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Administrative healthcare data as an addition to the Dutch surgical aneurysm audit to evaluate mid-term reinterventions following abdominal aortic aneurysm repair: A pilot study

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ABSTRACT

Background: The Dutch Surgical Aneurysm Audit (DSAA) is a nationwide mandatory quality registry that evaluates the perioperative outcomes of abdominal aortic aneurysms (AAAs). The DSAA includes perioperative outcomes that occur up to 30 days, but various complications following AAA repair occur after this period. Administrative healthcare data yield the possibility to evaluate later occuring outcomes such as reinterventions, without increasing the registration burden. The aim of this study is to assess the feasibility and the potential benefit of administrative healthcare data to evaluate mid-term reinterventions following intact AAA repair.

Method: All patients that underwent primary endovascular aneurysm repair (EVAR) or open surgical repair (OSR) for an intact infrarenal AAA between January 2017 and December 2018 were selected from the DSAA. Subsequently, these patients were identified in a database containing reimbursement data. Healthcare activity codes that refer to reinterventions following AAA repair were examined to assess reinterventions within 12 and 15 months following EVAR and OSR.

Results: We selected 4043 patients from the DSAA, and 2059 (51%) patients could be identified in the administrative healthcare database. Reintervention rates of 10.4% following EVAR and 9.5% following OSR within 12 months ($p = 0.719$), and 11.5% following EVAR and 10.8% following OSR within 15 months ($p = 0.785$) were reported.

Conclusion: Administrative healthcare data as an addition to the DSAA is potentially beneficial to evaluate mid-term reinterventions following intact AAA repair without increasing the registration burden for clinicians. Further validation is necessary before reliable implementation of this tool is warranted.

1. Introduction

The Dutch Surgical Aneurysm Audit (DSAA) is a nationwide mandatory quality registry that monitors and evaluates the perioperative outcomes of the treatment of abdominal aortic aneurysms (AAAs), performed by Dutch vascular surgeons in all Dutch hospitals [1]. Data of the DSAA, prospectively collected by vascular surgeons, reflect real-world practice and are mainly used for quality indicators to

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provide feedback to hospitals on their performances. Secondary, the data of the DSAA is used for scientific research that evaluates the quality of the Dutch AAA-care on a national level [2].

The DSAA includes perioperative outcomes that occur up to 30 days postoperatively or during the same hospital admission. However, complications and reinterventions that occur after 30-days are not scarce following EVAR and OSR [3]. Several patients treated with endovascular aortic aneurysm repair (EVAR) experience long-term endograft complications resulting in reintervention [3,4], while patients treated with open surgical repair (OSR) are at-risk for reinterventions for complications related to the laparotomy [3,5]. Therefore, as most patients survive multiple years following an AAA-repair [6,7], reliable data on long-term results, especially the durability of EVAR, are of utmost importance. Available data that evaluates mid and long-term reinterventions especially describes data from randomized controlled trail [6,7]. Observational studies often contain data from centers of excellence [4], while nationwide data on mid and long-term reinterventions to evaluate the nationwide impact of reinterventions are scarce.

A limited registration burden is crucial for quality registries [2]. Therefore, it might be valuable to add administrative healthcare data to the DSAA to evaluate the number and percentage of mid-term reinterventions following intact AAA repair without increasing the registration burden for clinicians. However, research that is performed with administrative healthcare data may be subject to several limitations [8]. Thus, the aim of this study is to assess the feasibility and the potential benefit of using administrative healthcare data to evaluate the frequency and type of mid-term reinterventions (reinterventions within 12 and 15 months) following intact AAA repair.

