from www.mindtools.com).*

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NOTES

CASE 5.

CLASHES BETWEEN DIFFERENT PROFILES

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THEORETICAL INFORMATION

Main Skill

Leadership

Secondary Skills

Teamwork

Communication and Interaction

Presenting this practical case, related with the competition between different profiles, in a particular perspective related with leadership, it is important to frame the main elements centred on the five key concepts of leadership theoretically used (Registered Nurses' Association of Ontario [RNAO], 2013), which may be related with the main outcomes: building trust relations; create an empowerment-based work environment; create an environment that supports knowledge development and integration; lead and support change; balance system complexities (managing competing values and priorities).

In the operating room, teamwork is a secondary skill mobilized in this practical case, but the concept should be seen as an important component in the health professionals practice, in order to assure the efficiency, quality of care and patient safety, decreasing the possibility of emerging errors during the surgical procedure and that can have disastrous consequences, not only for patients but also for families, caregivers and organizations (Sexton *et al.*, 2006).

Although in this practical case, communication and interaction are ancillary skills, several studies confirm the extreme importance of communication in order to ensure safe and effective clinical practice, confirming that good communication among health professionals is essential to improve the working environment and patient safety in the operating room (Weldon, Korkiakangas, Bezemer & Kneebone, 2013).

Assuming that there is a set of common purposes regarding practical cases aimed at developing leadership skills, the following **learning objectives** stand out:

- To demonstrate leadership strategies to manage competition among different profiles.
- To recognize the different emotions in the surgical team.
- To manage surgical team emotions effectively.
- To demonstrate self-motivation mobilizing the team resources.
- To manage relationships effectively (managing the emotions).
- To utilize appropriate language to communicate effectively.

The definition of competences within this scope is also based on the same assumptions. The following **competences** are highlighted:

> - Demonstration of leadership strategies to manage competition between different profiles.
> - Recognition of the different emotions in the surgical team.
> - Effective management of surgical team emotions.
> - Ability to demonstrate self-motivation mobilizing the team resources.
> - Effective relationship management (managing the emotions).
> - Appropriate language utilization in the communication process.

METHODOLOGY AND TRAINING APPROACHES

Assuming that the trainee already knows how to use S4Game and before starting this practical case (briefing), he should be informed by the trainer regarding the learning objectives associated with it.

The performance of the activities proposed in this practical case implies that the trainee follows a series of sequential activities', each one presented with 4 proposals for resolution, being only one of them the correct one. Marking the correct option, the trainee will proceed to the next activity, until the entire process is complete. The success of the practical case resolution will be assessed by the number of correct and incorrect options selected by the trainee throughout the proposed process.

After completing the practical case (debriefing) the trainee, with the supervision of the trainer, should reflect about it and carry out the consequent appreciation of the developed learning, using a checklist developed for this purpose.

PRACTICAL INFORMATION

The operating room is a complex and challenging workplace where patients are subjected to a strange environment, and may undergo different and non-invasive surgical procedures and anaesthetic techniques, which require various instruments and materials and this way demands a constant update from professionals. Different professional work classes (surgeons, anaesthesiologists, nurses, specialized technicians, operating assistants), in the operating room have to work as a team in order to be able to respond to every problem and challenge that might arise during surgical interventions (Wakeman & Langham Jr., 2018).

For the activities developed in this context to proceed in a coordinated and systematic manner, members of the surgical team must apply Leadership, Communication and Interaction and Teamwork skills (The Royal College of Surgeons of England, 2014). All members of these teams (surgeons/anaesthesiologists/nurses, etc.) have their clearly defined "roles", responsibility to the patient and, consequently, an opinion/position in the different decisions to be taken.

As an example, we can consider an operating room (multipurpose), in the afternoon shift (16 to 24 hours) the team consisting only of four elements – three nurses (circulating/anaesthesia/instrumentalist), and an anaesthesiologist – team that should give response to surgical situations that may exist.

In one of the rooms (A), there is a general surgery going on, which lasted from the previous shift (laparoscopic cholecystectomy), with the team present in this room consisting of two general surgeons, an anaesthesiologist and three nurses (circulating/anaesthesia/instrumentalist). At the beginning of a new work shift, the nursing team, also made up of three nurses, is replaced, the surgeons continuing to be the same as well as the anaesthesiologist, which allows the surgery to continue.

About 90 minutes later, the nurse in charge answers the phone and is informed by the obstetric surgeon that there is a pregnant woman in labour, who will have to undergo an urgent caesarean section, because the foetus is in distress. The occurrence and information are shared with the surgical team in room A.

Thus, there is a situation in which a surgery is taking place in room A, performed by a medical team (two general surgeons and an anaesthesiologist), and it is necessary to start another surgery in room B, performed by other medical team (two obstetric surgeons and an anaesthesiologist). There is only one single nursing team, consisting of three nurses, performing different functions (circulating/anaesthesia/instrumentalist) in room A.

In this situation, it is compulsory to make a decision that will inevitably have to be based on a shared leadership perspective, assuming communication/interaction between the different team members as a key role, based on a group work vision in which the different elements contribute to solving this problematic situation. It implied that the different members of the surgical team communicated with each other, having the opportunity to present their views, which also implies an ability to assume leadership skills in adverse situations, aiming at successful problem solving.

The decision-making process that makes possible a proper solution to the problem is a follows:

- • The general surgeons in Room A, because the surgery could not be interrupted, decide to continue without an instrumentalist nurse, keeping a nurse who performs anaesthesia and circulating functions.
- • The obstetric surgeons in room B undertake the planned surgery without the contribution of an instrumentalist nurse.
- • The anaesthesiologist in room A agreed to have a nurse performing anaesthesia and circulation, while the anaesthesiologist in room B would have no change regarding their support.
- • The nursing team, considering that the normal functioning of a room is ensured by three nurses, and given the situation presented, would have to be distributed between the two rooms, leaving in room A a nurse who ensures anaesthesia and circulation functions, continuing the surgery without an instrumentalist nurse, while in room B the surgery would be performed without an instrumentalist nurse (in room B there is a need for two nurses, because during surgery, while birth is occurring the nurses have to provide care to two patients, the pregnant woman and the new-born).

Initially a nurse from room A (instrumentalist) will leave, and prepare room B to receive the emergency obstetric surgery and, when this starts, the second nurse from room A will leave leaving just a nurse, who will assume circulating/anaesthesia functions. Nurses in room B will assume the functions of circulating and anaesthesia.

RESOURCES

To ensure that this serious game enables an approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

- 2 standard operating rooms (A/B).
- Operating room A equipped with laparoscopy tower.
- Operating room B equipped with neonatal resuscitation equipment.
- General surgery team – two surgeons (operating room A).
- Obstetric surgery team – two surgeons (operating room B).
- Anaesthesia team – two anaesthesiologists (operating room A and B).
- Nurse team – three nurses (initially: 3 nurses – operating room A/latter: a nurse – operating rooms A; two nurses – operating room B).
- Patients – two patients (laparoscopic cholecystectomy patient – operating room A / caesarean patient – operating room B).

ASSESSMENT

Although the use of virtual reality in technical skills training has increased, the use of virtual reality systems in health education can still be considered recent, particularly in the field of non-technical skills. Despite the importance of defining evaluation processes for the outcomes from the use of virtual reality systems as training tools, this assessment currently continues to focus on evaluating the usability and acceptability of virtual reality simulation (Bracq, Michinov & Jannin, 2019).

Considering the five key concepts related to Leadership (RNAO, 2013), already stated, it would be important that the practical case evaluation fit into aspects such as:

- Building relationships and trust as a critical leadership practice, the foundation on which the other practices rest, including relationships between individual health professionals, on teams and in internal and external partnerships.
- Building an empowering work environment based on respectful, trusting relationships among people in a work setting, allowing access to information, support, resources and opportunities to learn and grow, in a setting that supports professional autonomy and strong networks of cooperative support.
- Promoting a culture that supports knowledge development and integration involves fostering both the development and dissemination of new knowledge and instilling a continuous-inquiry approach to practice, where knowledge is used to continuously improve clinical and organizational processes and outcomes.
- Leading and sustaining change involves the active and participative implementation of change, resulting in improved clinical and organizational processes and outcomes;
- Balancing the complexities of the system, managing competing values and priorities entails advocating for the health resources necessary for high-quality patient care, while recognizing the multiple demands and complex issues that shape organizational decisions, considering that the proper use of evidence is essential.

