Original article

Early outcomes from the Dutch Upper Gastrointestinal Cancer Audit

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Background: **In 2011, the Dutch Upper Gastrointestinal Cancer Audit (DUCA) group began nationwide registration of all patients undergoing surgery with the intention of resection for oesophageal or gastric cancer. The aim of this study was to describe the initiation and implementation of this process along with an overview of the results.**

Methods: **The DUCA is part of the Dutch Institute for Clinical Auditing. The audit provides (surgical) teams with reliable, weekly updated, benchmarked information on process and (case mix-adjusted) outcome measures. To accomplish this, a web-based registration was designed, based on a set of predefined quality measures.**

Results: **Between 2011 and 2014, a total of 2786 patients with oesophageal cancer and 1887 with gastric cancer were registered. Case ascertainment approached 100 per cent for patients registered in 2013. The percentage of patients with oesophageal cancer starting treatment within 5 weeks of diagnosis increased significantly over time from 32·5 per cent in 2011 to 41·0 per cent in 2014 ($P < 0·001$). The percentage of patients with a minimum of 15 examined lymph nodes in the resected specimen also increased significantly for both oesophageal cancer (from 50·3 per cent in 2011 to 73·0 per cent in 2014; $P < 0·001$) and gastric cancer (from 47·5 per cent in 2011 to 73·6 per cent in 2014; $P < 0·001$). Postoperative mortality remained stable (around 4·0 per cent) for patients with oesophageal cancer, and decreased for patients with gastric cancer (from 8·0 per cent in 2011 to 4·0 per cent in 2014; $P = 0·031$).**

Conclusion: **Nationwide implementation of the DUCA has been successful. The results indicate a positive trend for various process and outcome measures.**

*Other members of the DUCA group are co-authors of this study and can be found under the heading Collaborators

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Introduction

In the Netherlands, the incidence of oesophageal cancer has increased over the past two decades[1]. At the same time, the incidence of gastric cancer has decreased[2]. As a consequence, the annual number of oesophageal resections for cancer doubled whereas the annual number of gastric resections for cancer decreased[3]. Together with the introduction of a minimum volume standard (per year per hospital) for oesophageal cancer surgery in 2006, this led to centralization for oesophageal, but not gastric, cancer surgery[4]. Within the past 20 years, 5-year survival rates have doubled for patients with oesophageal cancer, but with no improvement for those with gastric cancer[1,2]. The postoperative mortality rate after gastric resection for cancer has remained high compared with that in other European countries[5].

In 2007, the Quality of Cancer Care taskforce of the Dutch Cancer Society evaluated quality of cancer

care in the Netherlands[6]. This taskforce concluded that the overall quality of cancer care was high, but reducing variation between providers could lead to further improvement. Recommendations involved the introduction of multidisciplinary quality standards, and monitoring and benchmarking patient outcomes between providers (*Table S1*, supporting information). The minimum volume standard for oesophageal cancer surgery was set at ten resections per year per hospital in 2006, and 20 resections per year per hospital from 2011. For gastric cancer surgery, a minimum volume of ten resections per year per hospital in 2012, and 20 resections per year per hospital as of 2013, was required. In 2011, the Dutch Upper Gastrointestinal Cancer Audit (DUCA) group began nationwide registration of all patients undergoing surgery with the intention of resection for oesophageal or gastric cancer. The goal was to improve the quality of care by providing (surgical) teams with reliable and benchmarked information on process and (case mix-adjusted) outcome parameters regarding their patients. This information was used to monitor national guideline adherence and patient outcomes.

The aim of this study was to describe the initiation and implementation of the DUCA, and provide an overview of the first results after 4 years of auditing.