2. Methods

2.1. Study design and data sources

This study serves as a pilot study to explore adding mid-term reinterventions following AAA repair to the Dutch Surgical Aneurysm Audit using administrative healthcare data. For this observational multicenter retrospective cohort study, two separate datasets were constructed. The first dataset was retrieved from the Dutch Surgical Aneurysm Audit (DSAA-dataset), a mandatory nationwide quality registry in the Netherlands. The DSAA was established in 2013, and from that year forward, each hospital started registering all patients that underwent repair of an infrarenal or juxtarenal aneurysm without previous aortic surgery performed by vascular surgeons. Data verification of the DSAA was performed in a random sample of hospitals, indicating high reliability of data [9]. The administrative healthcare data, the second dataset, was retrieved from the 'Benchmark Database' serviced by LOGEX, a Dutch healthcare analytics company. This database is primarily used for reimbursement purposes and contains information on diagnosis and specific healthcare activity codes developed by the Dutch Healthcare Authority (NZA) [10]. Both AAA repairs and reinterventions are represented in specific healthcare activities codes. Healthcare insurance is mandatory in the Netherlands, and invoices to insurance companies are based on healthcare declaration codes that include specific healthcare activity codes. Dutch administrative healthcare data has previously been used for scientific purposes [11,12] and is considered accurate [12]. The administrative healthcare dataset was constructed using specific healthcare activity codes that described EVAR and OSR. This dataset also included information on reinterventions following an aneurysm repair, as well as limited information regarding patient and treatment characteristics.

2.2. Patient selection

For this study, the following in and exclusion criteria were used: all patients that underwent primary EVAR or OSR with clamping below the renal arteries for an intact infrarenal AAA between January 2017 and December 2018 were selected from the DSAA and included in the DSAA-dataset. Patients who were attempted to be treated endovascular but were converted from EVAR to OSR during surgery were not included in this study. Patients with an age below 20 or above 90 years were excluded. Subsequently, the administrative healthcare data was extracted from the administrative healthcare database by selecting patients with healthcare activity codes corresponding to EVAR or OSR (without reconstruction of one or two renal arteries) and the diagnosis code 'aneurysm of the aorta and arteries', whereafter these patients were included in the administrative healthcare dataset. The date of surgery noted in these specific healthcare activities that describe EVAR or OSR (shown in Table 1**)** determined the start of the follow-up periods of 12 and 15 months. Due to privacy restrictions, patient data in the administrative healthcare database was fully anonymized and could not be linked on patient-level to the DSAA dataset. Also, reintervention rates per hospital could not be assessed. Only patients that underwent a reintervention in the same hospital as their primary AAA-repair could be identified in the administrative healthcare database and were included in the administrative healthcare dataset. This study was conducted in 2020 and 2021.

2.3. Definitions and outcomes

2.3.1. Definitions

Reinterventions were selected from the administrative healthcare database using codes for specific care activities. The codes representing the reinterventions were selected based on clinical relevance. The selected reinterventions were divided into 'vascular-related reinterventions', which included aneurysm-related reinterventions, peripheral vessel-related reinterventions, amputations, and other vascular reinterventions, and 'abdominal reinterventions' that included laparotomies and corrections of incisional hernias. Within each category, reinterventions that described similar procedures were summarized into one subcategory. A complete overview of included reinterventions is presented in **Supplementary Material Table 2–6.** Due to privacy restrictions, the exact time in months or days between the primary intervention and the reintervention could not be extracted from the administrative healthcare database.

2.3.2. Outcomes

Outcomes of this study were the number and percentage of reinterventions (reinterventions per category and individual reinterventions) within 12 months and 15 months following intact AAA repair, stratified for EVAR and OSR, and the number of specific reinterventions that occurred in the administrative healthcare dataset. Both reinterventions within 12 and 15 months following AAA repair were examined to provide insight into the possible risk of selection bias that could be caused due to clinical follow-up moments with computed tomography angiography (CTA) scanning that most patients undergo at 12 months after surgery [13].

2.4. Statistical methods

Categorical variables were presented in numbers (%), and continuous variables that followed a normal distribution were presented as mean and standard deviation (SD). Differences in patient characteristics that were present in both the DSAA-dataset and the administrative healthcare dataset were examined between the DSAA-dataset and administrative healthcare dataset stratified for EVAR and OSR using chi-square and Fisher exact tests when appropriate. Differences in continuous variables were examined between the groups by independent-samples t-tests. In order to evaluate the frequency and type of mid-term reinterventions (reinterventions within 12 and 15 months) following intact AAA repair, differences in the overall number of reinterventions within 12 and 15 months following EVAR and OSR were examined between EVAR and OSR, stratified for 12 and 15 months,

Table 1
Characteristics of patients included in the DSAA dataset and characteristics of patients included in the administrative healthcare dataset. Characteristics were chosen based on relavence and availability of information in the datasets. Information that was not available in the DSAA-dataset or administrative healthcare dataset was displayed as 'n.a.'.

