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## **Implementing patient safety in laparoscopic surgery: quality assessment and process analysis**

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# Chapter 1

**General introduction**

Due to the wide availability of therapeutic treatment options, nowadays it is not just the availability of care, but mainly the outcome of the care that has become important. To put it more strongly, it is particularly the prevention of suboptimal or undesired outcomes of care that has come to the fore [1]. This trend was first noted by the well-known report of the Institute of Medicine: *To Err is Human* [2]. At that time the world was first startled by the fact that in the USA alone annually between 44,000 and 98,000 patients die as a result of medical errors. Thus the term '*patient safety*', which is defined as reducing the risk of unnecessary harm associated with healthcare to an acceptable minimum, was born [3].

Quality is obtained by ensuring safety. Safety is ensured by guaranteeing in advance the frameworks in which care is provided. By measuring these processes and outcomes, the quality is determined afterwards [4]. With regard to the introduction of new surgical techniques and technologies (hereinafter referred to as '*new interventions*') it is conventionally recognized that efficacy and safety (i.e. major short-term safety issues) are assessed by means of Randomized Controlled Trials (RCT). To demonstrate long-term safety, cohort studies are the gold standard. The major disadvantage of RCTs is that they are not suitable for detecting complications with a low incidence. In addition, large numbers are required for both study designs, which means that in daily clinical practice such studies can be difficult to perform, for example, when there are rapid successive developments [5]. The question is: how can the quality of care be determined in such a situation?

In order to make quality comprehensible and transparent, quality indicators have been created [6]. Three different types of quality indicators can be distinguished: structure, process and outcome indicators [7]. Structure indicators assess the setting in which care takes place (e.g. the adequacy of facilities and equipment; the qualifications of medical staff). Process indicators examine the process of care itself (e.g. technical competence in the performance of surgical procedures; adherence to guidelines). Finally, outcome indicators (e.g. mortality, return to work) are the most frequently used by doctors as an indicator of the quality of healthcare. A major disadvantage of outcome indicators is that outcomes are influenced by many factors other than medical care itself. Using process indicators eliminates this problem as they focus on applying what is now known to be 'good' medical care. Although the estimates of quality that one obtains are less fixed/definite than those derived from the measurement of outcomes, they may be more relevant to the question at hand: whether medicine is properly practiced [7]. However, scientifically well-founded quality indicators are scarce.

Concerns with respect to potentially preventable damage are recognized in the field of minimally invasive surgery (MIS), especially in advanced laparoscopic procedures. These concerns are mainly due to two factors. The first factor is the use of advanced technology

in this surgical technique. This results in a high number of errors that are attributable to equipment [8, 9]. Secondly, MIS is already very safe in general. The introduction of a new intervention can thus potentially yield only marginal benefits, but unexpectedly could also entail new risks with possibly much greater consequences [10]. An example is the occurrence of capacitive coupling between an insulated electrode and a surrounding metal sleeve that has been suggested as the cause of unintended injury during laparoscopy [11, 12]. This pitfall was also emphasized in a report published by the Dutch Health Care Inspectorate (IGZ) in 2007 [13]. One of the suggested measures that had to be taken to prevent laparoscopic surgery from being unnecessarily risky was to guarantee patient safety by developing a quality-control system. Ideally, such a system should be based on clinically relevant indicators for quality.

Especially in MIS, new interventions are introduced in rapid succession or even simultaneously into the operating room (OR). To guarantee safety during this process, ideally, this implementation is preceded by performing a Prospective Risk Inventory (PRI) based on the Healthcare Failure Mode and Effect Analysis method (HFMEA) [14]. This approach has been promoted in the guideline 'New interventions into clinical practice' that was developed by the Dutch Order of Medical Specialists (OMS) in 2014 [15]. However, according to this guideline, an analysis of safety and effectiveness should be performed after 6 to 12 months *after* the actual introduction. Therefore safety *during* this first period of the introduction of new interventions is not completely ensured [10, 16]. Inherently, this causes a potential patient safety hazard that should be prevented.

Nevertheless, detection of safety issues during the introduction of new interventions is difficult [5]. One of the current theories about the origin of adverse events is the Swiss cheese model, which has been described by Reason [17]. Only in situations in which a variety of contributing factors combine to breach the many barriers and safeguards (i.e. when all holes are aligned) an adverse event may occur. The crux is therefore to find markers for the near misses and to learn from them so that they can be prevented in the future [18]. Clinicians must therefore actively seek other measuring instruments to continue to guarantee safety even during the introduction of new interventions.

Safety is monitored not only during a surgical procedure but also during the entire perioperative process. Technical solutions that autonomously ensure safety in the OR are being widely implemented. Well known are the systems that provide continuous monitoring of sterility, door movements, air temperature and air quality [19]. More recent developments are systems that report the location and maintenance status of the devices [20]. Both of these technical solutions constantly monitor factors that potentially affect the safety during the procedure and consequently lower the risks of adverse outcomes. However, monitoring of the progress of the surgical procedure is still depending almost completely on manpower.

A system that can automatically monitor the progress of the surgical procedure in real-time can offer many benefits. Due to increased efficiency of the OR schedule, more interventions will be ready during daytime instead of being delayed in after-hours. This is desirable, in particular with respect to the current staffing at all departments during after-hours [21]. Therefore, there are many initiatives worldwide to increase the efficiency of the OR [22]. This is typically attempted by better planning, i.e. better estimation in advance of the planned duration of the procedure [23]. However, the course of surgical procedures seems to be difficult to predict in practice [24]. Perioperative delays are very common in surgical procedures and moreover are hard to anticipate beforehand. Currently, any deviation from the planning must be recognized by the OR team and/or the OR manager. The OR schedule is therefore unreliable and not comprehensible for other participants throughout the process (patient ward, holding/recovery department, OR cleaning services, hospital transport, surgeon of next procedure etc.) [25, 26]. Allowing technical solutions to take over this task can support the clinicians better and more accurately so that they can engage in their primary task: to provide good care. This can potentially further improve the quality and safety of the surgical process [27].