In order to make the evaluation process concrete and objective, the following elements are established as its structural components:

- Select the right options for an effective leadership process.
- Sequentially choose two or more options that promote an effective leadership process.
- Select options that result in adequate leadership processes.

In a simple way, the evaluation of the practical case can be done based on a checklist. These are the main aspects to consider:

- Management of the need for division of nursing staff by operating rooms A and B.
- Argument/decision making of the nursing staff of the operating room A.
- Argument/decision making by the general surgeon team in operating room A.
- Argument/decision making of the obstetric surgeon team in operating room B.
- Argument/decision making from anaesthesiologists in operating rooms A and B.
- Decision-making/division of nursing staff tasks to ensure the functioning of operating rooms A and B.

Several behavioural strategies can be adopted by leaders of the surgical team to improve performance, such as reducing negative forms of criticism and increasing engagement of team members in the performed tasks (Stone *et al.*, 2017). The checklist will detail parameters for assessment of the decisions selected by serious game users, aiming the adoption of leadership skills consistent with an effective management of the practical case presented.

Includes the surgical team in problem solving processes.	YES	NO
Involves the surgical team in the planning and implementation of solutions.	YES	NO
Acts appropriately in stress management of surgical team members.	YES	NO
Values the contributions provided by the surgical team.	YES	NO
Reflects about the suggestions made by the surgical team.	YES	NO
Monitors the solutions presented by the surgical team in accordance with the recommended standards.	YES	NO
ervenes effectively when there are deviations in the performance of the surgical team regarding the recommended standards.	YES	NO
Diverges when necessary in relation to the recommended standards with the approval of the surgical team.	YES	NO
Reveals proper assertiveness before the surgical team.	YES	NO
Shares the outlined action plan with the surgical team.	YES	NO
Verifies the understanding of the surgical team regarding the actions to be performed.	YES	NO
Takes control of situations mobilizing the resources available to the surgical team.	YES	NO
Prioritizes the accomplishment of tasks by the surgical team properly.	YES	NO
Carries out the distribution of tasks by the surgical team appropriately.	YES	NO
Allocates the time required to perform the tasks by the surgical team.	YES	NO
Assumes the decisions defending the position of the surgical team.	YES	NO

Table 1. *Checklist for case 5 (Adapted from Mishra, Catchpole & McCulloch, 2009 - NOTECHS).*

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NOTES

CASE 6.

MISSING INSTRUMENT

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THEORETICAL INFORMATION

Main Skill

Decision making

Secondary Skills

Teamwork

Communication and Interaction

Generally, many activities go simultaneously on in our working environment (the ward, the operating room), or we are so absorbed in our own thoughts, that we fail to recognize those things that could pose a serious threat to the safety of our patients during surgery. Situation awareness describes an individual's perception, comprehension, and subsequent projection of what is going on in the environment around him/her. The concept of situation awareness belongs to the group of soft skills that include teamwork, communication and managing hierarchical lines of communication. The lack or temporary loss of situation awareness may be the cause of a variety of unexpected and catastrophic events (Gluvas *et al.*, 2016; Nomikos, 2018.).

A retained surgical instrument is considered to be any item inadvertently left behind in a patient's body during surgery. In 2013, the Sentinel Event Alert from the Joint Commission drew the attention of clinicians to the dangers of retained surgical items after invasive procedures. Depending on the type of object retained and the length of time it is retained, these retained surgical items can cause infections and death, and surviving patients may sustain both physical and emotional harm (Infection Control Today, 2017; Joint Commission, 2013).

Retained foreign objects are most commonly detected immediately post-procedure by counting or by X-ray, during follow-up visits or from the patient's report of pain or discomfort. The most commonly left behind retained surgical instruments are (AORN, 2017.):

- Soft goods, such as sponges and towels.
- Small miscellaneous items, including unretrieved device components or fragments (such as broken parts of instruments), stapler components, parts of laparoscopic trocars, guidewires, catheters, and pieces of drains.
- Needles and other sharp implements.
- Instruments, most commonly malleable retractors.

High body mass index is the most common risk factor of retained surgical instruments, but adhesion formation after previous abdominal surgery, multiple staff turnovers during long lasting procedure, an emergent/urgent procedure (most often bleeding and its control) or unexpected change during surgery

also increase the risk of leaving foreign objects inside the patient. Occurrence of retaining instruments was nine times as likely when an operation was performed on an emergency basis and four times as likely when the procedure changed unexpectedly (Gluvas *et al.*, 2016).

The most common causes of retained surgical instruments are the absence of guidelines, failure to comply with existing policies, problems with hierarchy within the operating members, failure in communication between the surgical team, failure of staff to communicate relevant patient information, and inadequate or incomplete training of staff.

The most common way to prevent retained surgical instruments is by simple counting. Despite today's modern technical advances, this ancient method still works best, even if manual counting protocols have a 10 to 15 percent error rate. In addition, 80 percent of retained sponges occur with what staff believe is a correct count. Improvements to counting procedures are the most obvious solution to the problem, surgical teams have to embrace standardized practices, meaning to develop and sustain reliable counting practices that ensure all surgical items are accounted for and recorded (Joint Commission, 2013).

Breakdowns in teamwork and communication are common risk factors for unintended events like retained surgical instruments and sponges, wrong-side/wrong-site, wrong-procedure, and wrong-patient events and inadvertent disease transmission to transplant recipients. In this case, communication is a secondary skill, however it routinely finds in the top three persistent root causes of patient safety issues in US hospitals. Furthermore, teamwork and communication processes have also been associated with case efficiency, operating room utilization and scheduling and burnout.

In this practical case, teamwork and communication are secondary skills, however at least as essential components in the health professional's practice. Surgeons, the operative staff, and other direct care providers along the perioperative continuum can directly support to maintaining a context for effective teamwork by adopting a team-oriented attitude in their daily work and committing to actively participate in team strengthening activities such as briefings and debriefings. Committing to demonstrate and role-model effective teaming attitudes and behaviours in practice are powerful mechanisms for meaningfully optimizing surgical care processes and outcome for patients, as well as the daily work experiences of the teams, working to provide world-class surgical care (Weaver *et al.*, 2017).

Assuming that there is a set of common purposes regarding practical cases aimed at developing your situation awareness with the following **learning objectives**:

- To recognize your own situation awareness level.
- To monitorize unexpected events and their consequences continuously.
- To improve information gathering skills.
- To organize surgical team effectively.
- To develop communication skills under time pressure.
- To evaluate the results of your problem management.

The necessary **competencies** to manage properly a similar situation:

- Knowledge of a correct situation awareness process.
- Keep in mind that an unexpected event can happen at any time.
- Ability to demonstrate conscious presence.
- Effective relationship management (quick adaptation to the new situation).
- Appropriate communication techniques between the team.

METHODOLOGY AND TRAINING APPROACHES

Assuming from the outset that the trainee already knows how to use S4Game and before starting this practical case (briefing), he should be informed by the trainer regarding the learning objectives associated with it.

The performance of the activities proposed in this practical case implies that the trainee follows a series of sequential activities', each one presented with 4 proposals for resolution, being only one of them the correct one. Marking the correct option, the trainee will proceed to the next activity, until the entire process is complete. The success of the practical case resolution will be assessed by the number of correct and incorrect options selected by the trainee throughout the proposed process.

After completing the practical case (debriefing) the trainee, with the supervision of the trainer, should reflect about it and carry out the consequent appreciation of the developed learning, using a checklist developed for this purpose.

PRACTICAL INFORMATION

In this case study, we would like to present that each team member has essential role in the outcome of surgery in the operating room. To avoid the patient from further complications and surgical interventions, continuous observation and attention is required from all members of the surgical team. A small inadvertence of any team member or failure in communication between the staff, may seriously affect the outcome of surgery and cause lifelong complications and more serious problems for the patient.

In a transplant centre, Monday morning a 46-years-old male patient is scheduled for kidney transplantation due to a severe polycystic kidney disease. The surgical team consists of a urologist and a surgeon experienced in transplantation as an assistant, an anaesthesiologist, an anaesthesiologist assistant, a scrub nurse, and a circulator. If necessary, a PGY 5 resident is ready to scrub in.