	EVAR DSAA-dataset	Administrative healthcare dataset	P-value	OSR DSAA-dataset	Administrative healthcare dataset	P-value
Number of patients	3372	1734		671	325	
Number of hospitals	58	44		55	45	
Sex			0.691			0.988
female	482 (14.3%)	240 (13.8%)		136 (20.3%)	65 (20.0%)	
male	2890 (85.7%)	1494 (86.2%)		535 (79.7%)	260 (80.0%)	
Age, years			0.602			0.826
≤ 62	203 (6.0%)	119 (6.9%)		92 (13.7%)	42 (12.9%)	
63–72	1139 (33.8%)	592 (34.1%)		298 (44.4%)	142 (43.7%)	
73–82	1574 (46.7%)	785 (45.3%)		247 (36.8%)	120 (36.9%)	
83–90	456 (13.5%)	238 (13.7%)		34 (5.1%)	21 (6.5%)	
ASA						
0	n.a.	450 (25.7%)		n.a.	78 (24.0%)	
1	n.a.	8 (0.5%)		n.a.	3 (0.9%)	
2	n.a.	413 (23.8%)		n.a.	78 (24.0%)	
3	n.a.	749 (43.2%)		n.a.	146 (44.9%)	
4	n.a.	119 (6.9%)		n.a.	22 (6.2%)	
Charlson comorbidity index						
1	n.a.	1 (0.1%)		n.a.	2 (0.6%)	
2	n.a.	35 (2.0%)		n.a.	16 (4.9%)	
3	n.a.	211 (12.2%)		n.a.	64 (19.7%)	
4	n.a.	495 (28.5%)		n.a.	10,195 (29.2%)	
5	n.a.	391 (22.5%)		n.a.	57 (17.5%)	
6	n.a.	601 (34.7%)		n.a.	91 (28.0%)	
Pulmonary comorbidity						
No	2447 (72.6%)	n.a.		502 (74.8%)	n.a.	
Yes	851 (25.2%)	n.a.		155 (23.1%)	n.a.	
Missing	74 (2.2%)	n.a.		14 (2.1%)	n.a.	
Cardiac comorbidity						
No	1161 (34.4%)	n.a.		237 (35.3%)	n.a.	
Yes	2149 (63.7%)	n.a.		427 (63.6%)	n.a.	
Missing	62 (1.8%)	n.a.		7 (1.0%)	n.a.	
Creatinine	90 [77, 108]	n.a.		90.0 [74, 107]	n.a.	
Aneurysm diameter (mean ± sd)	59.9 ± 10.5	n.a.		62.9 ± 13.1	n.a.	

using chi-square and Fisher exact tests when appropriate. Similar analyses were performed to assess differences between EVAR and OSR within the categories of reinterventions.

3. Results

In total, 4 043 patients from 58 hospitals that underwent EVAR or OSR with infrarenal clamping for an intact infrarenal AAA between January 2017 and December 2018 were selected from the Dutch Surgical Aneurysm Audit and included in the DSAA-dataset (Fig. 1). A total of 2 059 patients from 46 hospitals were identified in the administrative healthcare database. The specific healthcare activity that describe EVAR and OSR and which were used to construct the administrative healthcare dataset are described in Supplementary Table 1. In total, 3 372 patients that underwent EVAR were included in the DSAA-dataset, compared to 1 734 (51.4%) patients which were included in the administrative healthcare dataset. Furthermore, 671 patients that underwent OSR were included in the DSAA-dataset, compared to 325 (48.4%) which were included in the administrative healthcare dataset.

3.1. Patient characteristics

Characteristics of the patients included in the DSAA-dataset, as well as the patient characteristics that are detailed in the administrative healthcare dataset, are shown in Table 1**.** No differences in age and sex were seen between patients included in the DSAA-dataset and the administrative healthcare dataset.

3.2. Reinterventions within 12 months and 15 months following EVAR and OSR

Table 2 shows an overview of the reinterventions detected within 12 and 15 months following EVAR and OSR. The percentages of reinterventions within 12 and 15 months following EVAR compared to OSR did not differ. More vascular reinterventions were detected within 12 months following EVAR compared to OSR (9.2% vs. 4.6%; $p = 0.009$). In addition, more abdominal reinterventions were detected within 12 months following OSR compared to EVAR (6.2% vs. 1.6%; $p < 0.001$). Similar results were found when examining the reinterventions that occurred within 15 months.

