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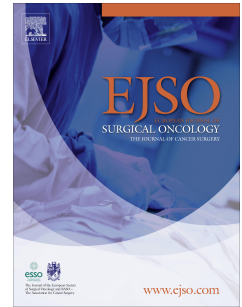
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The Quality of Cancer Care Initiative in the Netherlands

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On behalf of the 'Quality of cancer care' task force of the Signalling Committee Cancer of the Dutch Cancer Society (the committees full report is available on www.kwfkankerbestrijding.nl)

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Abstract

Background: In 2007 the Dutch Cancer Society formed a 'Quality of Cancer Care' taskforce comprising medical specialists, from all disciplines involved in the care for cancer patients. This taskforce was charged with the evaluation of quality of cancer care in the Netherlands and the development of strategies for improvement.

Objective: The experts first focused on the relation between procedural volume and patient outcome and later aimed to identify other factors associated with high and low quality of the care provided in different regions and (types of) hospitals in the Netherlands. The question if cancer care in the Netherlands could be organized differently to assure high quality of care for all patients, was the main subject of investigation.

Methods: An extensive review of the literature on infrastructure, volume and specialization on the one hand and outcome on the other was performed. In addition, a meta-analysis of the volume-outcome relationship for pancreatectomies, bladder, lung, colorectal and breast cancer resections was performed. Finally, variation in quality of cancer care between regions, groups of hospitals and individual hospitals in our country was investigated on data from the Netherlands Cancer Registry.

Results: In the Netherlands quality of care varies by hospital and region. These differences are not limited to surgical procedures and postoperative mortality, but are also demonstrated in other parts of the care process. Differences are only partly explained by differences in infrastructure, procedural volume and specialization between hospitals. Essential information on differences in case mix between these hospitals are lacking from the Netherlands Cancer Registry. More detailed clinical data are needed to reveal the mechanisms behind the differences in quality of care between Dutch hospitals.

Conclusion: On a population level, there is potential for improvement of outcome for cancer patients in the Netherlands by reducing variation in optimal treatment rates between hospitals. Not only treatment of tumours with a low incidence but also other complex or high risk cancer procedures should be provided in a specialized setting, with the right infrastructure, sufficient volume and adequate expertise. In addition, outcomes should be monitored continuously and fed back to individual caregivers.

Introduction

In most European countries quality of care is high on the political agenda. Especially in cancer care future developments force us to re-evaluate the way care is provided for our patients. First the number of cancer patients is rising and will continue to do so. Second, the relative part of elderly cancer patients, with an increased risk of treatment related morbidity and mortality will rise. Moreover, care processes, including diagnostic procedures, multidisciplinary decision making and combined modality treatments, are becoming more and more complex, demanding more specific knowledge, expertise and infrastructure in institutions providing cancer care.

Simultaneously, there is a growing concern about the quality and safety of health care: it harms too frequently and routinely fails to deliver the desired benefits(1). A plethora of articles on variation in quality of care delivered by different types of hospitals, has contributed to the concern that the care delivered is not always, the care that should be received (2-4).

Authorities as well as the public demand more accountability and transparency in the quality of the care provided. In many countries quality indicators are developed to gain insight in differences in quality of care between institutions. Unfortunately, few quality indicators are validated; have proven their capacity to discriminate between high and low quality of care.

In the Netherlands, under the supervision of the Signaling Committee of the Dutch Cancer Society a 'Quality of Cancer Care' taskforce was formed in 2007, comprising medical specialists, from all disciplines involved in the care for cancer patients, who had expertise in quality of care improvement projects. This taskforce was charged with the evaluation of quality of cancer care in the Netherlands and the development of strategies for improvement. The experts first focused on the relation between procedural volume and patient outcome and later aimed to identify other factors associated with high and low quality of the care provided in different regions and (types of) hospitals in the Netherlands. The question if cancer care in the Netherlands could be organized differently to assure high quality of care for all patients, was the main subject of investigation.

