CHAPTER 10

General discussion and summary of this thesis

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With the ever-expanding technological advances, the boundaries of healthcare continue to be moved. Especially, oncological care is developing rapidly. As staging methods, surgical-, medical- and non-medical care evolve, the patient with cancer is increasingly approached in a multidisciplinary fashion. The ageing population leads to a higher proportion of cancer patients that is susceptible for complications secondary to cancer treatment, as a result of prevalent comorbid illnesses.

In this era of expanding indications and increasing complexity of treatments, healthcare providers are more and more conscious of the need for evaluating the processes and outcomes of the care they provide. These developments are accelerated by the fact that doctors are progressively confronted with payers and policy makers demanding information that should enable them to allocate resources towards cost-efficient providers with the best outcomes. Patients, nowadays increasingly organized in- and represented by- patient associations, also call for information concerning safety and effectiveness of treatments in different hospitals.

COMPARING HOSPITALS

With the growing societal demand for quality information on healthcare providers, the lay press increasingly publishes reports on presumed quality of health care of providers. For instance, in the Netherlands, everyone is familiar with the league tables provided each year by some journals (Elsevier's best hospitals, AD hospital top 100). Focusing on outcome, the hospital standardized mortality rate (HSMR) is calculated annually. In 2014, it became mandatory for Dutch hospitals to publish their HSMR. The HSMR comprises of an average mortality in-hospital rate from 50 main diagnoses. These

rates are merged into one hospital-wide mortality rate, adjusted for secondary diagnosis codes. A problem with this method is that secondary diagnosis codes are insufficient for a comprehensive and reliable risk adjustment, as they do not allow procedure-specific risk-adjustment[1]. Moreover, the mortality rate itself is an average hospital-wide mortality rate, and not procedure- or diagnosis specific. HSMRs are often displayed as simple rankings, which are unsubtle and arguably unreliable[2].

Both the lay press league tables as well as the HSMR lack face validity for doctors[3,4].

This lack of face validity with doctors is important, because without it, it is less likely to result in actual improvement of quality of care. Recent studies from the Netherlands show that patients so far aren't using available quality information for choosing a hospital[5,6].

MEASURING QUALITY OF CARE

Measuring quality of care classically comprises three overlapping aspects; structure (the environment in which the provision of care takes place), process, and outcomes. This triad is referred to as the 'Donabedian paradigm'[7]. Measuring quality of care information in a comprehensive manner, and feeding this back to the participating healthcare providers can enhance the quality of delivered care[8].

In 2010 and 2011, the Boston Consulting Group published two reports elaborating on a comparison between the Dutch and Swedish healthcare systems[9,10]. The main conclusion was that the quality of care is generally high in the Netherlands, but that costs can be reduced and outcomes improved when compared to Sweden. The main recommendation was to initiate nationwide clinical registries,

with a focus on generation of meaningful outcome indicators, which is common practice in Sweden for years.

Dutch Surgical Colorectal Audit

Initiated by the Association of Surgeons of the Netherlands, the Dutch Surgical Colorectal Audit (DSCA) started in 2009 as a nationwide quality improvement program auditing the surgical treatment of patients with primary colorectal cancer in the Netherlands. One of the main focus points of this initiative is reduction of adverse event rates. Colorectal cancer surgery was considered a logical starting point: colorectal surgery accounts for a disproportionate share of morbidity, mortality and excess length of stay among all general surgical procedures. It accounts for roughly a quarter of all adverse events in general surgery[11].

In contrast to other initiatives and registrations, the DSCA is characterized as doctor-driven with a high face-validity among surgeons. This is important, as it assures a high participation rate, case-ascertainment and accuracy of data, as well as a smooth implementation of improvement projects once targets for improvement have been signalled. A main feature is a quick feedback loop to the participating surgeons, enabling quality assurance and improvement. This is done through web-based feedback of outcomes with the national average as a benchmark to participating clinics[12]. Importantly, the audit was designed to capture many patient- and disease related risk factors that may add to hospital variation in outcomes when they would be unevenly distributed among hospitals[13]. Where possible, outcomes are adjusted for these factors so comparisons are as fair as possible. Accumulative evidence shows the benefits of such a program[8]. A well-known example of improvement through measurement and feedback is from Canada: in 1999, pancreatic cancer surgery was centralized in two Canadian provinces. In Quebec, the regionalization was ac-