3.3. Reinterventions within the subcategories and the identification of reinterventions in the administrative healthcare database

Tables 3A-E show an overview of subcategories of reinterventions and individual reinterventions within 12 and 15 months following EVAR and OSR. **Supplementary material Table 2–6** show all healthcare activity codes that were selected from the administrative healthcare database.

3.3.1. Aneurysm-related reinterventions

Table 3A shows the reinterventions that took place at the central vessels. In this category, 21 healthcare activity codes that describe reinterventions at the central vessels were selected from the administrative healthcare database. From these healthcare activity codes, 7 different healthcare activity codes were present in the administrative healthcare dataset, while some healthcare activity codes did not occur in this dataset. Most reinterventions that occurred within 12 months were registered in the subcategory 'Reconstruction of the aorta or side

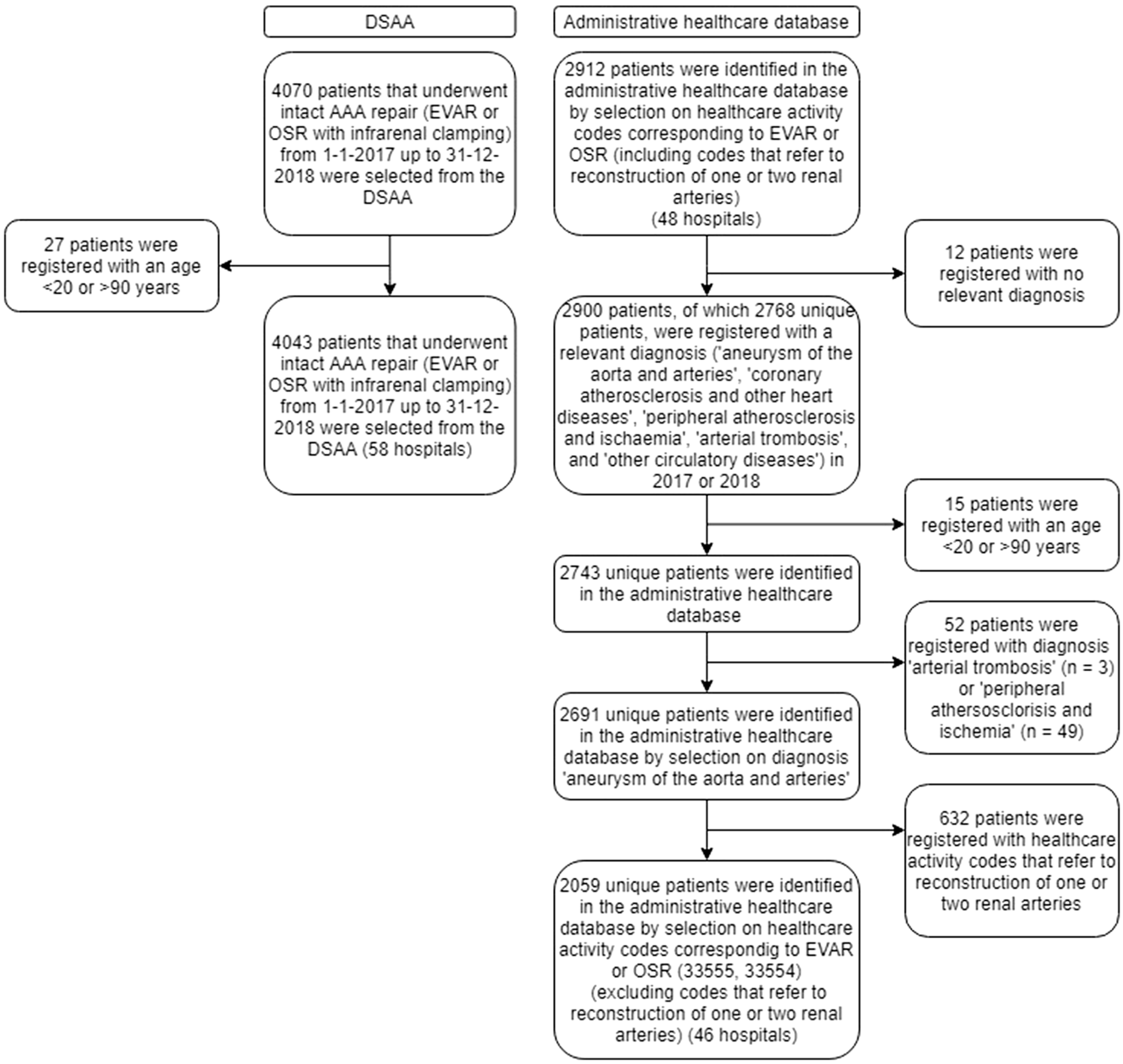

Fig. 1. Flow chart of patients included in the DSAA dataset and administrative healthcare dataset (flow chart was created by the authors).

