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Implementing new technologies for complex care: The role of embeddedness factors in team learning

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Abstract

Bearing the rising health care costs of our aging global population is one of the most urgent challenges society is facing. We study the implementation of new medical technologies as one way to increase the effectiveness of care, particularly in the area of aortic disease—a condition that affects an increasing number of patients globally. Our research focus is the implementation of complex endovascular treatment techniques by a multidisciplinary aortic treatment group, in addition to their traditional open treatment of aortic disease. We find that relational and cognitive embeddedness factors support team learning, which in turn enables the team to achieve its self-set goals of treating more patients; offering more tailor-made care; and providing endovascular treatment in emergency situations. At the end of our data collection period, the first steps toward the team's ultimate goal of offering patient-centered care were also taken.

KEYWORDS

technology implementation, team learning, health care, embeddedness, medical suppliers, longitudinal study

1 | INTRODUCTION

> *In modern industry, harmony among people in a group, as in teamwork, is in greater demand than the art of the individual craftsman.*
> Taiichi Ohno, founder of the Toyota Production System, (1978)

Implementing new technologies in health care is a difficult and complex task. The Dutch Ministry of Health, Welfare and Sport found that avoidable deaths increased in 2015–2016 compared to 2011–2012 only in academic hospitals (Langelaan et al., 2017). The report suggests that a contributing factor was insufficient cooperation and communication between different specialists in various disciplines, during treatments where the physicians' technical skills were important (Klopotowska, Schutijser, Bruijne, & en Wagner, 2016). We examine the challenge of new technology implementation by focusing on how embeddedness factors impact team learning using an in-depth case study approach of one medical group.

Our study took place at the Leiden University Medical Centre (LUMC), one of the eight university hospitals in the Netherlands. More specifically, we looked at how open reconstruction of complex aortic disease by members of the vascular surgery and thoracic surgery departments is supplemented (and later partly substituted) by endovascular reconstruction of complex aortic disease by the endovascular treatment team (ETT) composed of members of the vascular surgery and the interventional radiology departments. All treatment decisions, however, continue to be taken by the Aorta Group, which brings together members of the vascular surgery, thoracic surgery, and interventional radiology departments.

Cardiovascular disease is one of the leading causes of global mortality and morbidity. According to the World

Health Organization (WHO), it was responsible for an estimated 17.7 million deaths worldwide in 2015, which is 31% of all deaths. Between 2005 and 2015, cardiovascular disease accounted for the majority of the global health care burden and ranked first in disability-adjusted life years lost (Global Burden of Disease Study, October, 2016).

Cardiovascular disease thus represents a major economic burden in terms of direct costs (e.g., hospitalizations, rehabilitation services, physician visits, drugs) as well as indirect costs (e.g., loss of workforce productivity) associated with disability due to morbidity and mortality. What is more, increased life expectancy and obesity rates are likely to increase the cost of cardiovascular disease even further. Therefore, we consider vascular treatment as an important topic of study. Our research focuses on a team that provides low-volume, high-complexity care, which differentiates our work from earlier studies into high-volume, high-efficiency care.

The ETT aims to master the new technology in order to (1) be able to treat more patients; (2) provide care that is better tailored to each individual patient; (3) apply the new treatment in emergency cases; and ultimately, (4) provide more patient-centered care by involving patients more actively into their own care path. In our case study, we found evidence for 1–3, while during the final stages of our study, initial steps were taken with regards to 4. We find that embeddedness contributes to the ETT's ability to learn the new technology.

Embeddedness consists of three types of factors: structural, relational, and cognitive (Sting, Stevens, & Tarakci, 2019). Structural factors refer to the operational integration of different organizations—mostly buyers and suppliers (Carey, Lawson, & Krause, 2011; Cousins & Menguc, 2006). We studied an intraorganizational team, which by being part of the same organization, by definition is structurally embedded. Relational and cognitive embedding, however, do not automatically follow from structural embeddedness. Relational embeddedness consists of mutual trust, friendship, and goodwill and is enabled by frequent, informal communication, and repeated interactions (Uzzi, 1996, 1997). Cognitive embedding consists of shared culture, norms, procedures, meaning, and understanding (Lusch & Brown, 1996; Nahapiet & Ghoshal, 1998) and often has both structural and relational embedding as its source.

Relational embedding and particularly its sub-dimension trust became recognized during the 1990s as a main factor in Japanese automotive firms' ability to manage the increasing complexity and depth of exchange with suppliers needed at the time (Dyer, 1996). We are interested in whether the increasing complexity of medical treatments and depth of exchange between different specialists can be supported by similar factors.

After completing the first round of our data analysis in 2017, the Ministry of Health, Welfare, and Sport published a report about avoidable death and injury in Dutch hospitals. It was found that this was particularly linked to treatments whereby technical skills of the physician, as well as simultaneous treatment by multiple specialists, are important (Langelaan et al., 2017). A follow-up study found that insufficient cooperation and communication between different specialists amplified problems (Klopotowska et al., 2016). These findings suggest that the role of team embeddedness factors in new technology implementation require further study. While a vast body of the literature discusses embeddedness at the inter-organizational level, it is less often applied to teams (for an exception in a health care setting see Reagans, Argote, & Brooks, 2005). We argue that this is a missed opportunity, as relational and cognitive factors of embeddedness can enable team learning, as we find in our case.