companied by an audit cycle, feeding back mortality data to hospitals, whereas Ontario did not have an additional audit program. As a result, mortality decreased dramatically in Quebec (from 10 to 2%) but remained constant in Ontario[14]. Similarly, the American National Quality Improvement Project (NSQIP) is a large-scale clinical registry that provides feedback of outcomes to participating hospitals. Initiated in Veteran's Affairs hospitals and later adopted by the American College of Surgeons, the project has led to a significant decrease in postoperative adverse events[15,16].

In the DSCA improvement cycle, a team of experts led by the Association of Surgeons of the Netherlands helps clinics with morbidity or mortality rates that are significantly higher than the national average ('outlier hospitals') to initiate targeted improvement projects. Already after a few years of auditing, the first improvements in terms of higher standards and reduced variation in guideline adherence, as well as a reduction in the number of adverse outcomes are becoming apparent[12]. After the example of the DSCA, various (surgical) clinical audits were initiated in the Netherlands: the Dutch Upper GI Cancer Audit (DUCA; 2011), the NABON Breast Cancer Audit (NBCA, 2011) and the Dutch Lung Surgery Audit (DLSA, 2012). Quite recently, this number has increased even more. After Swedish example, the Association of Surgeons of the Netherlands has set the goal to make outcomes of the audits publicly available. To reach this goal, a process in which outcomes of the audits will become publicly available in a stepwise fashion throughout the years was initiated.

OUTCOMES RESEARCH

In programs like these audits, determining outcomes that measure and represent actual quality of care remains challenging and depends

on the condition of interest and the patient population. In surgical oncology, outcomes can be roughly divided into 'achieving goal', i.e. performing a resection with tumor-free margins and harvesting enough lymph nodes; and 'avoiding adverse events' on the other hand. With a good performance on both aspects, the ultimate goal of long-term survival and quality of life can be pursued. Quality of care for procedures that are relatively high-risk, as is the case with surgery for cancer of the digestive tract, is often assessed using adverse event outcome measures such as morbidity or mortality rates.

In order to identify good and bad performers, outcomes reflecting hospital performance must be investigated. The specific value or usability of such outcome indicators is not always clear. Outcome indicators should represent meaningful differences between caregivers. This thesis, focusing on clinical adverse event outcomes associated with surgical oncological procedures, should be seen in the light of the recent developments around the Dutch nationwide outcome registries. The studies contribute to the knowledge about the meaning of, and interaction between certain clinical outcome indicators that are used in hospital comparisons. This may contribute to more targeted feedback to hospitals and a better understanding of results from the audits, which is especially important when outcomes become publicly available. Moreover, these studies add to the knowledge concerning risk factors and outcomes, which may aid in directing improvement efforts for the care of surgical patients on a national and local level.

HOSPITAL VARIATION

Postoperative mortality

Postoperative mortality is considered a very important outcome in major oncological surgical procedures like colorectal cancer surgery. It also may be considered one of the most delicate outcomes. Recently, in the United Kingdom, postoperative mortality rates per hospital and per surgeon became publicly available from the internet[17]. This development is laudable from a societal perspective. However, transparency of this kind of information should be well thought of. It is crucial that comparisons of caregivers are reliable as this information may influence the patients' trust and choice, as well as allocation of reimbursements by insurers and certification by policy makers. Unjustly stigmatizing a hospital as having a high mortality rate may have great impact on hospital reputation. Simple mortality league tables that may arise from this data may not be reliable[18,19].