The patient had a 10-years known history of multiple cysts in both kidneys, and so far, its complications have been conservatively treated. The patient had hypertonia, around 160/100 mmHg, but with antihypertensive drug treatment it can be maintain at 140/90 mmHg value. In the last few weeks, he is presenting complains of right flank pain, generalized headache, swelling in his ankles and feet and an increase in size of the abdomen. He has no history of admission, nor drug or food allergy. He has a family history of diabetes mellitus type 2; his mother is also diabetic. The patient underwent the following investigations: ECG, Echocardiogram, common laboratory test including urinalysis, abdominal pelvic USS, and abdominal CT- and MRI-scan, lipid profile, liver- and renal function test.

MR-imaging showed multiple renal cysts on both sides. Some of the cysts also showed high protein or haemorrhagic shares. In accordance with the previous MRI scan, the non-contrast CT examinations showed clear signs of space-occupying cystic lesions with polycystic kidney, low-grade ascites. Occasionally slightly enlarged lymph nodes were found. His restricted renal function showed a severely decreased Glomerular Filtration Rate (GFR), which was under 15 ml/min/1.73 m2; serum creatinine level was permanently above 850 micromoles/litre, while blood urea nitrogen (BUN) test was near 30 millimoles/litre. His urine output was under 400 ml/day (oliguria).

Based on his findings, dialysis treatment was started, and the patient was added on the transplant list and a suitable donor organ was found for him within half a year. Due to recurrent but also increasing complaints, marked restriction of lifestyle and the risk of dialysis a right sided nephrectomy was performed before the planned kidney transplantation.

Preoperatively the patient is conscious, oriented, afebrile, haemodynamically stable, with a regular auscultatory finding on the heart and lungs and without neurological outbreaks. The patient is negative

for allergies. Preoperative laboratory analyses were acceptable. At 8:30 general anaesthesia introduced and maintained with intratracheal narcosis without any complications.

The surgery lasts 5 hours, avoided any unusual things. Firstly, both cystic kidneys were removed from upper and median laparotomy. Their total weight was nearly 10 kg, and the patient's abdominal circumference was reduced by 20 cm after surgical intervention. After bilateral nephrectomy, the first operating area was closed with two-layer, running suture lines. Secondly, the left cadaver kidney graft was implanted through another incision into the right iliac fossa. During the whole procedure, the members of the operating team have continuously informed each other and followed the steps of surgery. Halfway through the surgery the surgeon asked an account of the used equipment and towels, at this time everything was found to be in order. The surgeon started closing the second incision, parallelly the operating staff summarized the instruments, swabs and towels used during surgery. The scrubbing nurse realized that a swab is missing. At this point, the first incision has already been closed and the second one was also almost closed.

The surgeon immediately assessed the situation and gathered the needed information. Towels and swabs were recalculated immediately, however, the numbers were not correct a second time. The operating room assistant and the anaesthesiology assistant looked around the operating room but found nothing. After the surgeon thinks, the missing swab is still remained in the patient's abdominal cavity. Because both incisions were almost closed, and the surgery became long, the surgeon asked the mobile X-ray machine into the operating room to make sure there was no swab left in the patient. Unfortunately, or fortunately, X-ray examination did not show any foreign bodies in the abdominal cavity.

By this time, the surgery had been going on 6 hours and the swab was still missing, but there was no indication that it had remained in the patient. The surgeon finally decided not to look for it any further, the surgery was completed, the patient was awakened and placed in the ICU. The case was recorded in detail in the surgical diary and after awakening, the patient was also informed that it is possible that a swab remained in his abdominal cavity as a foreign body. For the next 4 days, the patient's condition was stable, he was admitted to a sterile room, his wounds healed nicely, and there was no sign of graft rejection, or inflammation, or possibly fever.

Every Friday, the operating block was fully cleaned and disinfected, which was performed in the afternoon, at the end of the surgical program. For proper hygiene, the equipment- including the operating tables - are moved. When this was done, the missing swab came out from under the legs of the operating table. Probably during surgery, the swab was fallen down, and someone accidentally kicked it under the operating table. As can be seen, even with the most careful attention and continuous cooperation, unexpected events may happen.

RESOURCES

To ensure that this serious game enables an effective approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

- A standard operating room.
- Transplantation team – a urologist specialist and a surgeon and second assistant (resident PGY5).
- Anaesthesia – one anaesthesiologist.
- Nurse team – three nurses (circulating/anaesthesia/scrub).
- Patient – one male patient (with polycystic kidney disease).

ASSESSMENT

Situation awareness is crucial factor in safety critical domains related to individual and team performance and a key consideration in system design and evaluation of command-and-control systems, training programs and procedures. Furthermore, team briefings have to be a standard part of surgeries to allow chance for any team member to express concerns they have regarding the safety of the patient, including the potential for a retained surgical instrument. This will promote open communication among surgical team members.

It is important to point out all perioperative team members are responsible for preventing unexpected events. The first step of retained surgical instrument prevention is creating a safe surgical environment which is free from distractions, noise, and interruptions during critical phases of patient care, including surgical counts. Distractions, noise, and interruptions increase the risk of inattention and omission (e.g., not counting an item, thinking an item has already been counted) and decrease concentration (AORN, 2016.).

It is also important to accurately document the results of counts of surgical sponges, instruments, or any items intentionally left inside a patient (such as needle or device fragments deemed safer to remain than remove), and actions taken if count discrepancies occur. Tracking counting during surgical procedures is important to understanding practical problems and improve the everyday practice. Accurate data analysing is key to understand the frequency of retained surgical instruments, identifying the risk factors, and developing preventing strategies. Counting guidelines should be developed by multidisciplinary approach involving different specialists like surgeons, anaesthesiologists, scrubbing nurses, radiologists, etc. The main aim is to develop and implement effective evidence-based organization-wide standardized policy to decrease the defects to zero in the everyday surgical practice (Joint Commission, 2013).

The most important aspects are:

- Counting should be performed audibly and visibly by two team members engaged in the surgery, usually these are the scrub nurse and circulating nurse. The surgical team should verbally acknowledge verification of the count.
- Include counts of all items used during the procedure.
- Include counts of soft goods, needles/sharps, instruments, and small miscellaneous items, and document unretrieved device fragments.
- Serial numbers printed on pre-packaged sponges and instrument sets are correct. Handle the discrepancy according to the organization's policy.
- Counting should be performed before the procedure in order to establish a baseline count, before the closure of the operating field and at end of procedure.
- Guideline should be applicable in all invasive procedures.
- It has to be revised periodically and improve according to the current data.

Assessing situation awareness - including teamwork - is a complex process focused on the evaluation of the role of the different members of the surgical team. The checklist details parameters for assessment of situation awareness of serious game users. The following checklist may help to systematically analyse our awareness process and helps to identify the points to change **(Table 1.)**. For each statement, mark the level (1 to 7, 1 means poor competency, 7 excellent competency) in the column that best describes the situation awareness technique.

STATEMENT	1	2	3	4	5	6	7
How familiar are you with the situation?							
How much information have you gained about the situation?							
How good information have you been accessible and usable?							
How much are you concentrating on the situation?							
How much mental capacity do you have to spare in the situation?							
How aroused are you in the situation?							
How complicated is the situation?							
How many variables are changing with the situation?							
How changeable is the situation?							
I determine the factors most important to the decision, and then use those factors to evaluate my choices.							

Table 1. *Questionnaire for case 6 (Adapted from Taylor, 1990 - SART).*

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NOTES

CASE 7.

ABSENCE OF CORRECT STAPLER

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THEORETICAL INFORMATION

Main Skill

Decision making

Secondary Skills

Communication and Interaction

Leadership

Surgical team members are usually faced with making decisions: in the operating room, in the clinic, in consultations or in meetings. They are faced with situations where quick, immediate decisive actions are required, but also situations where all the facts must be carefully considered so that balanced decisions are made, and the consequences are measured. All these decisions can influence performance, patient outcomes, colleague relationships, and of course the professional development of the individual surgical team member.