Because the process we investigate is complex and understudied, we adopt an in-depth case study approach covering all 68 complex open aortic treatments and 46 complex endovascular treatments conducted by the members of the Aorta Group during the four-year period between July 2013 and June 2017—a consecutive series of 114 treatments (see Table 1).

2 | THEORETICAL BACKGROUND

The positive relation between innovation on the one hand, and interactions between team members on the other hand, is well-known in the literature (Clark & Fujimoto, 1991; Gladstein, 1984). Likewise, the positive effect of including multiple perspectives and rich data when solving a problem is widely accepted (MacDuffie, 1997). Also in a health care setting, there is overwhelming evidence for the importance of teamwork for health care outcomes. For example, Edmondson, Bohmer, and Pisano (2001) found that the successful implementation of a minimal invasive technology for cardiac surgery depends on the medical specialists' ability to also act as skilled team leaders who could create an environment conducive to team learning. Edmondson, Higgins, Singer, and Weiner (2016) and Nembhard and Edmondson (2006) found that psychological safety in particular was important to enable learning in a health care team setting. Nembhard and Edmondson (2006) further underscored the importance of leader inclusiveness to team functioning, while Edmondson et al. (2001) suggest that hospital management should

TABLE 1 Treatments in our sample

	Open repair	Endovascular repair	Total
2013	17	1	18
2014	14	4	18
2015	15	6	21
2016	5	16	21
2017	17	19	36
TOTAL	68	46	114

foster physician leadership skills. In line with the opening statement of Ohno (1988, first published in 1978), Edmondson et al. conclude that: "In an industry context in which individual heroism and skill are assumed to be the critical determinants of important outcomes, … empowering a team and managing a learning process matter greatly for an organization's ability to learn in response to external innovation" (2001:712).

Gittell (2002) found that in the setting of surgical care for joint replacement, routines that enhanced interactions among participants had a positive effect on team performance. Avgerinos and Gokpinar (2017) found that particularly for complex tasks, team familiarity has a positive impact on team performance, and in line with Huckman (2003), they suggest that teams should be kept together when tasks are complex. In addition to complex treatments, those that are considered to be high tech also benefit from team familiarity (Wiegmann, ElBardissi, Dearani, Daly, & Sundt, 2007). Many organizations however use fluid teams—that is, teams of which membership changes over time—and accordingly, health care team research has often studied fluid teams performing a specific task (Avgerinos & Gokpinar, 2017; Nembhard & Edmondson, 2006). One example of a case study on stable teams that implement a new technology that is complementary to the incumbent technology is Edmondson et al. (2001).

Beyond the hospital walls, there is overwhelming evidence from research into manufacturing that relational embedding with suppliers has a positive effect on performance outcomes such as innovation. An important finding is that especially intensive communication (relational embeddedness factor) and goal congruence (cognitive embeddedness factor) are important to the successful involvement of suppliers (Yan & Dooley, 2013). An important challenge lies in designing mechanisms that motivate people to proactively share innovative ideas (Wagner & Bode, 2014), because an innovation-supportive culture often requires the simultaneous presence of the paradoxical elements of control and flexibility (Khazanchi, Lewis, & Boyer, 2007). One key element in increasing the likelihood of team effectiveness is jointly agreeing with all stakeholders on appropriate targets for a project. According to Petersen, Handfield, and Ragatz (2005), this is particularly important when someone is given a high level of responsibility. In the context of R&D project teams, Chandrasekaran and Mishra (2012) found that alignment between project metrics and organizational metrics can enhance psychological safety, as such alignment can provide an overarching structure for a team to build a more predictable environment for interactions. In a health care setting, Fredendall, Craig, Fowler, and Damali (2009) found that the lack of relational coordination between departmental units caused perioperative operational failures at a surgical services department in a community hospital.

What requires further attention is understanding how technologies in health care can be successfully implemented, and how team learning can support implementation (Edmondson, Winslow, Bohmer, & Pisano, 2003). According to Lemieux-Charles and McGuire (2006), the literature on the effectiveness of health care teams is "troubled by a lack of specificity regarding what teams are expected to be effective at doing." Research often ignores the specific goals set by teams themselves, and instead focuses on general measures such as mortality, blood loss, or length of stay. Clearly, the ETT tries to minimize these, but it is not their goal as such. With this study, we respond to the call of Lemieux-Charles and McGuire (2006) and take the goals set by the ETT members themselves as our point of departure.

3 | METHODS

To achieve insight into whether the ETT is achieving its goals, we follow Avgerinos and Gokpinar's (2017) advice to take an in-depth approach and Lemieux-Charles and McGuire's (2006) suggestion to study team dynamics longitudinally. In addition, we follow Hackman's (2003) advice to draw on all information available—qualitative, quantitative, and archival.