One of the drawbacks of rankings on this measure is that differences between hospitals may be influenced by the fact that hospitals treat patients with different characteristics

(" casemix"), associated with a different a priori risk of mortality (e.g., a hospital treating many elderly patients is likely to have a higher operative mortality rate because of this)[13]. Secondly, chance variation may play an important role. For hospitals with a small number of cases, it is difficult to know whether extremely high or low mortality rates are due to chance or caused by actual differences in quality of care. In this thesis, we showed the importance of adjustment for case-mix as well as statistical reliability adjustment[20] in rankings on postoperative mortality. Moreover, we found that 62% of variation between hospitals in mortality after colorectal cancer resections is due to chance (a 'rankability'[21] of 38%) **[chapter 2]** which can be attributed to a relatively low 'event rate' from a statistical point of view.

This implies that great caution should be used when interpreting hospital rankings on this outcome. Outcomes with a higher event rate may have a higher rankability. Lingsma et al. suggest that rankings are meaningless when rankability is lower than 50%[22]. Should rankings be attempted anyway, we suggest the percentile expected rank (PCER) should be used: the chance that the selected hospital has a better outcome than a randomly selected hospital **[chapter 2]**[23]. This way, the uncertainty concerning the outcome is included in the single percentage ascribed to each hospital. Future work will focus on inclusion of confidence intervals in displaying of ranks and on assessing the possibility to predict a hospital' s future rank based on previous years. The rankability of other outcomes should be determined.

Moreover, in the context of outcome indicators becoming public, it should be investigated whether measures like the PCER are comprehensible and usable for the general public.

Anastomotic leakage

The abovementioned study underlines the need for case-mix adjustment in hospital comparisons on postoperative mortality. This is achievable, but it requires a substantial registration effort to collect all possible confounding factors. Hence, it would be valuable to find outcomes that reflect differences in quality of care rather than differences in casemix. One of the most dreadful complications in colorectal surgery is anastomotic leakage[24]. The findings of this thesis suggest that hospital variation in anastomotic leak rates is relatively independent of patient- and tumor characteristics, and may be more related to treatment factors and in-hospital care processes when compared to mortality as an outcome indicator **[chapter 3].** A drawback of using anastomotic leak rates as an outcome indicator is that it is only useful for patients that had a primary anastomosis created.

Reoperation rates

Another often suggested outcome indicator in colorectal surgery is 'unplanned reoperations'. The indicator, a compulsory indicator collected by the Dutch Healthcare Inspectorate, is said to be useful because it discriminates more than mortality rates, especially in elective surgery where mortality rates are lower. It correlates with postoperative surgical complications, a prolonged hospital stay and mortality[25-27]. Not unimportant, it may be relatively easily obtained, for example from financial data or procedure codes. The problem is that most of the abovementioned evidence is based upon studies performed on a patient level. This thesis sought to determine the value of reoperation rates after colorectal cancer resections on a hospital level. It turns out that high reoperation rate outlier institutions (significantly higher rates than average) have similar outcomes as the hospitals with average reoperation rates **[chapter 4]**. The group of hospitals with lower reoperation rates had low mortality rates. Interestingly, when all hospitals are compared on an individual basis, results may be the other way around: high reoperation rates combined with low mortality or vice versa.

Defensive behaviour

Benchmarking hospitals on outcome indicators such as anastomotic leakage or reoperation rates to compare hospital performance may potentially lead to defensive behaviour among surgeons. For instance, surgeons may increasingly decide to construct a defunctioning ileostomy or colostomy proximal to the large bowel anastomosis in order to limit the rate of clinically relevant anastomotic leaks and subsequent reoperations. In the Netherlands, the number of defunctioning stomas after rectal resection with anastomosis has already increased over the last decade to more than 70%[28]. As such a stoma itself causes short-term but also longer-term morbidity for the patient[29,30],

there is increasing evidence that a more critical application of faecal diversion may be warranted. Auditing short-term outcomes such as anastomotic leakage may maintain a certain defensive attitude among surgeons, which may not always be in the interest of patients.

'Reoperation rate' as an outcome indicator has a similar ambiguity. A reoperation is a marker for surgical complications and has, by itself, a high impact on a patient. However, using reoperation rates as an outcome indicator may theoretically raise the threshold for a reoperation in case of a suspected surgical complication- while in fact, a surgical team that recognizes complications early in the process may save patients' lives by adequately performing reoperations. In a publication by Almoudaris et al., hospitals with low mortality rates after upper gastrointestinal cancer surgery were the ones with higher reoperation rates[31].