Survival of cancer patients in the Netherlands

In a European perspective the survival of cancer patients in the Netherlands is favourable for the majority of tumours (5;6). Especially, in head and neck tumors survival is highest in Europe, though in other cancer types, like esophageal, gastro-intestinal, liver, pancreatic and ovarian tumours, outcome is less favourable. In addition, recent Dutch studies show marked variation in outcome between different providers. Surgery for ovarian carcinoma by gynaecologists in the Netherlands proved to have better outcome than by general gynecologists (7). Morbidity and mortality after esophageal and pancreatic resections for cancer in high volume centers showed to be lower than in low volume center (8-10). These studies suggest that outcome of low volume cancer surgery could be improved by concentrating procedures at specialized high-volume providers(11). This is supported by the excellent results in the treatment of head and neck tumours in our country, for which surgery is concentrated in seven specialized centers.

Volume and outcome

Since, Birkmeyer et al published their article on the inverse relationship between hospital volume and mortality after high risk surgical procedures in the New England Journal of Medicine in 2002 (2), there has been a debate about volume and outcome of many cancer procedures in the Netherlands. Despite several publications on excess mortality of patients in who high risk cancer procedures, like esophagectomies and pancreatectomies, were performed in low volume hospitals (12;13), no change in referral patterns was seen during several years (14). Therefore, the Netherlands Health Care Inspectorate intervened and banned esophagectomies from hospitals with a mean annual volume less than 10. Nevertheless, doubts remained about actual improvement in outcome after concentrating these high risk cancer procedures. Selecting future referral centers exclusively on their procedural volume might not lead to actual improvements in outcome on a population level(15). Moreover, the relationship between volume and outcome could not only be limited to high-risk cancer surgery, but be present in several diagnostic and treatment procedures of different parts of the care process for cancer patients.

Therefore, the 'Quality of Cancer Care' taskforce performed an extensive review of the literature on infrastructure, volume and specialization on the one hand and outcome on the

other. Five hundred forty five publications were found and after exclusion of articles on non cancer related subjects and single institution studies 122 articles remained in the study. Most articles reported on surgical procedures, studies investigating other aspects of the care process for cancer patients were found sporadically. Besides, outcome was generally limited to postoperative morbidity and mortality, though some recent studies also report on use of breast conserving therapies, recurrence rates, survival, quality of life and patient satisfaction (16-18). Differences in quality of diagnostic procedures and pathology examinations between providers are certainly underexposed, in literature only a few articles addressing this subject were found (19-25).

For high risk cancer surgery, like esophagectomies, gastrectomies, pancreatectomies, liver resections, lung and bladder resections mortality proved to be significantly lower in high volume compared to low volume hospitals (Table1). In only a few studies survival was used as endpoint, but proved to be significantly related to hospital volume in most of them. Also the relation between surgeon volume and surgeon specialty on the one hand and mortality on the other was shown in several studies. Though, results of volume-outcome studies in colorectal surgery were less evident. Earlier studies have shown that morbidity in rectum resections is higher than in colon resections, though the risk of dying postoperatively is substantially higher in colon resections. Low hospital volume was found to be a predictive factor for mortality in colon (8 out of 9 studies) but not in rectum resections (1 out of 5). Though, in rectum resections 5 out of 5 studies investigating the relationship between hospital volume and morbidity, were positive. Moreover, several studies on surgeon volume and –specialty were positive for mortality, recurrence rates and survival. For ovarian and breast cancer resections more studies investigating survival with high- and low volume providers were found. Differences in outcome were more explicit for surgeon related factors, like surgeon volume and specialty, than for hospital characteristics.

Though literature on the volume - outcome relationship in cancer procedures proved to be extensive, the Dutch 'Quality of Cancer Care' taskforce found several impediments translating these results into policy. First, most studies are observational, using data collected for other purposes than the evaluation of quality of care and were performed in health care systems

essentially different from that in the Netherlands (for example studies on large insurance companies databases in the United States). Second, important case mix adjustments were frequently omitted. Moreover, cut offs between low- and high volume were very heterogeneous, high volume in one study could be low volume in the other. Therefore the risk of selection and publication bias in these studies is substantial. To anticipate on a number of these objections a meta-analysis was performed for a selection of tumour resections: pancreatic, bladder, colorectal, lung and breast cancer resections. Figures 1 and 2 show a summary of the results of the meta-analyses, of which several are published in this same issue of the European Journal of Surgical Oncology. Despite the results of these meta-analyses, the question remained if results from these studies could be extrapolated to the Dutch setting.