3.1 | Case selection

We conducted an in-depth case study at one of the eight to ten[1] hospitals in the Netherlands where endovascular reconstructions with custom-made stents of the entire aorta are being performed. Our data sources and details about the face-to-face interviews are provided in section 3.3. No medical data are reported in this article that can be linked to individual patients.

In our case, the new endovascular technology complements the existing open techniques, which will also be continued to be used and improved. The new technology required the addition to the team of new stakeholders, and in particular a much more involved role of the two device suppliers. Our unit of analysis is embeddedness between the members of the ETT and the effect it has on team learning. The outcome measure we focus on is the extent to which the ETT fulfills its own goals. Because the number of complex treatments is low and their diversity is very high, we cannot perform meaningful statistical analyses. Instead, we report absolute numbers and triangulate those with interview data.

Due to the extensiveness of the changes and learning required, we view the implementation as a process rather than an event. A process view inherently requires a longitudinal research design (van de Ven & Huber, 1990), and therefore we included data from the point of first implementation of the technology in July 2013, up until our interviews finished in July 2017.

We identified team learning in health care as a critical setting (Barratt, Choi, & Li, 2011) to study ways in which the effectiveness of health care can be enhanced. In order to gain fine-grained understanding of the ETT's own perception of achieving the goals it set for itself, we adopt an inductive case study approach. Such an approach is particularly suited to gain rich understanding (Eisenhardt, 1989).

3.2 | Case description

Arterial vascular disease includes any abnormality of the vessels that transport the blood from the heart to the organs (the arteries). Most types of arterial vascular disease are caused by a process called atherosclerosis. This process can cause arteries to clog, which can for example lead to a stroke or heart attack. Atherosclerosis can also cause arteries to widen. If this widening is more than 1.5 times the normal diameter of the artery, it is called an aneurysm.

Aneurysms are mostly found in the abdominal part of the main artery of the body (the aorta). The normal diameter of the aorta is approximately 2.5 cm varying with sex and body size. The most important risk factors for aneurysm formation are smoking, high blood pressure, obesity, and family history. The most important factors determining the prevalence of aneurysms are sex and age. Prevalence in men between 65 and 85 is highest at approximately 5 to 9% (Moll et al., 2011).

Aneurysms hardly ever cause symptoms until they rupture. The yearly risk of rupture increases with diameter growth of the aneurysm. At 5 cm, the yearly risk of rupture is approximately 3%; at 8 cm, this risk increases to over 40%. It is estimated that less than 50% of patients with ruptured aneurysms reach a hospital in time, and of those who do reach a hospital in time, less than 50% survive emergency treatment, creating an overall mortality after rupture of approximately 80% (Moll et al., 2011).

This high risk of mortality has pushed the development of treatment in the nonsymptomatic phase, that is, before rupture. The globally accepted guidelines for treatment of abdominal aortic aneurysms suggest to operate when the diameter exceeds 5.0 cm in women and 5.5 cm in men. At this diameter, the risk of dying of rupture is generally considered to be higher than the risks involved in nonemergency treatment.

Since the 1950s, open reconstruction has been the gold standard in treating aortic aneurysms. During the open procedure the abdomen is opened, the aorta is cross-clamped, and the diseased part is replaced by an artificial graft (flexible, tubular device made of synthetic cloth). This type of procedure poses high risks to the patient's cardiac, pulmonary, and kidney functions and hereby precludes patients with extensive comorbidities from being operated.

To make treatment of fragile patients possible—in surgery in general but especially in the case of cardiac and vascular interventions—research into minimal invasive techniques has burgeoned. These so-called "endovascular" approaches are based on the notion of treating the diseased vessel from the inside as opposed to from the outside. This means that access to the vessel from the outside, whereby the abdomen and chest have to be surgically opened, is no longer necessary. Instead an entry point (e.g., an artery in the groin or in the arm) is chosen to gain access to the vascular network.

In the case of endovascular treatment of aortic aneurysms, a large stent is placed in the aneurysm via the artery in the groin. Similar to grafts that are placed during the traditional open treatment, these endovascular stents can contain the blood flow and take off the pressure from the vessel wall, in order to prevent rupture of the aneurysm. Pioneered in the early nineties, the endovascular approach has become the treatment of choice for aneurysms of the abdominal aorta situated below the arteries to the kidneys (Figure 1a). If an aneurysm extends up to or above the arteries of the kidneys, they are called "complex" aneurysms (Figure 1b-d).

Up until the mid 2000s, complex aneurysms could not be treated with stents, as these would close off essential vessels branching from the aorta and hereby cause the organs supplied by such side branches to die, leading to the patient's death. This meant that open procedures with high mortality and morbidity rates were the only treatment option for complex aneurysms.

Advancements in technology resulted in the development of stenting techniques with which complex aortic aneurysms can be treated. These stents must be custom-made for each patient, because no two aorta's and their side branches are identical. Stents can be fitted with holes (fenestrations), or side branches, to ensure seamless integration with each individual aorta (Figure 2).