Clinical decision-making is a core competency of surgical practice. It involves mental processes ranging from intuitive and subconscious to analytical and conscious. In practice, individual decisions are usually made by a combination of each of these mental planes, according to the complexity of the situation and the personal experience. An experienced practitioner with acquired decision-making skills makes use of these processes with ease, as needed, and is able to apply learned rules or protocols to specific situations.

The expert recognises and responds quickly to any mismatch between what is observed and what is expected, dealing with gaps in information and making decisions even when critical data may be uncertain or unknown. Although the cognitive processes involved are difficult to articulate as they tend to be very complex, to help trainees develop their decision-making skills, processes need to be identified and defined and the specific competence must be measurable. For Crebbin *et al.* (2013), clinical decision-making involves three contexts: management of the patient; preparation of the surgical procedure; and review of the surgical procedure.

The decision analysis model, based on a decision tree, adequately represents clinical problems and that the use of decision analysis can improve clinical decision making. Using this type of decision tool, one must specify the options, specify the outcomes associated with each option, assign probabilities to those outcomes when they are not known with certainty, and assign values or utilities to those outcomes. And this is the system that has been adopted for the planning of this case.

Surgical decisions can be described by a limited number of disjunctives in a decision tree despite the much larger number of clinical problems. Depending on the decision pathway, similar decisions might be faced several times during a procedure. A good model of the surgical decision-making process should detail the steps useful in clinical decision-making. However, this is not always possible in a universally valid way in all circumstances. It is not possible to describe an absolute, all-encompassing decision tree. It will always be based on those situations that occur more frequently, involve more significant adverse effects or the standard patient characteristics.

Healthcare professionals who have greater contact with patients are those who obtain a greater flow of specific information from them, which implies a greater capacity to foresee possible complications. However, due to the volume of information to be managed, these professionals often have problems of communication and transfer of information to other members of the surgical team. Thus, in order to avoid the personal cognitive overload, it is important that all team members act as a whole, processing the information from different inputs and, making communication fluid and in full control of situational awareness (see Case 1).

Advanced systems based on artificial intelligence might assist on the decision-making process by automatically integrating data from different sources (informed consent, patient identification, electronic health record, risk factors, etc.) and analysing all gathered information for giving recommendations and/or probabilities for making decisions with the best patient outcomes.

The expected outcome of any decision-making training protocol should involve increased situational awareness for all team members and provide a standardised means of team communication while the operation is still underway. Lack of standardisation and team integration can be the main culprit for communication errors and, consequently, patient errors. The structure of training programmes during residency, and then in continuing education, must address the lack of integration. Since surgeons, anaesthesiologists and nurses are trained independently, following different programmes and learning specific forms of communication and decision-making, it is important that systems such as S4Game where all team members have a minimal opportunity outside the dynamic patient care environment to learn the key decisions that each must make.

Thus, the learning objectives of this practical case are:

- To anticipate possible errors that might result on patient damage.
- To recognize when a situation might go out of control through the perception of all the elements and people involved.
- To acquire the cognitive resources assisted through checklists to be able to work below the maximum workload to be supported.
- To recognize the consequences that decisions have.
- To develop communication skills under pressure

Furthermore, a set of associated competences can be defined:

- Ability to use a revision and check system for keeping attention.
- Appropriate language utilization in the communication with the rest of the surgical team.
- Ability to identify and recognise the potential risk of decisions during the surgical procedure.

METHODOLOGY AND TRAINING APPROACHES

The situation presented in the previous section can be applied under different training approaches:

> » **Best practice:** in this case, the trainee should watch the recording of an expert playing the game to learn the best options and decisions (best practice).
> » **Consultation:** in this case, a best practice approach is complemented with an initial briefing and a posterior debriefing.
> » **Test:** theoretical questions on the situation awareness domains or the different levels of situation awareness should be included in the case.
> » **Practical training:** the trainee plays the scene and is requested to make decisions during the game.
> » **Feedback:** each decision of a trainee is scored during the game, the points achieved correspond to the correctness of the trainee's reactions and lead to various actions (repetition of the game, presentation of bad choices) after its end explaining the correct/recommended steps including the justification of the extent of appropriateness of the selected actions.

In any case, the trainee should be informed by the trainer regarding the learning objectives associated with the practical case.

PRACTICAL INFORMATION

A 65-years old male patient undergoes bariatric surgery. He suffers from hypertension, overweight and chronic obstructive pulmonary disease (COPD), furthermore, he might present possible anaesthetic complications.

The surgeon begins the laparoscopic surgery by performing the gastric reservoir, for which the surgeon has requested 60mm Extra thick black staplers to the instrumentalist nurse. The surgery proceeds correctly. The surgeon performs the complete section of the stomach using 3 black staplers. Afterwards, the surgeon prepares to make the side-to-side jejunojejunal anastomosis to complete the surgery. For this procedure, the surgeon asks the instrumentalist nurse for a 45mm gold-plated vascular/medium stapler. At this point, the surgeon and the nurse responsible for the OR realise that there are no such staplers neither in the OR nor in the storage room. The staplers are in the storeroom of the other hospital which is 20 minutes away by ambulance.

In this situation, a decision must be taken based on the clinical as well as environmental factors, which might or might not put the patient into risk.

RESOURCES

To ensure that this serious game enables an approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

- One standard operating room.
- Chief surgeon.
- Anaesthesiologist.
- Responsible nurse.
- Instrumentalist nurse.
- Assistant surgeon.
- Obese patient

ASSESSMENT

Surgical teams are made up of members with different behaviours, training and experience. Similarly, each of them will also have a specific decision-making capacity. This unique and complex distribution can significantly hinder the quality and efficiency of overall decision-making in collaborative work environments. It might happen, especially in newly created teams, that team members work in the same environment without knowing the perspectives of the rest of the team members. So therein lies the importance of joint training and evaluation.

For surgical teams to achieve the highest level of effectiveness, all team members must be aware of the cognitive processes of the other team members. Furthermore, the most effective decision support systems for surgical teams will be built based on the results of theory-driven research and aimed at generating a comprehensive understanding of each team member's decision-making processes.

By making good use of decision trees, the surgical team member can also gain new knowledge and understand what happens when their decisions are not the right ones.

Research supports the need to develop training curricula and assessments that focus on knowledge-based peri-operative decision-making, not just technical skill. On the other hand, most surgical simulators currently on the market and used in skills training centres focus just on technical skills. Providing a training option, such as virtual reality that also focuses on decision-making training, can provide a broader approach with greater acquisition of interrelated knowledge.

Current assessments are subjective tools based on checklists. Assessment of intraoperative skills, such as technical skills, has previously been used as an objective measure to address such limitations. Objective measurement of non-technical skills in surgeons is still preliminary, and future work is needed to leverage objective metrics in parallel with current assessment tools.

The following checklist details items for assessment of the decisions selected by serious game users, aiming at raising awareness on the importance of surgical decision making beyond technical aspects.

Each member of the surgical team is aware of the consequences of a wrong decision.	YES	NO
For this intervention there is an established plan of: • Error prevention • Recognition of errors • Error resolution	YES	NO
Knows what to do in case of error.	YES	NO
Values the contributions provided by the surgical team.	YES	NO
Reflects about the suggestions made by the surgical team.	YES	NO

Table 1. *Checklist for case 7 (Adapted from Mishra, Catchpole & McCulloch, 2009 - NOTECHS).*

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NOTES

CASE 8.

MULTICULTURAL ENVIRONMENT

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THEORETICAL INFORMATION

Main Skill

Teamwork

Secondary Skills

Leadership

Communication and Interaction

One of the challenges of globalization is to work in a multicultural team, in which people of different nationalities and with unique cultures, have to achieve common goals. This practical case leads us to a situation where multiculturalism within a surgical team can cause tensions in teamwork. These tensions affect the efficiency of the team, and may even cause constraints in the organizational dimension. Communication and interaction between the people who make up the team are the main factors and the most complex in the management of this aforementioned work (Araújo, 2015).

Cultural differences can present communication "noises" and, if not resolved, can jeopardize the work done by the group and, in this particular case, the safety of the patient undergoing surgery. Different studies (Graça, 1992; Barbieri, 1997; Helmreich & Schaefer, 2015) have concluded that, more than technical errors, it is the soft skills that affect the team's performance, affecting its overall result, as well as the satisfaction of each of its members.