Variation in quality of care

To be able to answer the question to what extent variation in quality of cancer care exists between regions, groups of hospitals or individual hospitals in our country, data from the Netherlands Cancer Registry were investigated. In the Netherlands all newly diagnosed malignancies are registered in this nationwide population-based registry. Data are collected from the medical records by specially trained registrars and are coded according to a national manual. Information on patient characteristics, tumour characteristics, treatment, hospital of diagnosis, hospital of treatment and follow-up is recorded. For coding tumour site and morphology the International Classification of Diseases for Oncology (ICD-O) is used(26). Cancers are staged according the TNM classification(27). Quality of the data is high and completeness is estimated to be at least 95%(28;29).

For this study 4 tumour types were selected, based on their risk profile (Table 3). Invasive bladder cancer was selected as a low volume tumour type with a high risk on postoperative morbidity and mortality after bladder resection. Non-small cell lung cancer (NSCLC) as an intermediate volume tumour with a high risk on treatment morbidity and an unfavourable survival. Colorectal cancer is a high volume tumour with a high risk on postoperative morbidity, but a fair survival rate at 5 years. Finally, breast cancer was selected as a high volume tumour, with lower treatment related morbidity and a favourable survival. All patients diagnosed with these tumour types in the years 2001 until 2006 were included in the study. For all tumours

hospitals were grouped according to structural characteristics like diagnostic and procedural volume, academic and / or teaching status, radiotherapy facilities and their region (affiliation with one of the eight Comprehensive Cancer Centres). Aspects of quality of care to be evaluated in the studies were selected from the evidence-based guidelines valid in the study period.

For bladder cancer important differences in outcome between high and low volume hospitals were revealed. The risk of dying after cystectomy in the 44 low volume hospitals (≤ 5 / year) proved more than five times as high as in the 13 high volume hospitals (> 10 /year), respectively 6.4 and 1.2%. In addition, lymph node resections were performed more frequently in academic hospitals compared to hospitals without a teaching status for urologists (OR 2.7, $p<0.001$) and in high volume compared to low volume hospitals (OR 1.52, $p=0.04$). During the period under investigation there was only a small trend in centralization of cystectomies.

Patients with stage I and II NSCLC diagnosed in teaching hospitals for thoracic surgeons (OR 1.49, $p=0.001$) and in hospitals with a diagnostic volume of more than 50/year (OR 1.29, $p=0.001$) had a higher chance of resection of their tumour. Nevertheless, differences in resection rates between individual hospitals were much more distinct, ranging from less than 50 to more than 90%. Similar differences in the use of chemoradiation (radiotherapy combined with chemotherapy) between individual hospitals were seen, without a significant relation with a hospitals radiotherapy facilities.

In colon carcinoma, patients diagnosed in an academic hospital were more likely to have 10 or more lymph nodes evaluated after resection (OR 2.31, $p<0.001$). For patients in hospitals with a volume of more than 100 diagnoses a year the contrary was true (OR 0.69, $p<0.001$). Again, variation on the level of individual hospitals was much more distinct, varying from less than 20% to more than 70% of patients with 10 or more lymph nodes evaluated. Also the proportion of patients younger than 75 years receiving adjuvant chemotherapy for their stage III colon carcinoma varied by hospital, ranging from less than 60 to more than 90%. For rectal carcinoma the proportion of patients younger than 75 years with clinical stage T2/T3-N0/N1-M0 receiving preoperative radiotherapy varied widely on the individual hospital level, from less than 60 to more than 90%.

Despite the sentinel node procedure (SNP) was introduced in the Netherlands in 1996, the percentage of patients with pT1T2 N0 breast cancer receiving primary axillary lymph node dissection (ALND) varied widely on the individual hospital level during the studied period: 2003-2006. In 10 out of 97 Dutch hospitals 10% or less of the patients received an ALND, while in the same period 9 hospitals had a percentage of more than 40. Especially in non-teaching hospitals a large proportion of node-negative breast cancer patients received ALND. The differences between hospitals decreased over time, indicating that more and more surgeons use the SNP method instead of ALND. Nevertheless, investigators were surprised with the differences shown between fast and slow adapting hospitals, in the introduction of an operative technique that decreases morbidity substantially for a large number of breast cancer patients.