Such fenestrations and branches must be positioned at exactly the right height and angle to the most important side branches of the aorta. Toleration for deviation is practically zero. Via a guidewire technique the fenestrations or branches are connected to their "target vessels" that supply blood to the organs. This makes it possible to treat the entire aorta with stent grafts without compromising the blood flow to crucial side branches.

In line with their commitment to providing the best care possible to as many patients as possible, the Aorta Group decided to adopt the complex minimal invasive technique. To increase the effectiveness of the implementation of this complementary technique, the Aorta Group decided to form a dedicated ETT from their midst. Forming such a team of dedicated members was considered necessary because the low-volume, high-complexity nature of the new technique required additional learning and time investments of individuals and would not ensure enough exposure if the entire Aorta Group would participate. Selection to the ETT was an organic process combining self-proclaimed interest in the technology; recognition of capabilities; and the notion amongst senior medical specialists that the time investment needed for new skill acquirement would be more efficient for younger medical specialists.

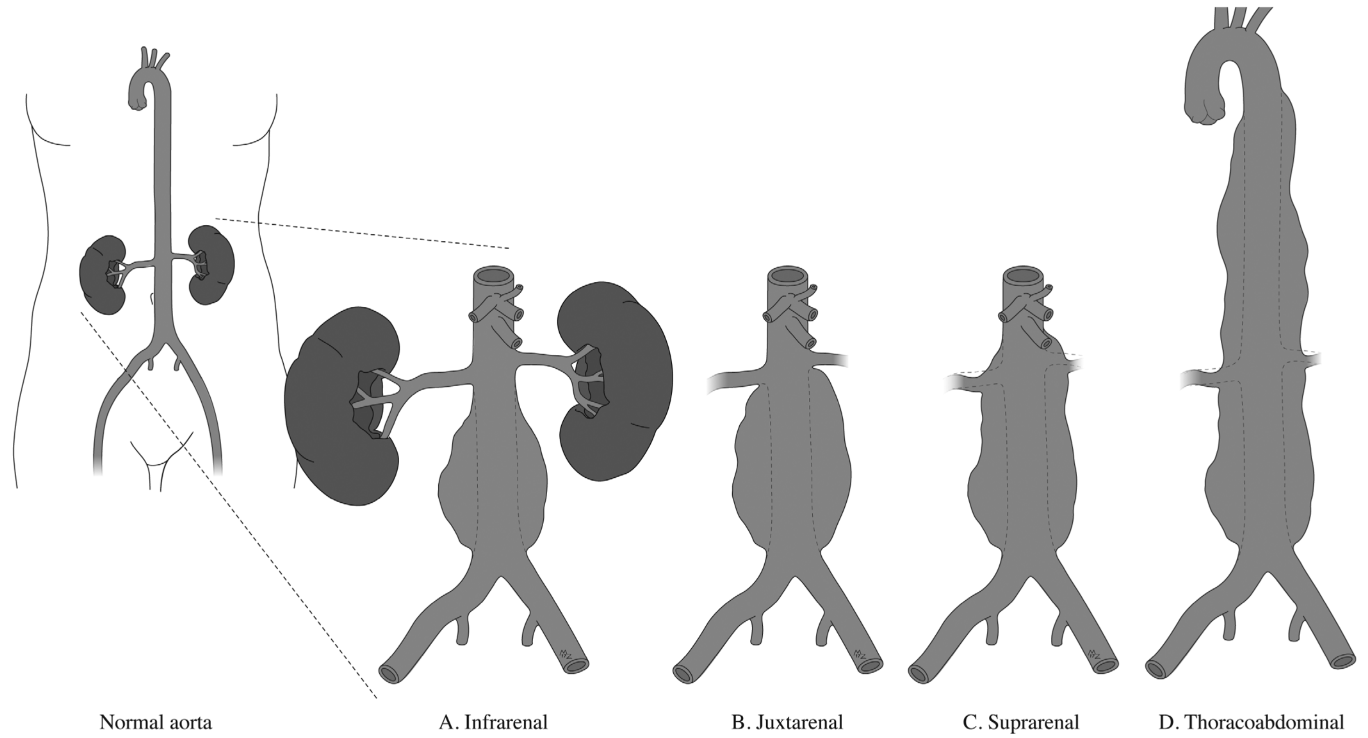


FIGURE 1 Four types of aortic aneurysms

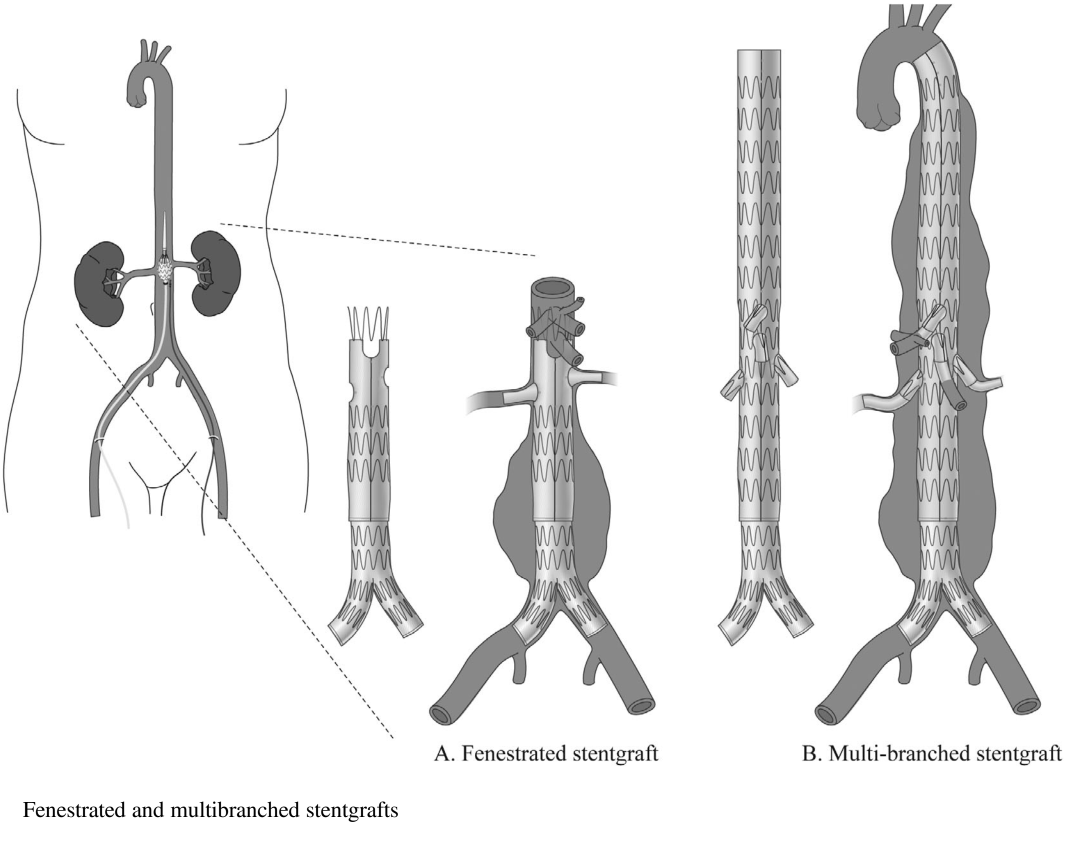


FIGURE 2 Fenestrated and multibranched stentgrafts

Before the formation of the Aorta Group, aortic pathology at our case hospital would be treated by particular specialists depending on the location of the pathology in the aorta (e.g., the chest or abdomen), or on the type of treatment selected (open or non-complex endovascular). Once a patient was linked to a particular medical specialization,

TABLE 2 Role description Aorta Group members

Roles that participate at the OR			
Function[a]	**Perioperative role**	**Intraoperative role Open treatment**	**Intraoperative role Endovascular treatment**
Vascular surgeon AG: 3 | Sample: 2	Chairs the Aorta Group meetings. Coordinates and conducts pre- and postoperative outpatient clinic visits of most patients (undergoing open or endovascular treatment).	Coordinates and participates in treatment together with thoracic surgeon.	Responsible for briefing, exposure and closure of access vessels. Coordinates and participates in treatment together with interventional radiologist.