So, reoperation rates are discriminative but do not tell the whole story when used in isolation **[chapter 4]**. A surgical team with high reoperation rates but a low mortality rate is at least able to rescue a patient with a surgical complication. The same thing applies to analyzing mortality rates in isolation: if mortality rates are low, though come at the cost of very high rates of reoperations, there is probably room for improvement.

Failure to rescue

An outcome indicator that may be of additional value is failure to rescue (FTR): the mortality rate among patients with a severe complication[32]. This outcome indicator reflects the ability of a surgical team to *manage* postoperative complications once they have occurred. This thesis explored the applicability of FTR as an outcome measure, finding a wide variation between hospitals **[chapter 5]**. Hospitals with high mortality rates will intuitively have higher complication rates. Although rates of severe complications differed between low- and

high-mortality hospitals, this difference was too small to explain the large difference in mortality. Instead, high- and low-mortality hospitals were distinguished by high and low FTR rates: their ability to treat and save patients with severe complications. These findings are consistent with recent international literature[33-35]. Hence, an important area for improvement of mortality rates may be found in early detection and aggressive treatment of postoperative complications.

So, FTR reflects processes in the perioperative care. It may explain why some teams or centers are able to prevent serious complications to lead to mortality. The rationale of using FTR is to help institutions understand and prevent this. Intuitively, using FTR as an outcome indicator would remove any hesitations to reintervene in case of a complication, as a successful reoperation will merely lower FTR rates. A limitation of this outcome indicator is that event rates are relatively low, as is the denominator: only complicated cases are used for calculation. This may increase chance variation and lower the strength of statistical modelling (and thus risk adjustment) in smaller datasets.

HOSPITAL CHARACTERISTICS AND OUTCOMES

Surgical teams differ in their ability to save patient's lives once complications occur. Why do FTR rates differ? Identification of the processes that account for superior results remains challenging[36]. Therefore, some argue to focus on exploring which hospital characteristics are associated with better outcomes. For instance, it has been suggested that a higher caseload per hospital is associated with lower FTR rates[37]. Similarly, in Anglo-Saxon literature, university hospitals or teaching hospitals have been described to have lower FTR rates than non-teaching hospitals[38], which may very well be related

to intensive care (ICU) characteristics. We found that in unadjusted analysis, a case volume of >200 patients/year, teaching status and higher level of ICU facilities were all associated with favorable FTR rates after colorectal cancer resection **[chapter 6].** After adjustment for each other, as well as for other confounders, only a higher level of ICU facilities remained significantly associated with better FTR rates. A beneficial effect of a higher standard of ICU care on FTR rates is in keeping with the fact that ICU treatment is an essential element of postoperative care in high risk patients: 15% of all patients undergoing elective colorectal cancer surgery receive ICU treatment postoperatively[39]. This rate is probably even higher in patients undergoing surgery in an urgent setting. In the Netherlands, standards of ICU care have traditionally been divided into three levels. A level 3 ICU is the highest level, comprising of a closed format ICU, with highest number of beds (12 minumum), nurses per bed, number of ventilator days per year, among other quality standards. On an ICU level 1, responsibility for the patient is not necessarily transferred to an intensivist, an intensivist is not exclusively available 24 hours a day, has less beds (6 minimum) and no minimum of ventilator days per year. A level 2 ICU is a closed format ICU with lower minimum standards of ventilator days, treatment days per year compared to a level 3 ICU[40].

In the study in **chapter 6**, levels 2 and 3 had a similar beneficial odds ratio for FTR when compared to level 1. A main difference between the levels is the 24-hour availability of an intensivist in levels 2/3. In the upcoming revised Dutch national ICU guidelines, the level classification is abolished and 24-hour intensivist staffing becomes a standard element of ICU care. Of note, this research focusing on hospital characteristics, aims to identify possible mechanisms behind differences in outcomes between hospitals. From **[chapter 6]** it follows that one of the possible factors may be a difference in standard of ICU

care. These differences in ICU level may reflect differences in clinical processes and resources, and further research in 'best practices' as well as the lesser performing centers should be aimed at unraveling the processes leading to better or worse outcomes. Combining data from the national Intensive Care registration (NICE) with DSCA data may be a valuable first step in this process.