Methods

Organization, implementation and funding

The Dutch Institute for Clinical Auditing (DICA) was founded in 2011 with the objective to facilitate and organize the initiation of nationwide audits in a uniform format[7]. In the same year, the DUCA group began nationwide registration of all patients undergoing surgery with the intention of resection for oesophageal or gastric cancer (*Table 1*). The DUCA was initiated by the former Dutch Oesophageal Cancer Group and the Dutch Gastric Cancer Group, nowadays fused into the Dutch Upper Gastrointestinal Cancer Group, and was mandated by the Dutch Association of Surgical Oncologists and the Association of Gastrointestinal Surgeons of the Netherlands. The audit is a surgical registration, initially funded and executed via quality improvement grants donated by the Dutch Associated Health Insurance Companies, Zorgverzekeraars Nederland. Structural funding was later achieved by hospitals paying a subscription fee for participation. These subscription costs were returned to the hospitals as they were enclosed in the reimbursement schemes for treating patients with oesophageal and gastric cancer. All participating hospitals were responsible for data registration and the costs of data registration themselves. Nationwide coverage of the audit was stimulated via the Association of Surgeons of the Netherlands (ASN) and the Health Care Inspectorate, as participation in the DUCA was defined as a mandatory quality standard as of 2012. Participation in the DUCA was also incorporated as a multidisciplinary quality standard defined by the Dutch Federation for Oncological Societies (*Table S1*, supporting information). As healthcare in the Netherlands is based on a public healthcare system, no private institutions are involved in oesophagogastric cancer surgery. Both the ASN and the Health Care Inspectorate ensure that all hospitals participate in this audit.

Quality measures and data set

A directional board and a scientific committee were formed comprising medical professionals in upper gastrointestinal cancer care (surgeons, medical oncologists, gastroenterologists, pathologists and radiation oncologists). Dutch evidence-based guidelines, and information from the Swedish national quality registry and the British National Oesophago-Gastric Cancer Audit (NOGCA) were used to formulate a set of quality measures to compose a data set[8–11].

The items in the registry were grouped in three categories. The first category included items necessary to enable sound and reliable data comparisons between hospitals (case mix variables). This concerned information regarding patient and tumour characteristics (age, BMI, co-morbidities, clinical stage of disease). The second category included items regarding processes of care (different modalities used during the diagnostic process, time interval between diagnosis and start of treatment, evaluation of patients' treatment plans in a multidisciplinary team (MDT) meeting). Clinical and pathological outcomes of surgery were registered in the third category.

Table 1 Dutch Upper Gastrointestinal Cancer Audit inclusion and exclusion criteria

Inclusion criteria	All patients who are undergoing surgery with the intention of a resection, with or without preoperative treatment, for: Primary tumours of the oesophagus, stomach or gastro-oesophageal junction Recurrent tumours of the oesophagus, stomach or gastro-oesophageal junction Prophylactic resection of the oesophagus or stomach (because of high-grade dysplasia or *CDH1* mutation respectively)
Exclusion criteria	Non-epithelial tumours (e.g. gastrointestinal stromal cell tumours) No cancer resection planned

The content of the data set has been evaluated on a yearly basis and items were removed or replaced by others as deemed necessary.

Data entry, storage and privacy

A generic, internet-based program was used to enable data entry to a secure online environment. Hospitals were free to decide who carried out the data registration (for example data managers, nurse practitioners or medical specialists). In all participating hospitals the final responsibility for data entry remained with the surgeon. Detailed descriptions of definitions used in the registry are provided via an information button in the online registry program. DICA has an advisory board to stimulate uniform data registration, and offers support via a help desk and a website (frequently asked questions) regarding data entry and for feedback regarding the registry. This information is also used for yearly evaluation of the registry. The help desk also provides yearly updated case report forms and data dictionaries. Registered data can be updated whenever necessary.

A third trusted party (TTP) is responsible for processing the data, and information regarding patient identification is encrypted directly after data entry. The TTP uses multiple secure and certified data centres throughout the Netherlands for data storage, and adheres to strict security standards required by the medical field and the Dutch law. Anonymized data are provided for quality assurance and research purposes. Participating hospitals maintain ownership of their own data.

Feedback and auditing

A secure online website is used for hospital feedback. The information presented via this website is updated once a week, and all participating hospitals can use it to monitor their own results in relation to the national average. Besides information about patient population, results for all process and (case mix-adjusted) outcome measures are presented using funnel plots with 95 per cent confidence limits that vary in relation to hospital volume[12]. The funnel plots provide information regarding specific process or outcome measures for individual hospitals in relation to the national average and in relation to results of other anonymized hospitals.

Both the Health Care Inspectorate and the ASN use this information on a yearly basis to monitor the quality of surgical care in all participating hospitals, and intervene when results show negative outliers (below or above the 95 per cent confidence interval, depending on the quality measure). A special audit taskforce, appointed by the ASN, visits underperforming hospitals and serves as an advisory board.