Thoracic surgeon AG: 2 | Sample: 2	Coordinates and conducts pre- and postoperative outpatient clinic visits of about 25% patients undergoing open treatment.	Responsible for briefing. Coordinates and participates in all thoracic and thoracoabdominal procedures together with vascular surgeon.	Currently observer role, future participant role aspired.
Interventional radiologist AG: 2 | Sample: 2	Presides over stent design development and product selection.	*None*.	Coordinates and participates in all treatments together with vascular surgeon.
Anesthesiologist AG: 6 | Sample: 3	Responsible for pre-operative work-up of the patient.	Responsible for anesthesia and systemic stability of the patient during treatment; Responsible for spinal protective measures during treatment.	*Idem open treatment*.
Clinical neurophysiologist AG: 1 | Sample: 1	Responsible for work-up for monitoring of spinal function in selected cases.	Responsible for intraoperative monitoring of spinal function in selected cases.	*Idem open treatment*.
Scrub nurse AG: 3 | Sample: 2	Responsible for availability surgical equipment needed for both treatments.	Responsible for assistance with sterile exposure; Responsible for on-table handling of equipment and operator assistance; Responsible for surgical equipment on site.	Responsible for assistance with sterile exposure, surgical exposure and closure of access vessels; Responsible for surgical equipment on site.
Radiology assistant AG: 3 | Sample: 3	Responsible for ordering radiological equipment needed for custom-made stent used in endovascular treatment.	*None*.	Responsible for assistance with sterile exposure; Responsible for on-table handling of equipment and operator assistance; Responsible for radiological equipment on site.
Clinical neurophysiology assistant AG: 2 | Sample: 1	Responsible for outpatient clinic visit to test patient's baseline neurology for both treatments in selected cases.	Executes intraoperative monitoring of spinal function in selected cases under direct (online) supervision of clinical neurophysiologist.	*Idem open treatment*.
Supplier specialist AG: 2 | Sample: 2	*Proctor (MD)*: Advisory role when a new device or technique is considered. *Technician*: Advisory role in stent design. *Sales representative*: facilitates stent design process.	*None*.	*Proctor (MD)*: Present when a new device or technique is implemented, may participate in treatment. *Technician*: Infrequent attendance on supplier initiative to learn from practice. *Sales representative*: present during most routine procedures, advisory role.