Table 2
Overview of total reinterventions and reinterventions per category within 12 months and within 15 months following EVAR and OSR.

		<12 months EVAR (n = 1734)	OSR (n = 325)	P-value	<15 months EVAR (n = 1734)	OSR (n = 325)	P-value
Total*		180 (10.4)	31 (9.5)	0.719	199 (11.5)	35 (10.8)	0.785
Vascular		159 (9.2)	15 (4.6)	0.009	178 (10.3)	15 (4.6)	0.002
	Central vessels	53 (3.1)	7 (2.2)	0.473	64 (3.7)	7 (2.2)	0.187
–							
	Peripheral vessels	63 (3.6)	6 (1.8)	0.129	70 (4.0)	6 (1.8)	0.055
	Amputation	7 (0.4)	0 (0.0)	0.605	7 (0.4)	0 (0.0)	0.605
	Other	87 (5.0)	7 (2.2)	0.020	96 (5.5)	7 (2.2)	0.008
Abdominal		27 (1.6)	20 (6.2)	<0.001	28 (1.6)	24 (7.4)	<0.001

* Total: both vascular and abdominal reinterventions.

branches' (2.4% following EVAR, 1.2% following OSR).

3.3.2. *Peripheral vessel-related reinterventions*

Table 3B shows the reinterventions that took place at the peripheral vessels. In total, 15 healthcare activity codes that describe reinterventions at the peripheral vessels were selected from the administrative healthcare database. From these healthcare activity codes, 11 different healthcare activity codes were present in the administrative healthcare dataset.

3.3.3. *Amputations*

Amputations following AAA repair are shown in Table 3C. Four healthcare activity codes that describe amputations were selected from the administrative healthcare database. From these healthcare activity codes, 3 different healthcare activity codes were present in the administrative healthcare dataset. No amputations were detected following

Table 3A
Reinterventions that took place at the central vessels within 12 and 15 months following intact AAA repair.

	<12 months EVAR (n = 1734)	OSR (n = 325)	P-value	< 15 months EVAR (n = 1734)	OSR (n = 325)	P-value
Vascular: central vessels	53 (3.1)	7 (2.2)	0.473	64 (3.7)	7 (2.2)	0.187
- Embolectomy of blood vessels of the abdomen (open or endovascular procedure) (35501, 35502)	8 (0.5)	2 (0.6)		9 (0.5)	2 (0.6)	
- Percutaneous transluminal angioplasty of the (non coronary) central vessels excluding the renal artery (33351)	10 (0.6)	1 (0.3)		13 (0.7)	1 (0.3)	
- Reconstruction of the aorta or side branches such as renal arteries, iliac arteries, or subclavian artery (open orendovascularprocedure) (33554, 33555, 33342)	41 (2.4)	4 (1.2)		48 (2.8)	4 (1.2)	
- Insertion of an aortic bifurcation prosthesis and reconstruction of both renal arteries, open procedure (33561)	1 (0.1)	1 (0.3)		1 (0.1)	1 (0.3)	

Table 3B
Reinterventions that took place at the peripheral vessels within 12 and 15 months following intact AAA repair.