Table 2 Patient and tumour characteristics for patients with oesophageal cancer or gastric cancer included in the Dutch Upper Gastrointestinal Cancer Audit (2011–2014)

	Oesophageal cancer ($n = 2786$)	Gastric cancer ($n = 1887$)
Age (years)		
≤ 70	2009 (72·1)	971 (51·5)
> 70	765 (27·5)	913 (48·4)
Unknown	12 (0·4)	3 (0·2)
Sex ratio (M : F)	2156 : 630	1179 : 708
ASA fitness grade		
I–II	2109 (75·7)	1293 (68·5)
≥ III	643 (23·1)	571 (30·3)
Unknown	34 (1·2)	23 (1·2)
BMI (kg/m^2)		
< 20	180 (6·5)	169 (9·0)
20–24	1061 (38·1)	759 (40·2)
25–29	1047 (37·6)	634 (33·6)
≥ 30	452 (16·2)	240 (12·7)
Unknown	46 (1·7)	85 (4·5)
Charlson Co-Morbidity Index score		
0	1399 (50·2)	860 (45·6)
1	706 (25·3)	426 (22·6)
≥ 2	681 (24·4)	601 (31·8)
Clinical tumour stage*		
0 (including T0 N0–2 M0)	12 (0·4)	29 (1·5)
I	380 (13·6)	338 (17·9)
II	661 (23·7)	601 (31·8)
III	1422 (51·0)	162 (8·6)
IV	21 (0·8)	53 (2·8)
Unknown	290 (10·4)	704 (37·3)
Histological type		
Adenocarcinoma	2186 (78·5)	1765 (93·5)
Squamous cell carcinoma	523 (18·8)	2 (0·1)
Other/unknown	77 (2·8)	120 (6·0)
Tumour location†		
Oesophagus, cervical part	5 (0·2)	–
Oesophagus, upper third	27 (1·0)	–
Oesophagus, middle third	313 (11·2)	–
Oesophagus, lower third	1629 (58·5)	–
Gastro-oesophageal junction	787 (28·2)	–
Stomach, fundus	–	162 (8·6)
Stomach, corpus	–	560 (29·7)
Stomach, antrum	–	728 (38·6)
Stomach, pylorus	–	145 (7·7)
Stomach, overlapping lesions	–	108 (5·7)
Gastric stump/anastomosis	–	74 (3·9)
Unknown	25 (0·9)	110 (5·8)

Values in parentheses are percentages. *TNM system (7th edition). †ICD-0 codes.

Verification and validation

For all DICA registries, validation of data entry takes place at two levels. During the registration process, various data fields report a warning or error whenever data are

Table 3 Treatment characteristics for patients with oesophageal cancer or gastric cancer included in the Dutch Upper Gastrointestinal Cancer Audit