(Continues)

TABLE 2 (Continued)

Function[a]	Perioperative role	Intraoperative role Open treatment	Intraoperative role Endovascular treatment
Roles that participate at the OR			
ICU doctor AG: 2 | Sample: 1	Estimation of risk during postoperative critical care.	Responsible for postoperative critical care directly following treatment.	*Idem open treatment*.
Perfusionist AG: 2 | Sample: -	Estimation of risk during perfusion in selected open procedures.	Responsible for extra-corporeal perfusion in selected procedures.	*None*.
Roles that do not participate at the OR			
Cardiologist (AG: 2)	*Consulting role*: Responsible for pre-operative cardiac work-up and treatment when necessary.		
Nephrologist (AG: 1)	*Consulting role*: Responsible for pre-operative nephrologic work-up and treatment when necessary.		
Clinical geneticist (AG: 1)	*Consulting role*: Responsible for pre-operative analysis when genetic disorder is suspected.		
Referring vascular surgeon	Guest at the Aorta Group meeting. Invited to partake in discussion about patients they referred to LUMC. Sometimes attend treatment as an observer.		

[a]Abbreviations: AG, number of people in this role in the Aorta Group; Sample, number of people in this role in our interview sample.

members of this specialization—based on their personal judgment—would decide on a specific treatment trajectory for the patient in question. Once the operation was scheduled, supportive staff such as scrub nurses and an anesthesiologist would be appointed depending on availability. That is, supportive staff would not be selected based on the experience or dedicated skills for the procedure in question.

Progress in medical science resulted in a shift from a disciplinary focus to an (organ) pathology focus leading to a surge in the formation of multidisciplinary teams in health care. In the same spirit, the Aorta Group was formed in 2011, bringing together members from several departments such as: vascular surgery, thoracic surgery, radiology, anesthesia, neurology, cardiology, intensive care unit (ICU), nephrology, and the perfusion as well as genetics departments. All of these members are involved in the treatment of aortic pathology, and all are invited to participate in the bimonthly Aorta Group meeting. Within the Aorta Group, some members are a part of treatment teams such as the ETT, while others have a consulting role. Members of treatment teams can be part of either the open treatment team or the ETT, or both. Table 2 gives an overview of all members of the Aorta Group, their perioperative role, as well as intraoperative role for both open as well as endovascular treatment.

Our interviewee selection criterion for this study was that interviewees in their role had to have a direct impact on procedural outcome of endovascular treatment (see description in the column "Intraoprative role Endovascular treatment" in Table 2). The stent suppliers are not official members of the ETT, but because they are invited to Aorta Group meetings and fulfill our interviewee selection criteria, we included them in our sample. Our case data support this decision as we learned that boundaries between the hospital-based members of the ETT and the stent suppliers become increasingly blurred. ICU doctors are not present at the OR, but because seamless coordination with the ICU is critical to treatment outcome, we included the ICU member of the Aorta Group in our interview sample.