Based on the results of these studies in bladder-, lung-, colorectal- and breast cancer, the taskforce concluded that variation in quality of care for cancer patients in the Netherlands varies by hospital and / or region. These differences are not limited to surgical procedures and postoperative mortality, but are also demonstrated in other parts of the care process. Sometimes, the range of variation is disturbingly high. Unfortunately, essential information on differences in case mix between these hospitals are lacking from the Netherlands Cancer Registry. More detailed clinical data are needed to reveal the mechanisms behind the differences in quality of care between Dutch hospitals.

Current strategies for quality improvement

In the Dutch health care system, the choice (and responsibility) to refer a patient needing specialized care to a colleague or hospital with adequate expertise is entirely in the hands of individual medical professionals. During the past 30 years the comprehensive cancer centres (CCCs), non-hospital organizations that serve as platforms for regional and national consultation between professionals, have played an important role in the coherence of cancer care in the Netherlands. Aim of the comprehensive cancer centres is that optimal cancer care is provided to each patient. Main focus groups are caregivers, such as medical specialists and organizations, such as hospitals. In the eighties cancer patients were treated in more than 170 hospitals all over the Netherlands with a wide varying quality. Main emphasis during that period

was the sharing of knowledge and multidisciplinary collaboration within hospitals and within regions. For example, weekly multidisciplinary oncology meetings, in which patient-specific issues regarding diagnosis and treatment can be discussed with regional experts, were organized in every hospital in the Netherlands. In addition, the Netherlands cancer registry was founded to get a better view on the incidence of different types of cancer as well as gaining insight in the quality of care provided. In the nineties several regional instruments were developed to encourage further improvements and diminish differences in provided care, such as regional guidelines and methods of self evaluation. The first decade of the millennium was characterized by increasing national collaboration. For example, regional consensus-based guidelines were replaced by national evidence-based. Besides many regional quality improving initiatives were successfully implemented often with the support of data collected by the cancer registry (www.ikcnet.nl).

Only recently, professional organizations like the Association of Surgical Oncologists of the Netherlands have started to formulate the terms for surgeons to perform specific cancer procedures. Until now, instruments used by professional organizations to improve quality of care were limited to guideline development, educational programs and site-visits. In only 19 of 50 professional guidelines on cancer treatment specific demands regarding infrastructure, procedural volume or referral of patients are mentioned (Table 4). A nationwide outcome registry (medical audit) to reveal differences in treatment patterns and quality of care in individual hospitals has started recently for colorectal cancer in the Dutch Surgical Colorectal Audit. In the first report on data collected on colorectal resections performed in 2009 important information on casemix differences between hospitals in the Netherlands are revealed and several quality issues appealing for improvement, were identified (www.dsca.nl).

Quality assurance, indicators and audits

Knowledge, experience and skills of individual medical specialists (or their teams) providing care for cancer patients might vary in such a way that it leads to variation in outcome. An overwhelming number of evidence-based guidelines were developed in our country to transfer the best available knowledge on cancer care to all physicians treating these patients.

Unfortunately, little is known about the adherence to these guidelines in daily practice and more interestingly: the reasons for non-compliance.

In randomized clinical trials it is recognized that treatment variation could influence the outcome of these trials and therefore should be minimized. Especially when surgery is part of a trial, variability in the skills of participating surgeons leads to irreproducible results. To reduce this variation, surgical quality assurance programs have been added to a number of trials, in which participating surgeons were trained to perform the procedure in an identical way.

However, quality assurance is not necessarily limited to the surgical aspects of treatment, but is a complete set of measures required to achieve a treatment result that meets a certain standard (30). For example, quality assurance was integrated in the Dutch TME trial, in which a new surgical technique was used in rectal cancer resections by all participating surgeons. To train these surgeons workshops, videotapes and instructors supervising the first 5 operations were used. Though, also for radiotherapy exact descriptions of dose, volume, fields and simulation techniques were used and for pathology a strict protocol was dictated, which gave the surgeons immediate feedback on their performance. The surgical quality assurance in this trial proved to be very successful: local recurrence rates were reduced by 50% compared to historical data(31). The association between circumferential resection margin (CRM) involvement and outcome (local recurrence, survival) demonstrated the importance of this parameter in evaluating surgical performance, not only in trials, but also in daily practice(32).