	Oesophageal cancer				Gastric cancer			
	2011	2012	2013	2014	2011	2012	2013	2014
Preoperative therapy*	*n* = 550	*n* = 716	*n* = 726	*n* = 781	*n* = 290	*n* = 387	*n* = 526	*n* = 562
None	40 (7·3)	76 (10·6)	77 (10·6)	88 (11·3)	132 (45·5)	165 (42·6)	254 (48·3)	245 (43·6)
Chemotherapy	63 (11·5)	84 (11·7)	57 (7·9)	55 (7·0)	150 (51·7)	204 (52·7)	264 (50·2)	307 (54·6)
Chemoradiotherapy	439 (79·8)	549 (76·7)	586 (80·7)	635 (81·3)	4 (1·4)	9 (2·3)	8 (1·5)	8 (1·4)
Radiotherapy	2 (0·4)	0 (0)	4 (0·6)	1 (0·1)	1 (0·3)	0 (0)	0 (0)	0 (0)
Unknown therapy	4 (0·7)	3 (0·4)	2 (0·3)	2 (0·3)	3 (1·0)	7 (1·8)	0 (0)	1 (0·2)
Unknown	2 (0·4)	4 (0·6)	0 (0)	0 (0)	0 (0)	2 (0·5)	0 (0)	1 (0·2)
Surgery	*n* = 551	*n* = 725	*n* = 728	*n* = 782	*n* = 314	*n* = 420	*n* = 565	*n* = 588
Type of surgery								
Transhiatal oesophagectomy	270 (49·0)	272 (37·5)	249 (34·2)	225 (28·8)	4 (1·3)	3 (0·7)	6 (1·1)	2 (0·3)
Transthoracic oesophagectomy	237 (43·0)	408 (56·3)	428 (58·8)	501 (64·1)	1 (0·3)	5 (1·2)	1 (0·2)	1 (0·2)
Total gastrectomy	7 (1·3)	9 (1·2)	18 (2·5)	21 (2·7)	109 (34·7)	147 (35·0)	207 (36·6)	223 (37·9)
Partial gastrectomy	2 (0·4)	2 (0·3)	1 (0·1)	2 (0·3)	177 (56·4)	211 (50·2)	272 (48·1)	293 (49·8)
No resection	30 (5·4)	29 (4·0)	31 (4·3)	31 (4·0)	20 (6·4)	50 (11·9)	75 (13·3)	59 (10·0)
Other/unknown	5 (0·9)	5 (0·7)	1 (0·1)	2 (0·3)	3 (1·0)	4 (1·0)	4 (0·7)	10 (1·7)
Approach								
Open	378 (68·6)	403 (55·6)	366 (50·3)	275 (35·2)	301 (95·9)	384 (91·4)	416 (73·6)	332 (56·5)
Minimally invasive†	171 (31·0)	320 (44·1)	362 (49·7)	507 (64·8)	13 (4·1)	32 (7·6)	149 (26·4)	255 (43·4)
Unknown	2 (0·4)	2 (0·3)	0 (0)	0 (0)	0 (0)	4 (1·0)	0 (0)	1 (0·2)
Location of anastomosis‡	*n* = 520	*n* = 662	*n* = 695	*n* = 752	*n* = 291	*n* = 370	*n* = 486	*n* = 528
No anastomosis	1 (0·2)	0 (0)	2 (0·3)	5 (0·7)	4 (1·4)	5 (1·4)	4 (0·8)	6 (1·1)
Neck	445 (85·6)	532 (80·4)	461 (66·3)	459 (61·0)	2 (0·7)	4 (1·1)	5 (1·0)	3 (0·6)
Intrathoracic	58 (11·2)	115 (17·4)	201 (28·9)	270 (35·9)	8 (2·7)	25 (6·8)	46 (9·5)	40 (7·6)
Intra-abdominal	7 (1·3)	8 (1·2)	13 (1·9)	7 (0·9)	266 (91·4)	314 (84·9)	412 (84·8)	463 (87·7)
Other/unknown	9 (1·7)	7 (1·1)	18 (2·6)	11 (1·5)	11 (3·8)	22 (5·9)	19 (3·9)	16 (3·0)
Postoperative therapy§	*n* = 520	*n* = 656	*n* = 691	*n* = 749	*n* = 265	*n* = 337	*n* = 463	*n* = 502
None	490 (94·2)	614 (93·6)	653 (94·5)	713 (95·2)	165 (62·3)	201 (59·6)	299 (64·6)	293 (58·4)
Chemotherapy	27 (5·2)	30 (4·6)	20 (2·9)	25 (3·3)	77 (29·1)	98 (29·1)	119 (25·7)	157 (31·3)
Chemoradiotherapy	0 (0·0)	4 (0·6)	11 (1·6)	3 (0·4)	15 (5·7)	28 (8·3)	37 (8·0)	37 (7·4)
Radiotherapy	1 (0·2)	0 (0)	2 (0·3)	1 (0·1)	0 (0)	0 (0)	1 (0·2)	2 (0·4)
Unknown therapy	0 (0)	4 (0·6)	2 (0·3)	3 (0·4)	5 (1·9)	9 (2·7)	6 (1·3)	9 (1·8)
Unknown	2 (0·4)	4 (0·6)	3 (0·4)	4 (0·5)	3 (1·1)	1 (0·3)	1 (0·2)	4 (0·8)

Values in parentheses are percentages. *Patients scheduled for curative resection. †Determined at start of surgical procedure, including conversions (and hybrid procedures for oesophageal cancer). ‡Patients who underwent resection. §Patients who underwent curative resection, determined at time of surgery.

missing or if data seem implausible compared with previously registered information. Each hospital has access to an electronic report, summarizing missing variables and those that are potentially erroneous.