Teamwork in the operating room is the main competence mobilized in this practical case. Teamwork being understood as the balanced participation of all elements, the individual contribution with their own ideas and skills, the renouncement of a personal position in favour of the team, the development of internal evaluation strategies and processes, the responsibility of each one for the good team relationship and the accomplishment of tasks in order to achieve the defined results (Wisinski, 1994; Moscovici, 2016). As secondary skills, communication and interaction, as well as leadership, will be worked on.

In view of the relationship between the primary and secondary competencies developed in this practical case, the following learning objectives are identified:

Considering there are a set of mutual purposes concerning practical cases aimed at developing teamwork skills, the following **learning objectives** are stated:

- To identify the main issue regarding the multicultural differences.
- To recognize the different points of views.
- To explain one's own cultural points of views.
- To assume an open attitude with the surgical team.
- To evaluate the different options presented by the surgical team members.
- To select the right path to solve the divergences between the surgical team.

In addition, the definition of **competences** within this scope is also based on the same purposes, being highlighted the following:

- Identification of the main issue regarding the multicultural differences.
- Recognition of the different points of views.
- Explanation of one's own cultural points of views.
- Assumption of an open attitude with the surgical team.
- Evaluation of the different options presented by the surgical team members.
- Selection of the right path to solve the divergences between the surgical team.

METHODOLOGY AND TRAINING APPROACHES

Assuming from the outset that the trainee already knows how to use S4Game and before starting this practical case (briefing), he should be informed by the trainer regarding the learning objectives associated with it.

The performance of the activities proposed in this practical case implies that the trainee follows a series of sequential activities', each one presented with 4 proposals for resolution, being only one of them the correct one. Marking the correct option, the trainee will proceed to the next activity, until the entire process is complete. The success of the practical case resolution will be assessed by the number of correct and incorrect options selected by the trainee throughout the proposed process.

After completing the practical case (debriefing) the trainee, with the supervision of the trainer, should reflect about it and carry out the consequent appreciation of the developed learning, using a checklist developed for this purpose.

PRACTICAL INFORMATION

In today's society there is a constant migration of people between regions, countries and even continents, a situation that results in an intense miscegenation of cultures, customs, races and creeds, a fact that decisively influences work environments, where professionals with the most varied cultural backgrounds often meet, which also integrate the same work team. We live in a global world, requiring a constant capacity for adaptation and acceptance in the most diverse environments that assume an effective multicultural character (Sogancilar & Ors, 2018).

This phenomenon is also felt in health services, with multidisciplinary health teams from different geographic areas, different mother languages, often influenced by their previous experiences, in cultural, ethnic, religious and social terms. These factors can often be obstacles to an effective communication process, essential in a surgical context (Weldon, Korkiakangas, Bezemer & Kneebone, 2013).

This reality is naturally present and frequent in the surgical teams that develop their activity in the operating rooms. It is therefore essential the adoption of strategies based on skills associated with teamwork, grounded in areas such as communication, interaction and leadership, so that these teams are able to function adequately in the course of providing healthcare to patients as well as maintaining a high standard of quality (Kumar, Morad & Sonsati, 2019).

The case presented takes place in a hospital in the country interior which, due to all the problems inherent to the interior, has difficulty in hiring specialized health technicians, namely doctors of different specialties.

Because the hospital is close to the border, the hiring of specialist doctors in the neighbouring country is a current practice, with the majority of employment contracts being in service provision. In this hospital, doctors and nurses of other nationalities are also on present in the staff.

This situation takes place on a Saturday, in the morning shift (8 to 16 hours). The team assigned to the operating room (multipurpose) consists of only 4 elements – 3 nurses, with different functions (circulating/anaesthesia/instrumentalist) and 1 anaesthesiologist (contract under service provision) – team that should respond to any surgical situation that may occur.

The anaesthesiologist on duty is new to the hospital, has Peruvian nationality and lives in Spain. After arriving he introduces himself to the nursing team. During the shift, the nursing team realizes that this doctor is not fluent in Portuguese and was not integrated into the service by one of the resident anaesthesiologists, so he does not know the department's routines and rules, the available equipment (such as the type of ventilator) or what medication is available, among other aspects.

Around 10 o'clock, the operating room team is called by the obstetrics department who informs about the need to perform an urgent caesarean section on a pregnant woman with pre-eclampsia.

The operating room is prepared and the patient enters the operating room, together with the two obstetricians on duty, one of them belonging to the staff of the hospital while the other, of Malaysian nationality, only sometimes provides services to this hospital.

The anaesthesia nurse asks the anaesthesiologist about the type of anaesthesia he will use and what he needs. The anaesthesiologist is confused because in his home hospital he works alone. It is not common to have a nurse available for the anaesthesia function.

The anaesthesia nurse has to explain the reality of this hospital, and that his role is to work directly with the anaesthesiologist. For the preparation of anaesthesia, the anaesthesiologist requests an opioid analgesic, remifentanil, which is not available. In this situation, the anaesthesia nurse has to explain what similar drugs are available.

During the anaesthetic induction process, the anaesthesiologist has difficulty expressing clearly what he wants because he does not speak Portuguese. The circulating nurse in the team is of Spanish nationality, speaking the same language as the anaesthesiologist, and must assist the anaesthesia nurse in the communication process in order to facilitate teamwork.

As a result of pre-eclampsia the patient his hypertensive and the main obstetric surgeon, of Malaysian nationality, asks the anaesthesiologist to control blood pressure. The two are unable to understand each other properly, because of not communicating in each other's mother language and also due to the fact that they are unable to communicate properly in the language of the country where they are located.

Communication has to be mediated by the second obstetric surgeon and the nursing team, who bridge the gap between the two, in order to reach understanding and the health problem present with the patient can be solved quickly.

Again, the medication requested by the anaesthesiologist to control blood pressure is not part of the hospital stock, and the anaesthesia nurse has to present similar medications available, which creates some confusion, because the anaesthesiologist has difficulty in recognizing some of them, because he does not usually use them.

They end up reaching an understanding, after a new intervention by the circulating nurse in the mediation of communication, with the appropriate medication being selected and administered, and the patient's blood pressure is controlled. The caesarean section then proceeds without further complications or major problems, both for the mother and the new-born.

In short, the normal development of the surgical procedure was hampered by the presence of different nationalities in the multidisciplinary team, as well as different ways of working, and a lack of knowledge about the service (rules, materials and medicines available). The adoption of strategies based on teamwork allowed the surgery to be carried out, ensuring the quality of the care provided, and the following aspects are to be highlighted:

- Effective collaboration between the different members of the surgical team to solve situations.
- Promotion of communication and interaction to address the problems associated with difficulties in transmitting information.
- Leadership processes shared punctually by different members of the surgical team in order to overcome difficulties that have arisen.

RESOURCES

To ensure that this serious game enables an effective approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

- 1 standard operating room (equipped with neonatal resuscitation equipment).
- Obstetric surgery team – two surgeons (one of them Malaysian).
- Anaesthesia – one anaesthesiologist (Peruvian).
- Nurse team – three nurses (circulating/anaesthesia/instrumentalist).
  ‣ Circulating nurse (Spanish).
- Patient – one patient (caesarean patient).

ASSESSMENT

The virtual reality encompasses a wide range of resources that have been progressively adopted in the medical and nursing educational area, using immersive and interactive virtual environments that allow the trainees to develop their learning and experience in a virtual world. This technological didactic resource allows establishing processes of standardisation and scoring that can be used to evaluate the abilities developed, including within the scope of human factors and soft skills (Pottle, 2019).