The question is: should adequate quality control on how diagnostic procedures and treatments are performed be an integrated part of daily medical practice? The positive answer to this question is confirmed by national audit programs performed in several Scandinavian countries and the UK. For example, in Norway in the early 1990s, results for rectal cancer surgery were poor, with a 5-year survival of 55% and local recurrence rates of 28%. In addition, there was wide variation between individual hospitals (33). Therefore, the surgical community started training gastrointestinal surgeons and started monitoring the outcome of rectal cancer resections, in which individual results were fed back to the surgeons, case mix adjusted and in comparison to the national average (benchmarking). The results of this Norwegian Rectal

Cancer Registry were remarkable; after 4 years the proportion of TME surgery rose from 78 to 92% and the local recurrence rate dropped from 28 to 7% (34).

These results of outcome registration and casemix adjusted feedback to individual hospitals are not limited to rectal cancer surgery in which a new technique was introduced. A Dutch regional intervention study on oesophageal cancer surgery showed that timely feedback of results to individual hospitals and surgeons led to voluntarily changes in referral patterns in 2 to 3 years time. Marked improvements in mortality and survival were seen(11). Also, the National Surgical Quality Improvement Program (NSQIP) that began more than 20 years ago in the Veterans Affairs hospitals in the United States keeps reporting marked reductions in morbidity and mortality in the hospitals participating (35-37). This is accomplished by a peer-controlled program of continuous and timely feedback of case mix adjusted outcomes of surgical care (38). From these projects, and there are more to mention, we learn that 'mirror-information' works as a catalyst for quality improvement in surgical care.

As mentioned above, in the Netherlands surgical audit programs, like those in the UK, Scandinavian countries and United States have only recently been started by the Association of Surgeons of the Netherlands and only for the surgical treatment of colorectal cancer. These audits are essentially different from the quality indicators that are developed by the Netherlands Health Care Inspectorate and the Ministry of Health. While audits are primarily an instrument for caregivers to improve the care they provide, the primary purpose of quality indicators is the public disclosure of the quality of health care. Unfortunately, quality indicators lack important case mix adjustments and their capacity to discriminate high from low quality of care is seldom proven. Audit programs have the potential to provide patients and payers with valid case mix adjusted quality information, protecting physicians and hospitals from an unjust appraisal of their performance.

International perspective

The first population based colorectal audits were set up in the mid nineties in the Scandinavian countries. More recently, similar colorectal audit initiatives were introduced in the UK, Belgium, the Netherlands, Spain, Germany and Poland. Other European countries started regional initiatives.

Despite all these quality efforts, still considerable differences in survival rates between European countries exist. For instance, 5 year relative survival after colorectal cancer varies between 32% and 64% [eurocare-4]. To reduce those differences and generate the best care for colorectal cancer in the whole of Europe, a deep and broad insight in the results of colorectal cancer treatment is needed in all its nations. The inevitable conclusion is that a European audit registration is needed to ameliorate the treatment of rectal cancer even further and decrease variation in the quality of care.

Urged by these arguments, the European Society of Surgical Oncology (ESSO) initiated an international multidisciplinary outcome-based quality Improvement project: 'European Registration of Cancer Care' (EURECCA). This initiative has been fully embraced by the European Cancer Organization (ECCO). EURECCA's goal is to create a multidisciplinary European registration structure of patient, tumour and treatment characteristics linked to outcome registration (morbidity, mortality, loco-regional control, and survival). The registration will be used for benchmarking and internal feedback among participants and hereby further improvements in quality and efficiency of cancer care. Nine European audits from 11 European countries decided to collaborate closely within the EURECCA project. Together with the European Society for Therapeutic Radiology and Oncologists (ESTRO) and the European Organisation of Research and Treatment of Cancer (EORTC), the project will speed up identification and dissemination of best practice around the continent. Furthermore, countries that don't have surgical audits can be helped in setting up one, making use of the available knowledge and experience. Finally, the size of the pooled project will generate enough statistical power to allow research on patient groups that are usually excluded from clinical trials, such as elderly or patients with much comorbidity. More information about this project can be found on the webpage (www.canceraudit.eu).