Centralization

There is no consensus for concentration of care for common oncological procedures like colorectal cancer surgery[41,42]. A Cochrane review showed a volume-outcome relationship in colorectal cancer surgery, but not between postoperative mortality and hospital volume[43]. The review acknowledges that results vary per country or region. In a recent Dutch publication, no differences in mortality were seen between high- and low volume hospitals performing colon cancer surgery[44]. The absence of association between hospital volume and FTR in this thesis **[chapter 6]** is in line with this study.

In contrast, the volume-outcome relationship is more convincing for high-complex low-volume procedures like pancreatic or upper gastrointestinal cancer surgery[45]. In esophageal cancer surgery, there is compelling evidence that patients have better short- and long-term outcomes when operated in a hospital with a high annual caseload of esophagectomies, including some evidence from Dutch studies[46,47,48]. Therefore, around the world there is a growing consensus to centralize esophageal cancer surgery to high-volume centers. However, many different definitions of a 'high-volume hospital' are proposed in the recent literature, ranging from more than 5 to more than 86 esophageal cancer resections annually[45,46,49-75]. No research was done to define to what extent the volume-outcome relationship remains. Consequently, minimum volume standards for esophagectomies vary per country or region[76-78]. The current Dutch minimum

volume standard, set arbitrarily in 2007, is 20 esophageal cancer resections per hospital per year[79]. From **chapter 7** it follows that further centralization of esophagectomies may lead to a decrease in postoperative mortality and survival. Better outcomes in hospitals with a higher hospital volume may be a reflection of a variety of factors in the process of care, such as an integrated multidisciplinary approach, improved patient selection, and protocols; as well as superior resources.

In contrast to the well-established relationship between hospital volume and postoperative mortality, this association is less established in colorectal cancer surgery. In a meta-analysis by van Gijn et al., non-significant results were found in both rectal cancer surgery and colon cancer surgery, although the result became significant in favor of high-volume hospitals with exclusion of the study that did not adjust for confounders[42]. This excluded study was the only Dutch study in the analysis. Of note, the relationship between hospital volume and longer-term survival was in fact significantly in favor of high volume.

An original study from the Netherlands also did demonstrate no relationship between volume and postoperative mortality in colon cancer surgery[44]. This notable difference between Upper GI cancer surgery and colorectal cancer surgery remains subject of speculation. A factor may be that esophagectomy and gastric tube reconstruction is perhaps technically more challenging and a physically more demanding procedure for the patient compared to a segmental colectomy. As (surgically treatable) esophageal cancer is far less common than colon cancer, treatment in a high-volume would then be more important for esophageal cancer patients compared to colon cancer patients. Contradicting this theory is that postoperative mortality rates after colectomies in the Netherlands are comparable to those of esophagectomies. Perhaps case volume is less an issue in colorectal

cancer surgery, but when compared to esophageal cancer surgery, dedication of the team to this type of surgery may be. In esophageal cancer, a high degree of dedication came along with the introduction of the minimum volume standards. Perhaps the introduction of the DSCA reflects an increasing awareness in the field of colorectal cancer surgery that more dedication with multidisciplinary teams, enhanced perioperative care protocols and a smoother run-through time from diagnosis to surgery- thereby avoiding surgery in the urgent setting- is the way to go in order to further improve outcomes for colorectal cancer patients. Moreover, a drawback of using case volume as a proxy for quality of care is that nothing can be learnt from it[80,81]. In both esophageal cancer surgery and colorectal cancer surgery, in order to reduce morbidity and mortality, it is important to understand the mechanisms behind the development of complications and the way they lead to fatal outcomes. Nationwide audits have the potential to indicate areas for improvement, enabling surgical teams to move forward.