To improve further the reliability of the registered data, an independent team of data managers evaluated the total number of patients registered in 2013, and an in-depth quality investigation was performed on a random data sample.

Completeness of the total number of patients included in the DUCA was also evaluated in a comparison with an external data registration (Netherlands Cancer Registry, NCR), which contains data on all newly diagnosed malignancies in the Netherlands.

Analysis of registered data

A minimum number of items per patient was required in order to consider a patient eligible for analysis. These were: information on tumour location, date of birth, date of surgery, intent of surgery as defined at the end of the operation (potentially curative resection, palliative resection or no resection) and vital status 30 days after surgery and/or at time of discharge.

Patient, tumour and treatment characteristics were described using frequency tables. The number of participating hospitals was analysed for different volume categories. National results for various quality measures are shown for different years of registration, and results are compared using χ^2 tests for trend. For this study, no ethical approval or informed consent was required under Dutch law.

Reporting

Both the directional board and the scientific committee of the DUCA were responsible for presenting results and

Table 4 Results of individual performance indicators for patients with oesophageal cancer or gastric cancer included in the Dutch Upper Gastrointestinal Cancer Audit

	2011	2012	2013	2014	*P*§
Oesophageal cancer					
Process	*n* = 551	*n* = 725	*n* = 728	*n* = 782	
Preoperative MDT meeting	546 (99·1)	720 (99·3)	724 (99·5)	780 (99·7)	0·108
Time from diagnosis to treatment < 5 weeks*	179 (32·5)	226 (31·2)	248 (34·1)	321 (41·0)	< 0·001
Postoperative MDT meeting	503 (91·3)	682 (94·1)	693 (95·2)	762 (97·4)	< 0·001
Preoperative treatment†	508 of 550 (92·4)	636 of 716 (88·8)	649 of 726 (89·4)	693 (88·6)	0·037
Outcome‡	*n* = 511	*n* = 644	*n* = 678	*n* = 738	
≥ 15 lymph nodes in resection specimen	257 (50·3)	390 (60·6)	431 (63·6)	539 (73·0)	< 0·001
Tumour-negative resection margins	470 (92·0)	586 (91·0)	621 (91·6)	701 (95·0)	0·023
Complicated postoperative course	162 (31·7)	180 (27·9)	195 (28·8)	253 (34·3)	0·183
In-hospital/30-day mortality	21 (4·1)	26 (4·0)	31 (4·6)	26 (3·5)	0·684
Gastric cancer					
Process	*n* = 314	*n* = 420	*n* = 565	*n* = 588	
Preoperative MDT meeting	299 (95·2)	411 (97·9)	552 (97·7)	579 (98·5)	0·009
Time from diagnosis to treatment < 5 weeks*	149 (47·4)	186 (44·3)	283 (50·1)	270 (45·9)	0·915
Postoperative MDT meeting	293 (93·3)	397 (94·5)	542 (95·9)	576 (98·0)	< 0·001
Preoperative treatment†	158 of 290 (54·5)	220 of 387 (56·8)	272 of 526 (51·7)	316 of 562 (56·2)	0·917
Outcome‡	*n* = 261	*n* = 334	*n* = 457	*n* = 497	
> 15 lymph nodes in resected specimen	124 (47·5)	197 (59·0)	295 (64·6)	366 (73·6)	< 0·001
Tumour-negative resection margins	216 (82·8)	297 (88·9)	397 (86·9)	437 (87·9)	0·157
Complicated postoperative course	51 (19·5)	71 (21·3)	94 (20·6)	90 (18·1)	0·474
In-hospital/30-day mortality	21 (8·0)	16 (4·8)	21 (4·6)	20 (4·0)	0·031

Values in parentheses are percentages. *Interval between diagnosis and start of neoadjuvant therapy or day of surgery. †Patients scheduled for curative resection. ‡Patients with a primary tumour who underwent potentially curative surgery, as decided by the surgeon at the end of surgery. MDT, multidisciplinary team. §χ^2 test for trend.

defining targets for quality improvement. Annual overall results of the audit were published, facilitated by the scientific bureau of DICA[4,13]. DICA has a methodological board consisting of statisticians and epidemiologists. This advisory board supervises methodology used by DICA registries[7]. As of 2016, clinicians participating in the DUCA can use registered data for research purposes by submitting a research application. Two members of the scientific committee of the DUCA and the scientific bureau of DICA review each application and monitor statistical methods described in these applications.