Conclusions

In the opinion of the medical professionals participating in the quality of cancer care taskforce of the Dutch Cancer Society, overall quality of care for cancer patients treated in the

Netherlands is high. Nevertheless, there is potential for further improvement of outcome on a population level by reducing variation in optimal treatment rates between hospitals. This opinion is based on an extensive review of the literature and evaluation of the best available data on the performance of individual hospitals in our country. Care processes for the diagnosis and treatment of cancer patients are getting more and more complex, demanding more and more experience, expertise and skills of individual medical specialists and their teams. This should have consequences for the way cancer care is provided in the near future. Not only treatment of tumours with a low incidence but also other complex or high risk cancer procedures should be provided in a specialized setting, with the right infrastructure, sufficient volume and adequate expertise. In addition, outcomes should be monitored continuously and fed back to individual caregivers (and their hospitals) accompanied with actable information to improve quality of care.

The taskforce has the following recommendations to improve quality of cancer care in the Netherlands:

- Essential information on variation in patterns and outcome of cancer care between providers should come available to reduce variation and improve outcome on a population level.
- Research projects aiming to reveal the mechanisms behind variation in quality of care and to identify best practices should be facilitated financially.
- Concentration of complex cancer care is necessary and should be based on criteria concerning infrastructure, procedural volume, specific expertise and the outcomes of the care provided.
- Professional organisations should take their responsibility to make adequate evaluation of the care provided by their members possible.
- Valid information on (differences in) quality of care should be made available for the public, payers and individual patients,

- Regional and multidisciplinary cooperation and referral of patients for specific cancer treatments between hospitals and physicians should be stimulated.
- Next to monodisciplinary quality initiatives more multidisciplinary collaboration in improving quality of care should be initiated,
- Coordination of multidisciplinary quality initiatives could be provided by the Comprehensive Cancer Centres collaborating in a national organisation.
- Valid case mix adjusted outcome information should be collected in national audit programs and fed back to individual hospitals and physicians continuously.
- Professionals should determine which information is essential to assess the quality of care provided to each patient.
- These 'minimal datasets' should be integrated unambiguously in the Electronic Health Records of each hospital in the Netherlands.
- Long term outcome information (recurrences, survival) can be added to the in-hospital information collected by medical audits by the Netherlands Cancer Registry.
- Next to information on the outcome of the care process in individual hospitals, the evaluation of patient satisfaction is equally important.

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Table 1 Studies on hospital or surgeon volume (HV or SV) and hospital or surgeon specialization (HS or SS).

Tumour procedure	Subject*	Outcome	Result# (significant)	References
Esophageal resections	HV	mortality	15 / 16	(2;10;13;39-51)
		mortality	1 / 1	(52)
		survival	1 / 1	(18)
	SV	mortality	3 / 4	(48;53-55)
		SS	mortality	1 / 1
Stomach resections	HV	mortality	8 / 9	(2;40;44;46;53;57-60)
		survival	1 / 1	(61)
	SV	mortality	3 / 3	(53;57;59)
	SS	mortality	1 / 1	(57)
Pancreatic resections	HV	mortality	17 / 18	(2;8;14;39;40;44;46;50;62-71)
		survival	2 / 2	(62;63)
	SV	mortality	4 / 4	(54;67;69;71)
Liver resections	HV	mortality	12 / 12	(39;42;46;52;63;64;70;72-76)
		survival	0 / 1	(63)
	HS	mortality	1 / 1	(56)
	SS	mortality	1 / 1	(56)
Colonresections	HV	mortality	8 / 9	(2;44;46;57;59;70;77-79)
		morbidity	1 / 2	(78;79)
		survival	2 / 2	(80;81)
	SV	mortality	4 / 4	(57;59;77;82)
		morbidity	1 / 1	(79)
		survival	0 / 1	(83)
	SS	mortality	2 / 2	(57;83)
		morbidity	1 / 1	(82)
	survival	1 / 1	(83)	
Rectumresections	HV	mortality	1 / 4	(78;84-86)
		morbidity	4 / 4	(84;86-88)
		recurrence	1 / 2	(89;90)
		survival	2 / 7	(81;84-86;88-90)
	SV	mortality	0 / 1	(86)
		recurrence	1 / 1	(91)
		survival	2 / 3	(83;86;91)
SS	survival	1 / 1	(83)	
Colorectal resections	HV	mortality	2 / 4	(50;92-94)
		recurrence	1 / 1	(95)
		survival	1 / 2	(95;96)