	< 12 months EVAR (n = 1734)	OSR (n = 325)	P-value	< 15 months EVAR (n = 1734)	OSR (n = 325)	P-value
Vascular: peripheral vessels	63 (3.6)	6 (1.8)	0.129	70 (4.0)	6 (1.8)	0.055
- Percutaneous transluminal angioplasty of the peripheral arteries (33672)	10 (0.6)	1 (0.3)		11 (0.6)	1 (0.3)	
- Embolectomy of peripheral blood vessels (33600)	19 (1.1)	2 (0.6)		21 (1.2)	2 (0.6)	
- Axillobifemoral bypass graft (33673)	1 (0.1)	0 (0.0)		1 (0.1)	0 (0.0)	
- Carotid-subclavian bypass graft or femorofemorol bypass graft (33677, 33678)[1]	20 (1.2)	1 (0.3)		22 (1.3)	1 (0.3)	
- Femoro-crural bypass graft, open procedure (33680)	2 (0.1)	0 (0.0)		2 (0.1)	0 (0.0)	
- Endovascular treatment of femoro-crural or femoropopliteal traject (33681, 33679)[2]	3 (0.2)	1 (0.3)		4 (0.2)	1 (0.3)	
- Endovascular reconstruction of open repair of a peripheral artery (33668, 33669, 33670)[3]	24 (1.4)	3 (0.9)		27 (1.6)	3 (0.9)	

Table 3C
Amputations within 12 and 15 months following intact AAA repair.

	<12 months EVAR (n = 1734)	OSR (n = 325)	P-value	<15 months EVAR (n = 1734)	OSR (n = 325)	P-value
Vascular: amputations	7 (0.4)	0 (0.0)	0.605	7 (0.4)	0 (0.0)	0.605
- Transfemoral amputation (38590)	1 (0.1)	0 (0.0)		1 (0.0)	0 (0.0)	
- Transtibial amputation (38690)	3 (0.2)	0 (0.0)		3 (0.2)	0 (0.0)	
- Amputation or exarticulation of a toe (38791)	4 (0.2)	0 (0.0)		4 (0.2)	0 (0.0)	

Table 3D
Other vascular reinterventions within 12 and 15 months following intact AAA-repair.

	<12 months EVAR (n = 1734)	OSR (n = 325)	P-value	<15 months EVAR (n = 1734)	OSR (n = 325)	P-value
Vascular: other	87 (5.0)	7 (2.2)	0.020	96 (5.5)	7 (2.2)	0.008
- Percutaneous transluminal angioplasty for stenosis or occlusion at other non-coronary vessels (80821, 80822)[1]	54 (3.1)	6 (1.8)		59 (3.4)	6 (1.8)	
- Trombolysis using medication (i.e. urokinase, streptokinase) (80829)	29 (1.7)	0 (0.0)		32 (1.8)	0 (0.0)	
- Embolisation of vessels (80828, 80028)[2]	22 (1.3)	1 (0.3)		28 (1.6)	1 (0.3)	

OSR.

3.3.4. Other vascular reinterventions

Table 3D shows other vascular reinterventions. In this category, 5 healthcare activity codes that describe other vascular reinterventions were selected from the administrative healthcare database. All these 5 healthcare activity codes were present in the administrative healthcare dataset. Following EVAR, a percutaneous transluminal angioplasty for stenosis or occlusion was most common (3.1%) in the dataset that included reinterventions within 12 months.

3.3.5. Abdominal reinterventions

Abdominal reinterventions are shown in Table 3E**.** In this category, 14 healthcare activity codes that describe abdominal reinterventions were selected from the administrative healthcare database. From these healthcare activity codes, 9 different healthcare activity codes were present in the administrative healthcare dataset. Following OSR, an exploratory laparotomy was most often present in both datasets representing reinterventions within 12 and 15 months (4.6%).

4. Discussion

In this study, we evaluate the feasibility and the potential benefit of using administrative healthcare data as a source for mid-term outcomes

Table 3E
Abdominal reinterventions within 12 and 15 months following intact AAA-repair.

	<12 months			<15 months		
	EVAR (n = 1734)	OSR (n = 325)	P-value	EVAR (n = 1734)	OSR (n = 325)	P-value
Abdominal	27 (1.6)	20 (6.2)	<0.001	28 (1.6)	24 (7.4)	<0.001
- Exploratory laparotomy (35512)	6 (0.3)	15 (4.6)		6 (0.3)	15 (4.6)	
- Small bowel resection, open procedure (34638)	2 (0.1)	2 (0.6)		2 (0.1)	2 (0.6)	
- Colon resection, with or without coecostomy, open or endoscopic procedure (34738, 34739)	14 (0.8)	1 (0.3)		15 (0.9)	2 (0.6)	
- Colostomy or ileostomy creation following laparotomy, open procedure (34752)	3 (0.2)	1 (0.3)		3 (0.2)	1 (0.3)	
- Ileus that requires surgery, without resection or anastomosis, open or endoscopic procedure (34880, 34881)	4 (0.2)	3 (0.9)		4 (0.2)	3 (0.9)	
- Incisional hernia (open / laparoscopic procedure), or incarcerated hernia without bowel resection (35740, 35741, 35702)	5 (0.3)	5 (1.3)		5 (0.3)	8 (2.5)	