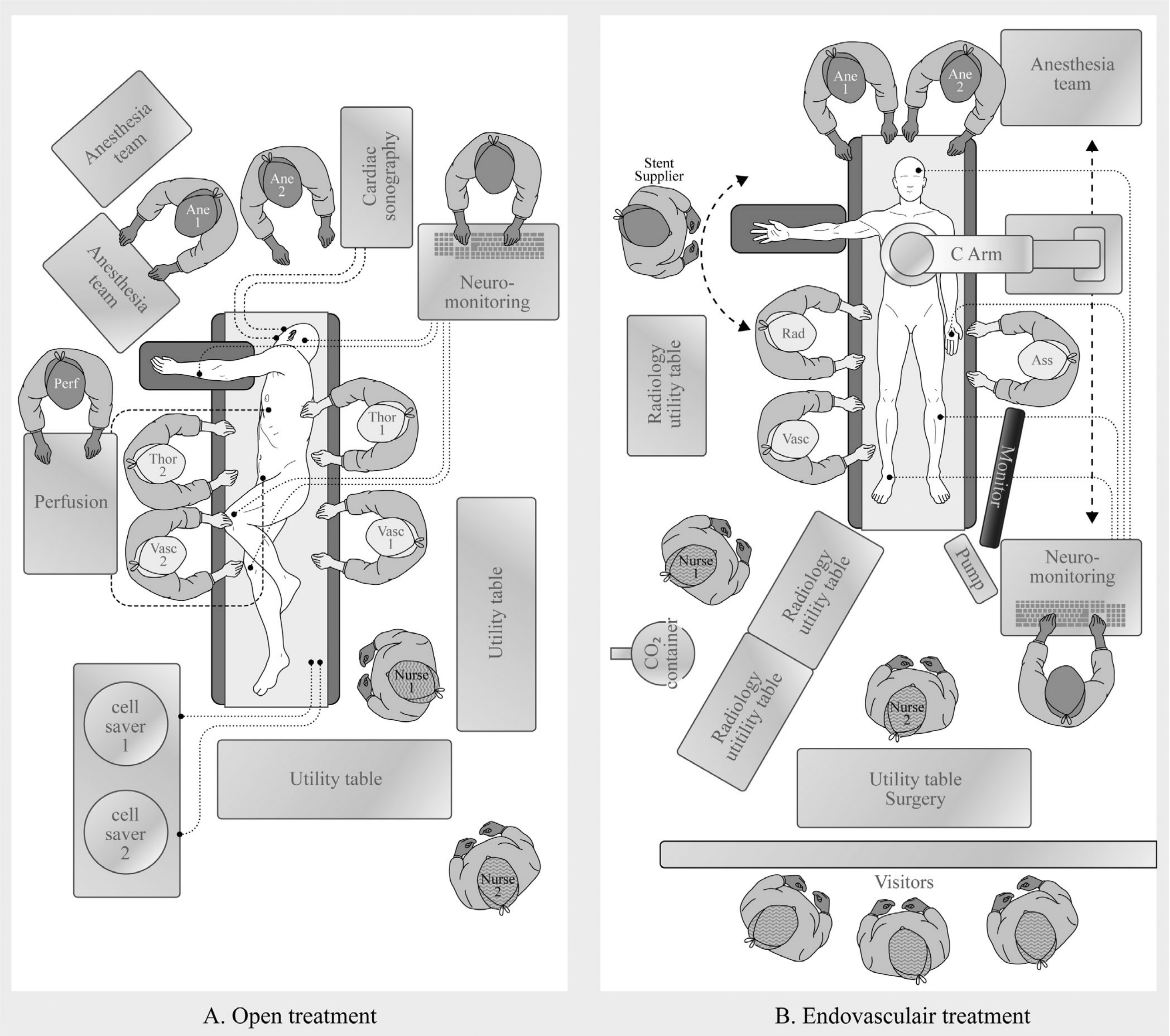
To ensure anonymity, we refer to the stent suppliers as Supplier 1 and Supplier 2. Both suppliers are able to produce stents for noncomplex aneurysms (Figure 1a—stent drawing not included), as well as fenestrated stent grafts (Figure 2a) for complex abdominal aneurysms (Figure 1b,c). Only Supplier 1 is able to produce multibranched stent grafts (Figure 2b) for thoracoabdominal aneurysms (Figure 1d).

Figure 3 provides an overview of the open and ETT composition at the OR. As can be seen, during the open approach (A), a thoracic surgeon is involved, while supplier representatives are never present. During an endovascular approach (B), the thoracic surgeon is not always present, but an interventional radiologist is always involved. Furthermore, a supplier specialist is often present (for different supplier specialist roles, see Table 2).

3.3 | Data analysis

We conducted an in-depth, longitudinal, inductive case study of the introduction of endovascular treatment in addition the traditional open treatment of complex aortic aneurysms by the Aorta Group in real time over four years. Our data consist of semistructured, face-to-face interviews conducted in 2017 with all 19 ETT members (for a list of interview questions see Appendix A); nonmedical data from all Aorta Group meeting reports; intraoperative treatment details as well as patient demographics of all 68 complex open aortic treatments and 46 complex endovascular treatments conducted by members of the Aorta Group during the four-year period between July 2013 and June 2017. To ensure the anonymity of patients, the first author was not allowed to view any patient-related documents. To ensure the anonymity of our interviewees, the second author, who is one of the three vascular surgeon members of the Aorta Group and the ETT, did not view the interview transcripts. The second author was not included as an interviewee in this study.

The first step in our study was to draw up a process map of all steps undertaken by the ETT for each patient from their presentation—either by their GP or another hospital—until the procedure (i.e., treatment) undertaken by the ETT (see Appendix B). Precise medical steps undertaken at the OR during the procedure are beyond the scope of the current study; interactions between team members at OR are discussed qualitatively in our findings section. The detailed process map in Appendix B was condensed into the Simplified Process Map as shown in Figure 4. This process map, along with the list of ETT members present during surgery in Figure 5, was shared during the second step in our study—the interviews—to ensure a common understanding of the process. To ensure a common starting point for all informants, the interviews were conducted during an 11-day period between June 26th and July 6th, 2017, after the consecutive series of 114 procedures in Table 1 was completed. We took this approach to avoid recency bias; a fresh memory of a procedure that went very well or not well at all could color our interviewees' answers. Our interviews lasted between 50 and 100 min.