	SV	mortality	2 / 2	(93;94)
		recurrence	1 / 1	(95)
	SS	survival	1 / 1	(83)
Lung resections	HV	mortality	7 / 8	(2;40;44;50;59;70;97;98)
	HS	survival	1 / 1	(97)
	SV	mortality	2 / 2	(54;59)
	SS	mortality	1 / 1	(99)
Bladder resections	HV	mortality	6 / 6	(2;44;100-103)
	SV	mortality	1 / 2	(54;101)
Kidney resections	HV	mortality	2 / 4	(2;44;102;104)
Prostate resections	HV	mortality	3 / 4	(102;105-107)
		morbidity	3 / 3	(105;107;108)
		adjuvant therapy	1 / 1	(106)
	SV	mortality	0 / 1	(105)
		morbidity	2 / 2	(105;108)
Ovarium resections	HV	mortality	0 / 2	(109;110)
		morbidity	1 / 2	(109;111)
		survival	2 / 3	(110;112;113)
	HS	survival	1 / 2	(7;113)
	SV	mortality	0 / 2	(109;110)
		morbidity	0 / 1	(111)
	SS	survival	2 / 2	(7;114)
Breast resections	HV	survival	4 / 6	(115-120)
		% breast cons.	2 / 2	(16;121)
		mortality	1 / 1	(70)
	SV	survival	5 / 5	(120;122-125)
		% breast cons.	1 / 1	(16)
		recurrence	1 / 1	(122)
	SS	survival	1 / 1	(120)

*HV hospital volume; HS hospital specialization; SV surgeon volume; SS surgeon specialization

Number of studies with significant results versus total number of studies

Table 2 Profile of tumours investigated by the 'Quality of Cancer Care' working party.

Tumour	Number / year	Morbidity	5- year survival
Invasive bladder cancer	1 300 / year	High	33%
Non-small cell lung cancer	6 400 / year	High	15%
Colorectal cancer	10 000 / year	High	59%
Breast cancer	13 000 / year	Low	86%

Data-source: Netherlands Cancer Registry www.kankerregistratie.nl

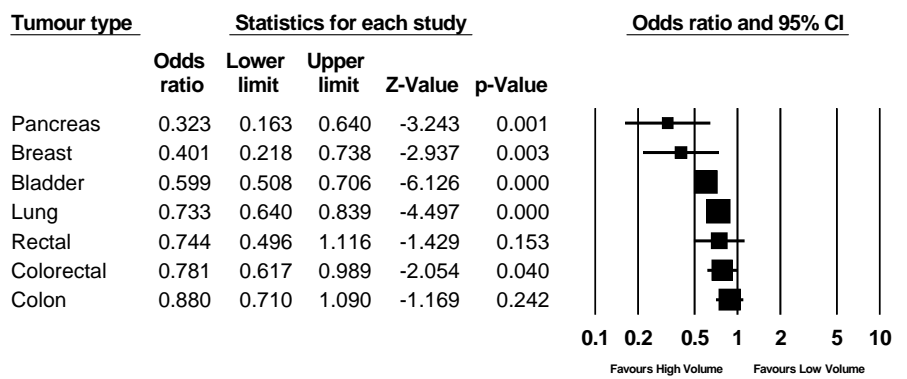
Table 3 Professional guidelines with specific standards on infrastructure, procedural volume, referral of patients or outcome registration.

Guideline	Infrastructure	Volume / referral	Outcome registration
Breast cancer	+	-	-
Colon cancer	-	+	+
Rectal cancer	+	+	+
Bladder cancer	+	-	-
Prostate cancer	+	-	-
Testis cancer	+	+	-
Esophageal cancer	+	+	-
Livermetastases	+	-	-
NSCLC	+	-	-
Pharyngeal cancer	+	-	-
Stomach cancer	+	-	-
Pancreatic cancer	-	+	-
Cervical cancer	+	-	-
Ovarian cancer	+	-	-
Endometrium cancer	+	+	-
Vulva cancer	+	-	-
Vagina cancer	+	+	-
Carcinoid	+	-	-
Leptomeningeal metastases	+	-	-