An effective teamwork, sustained in a culture of supportive discussion, personal responsibility and trustworthiness, is essential to provide high quality and safety in the patient care implying promote a constructive working environment around the surgical team, that improves the performance of their members and increase health outcomes for the patients. Thus, in the practical case evaluation it is important to consider some aspects related to Teamwork (The Royal College of Surgeons of England, 2014), such as:

- Work effectively and harmoniously with all members of the surgical team, engaging and encouraging reflection and learning from the activity developed and appropriate actions in response.
- Understand and respect the roles and points of view of other members of the surgical team, promoting structured and inclusive processes that encourage contributions and ensuring that all opinions are taken into account.
- Encourage a culture of safety, truthfulness and constructive challenge in the surgical team, ensuring that each member understands its own and each other's role and responsibilities.
- Understand the risks of diffusion of responsibility in the surgical team ensuring that shared and corporate responsibility does not interfere with or decrease owns professional responsibility to the patients.
- Respond to demands for assistance or collaboration from other members of the surgical team, providing support in order to give priority to the patient care.
- In order to make the evaluation process concrete and objective, the following elements are established as its structural components.
- Select the right options for an effective teamwork.
- Sequentially choose two or more options that promote an effective teamwork.
- Select options that result in adequate teamwork.
- In a simple way, the evaluation of the practical case can be done based on a checklist. These are the main aspects to consider.
- Management of the surgical team constituted by professionals from different countries with different mother languages.
- Promotion of cooperation between the members of the surgical team in a multicultural environment.
- Management of communication and interaction processes to solve problems associated with difficulties in transmitting information.
- Sharing leadership processes between different members of the surgical team for effective problem solving.

Teamwork assessment is a complex process focused on the evaluation of the behaviours showed by the different members of the surgical team (Whittaker, Abboudi, Khan, Dasgupta & Ahmed, 2015). The checklist will detail parameters for assessment of the decisions selected by serious game users, aiming the adoption of teamwork skills consistent with an effective management of the practical case presented.

Establishes atmosphere for open communication and participation in the surgical team.	YES	NO
Open to opinions from other surgical team members.	YES	NO
Members of the surgical team recognize previous needs / emotions of others.	YES	NO
Surgical team members act in a polite and friendly manner / assertiveness.	YES	NO
Takes condition of other surgical team members into account.	YES	NO
Acknowledges the contribution made by other surgical team members.	YES	NO
Maintains a positive support with the whole surgical team.	YES	NO
Respects others surgical team members ideas and opinions.	YES	NO
Concentrates on what is right rather than who is right handling conflicts.	YES	NO
Helps other surgical team members in demanding situation.	YES	NO
Supportive of other surgical team members.	YES	NO
Takes control of situations mobilizing the resources available to the surgical team.	YES	NO
No prejudices are involved in the surgical team practice.	YES	NO
Helps other surgical team members to perform tasks.	YES	NO
Members of the surgical team are engaged in the outcomes.	YES	NO

Table 1. *Checklist for case 8 (Adapted from Mishra, Catchpole & McCulloch, 2009 - NOTECHS).*

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NOTES

CASE 9.
PROBLEM OF SPREAD ATTENTION

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THEORETICAL INFORMATION

Main Skill

Communication and Interaction

Secondary Skill

Teamwork

The main aims of this practical case include the following knowledge, skills and abilities:

- to recognise the principles and potential of teamwork.
- to practice the team communication skills.
- to use the empathy in the team communication.
- to systemise the course of action.
- to differentiate the priorities of the steps needed.
- to modify own behaviour according to the context.
- to estimate his/her skills to tackle with the current situation.
- to manage the multitasking activities during the intervention and education.
- to reconstruct the previous situations and to prevent the mistakes according to the analysis.

After completing this practucal case, the trainee will reach the following knowledge, skills and abilities:

- overview of the critical parts of the endoscopy and teaching.
- learning how to identify and recognise the potential bottlenecks.
- getting used to prevent them and/or adequately solve them.

The practical case is focused on adequate behaviour within the team during the endoscopy and simultaneous undergraduate teaching of medical students (a situation that commonly occurs in tertiary endoscopic centers in university hospitals). It is crucial are able that the leader endoscopist and the teacher (in one person) is able to adequately manage both of his/her roles in this situation and ensures not only adequate performance of the medical procedure, but also quality teaching of medical students. The basis are excellent communication skills, adequate management of both simultaneous processes and delegation of some roles to other team members according to their qualifications and abilities.

METHODOLOGY AND TRAINING APPROACHES

Interpersonal as well as communication and coordination skills are crucial. These can both support and accelerate the procedure or any other medical intervention, or these might prolong the course of action, confuse the involved participants or even worsen the health condition of the patient due to particular misunderstandings, incorrect procedures, conflicts, ambiguous situations or similar problems. In particular, the aforementioned issues are mostly connected with the interpersonal and communication skills. All soft skills can be partly trained, learned and practiced. For these purposes, the following case focuses on the inter-team communication. The skills how to behave and react are prevalent. Nevertheless, dealing with the external disturbances and other issues should be managed as well. Therefore, these are emphasised in particular situations and decisional actions. The following methods are used in this case:

Consultation - watch the demo of the game and answers to arising questions from a trainee.

Role reversal - inexperienced team member x team leader - trainee will go through the game in both roles to see different perspectives (note: so far only two roles are described and prepared, the further can be developed in the future).

Review and video training - recording the behaviour of a trainee inside the game, observation of the activities and selected steps including the consequences arisen.

**Practical training** - going through the game, fulfilling the tasks, making decisions.

Feedback - each decision of a trainee is scored during the game, the points achieved correspond to the correctness of the trainee's reactions and lead to various actions (repetition of the game, presentation of bad choices) after its end explaining the correct/recommended steps including the justification of the extent of appropriateness of the selected actions.

PRACTICAL INFORMATION

The location of this case is the endoscopy room at the university centre. The crucial part of the work of professionals at such workplace include the teaching and training of the medical students. The important role during this type of education plays the contact teaching which is represented by the participation of medical students in the medical procedures within which the real patient is included. The trainees are not only observing, but also significantly having the opportunity to see the real course of action during the procedures. Considering the latter, the presence of medical students in the endoscopy room is common. Nevertheless, this makes harder the organisation, interaction as well as communication of all participants during such procedures. The influence of the inclusion of medical students increase the demands on the medical professionals in relation to the soft skills, the leadership and teamwork in particular. The case demonstrates the educational colonoscopy with the presence of four medical students. The specific type of medical students/endoscopy trainees is not relevant for the case. The basic skills being trained within this case include the communication, interaction and the teamwork.

At the beginning, the patient is in a colonoscopy position (lying on his left side). The room is commonly equipped, see the plan below.
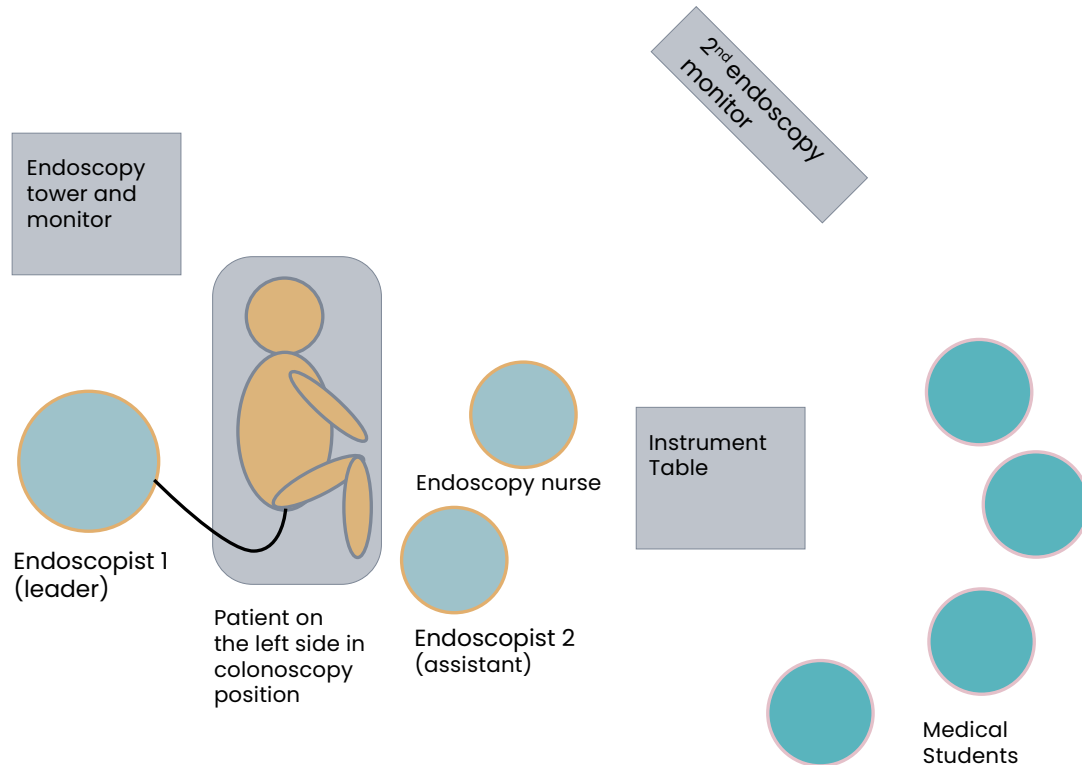
The team consisting of 7 members in 2 groups

- Endoscopy team responsible for the colonoscopy procedure and teaching:
  - Endoscopist 1 (leader endoscopist, tutor, leader of the team).
  - Endoscopist 2 (assistant, endoscopy fellow in training).
  - Endoscopy nurse.
- Student team including 4 medical students.