Outcome based referral

Nonetheless, in upper GI cancer surgery in the Netherlands, the centralization- and thereby case-volume- discussion continues. Patient advocates and some opinion leaders plea for further centralization; some go as far as advocating centralization towards a maximum of 5-7 upper GI cancer centers, like is the case in Denmark.

Hospital volume and other structural factors reflect a certain environment in which the chance that caregivers can achieve optimal results for their patients is high. Maintaining a minimum volume standard is therefore likely to be beneficial for the outcomes of the whole group of patients. However, hospitals with less favorable characteristics or lower annual caseloads may achieve excellent results with a similar approach and environment. Moreover, pure

volume-based referral carries the risk that high volume hospitals with unfavorable outcomes are selected as referral centers[45,76]. In contrast to volume-based referral, outcome-based referral can avoid this problem by selecting hospitals as referral centers based on their outcomes. As an example, postoperative mortality after esophagectomy dropped from 11.6% to 3.1% in the western part of the Netherlands after the region started to selectively refer patients to the three best performing hospitals in the region instead of the original 11 hospitals[82]. The additional benefit of feedback besides pure volume based centralization was illustrated in the centralization process of pancreatic cancer surgery in Canada, with mortality decreasing in the province in which outcomes were monitored; and mortality remaining constant in Ontario, where only volume-based centralization took place[14].

Identification of centers of excellence, which should become the referral centers, requires valid, reliable, complete, and adequate risk-adjusted registration of outcomes through audits. Auditing of upper gastrointestinal cancer surgery treatment is for example performed in the ACS-NSQIP[83] in the US, and various similar projects for upper gastrointestinal cancer run in Europe on a national level in Denmark[84], Sweden, United Kingdom and the Netherlands. An additional effect in improvement of outcomes may be expected from such audits, which provide insight in care patterns and allows surgical teams to benchmark their outcomes[85]. Further quality improvement through centralization may come at the cost of increased waiting times which are already a problem for patients undergoing esophageal surgery in the Netherlands, with the median waiting time between diagnosis and treatment for resectable esophageal cancer being 6 weeks[86]. It is a challenge for the Dutch hospital system to rearrange referral and care patterns on a relatively short notice in this dynamic field.

Patients at risk

In order to reduce morbidity and mortality, it is important to understand the mechanisms behind the development of complications and the way they lead to fatal outcomes. Besides enabling individual hospitals to improve care through benchmarking of outcomes, audits help with identification of areas for improvement, enabling surgeons nationwide to move forward. From the DSCA for example, it became evident that elderly patients undergoing colon cancer surgery in an emergency setting for colonic obstruction or tumor perforation have a risk of postoperative mortality as high as 41%[87]. Fortunately, the majority of patients are operated in an elective setting; but also elective colorectal cancer surgery is not without risks[11].

In a detailed analysis of patients undergoing colon cancer resections, we found lower anastomotic leak rates in patients undergoing left-sided resection compared to right sided colectomies. However, the risk of dying when a leak has occurred is twice as high following a right-sided leak **[chapter 8].** Additionally, in this thesis, a further investigation into the differences in postoperative events between patients undergoing rectal and colonic resections was performed. Even though severe postoperative complications occured more often in rectal cancer patients than in colon cancer patients, the chance of dying secondary to a severe complication is twice as high in the latter group **[chapter 9].** Part of the explanation for this is the fact that colon cancer patients are on average four years older and have more comorbidity, though adjusted for these factors the difference remained.

Importantly, non-surgical complications such as cardiac and pulmonary events appear to have a great impact on mortality. Friese et al. described mortality rates and their relation with complications in 25,957 patients that underwent a surgical resection for colorectal- and other types of cancer[88]. Mortality was most frequently secondary

to respiratory compromise (37% of postoperative mortality) and pneumonia (26%). Surgical complications may start a chain of non-surgical adverse events, leading to quick clinical deterioration of patients. Failure to rescue rates increased drastically with the number of postoperative complications **[chapter 9].** It seems that a further reduction in mortality may come from prevention of, and aggressive treatment of cardiopulmonary complications and non-surgical infections besides the already intuitive vigilance for anastomotic leak. Fuchshuber et al. describe how a hospital drastically decreased the number of patients on a ventilator for >48 hours, and achieved a zero postoperative pneumonia rate in patients undergoing thoracoabdominal surgery during seven months by strictly adhering to a few perioperative steps[89]. Similar achievements have been published about reducing the number of acute bloodstream infections related to central venous catheters[90].