To ensure patient safety during the introduction of new interventions in MIS, both the clinical questions and the technical process should be addressed. Therefore, the main objectives of this thesis are:

- To obtain clinically relevant tools to evaluate quality of minimally invasive surgical procedures, both in general as well as specifically regarding laparoscopic hysterectomy (LH), as the most frequently performed advanced gynecological MIS procedure; and
- To support clinicians to ensure surgical safety by means of process analysis.

## **Outline of this thesis**

Conversion is suggested in the report of the Dutch Healthcare Inspectorate as a potential quality indicator [13]. The main reason for this is that a patient is exposed to the risks of complications specific to both surgical approaches if the laparoscopic procedure is converted to a laparotomy. Moreover, between different hospitals, a wide range of conversion rates are reported for the same procedures. However, these numbers cannot be used for reliable comparison at this time because very different definitions are used for what is referred to as conversion. Furthermore, in literature there is no consensus regarding an unambiguous definition and the same definitions are interpreted differently between different specialties.

**Chapter 2** describes a study aimed at achieving multidisciplinary consensus on a generally applicable definition of conversion in laparoscopic surgery by means of the Delphi approach.

Furthermore, based on the results of a prospective cohort study and after obtaining systematic data on conversion rates, **Chapter 3** hypothesizes the extent to which conversion rate can act as a means of evaluation in an advanced MIS procedure. The LH was chosen as the procedure under research, requiring a wide array of endoscopic instruments and equipment.

A major complication after LH whose causation is sought in the applied technique and/or technology is the vaginal cuff dehiscence (VCD). The risk of VCD after an LH is higher than after vaginal or abdominal hysterectomy [28, 29]. The technology (e.g. type of electrosurgery used for the colpotomy) as well as the technique (type of suture and suturing technique) are thought to affect the risk of VCD. However, very few well-conducted RCTs or cohort studies are available, due to the rapid succession of new techniques and electrosurgical devices that are used. Since the facts have not been elucidated after all these years, a detailed analysis of occurred VCDs may further unravel the etiology of this major complication. **Chapter 4** compares the incidence of vaginal cuff dehiscence after different suturing methods of the vaginal vault after LH.

A group of patients that is a priori at risk for adverse events after surgery are the very obese and morbidly obese ( $\text{BMI} \geq 35 \text{ kg/m}^2$ ). Undeniably, the prevalence of these patients has been rapidly increasing in Western countries in the past decades [30, 31]. Obesity can cause a number of gynecological diseases, such as abnormal uterine bleeding and endometrial hyperplasia [32]. As a result, a higher prevalence of enlarged uteri and especially a higher incidence of endometrial carcinoma are observed among these patients [33-35]. Inherently, the number for which hysterectomy is indicated has been rising over time. However, since this group of patients is almost always excluded from RCTs based on their BMI, no conclusive evidence on the preferred route of hysterectomy is available. In **Chapter 5** the outcomes of abdominal, laparoscopic and vaginal hysterectomy in very obese and morbidly obese patients ( $\text{BMI} \geq 35 \text{ kg/m}^2$ ) are evaluated by means of a systematic review with cumulative analysis.

Currently, a measurement tool to monitor safety at the time of introduction of new interventions in MIS procedures does not exist. A novel method to evaluate safety is by observing the presence and effect of '*surgical flow disturbances*' during the course of a surgical procedure. These disturbances are defined as stimuli that distract one or more members of the sterile team and could potentially precede a safety issue (i.e. the Swiss cheese model) and are thus a good marker for measuring safety [36, 37]. Up till now, the most widely used method of assessing safety is analysis by a human observer in the OR. However, safety issues are complex and sometimes only noticeable afterwards. In addition, an observer in the OR influences the behavior of the team and/or the course of a procedure (Hawthorne effect) and can hardly identify real-time consequences of previous actions with subsequent effects [27, 38, 39]. Video observation



overcomes these shortcomings and is therefore acknowledged as the ultimate way to analyze the surgical workflow and assess safety in retrospect. Using video observation, in a prospective observational study, we compare a conventional OR with an integrated OR with regard to the incidence and effect of equipment-/instrument-related surgical flow disturbances during an advanced laparoscopic gynecological procedure (i.e. LH) (**Chapter 6**).

However, in daily clinical practice, extensive analysis of the entire procedure is difficult to perform. Firstly, it is time consuming and therefore expensive; at the same time, also privacy issues can be an obstacle. A specific questionnaire filled in by all members of the OR team (surgeon, scrub nurse, anesthetist(-assistant)) could possibly serve as a proxy for the presence of these surgical flow disturbances. Therefore, **Chapter 7** observes whether judgments of the surgical team are a reliable measure of surgical safety. A questionnaire that had to be filled out immediately after surgery was developed to measure surgical safety. Next, the validity of the questionnaire was assessed by comparison with the results from independent video analysis of these procedures.

Finally, **Chapter 8** describes a novel system for automated procedural progress monitoring that will be able to predict the remaining procedure duration. First, it is tested whether adaptation of the planned procedure duration with phase-specific reference data provides a reliable estimation of the actual procedure duration. Subsequently, the requirements for an automated real-time procedural progress monitoring system are described.

In **Chapter 9** the general discussion of the findings is provided and perspectives for future research will be given. **Chapter 10** gives a summary of this thesis.

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