All endoscopy team members are dressed according to the endoscopy room dress code (including the personal protective equipment): surgical mask, blue isolation gown, gloves, eye protection (googles), disposable hair cap, shoes. Medical students are dressed in green gowns with surgical masks.

The endoscopy starts. The leader of the team is commenting the procedure. He is addressing the medical students who do not pay full attention to his demonstration. Concurrently, the endoscopy nurse notices the intolerance of the ongoing endoscopy by the patient. As another problematic issue the complication of the endoscopy procedure is occurring. This implies various reactions and feedbacks of the medical students as well as team members. The secretary entering the room during the endoscopy is another external disturbing factor. Moreover, she is coming with the information not related to the particular case. The nervousness is increasing and the atmosphere is very tight. The case demonstrates the interaction among the leader endoscopist, the medical students as well as the endoscopy nurse. The aim is to teach the adequate reactions and actions to keep the quality of the endoscopy itself and to manage the communication and interaction among all participants.

RESOURCES

To ensure that this serious game enables an approximation to real contexts where the present practical case is supposed to occur, the scenarios idealised in VR should include the following elements:

- Endoscopy room equipped with the endoscopy tower and monitor, table with accessories as well as the second endoscopy monitor
- Team comprising two groups:
    - Endoscopy team responsible for the colonoscopy procedure and teaching:
        ▸ Endoscopist 1 (leader endoscopist, tutor, leader of the team)
        ▸ Endoscopist 2 (assistant, endoscopy fellow in training)
        ▸ Endoscopy nurse
    - Student team including 4 medical students: participating in role of observers who should follow the course of action and learn
- Patient in colonoscopy position: procedure in analgosedation, enabling communication with the patient within the case

Assuming that the trainee already knows how to use S4Game and before starting this Practical Case (briefing), he/she should be informed by the trainer regarding the learning objectives associated with it. Moreover, he/she should go through the practical situational description of the particular case to be prepared what to expect and in which context the case happens.

The course of action than follows particular development of the colonoscopy procedure within which the particular decisional situations occur. The trainee has to choose from the provided options. He/she has limited time for these decisions. The colonoscopy procedure itself from the medical point of view creates just the external conditions as well as situational determination whereas the emphasis is put on the interpersonal relations and the overall atmosphere among all the staff in the operating room. Therefore, just the soft skills are trained and practised.

Each decisional situation forwards the trainee to the new situation. The points are allocated to the trainee according to the correctness of his/her decision/answer. In case of running out of time or selecting just absolutely inappropriate option, the game might be quitted and the trainee will have to play it again. At the end of the game, the trainee is assessed (see above the full methodology of the total percentage and the corresponding categories of the outputs). The results imply the overall outputs for the trainee. Accordingly, the trainee gets the recommendation to continue to another case or to repeat the same case in pursuit to improve and get better result. Moreover, the debriefing with the trainer would be useful. The supervised and guided reflection of the mistakes and of the correct decisions should provide the value-added learning experience. This debriefing should lead to the adoption of the skills within the trainee's behaviour and consequently to the ability to apply the acquired knowledge in the real situations.

ASSESSMENT

The use of virtual reality for the educational purposes is worthy for both the hard and soft skills. The correct interpretation of the serious game is the integral part of the educational process. Therefore, the appropriate attention should be paid to it.

Within the game, two types of assessment are relevant as well as considered. The first one includes the feedback to the trainee. Whereas the second one is related to the evaluation of the benefits of the game itself, i.e. for the team, department or the whole hospital.

The feedback for the trainee is based on the multiple-choice answers which are assessed with different number of points allocation. These are derived based on the importance as well as correctness of the answers. Similarly, the time limit is allocated to all questions to evoke the time pressure during the medical intervention. The details of the feedback are provided in the Assessment and feedback section. Nevertheless, the feedback to the trainee is mostly provided in the end of the game. The trainee will see all questions including the correct answers and their choice as well. Both the justification and the explanation of the correct and incorrect answers will be available as well. This should ensure the appropriate outcomes and the value added to the trainee. Moreover, he/she will see the reasons and get the scope for their development and improvement of their knowledge/expertise. This should eliminate the mistake repetition in the future and enhance the 'digestion' of the appropriate course of action. The only exception will be represented by the questions within which the bad choice would lead to the fatal consequences. Therefore, the simple feedback in case of a fatal mistake is be provided immediately through 'game over' notification. The final results will be discussed during the debriefing activity with the trainer. Scoring also provide the possibility to compare the results among the medical students as well as the progress of a particular medical student him/herself.

The evaluation of the case might employ the Non-Technical Skills of Surgeons (NOTSS) system (Jung *et al.*, 2018). This methodology is considered as being valid, feasible and reliable. The checklist of the skills development and progress might be primarily measured within the following areas (Jung *et al.*, 2018; Crossley *et al.*, 2011; Sharma *et al.*, 2011):

- Situation Awareness: The situation awareness assesses the understanding and interpretation of data collected from the environment (about patient, team, time, displays, equipment, etc.). These imply the preparedness of the trainee for the current as well as future course of action.
- Decision Making: This skill corresponds with the ability to judge the situation and to choose the appropriate option about the further steps.
- Communication & Teamwork: The communication together with the teamwork represent important skills and abilities to cooperate effectively, share the perception of the situation and complete the tasks as required and needed.
- Leadership: Leading, guiding and directing all team members requires patience and experience. The leader should be able to consider individual needs of his/her colleagues.

After the case and after the initial feedback outputs, the trainee might fulfil the following table subjectively and see how it fits with his/her feelings and experience. The abovementioned categories should be assessed on the scale from Poor to Good described below (NOTSS, 2021):

- Poor: Performance endangered or potentially endangered patient safety - remediation is needed
- Marginal: Performance implied particular concern - significant improvement is required
- Acceptable: Performance had a satisfactory standard - particular improvement is possible
- Good: Performance was of a high standard - best practice might be shared within the community

Except from the mentioned assessment options, the 'Not applicable' option is provided for the cases within which the element is not relevant or assessable.

	POOR	MARGINAL	ACCEPTABLE	GOOD	NOT APPLICABLE
SITUATION AWARENESS					
Gathering information					
Understanding information					
Projecting and anticipating future state					
DECISION MAKING					
Considering options					
Selecting and communicating option					
Implementing and reviewing decisions					
COMMUNICATION & TEAMWORK					
Exchanging information					
Establishing a shared understanding					
Co-ordinating team activities					
LEADERSHIP					
Setting and maintaining standards					
Supporting others					
Coping with pressure					

Table 1. *Checklist for Case 9 (Adapted from NOTSS, 2021).*

According to the assessment in the table, the trainee (ideally in cooperation with the trainer) might check the feedback and consider the further skills improvement including the need to focus on any issues and weaknesses identified. Thanks to these results, he/she might get the overview of the problematic skills. Then, it is easier to develop them in the desired way. The best effect is reached when the trainee does the assessment before and after the training using the serious games. The comparison of the results might show the training value added of the learning process as well as the progress of the individual, team and potentially the whole department or the hospital.

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NOTES

CASE 10.