for patients undergoing EVAR and OSR to evaluate reinterventions within 12 and 15 months following intact AAA repair. By first selecting patients that underwent an intact AAA repair from the DSAA, whereafter patients were selected from the administrative healthcare database, we could estimate the proportion of patients that were identified in the administrative healthcare database. Moreover, multiple detailed reinterventions were present in the administrative healthcare database, and thus, many reinterventions following intact AAA repair could be evaluated. However, within our study design, it was not possible to link the administrative healthcare data directly to the DSAA on a patient-level due to privacy restrictions.

Our study reported reintervention rates of 10.4% following EVAR and 9.5% following OSR within 12 months following AAA repair. Unfortunately, available follow-up data was limited, and therefore, we could not include reinterventions that occurred after 15 months following AAA repair. As far as we know, only one other quality registry, the Vascular Quality Initiative, in which hospitals participate electively [14], has studied reinterventions following EVAR after linkage of Medicare claims data [8,15] and another claims database [16], and demonstrated a 1-year reintervention rate of 6% following EVAR [8]. Furthermore, a *meta*-analysis reported higher long-term reinterventions rates following EVAR compared to OSR using data from 4 randomized controlled trials [17]. Another *meta*-analysis that included both RCTs and observational cohort studies reported long-term reintervention rates (5 to 9 years) of 17.6% following EVAR and 14.9% following OSR [4]. However, interestingly, a population-based matched cohort study using administrative healthcare data described that long-term reintervention rates did not differ following EVAR and OSR [18]. Despite the considerable number of performed studies, the exact percentages of reinterventions in literature and our study are hardly comparable since each study used other criteria for describing reinterventions [17] and reported other follow-up periods. Nevertheless, reporting reinterventions at the national level might be valuable to evaluate the nationwide impact of the reinterventions following EVAR and OSR, especially since reinterventions significantly raise the costs of AAA repair [19,20]. Although we could only report on a large sample of nationwide data within this study design, which had similar patient characteristics (age and sex) when comparing the administrative healthcare data with the DSAA, this study revealed that about 1 in 10 patients received a reintervention within 12 months following EVAR and OSR.

The development of quality registries should not be inherent with an increase in registration burden [21]. One advantage of adding administrative healthcare data to our quality registry is that this method does not impose an extra registration burden on physicians since the administrative healthcare data is collected routinely within the hospital information systems [22]. However, within this pilot study, it was not feasible to link the administrative data to the DSAA patients due to privacy restrictions under Dutch law. Patients included in the DSAA are registered by all 58 hospitals that perform intact AAA repair in the Netherlands. Due to this high number of hospitals that register patients in the DSAA, we chose to examine the potential of adding healthcare administrative data to the DSAA. However, linkage of data, which could be achieved by asking permission to all 58 hospitals, will be needed to optimally use the additional information regarding reinterventions provided by the administrative healthcare data. With a linkage of the administrative healthcare dataset to the DSAA-dataset, it will be possible to examine whether specific patient or aneurysm-related factors registered in the DSAA are associated with particular reinterventions or reinterventions in general. Moreover, when evaluating the number of reinterventions following OSR compared to the number of reinterventions following EVAR, it will be necessary to adjust for potential confounders since the crude number of reinterventions might be influenced by selection bias [22] as EVAR could be performed in patients that were unfit for OS [23] or had more comorbidities [4]. Therefore, the results of this study could serve as a preview of the additional information that could be added to the DSAA when a combined data source is available.