Transparency

One of the objectives of the DUCA was to improve transparency regarding the quality of (surgical) care for patients with oesophageal or gastric cancer. To accomplish this, individual hospital results for all quality measures were made available for third parties after authorization by the hospital board. For instance, healthcare insurance companies are able use this information in their negotiations with hospitals, and patients receive this information via patient advocacy groups. Transparency is achieved according to a stepwise model, as defined by the ASN: participating in the audit (first year), transparency of process measures (second year) and transparency of outcome measures (third year).

Results

Between January 2011 and December 2014, a total of 2786 patients with oesophageal cancer and 1887 patients with gastric cancer were registered. Case ascertainment for the DUCA in 2013 was estimated at 97·8 per cent of all primary oesophageal cancer resections and 96·2 per cent of all primary gastric cancer resections, as registered in the NCR.

Patient and tumour characteristics are shown in *Table 2*. Patients with gastric cancer were older, and had more co-morbidities as reflected by higher Charlson scores and a higher ASA grade, compared with patients with oesophageal cancer. The clinical tumour stage was not registered completely in 37·3 per cent of the patients with gastric cancer. Patient and tumour characteristics did not change over the years (data not shown).

Treatment

Treatment characteristics are shown in *Table 3* according to the year of registration. The percentage of minimally invasive procedures (at the start of the procedure, including conversions, and hybrid procedures for oesophageal cancer) increased over time for both patients with oesophageal cancer (from 31·0 per cent in 2011 to 64·8 per cent in 2014; $P < 0·001$) and those with gastric cancer (from 4·1 per cent

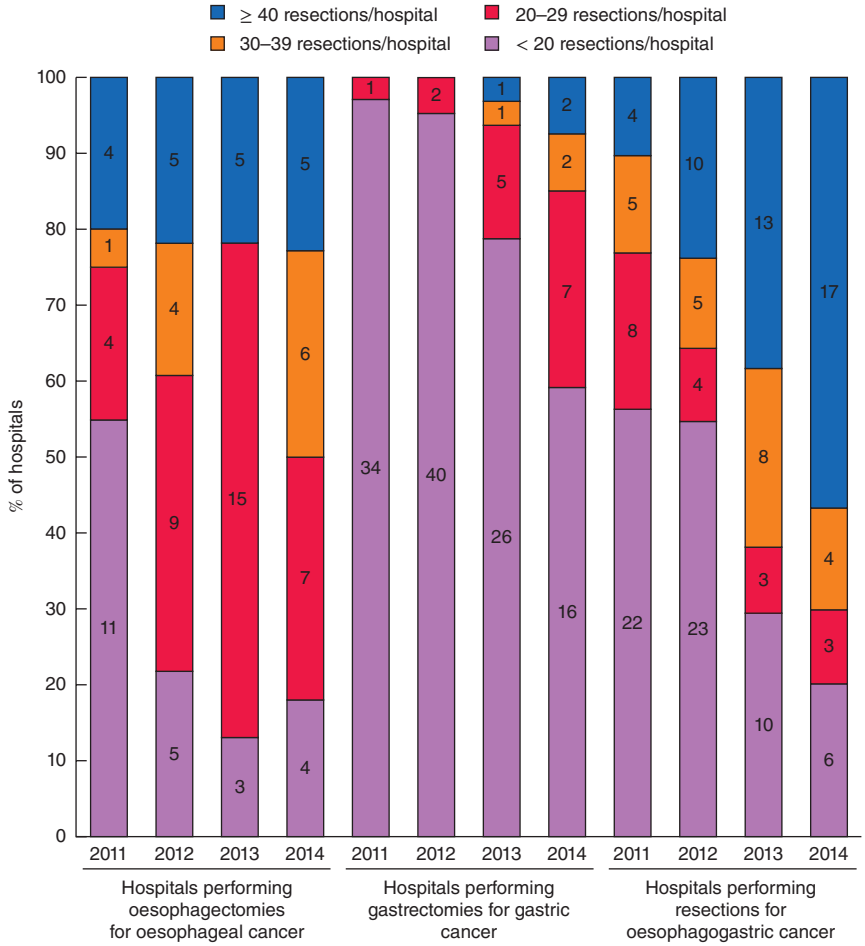

Fig. 1 Process of centralization for hospitals involved in the surgical treatment of patients with oesophageal or gastric cancer