TIME PRESSURE

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THEORETICAL INFORMATION

Main Skill

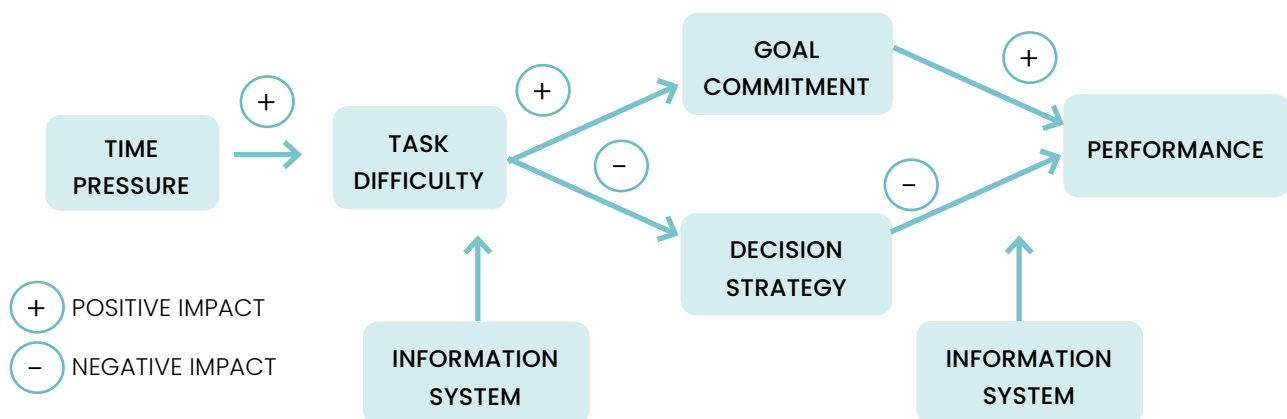

Decision Making

Secondary Skill

Situation awareness

Time pressure is typical boundary condition in the operating room. It considers either the own life of the patient and the number of patients waiting for an intervention. The training of this situation is essential because the lack of action on these moments leads to unintended consequences.

According to (Ahituv, N *et al.*, 1998) individuals perform more poorly under time pressure than they do when they are under no time constraints, because time pressure affects the accuracy and effectiveness of decision making and judgment. That is why a training is needed, in order to avoid complications due to time pressure.

(Hwang, M. I., 1994) proposes the following model of decision making under time pressure

A we can see, sometimes time pressure can affect positively to the process of decision making if trained properly. The question now is, how to train it properly? The same reference gives us another interesting result: a proper design of the decision-making protocol is the core of time pressure training.

Learning objectives:
- To be able to stablish a protocol of decision making under time pressure.
- To continue working under time pressure.
- To be able to give commands to other members of the team under time pressure.

PRACTICAL INFORMATION

In this case study, the goal is to show how time pressure affects performance and how to work on it. This is a patient who is suffering heavy bleeding and his heart rate is gradually reducing. In the operating room there is a surgeon, an anaesthetist, a nurse and a scrub nurse.

That afternoon, the same team must attend to a major operation, so the excess time spent would significantly delay the flow of operations.

The surgeon is aware that if the situation is not controlled, the patient could die, so he must involve the team and perhaps make decisions under this pressure. In this section, we describe the situation, participating roles, etc. whatever information necessary to carry out the case.

For the integration in virtual reality, the same way as other practical cases will be carried out, but with the difference that in this case it is also important to add some form of measurement of the time that passes. The measurement can be carried out in two non-exclusive ways. The first way is the development of the operation itself: the measurement of the heart pulse or pressure. The second is the inclusion of a clock in the room that allows us to measure the passage of time. It is not that it is a watch to use (hours and minutes), but a simple counter that with the passage of time and the progressive changes of colour indicates that time is passing, manifesting this pressure that is sought.

Pressure also manifests itself in nervousness, which in turn manifests itself in shaking of the hands and body. In what way could virtual reality be integrated here? One possibility would be to add haptic feedback to the controls, that is, vibrations that gradually increase as time progresses, progressively increasing their frequency and amplitude. The most widespread virtual reality equipment, such as HTC Vive or Oculus, have precise virtual reality controls, which allow to implement this feedback. On the other hand, vibration feedback is normally complemented by sound feedback, which can have two manifestations:

1. Dynamic soundtrack that increases the number of instruments and / or speed as the time decreases. Every time you go through a high-pressure situation, return to a "valley of relief" where everything calms down again.

2. Dynamic sound effects that accelerate in the same way as the soundtrack.

At last, the objective is to transmit pressure, both by intrinsic agents (the situation itself), and extrinsic (the feedback shown).

The roles presented are those that set the plot of the practical case in motion and allow it to be executed:

The surgeon, who must carry out the operation and be a thinking mind in the situations raised.

Nurses must be quick to carry out their tasks.

The anaesthetist, who must coordinate correctly with the other two parties.

The environment consists only of the operating room, where the operation takes place. The medical instruments should appear by default, focusing on implementing the heart rate monitor and other indicators in detail, in such a way that the urgency of the situation is revealed, and the user can observe the evolution of the case.

As mentioned above, this case includes not only dialogues, but also practical surgical operations on the patient. The objective is that the surgeon must perform the operation with these time restrictions and with the pressure that he receives. At the same time, he will receive messages from the anaesthesiologist and nurses hurrying, so that it is more difficult. Every time a message is received in a hurry, the haptic

system of the controls will vibrate, so that the feeling of being overwhelmed is greater. Every time a small exercise is carried out (incision, sewing, injection, extraction …), positive feedback will be received, manifested in a "beep" signal and a soft vibration (high frequency and low amplitude), so that the user shows rewarded.

For the practical exercises, *Trauma Center* video game saga can be taken as a reference, where parts of the operation take place where the user, with the help of their controls or touch panel (depending on the platform used), performs these exercises.

Possible questions posed to each part of the team:

> - **Surgeons**
>   - ‣ *Adequate performance of the operation* (measured by the S4Game Software).
> - **Anaesthesiologist**
>   - ‣ How can I help the surgeon to manage the lack of time?
>   - ‣ How should I personally manage the stress generated by the lack of time to collaborate with the team?
> - **Nursing team**
>   - ‣ How can I help the surgeon to manage the lack of time?
>   - ‣ How should I personally manage the stress generated by the lack of time to collaborate with the team?

RESOURCES

Considering that it is a practical case using a serious game based on virtual reality, the use of standardized hardware and technically recommended software for this operation are suggested, namely:

> - Hardware:
>   - ‣ Desktop / Portable Computer (Intel i7 / SSD + HDD / 16GB RAM / Nvidia 1070GTX) or compatible.
>   - ‣ Virtual reality Glasses HTC VIVE PRO (2880 X 1600 px) / HTC VIVE (2160 X 1200 px) or compatible.
> - Software:
>   - ‣ S4Game (Serious game – Virtual reality).

Thus, to ensure that this serious game enables an effective approximation to real contexts where the present practical case is supposed to occur, the scenarios idealized in virtual reality should include the following elements:

> - 1 standard operating room for laparoscopic surgery.
> - Surgery team – a surgeon and his/her first assistant.
> - Anaesthesia – one anaesthesiologist.
> - Nurse team – three nurses (anaesthesia/scrub):
> - Patient – one obese female patient.

ASSESSMENT

The following questionnaire help us to systematically assess your decision-making technique and helps to identify the points to change **(Table 1.)**. For each statement, mark the statement (Not at all/ Rarely/Sometimes/Often/Very often) in the column that best describes the decision-making technique.

STATEMENT	NOT AT ALL	RARELLY	SOMETIMES	OFTEN	VERY OFTEN
I evaluate the risks associated with each alternative before making a decision.					
I try to determine the real issue before starting a decision-making process.					
I rely on my own experience to find potential solutions to a problem.					
I tend to have a strong "gut instinct" about problems, and I rely on it in decision-making.					
I use a well-defined process to structure my decisions.					
I think that involving many stakeholders to generate solutions can make the process more complicated than it needs to be.					
If I have doubts about my decision, I go back and recheck my assumptions and my process.					
I consider a variety of potential solutions before I make my decision.					
Before I communicate my decision, I create an implementation plan.					
When communicating my decision, I include my rationale and justification.					
I prefer to make decisions on my own, and then let other people know what I've decided.					
I determine the factors most important to the decision, and then use those factors to evaluate my choices.					
I emphasize how confident I am in my decision as a way to gain support for my plans.					
After I make a decision, it's final.					

Table 1. *Questionnaire for case 10 (Adapted from www.mindtools.com).*

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NOTES