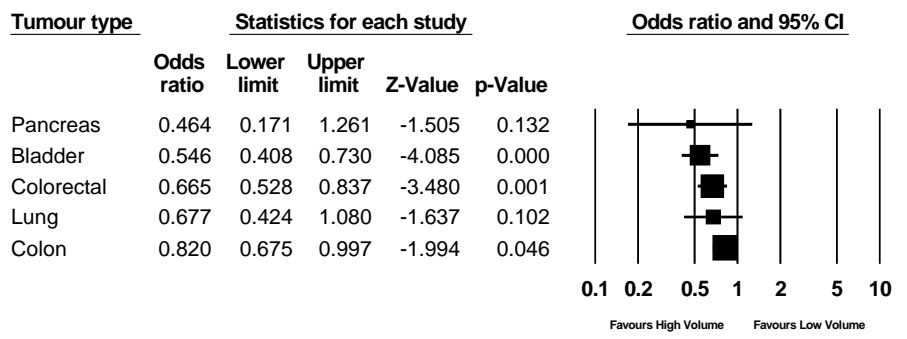
+ mentioned in guideline - not mentioned in guideline

Fig 1 Meta-analyses: odds ratio (OR) plots for postoperative mortality after pancreatic, breast, bladder, lung, and colorectal resections for cancer, in high volume versus low volume hospitals (figure a) and by high versus low volume surgeons (figure b). The center of the square represents the pooled OR and its extremities represent its 95% confidence interval

Random Effects Hospital Mortality

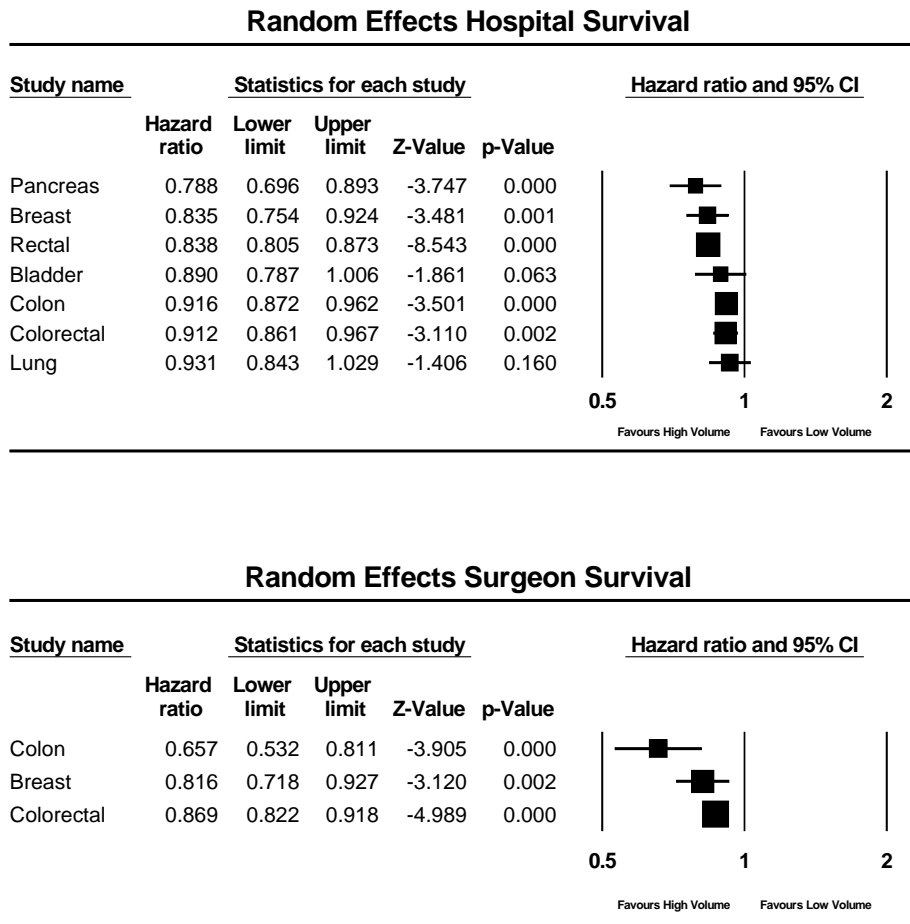


Random Effects Surgeon Mortality



ACC

Fig 2 Meta-analyses: hazard ratio (HR) plots for survival after pancreatic, breast, rectal, bladder, colon and lung resections for cancer, in high volume versus low volume hospitals (figure a) and by high versus low volume surgeons (figure b). The center of the square represents the pooled HR and its extremities represent its 95% confidence interval



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