in 2011 to 43·4 per cent in 2014; $P < 0·001$). The proportion of patients with oesophageal cancer who underwent resection via a transthoracic approach increased compared with the transhiatal approach (from 43·0 per cent in 2011 to 64·1 per cent in 2014; $P < 0·001$), with more frequent intrathoracic anastomoses (from 11·2 per cent in 2011 to 35·9 per cent in 2014; $P < 0·001$). No clinically relevant trends were seen with regard to perioperative treatment.

Quality measures

Improvements were seen in various predefined process and outcome measures (*Table 4*).

The percentage of patients discussed in a pre- and post-treatment MDT meeting remained high during the study period (95·2–99·7 and 91·3–98·0 per cent respectively). The percentage of patients with oesophageal cancer starting treatment within 5 weeks after diagnosis significantly increased over time (from 32·5 per cent in 2011 to 41·0 per cent in 2014; $P < 0·001$).

The percentage of patients with a minimum of 15 examined lymph nodes in the resection specimen increased for both patients with oesophageal cancer (from 50·3 per cent in 2011 to 73·0 per cent in 2014; $P < 0·001$) and those with gastric cancer (from 47·5 per cent in 2011 to 73·6 per cent in 2014; $P < 0·001$). A higher percentage of tumour-negative resection margins was found for both patients with oesophageal cancer (from 92·0 per cent in 2011 to 95·0 per cent in 2014; $P = 0·023$) and those with gastric cancer (from 82·8 per cent in 2011 to 87·9 per cent in 2014; $P = 0·157$). For patients with oesophageal cancer, in-hospital/30-day mortality rates remained stable at around 4·0 per cent, whereas the rate decreased significantly from 8·0 per cent in 2011 to 4·0 per cent in 2014 among patients with gastric cancer ($P = 0·031$).

Hospitals

In the first year of registration, a total of 39 hospitals participated in the DUCA. Since the start of registration, the number of hospitals performing oesophageal cancer surgery and/or gastric cancer surgery decreased, while the annual caseload per hospital increased over time (*Fig. 1*).

Discussion

This study provides an overview of the implementation of a nationwide audit evaluating the quality of care for patients who had surgery for oesophageal or gastric cancer in the Netherlands. The main purpose of the audit was to improve the quality of care for these patients by providing (surgical) teams with reliable, benchmarked information on process and (case mix-adjusted) outcome parameters regarding their patients. Between 2011 and 2014, 2786 patients with oesophageal cancer and 1887 with gastric cancer were registered. Case ascertainment approached 100 per cent for patients registered from 2013. During the study period a trend towards better results for various process and outcome measures was observed. Both auditing and the process of centralization might have contributed to this[14].

In 2014, approximately 2500 patients were diagnosed with invasive oesophageal cancer (including gastro-oesophageal junction tumours) and approximately 1400 patients were diagnosed with invasive gastric cancer in the Netherlands[15]. Oesophagogastric cancer surgery is considered a high-risk and low-volume surgical procedure, with substantial morbidity and mortality and poor survival[16], making it an appropriate subject for clinical audit.

Clinical auditing aims to improve standards of care using benchmarked information, and by initiating improvement programmes or in-depth research to clarify underlying causes and mechanisms. Additionally, clinical auditing has the potential to provide patients and third parties with valid case mix-adjusted quality information. Transparency of treatment results could lead to outcome-based referral instead of volume-based referral[17]. Clinical audit can also act as a source of information for research by providing data on a non-selected patient cohort including patients who do not enter clinical trials.

Several European countries have started registering detailed information about patients treated for oesophagogastric cancer. For instance, in Denmark and Sweden a national oesophagogastric cancer registry was initiated in 2003 and 2006 respectively, and the NOGCA in the UK started collecting detailed information about this group of patients in 2011.