Perioperative care

Unraveling the mechanisms leading to complications and mortality as well as perioperative care processes associated with best practice should be investigated in-depth and shared in order to initiate improvement widely.

Adequate patient selection and preoperative optimization of the patient's condition may be an important step. Carlisle et al. analyzed the effect of a specialized, anesthesiologist-led preoperative high-risk clinic in colorectal cancer patients[91]. The introduction of this high-risk clinic led to a drastic improvement of 1-year mortality in patients that were older and had more comorbidity. The authors emphasize that part of the success may be explained by the higher percentage of patients with planned ICU admissions postoperatively.

Furthermore, factors associated with timely recognition of complications should be explored[92]. Higher nurse-to-patient ratios, associ-

ated with lower FTR rates, may be related to this[93]. Although some patient-related risk factors for anastomotic leak were identified **[chapter 8]**, for the individual patient the exact mechanism leading to the development of leakage is mostly unknown. As the clinical assessment by the surgeon is of low predictive value for leakage[94], different algorithms to detect anastomotic leakage have been developed for left-sided large bowel anastomoses[95-97]. These algorithms may aid in standardized postoperative monitoring of patients and in selecting patients for defunctioning stoma creation at the end of the procedure. As this thesis underlines the higher risk of mortality associated with right-sided leakage, future studies should focus on further evaluation of these leakage scores in right-sided colectomies.

Also, less specific clinical scoring systems such as the early warning score (EWS) may improve clinical detection of postoperative complications[98]. Furthermore, measuring the C-reactive protein on postoperative day 4 has a pooled negative predictive value of 89% for predicting postoperative infectious complications after colorectal surgery, allowing safe discharge of patients not at risk[24].

Further in-depth studies in high and low performing centers concerning factors reflecting differences concerning in-hospital processes should be performed. This is probably a complex interaction between many factors e.g. the daily ward rounds, responsibility for the ward patients, staffing outside office hours, vital sign collection and reporting, the level of experience in a surgical team, team communication, guideline adherence and quality of care from nurses.

The apparently large burden of non-surgical complications may be sought in improvement of intra-operative factors such as intra-operative volume load, hypotension, ventilator techniques, blood loss, and duration of surgery. So far, the clinical audits contain little intra-operative factors but linking postoperative outcomes to intra-operative data may reveal new opportunities for improvement.

Secondly, hospital differences in FTR rates may be sought in differences in delay until the start of treatment of a complication. For instance, early reintervention for a surgical complication may prevent clinical deterioration and death. Alves et al. found lower mortality after reoperations performed before postoperative day five, although this difference was not significant[99]. Almoudaris et al. did not find a difference in time interval to reoperation between low- and high-mortality hospitals but the median day of reoperation was late, being posotoperative day 8 in both groups[34]. Ideally, improvement of (surgical) FTR rates would not imply higher reoperation rates, but earlier reoperations. However, slightly higher reoperation rates in order to prevent postoperative mortality secondary to surgical complications may prove acceptable.

The presence of rapid response teams[100] in a hospital may influence failure to rescue after colorectal surgery and should be investigated in this context.

With identification of specific care processes that account for differences in hospital FTR rates, local and national quality improvement initiatives can aim at reducing postoperative mortality by addressing the most important factors in the postoperative care process.

MOVING FORWARD

The introduction of the DSCA reflects a change in mind-set among colorectal surgeons in the Netherlands, characterized by – more than ever- increasing efforts to learn, to improve and to share in order to assure quality throughout the field. Already, within a few years after initiation, it has brought many improvements in the outcomes of surgical care for colorectal cancer patients[12], and continues to do so. In other gastrointestinal tumours, much attention still goes to case

volume, which historically has brought along many improvements. However, in order to take the next step in quality improvement, a change in paradigm- from volume-based to outcome-based quality assurance- is essential. Focus on 'best practice' should play a pivotal role.