With a combined data source, further research could also focus on the percentages of reinterventions within 12 or 15 months per hospital. These percentages might be relevant feedback to hospitals since the percentage of reinterventions could reflect long-term complication rates of individual hospitals. The individual hospital percentages of reinterventions could depend on local follow-up schemes to detect complications requiring a reintervention [13] and the degree of failure of surveillance [24]. Therefore, it could be valuable to evaluate whether significant variation in the number of reinterventions between hospitals exists using funnel plots that detect hospitals performing below or above the national average percentage of reinterventions within 12 or 15 months. Interestingly, it has been studied that although patients that are compliant with surveillance following EVAR may have an increased reintervention rate, compliance with surveillance does not appear to be associated with survival [25]. More recently, no difference in overall survival was described between patients that underwent secondary intervention following a type 2 endoleak and those who did not undergo secondary intervention [13]. Therefore, it would be interesting to examine the cause of increased reintervention rates in hospitals and to assess whether reinterventions influence long-term survival in future studies.

Although healthcare administrative data is potentially valuable to add to our quality registry, it is important to realize that administrative data has several limitations. First, data validity is crucial when data is used for evaluating quality of healthcare [26]. Another study describing administrative data linkage with registry data validated whether reintervention rates following AAA repair were accurately reflected in the administrative healthcare data [8]. Due to the previously mentioned privacy restrictions, we could not verify whether the described reintervention rates correspond with the data as registered in hospital charts. However, Dutch routinely collected claims data was considered accurate for patients with an acute myocardial infarction [12]. Secondly, since all healthcare activity codes within 12 or 15 months following AAA-repair that occurred in the administrative healthcare database were included and no additional details were provided within the descriptions of the reintervention, we could not determine whether the reinterventions were related to complications of the AAA-repair, or whether the reinterventions were related to another complication. Moreover, due to the limited information included in the description of the reinterventions, we could not determine which specific complication caused the reintervention. Also, only patients who underwent a reintervention in the same hospital as where their primary AAA repair was performed could be identified in the administrative healthcare dataset. Although we hypothesized that most patients underwent a reintervention in the same hospital as their primary intervention, the administrative healthcare data potentially did not provide a complete overview of the number of reinterventions that occurred. The VQI, which indirectly linked their data with a claims database could not capture all reinterventions as well, since data on care performed at Veteran's Association hospitals were not included in the claims database [16].

Also, our study design has certain limitations. First, the administrative healthcare database has a near nationwide coverage which means that not all hospitals that perform AAA repair are present in the administrative healthcare dataset. Therefore, the results of our study represented a large sample from a nationwide cohort instead of a nationwide cohort. Secondly, extensive analysis examining the influence of patient characteristics on reintervention rates or analysis on when reinterventions occur was not possible since the administrative healthcare data was not linked to the DSAA. Also, since there was no linkage of data, we could not verify whether reinterventions that were registered in the DSAA (reinterventions within 30 days) corresponded with reinterventions within 30 days that were registered in the administrative healthcare data. An important strength of this study was its simple study design in which the potential benefit of adding administrative healthcare data retrospectively to the DSAA could be examined.

In conclusion, adding administrative healthcare data to the DSAA is potentially beneficial to evaluate mid-term reinterventions following intact AAA repair without increasing the registration burden for clinicians. However, the administrative healthcare data should be linked with the DSAA to further validate this data before reliable implementation of this tool is warranted.

5. Summary table

What was already known on the topic:

Several patients treated with endovascular aortic aneurysm repair (EVAR) for an abdominal aortic aneurysm (AAA) experience long-term endograft complications resulting in reinterventions, while patients treated with open surgical repair (OSR) are at-risk for reinterventions for complications related to the laparotomy.

Available data that evaluate mid and long-term reinterventions following EVAR and OSR especially describe data from randomized controlled trails, while observational studies often contain data from centers of excellence. Nationwide data that evaluate the nationwide impact of mid and long-term reinterventions are scarce.

A limited registration burden is crucial for quality registries, and therefore, it might be valuable to add administrative healthcare data to the Dutch Surgical Aneurysm Audit (DSAA), a nationwide mandatory quality registry, to evaluate the number and percentage of mid-term reinterventions following AAA repair.

What this study added to our knowledge:

Multiple detailed reinterventions were present in the database with administrative healthcare data, and thus, many reinterventions following intact AAA repair could be evaluated.

Adding administrative healthcare data to the DSAA is potentially beneficial to evaluate mid-term reinterventions following intact AAA repair without increasing the registration burden for clinicians. However, the administrative healthcare data should be linked with the DSAA to further validate this data before reliable implementation of this tool is warranted.

Declaration of Competing Interest

HV is consultant for Medtronic, WL Gore, Terumo, Endologix, and Philips. The other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijmedinf.2022.104806.

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