The DUCA differs from these other audits in a number of ways. Weekly updated and benchmarked feedback of individual hospital results is provided, allowing hospitals and their medical teams to act on results at relatively short notice. Participation in the DUCA has been incorporated as a quality standard defined by medical specialists, supported by the Health Care Inspectorate. This stimulated successful nationwide implementation of the audit, in contrast with the voluntary nature of some audits and registries that could lead to participation mainly from dedicated hospitals and under-representation of underperforming hospitals (as in the US National Surgical Quality Improvement Program and the initial years of the UK NOGCA).

The present audit has limitations. As a surgical audit, there is no information about patients with oesophageal or gastric cancer undergoing non-surgical treatment or no treatment. The audit cannot, therefore, provide information about resection rates, toxicity of perioperative treatment and non-surgical treatment measures. As a result, no comparisons can be made between different surgical and non-surgical treatment strategies. The board and the scientific committee of the DUCA are working on the development of a nationwide multidisciplinary quality registration. The audit does not contain information about long-term follow-up. Links between other databases including the NCR could resolve this issue, making both registries more meaningful. There is no information about patient-reported outcome measures. Insight into patient views on outcomes will likely play an increasingly important role in improving the quality of care. Finally, registration of all data is time-consuming and burdensome for individual surgeons and hospitals. This issue could be resolved by linking the DUCA database with existing data systems and by computerizing as much as possible. Currently, a link between the DUCA and PALGA, the nationwide network and registry of histopathology and cytopathology in the Netherlands, is being established to reduce some of the registration burden.

Existing clinical audits focusing on oesophagogastric cancer care offer great opportunities. Benchmarking of outcomes might be expanded to a European level and treatment results can then be compared with those from a wider range of centres in different settings[18]. A comparison between four different European cancer registries and audits performed by Dikken and colleagues[5] in 2012 showed a significantly higher 30-day mortality rate after gastric resections for cancer in the Netherlands but, after 4 years of auditing, postoperative mortality rates in the Netherlands have declined and become more comparable to results in other European countries. Even so, it must

be acknowledged that recorded data vary by country and there are differences in data interpretation. A common data item list, as presented by the European Registration of Cancer Care in 2014, is likely to be of great value[18]. This list may prove beneficial for existing audits and could serve as an example for new audits. Additionally, international consensus on standardization of data collection is essential to assess and compare results from different countries[19].

Nationwide implementation of a surgical audit in the Netherlands has been successful, and included nearly 100 per cent of the patients with oesophageal cancer or gastric cancer who underwent surgery in 2013. The first results give a valuable insight into the quality of surgical care for patients with oesophageal or gastric cancer, with a positive trend for various process and outcome measures.

Collaborators

The following members of the DUCA group were collaborators in the study: K. Bosscha (Department of Surgery, Jeroen Bosch Hospital, 's-Hertogenbosch), A. Cats (Department of Medical Oncology, Netherlands Cancer Institute/Antoni van Leeuwenhoek Hospital, Amsterdam), J. L. Dikken (Department of Surgery, Leiden University Medical Centre, Leiden; Medical Centre Haaglanden, The Hague), H. H. Hartgrink (Department of Surgery, Leiden University Medical Centre, Leiden), P. C. de Jong (Department of Internal Medicine, St Antonius Hospital, Nieuwegein), V. E. P. P. Lemmens (Department of Public Health, Erasmus University Medical Centre, Rotterdam; Netherlands Comprehensive Cancer Organization, Eindhoven), G. A. P. Nieuwenhuijzen (Department of Surgery, Catharina Hospital, Eindhoven), J. T. Plukker (Department of Surgery, University Medical Centre Groningen, Groningen), C. Rosman (Department of Surgery, Radboud University Medical Centre, Nijmegen), T. Rozema (Verbeeten Institute, Tilburg), P. D. Siersema (Department of Gastroenterology and Hepatology, Radboud University Medical Centre, Nijmegen), G. Tetteroo (Department of Surgery, IJselland Hospital, Capelle aan den IJsel), P. M. J. F. Veldhuis (Netherlands Comprehensive Cancer Organization, Enschede) and F. E. M. Voncken (Department of Radiotherapy, Netherlands Cancer Institute/Antoni van Leeuwenhoek Hospital, Amsterdam).

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Supporting information

Additional supporting information may be found in the online version of this article:

Table S1 Dutch Federation for Oncological Societies: multidisciplinary quality standards for the treatment of patients with oesophageal and gastric cancer, version 4 (2016) (Word document)

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