Following the DSCA, clinical audits have been introduced in, among others, the fields of gastro-oesophageal and pancreatic cancer, aiming at further improving outcomes of care for these patients.

Selecting outcomes

This thesis has explored outcome indicators concerning adverse events. We showed that these outcomes, when used in isolation, do not entirely reflect quality of care (for instance, when assessing anastomotic leakage rates, stoma rates should not be ignored **[chapter 3]**). Moreover, indicators like surgical resection margins or lymph node yield are important predictors for long term survival but do not necessarily correlate with clinical outcomes[101]. Therefore, summarizing measures for outcome indicators, representing the number of patients in which all desired (short-term) goals are achieved may better reflect quality of surgical care. Kolfschoten et al. found that only half of colorectal cancer patients have a so-called ' textbook outcome' (hospital survival, radical resection, no reintervention, no ostomy, no adverse event, hospital stay <14 days) with a marked hospital variation. A quality measure like this may be an impetus for improvement on all separate components of the indicator.

Finally, medium term outcomes (90 days, 1 year) instead of the traditional in-hospital or 30-day outcomes may improve sensitivity for adverse events[102-105]. As medium-term events are less likely to be directly surgery-related[106], their use in clinical audits should be further explored.

Patient preferences

Ultimately, with transparency of outcomes comes the possibility for patients to use outcome information for selecting the hospital of choice for a certain treatment. So far there is little evidence that patients actually use such information. A survey among Dutch surgical patients revealed that quality information is not often used for choosing a hospital. Most mentioned reasons were 'hospital reputation', ' friendly atmosphere' and 'ease of access by (public) transportation'[6]. Only 3% of patients had used quality information. In another study, it was shown that even patients who had actively compared quality information of hospitals, mostly relied on their own and other peoples' experiences[5]. For future reference, patients most often (52%) would prefer a summary measure (textbook outcome) over more detailed, procedure-specific outcome measures[6].

The Dutch clinical audits bring together all stakeholders, including patients, doctors and payers in order to facilitate all with meaningful information. Importantly, this includes patient-related outcome measurements (PROMS). The DSCA is currently running a pilot project involving patients reporting their (functional) outcomes. With definitive incorporation of PROMS, a big step will be taken in participation of patients in monitoring quality of care, with potentially meaningful information for patients being generated.

CONCLUSIONS

The recent introduction of clinical audits in the Netherlands has already brought many improvements in the field of surgical oncology, reflecting the beginning of a new era of quality measurement and improvement. With tangible results after the first few years, they are promising tools for further nationwide quality improvement. With

consolidation of their role in quality policy of individual hospitals and the Association of Surgeons of the Netherlands, and increasing participation of patients and other stakeholders, further refinement of outcome measures is warranted.

This thesis explored the value of clinical outcome indicators in gastrointestinal cancer surgery on a hospital level. Interactions between outcome indicators are complex and measuring single outcomes in isolation do not seem to adequately reflect quality of care as related areas remain underexposed.

Rankings are not suitable for displaying hospital postoperative mortality rates in colorectal cancer surgery. Ranking caregivers on outcomes should only be done when rankability is high. Adjustments for casemix and reliability (sample size) should be made and preferably, rankings should be displayed as PCERs as this takes into account the uncertainty of the rank. The rankability of other outcomes should be explored. Measuring and comparing certain outcomes such as anastomotic leakage or reoperations between surgical teams may induce defensive behaviour, which is not always in the patient's interest. The indicator 'failure to rescue' is an interesting outcome measure that reflects the ability of a surgical team to detect and treat complications, thereby keeping patients alive. Identification of related hospital characteristics like procedural volume or level of ICU facilities, as well as identification of patient groups at risk may aid in further understanding the mechanisms leading to adverse events. Guided by clinical data, further in-depth research should focus on the differences in the perioperative care process between hospitals, accounting for superior results in some hospitals and suboptimal outcomes in others, ultimately leading identification and sharing of 'best practice' and improvements throughout the field.

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