A. Open treatment

B. Endovasculair treatment

FIGURE 3 Treatment team composition and position at OR

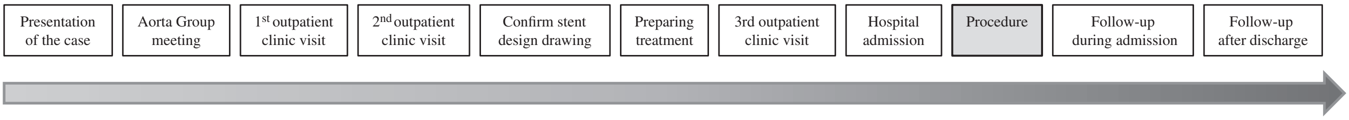


FIGURE 4 Simplified process map used during interviews

At the beginning of each interview, we explained to our interviewee that our main interest was finding out: "What you need to successfully fulfil your task in endovascular treatment." We transcribed all interviews verbatim and coded them using Atlas.ti as a supportive software. In our coding, we focused on all factors that our interviewees identified as enablers of their task—during endovascular treatment at the OR, but also outside of the OR. Table 3 provides a summary of the 14 main enablers that arose from our coding. We included how often and by which roles they were mentioned. Enablers are listed in descending order starting with the one that was mentioned by most interviewees. Our cut-off point was that enablers had to be mentioned at least ten times and by at least five interviewees. This resulted in 14 enablers in total (listed in column 1). We defined each enabler by going back to all related quotes in our interview transcripts and summarizing our interviewees' descriptions (in italics in column 1). Based on the extant literature, we subsequently coded each of the 14 enablers as either a relational embeddedness factor (Re); a cognitive embeddedness factor (Co); or a factor of team learning (TL) (see last column).

To further clarify our analysis process, we provide our coding tree in Figure 6. As first order codes, we provide examples that our informants identified as being important or particularly representative. We then axially coded these first-order codes to capture their commonalities in second-order codes. Finally we substantively coded our second-order codes into aggregate dimensions (Gioia, Corley, & Hamilton, 2012). As in Table 3, we relied on the extant literature on team learning and embeddedness when defining our aggregate dimensions in order to ensure a meaningful discussion.

The third step in our study was a detailed analysis of the consecutive series of 114 treatments included in our sample. For each patient we recorded, amongst others, date of treatment, age, and BMI. Subsequently, the second author developed an endovascular treatment complexity coding system (Table 4), which was verified by one additional vascular surgeon and one interventional radiologist who are part of the ETT.

The three physicians independently rated all 46 cases included in our study, at level 1, 3, 5, or 7—with 1 being least, and 7 most complex. The complexity of a treatment depends on individual patient pathology, because this dictates which stentgraft is needed, which roles should be represented at OR, and whether any additional supportive care is needed. Results were compared and all three specialists, independently, coded all 46 treatments exactly identically.

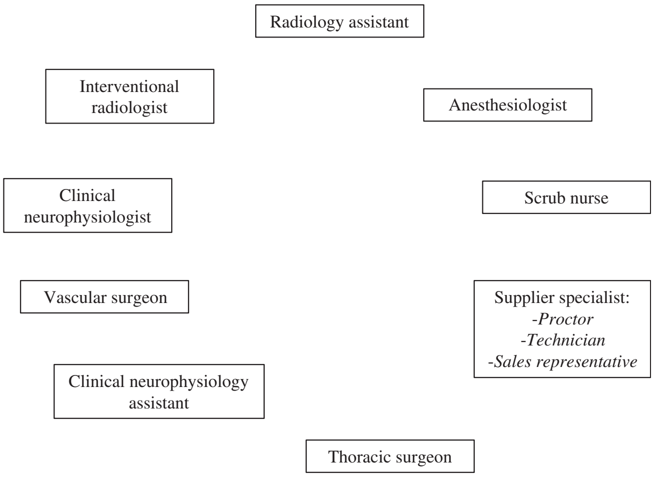


FIGURE 5 Overview of team roles used during interviews

As an additional test for our complexity coding scheme, we calculated the averages of the preparation time of the anesthesiology and surgery teams for each level of difficulty, based on our 46 cases. These times are routinely documented during treatment at the OR in the electronic patient file used at the LUMC. While indeed preparation time increases with complexity for the first three levels, preparation time for treatments of complexity level 7 is slightly lower than that of level 5. According to the team members, this is because approximately 2 hours of preparation time at OR represents a plateau for any complex procedure.

4 | FINDINGS

4.1 | Relational embedding

Our data presented in Table 3 and Figure 6 show that relational embedding assists team members in their learning of new endovascular technologies, which in its turn supports the overall implementation efforts. Perioperatively, relational embedding mainly takes place during the bimonthly Aorta Group meetings. All vascular surgeons; thoracic surgeons; interventional radiologists; and selected anesthesiologists; a clinical neurophysiologist and his assistants; perfusionists; ICU doctors; cardiologists; a nephrologist; a clinical geneticist; all regional surgeons who refer their complex aortic patients to the LUMC; and two supplier specialists are

TABLE 3 Main enablers of endovascular technology implementation as identified by interviewees

	Vascular surgeon	Thoracic surgeon	Interventional radiologist	Anesthesiologist	Clinical neurophysiologist	ICU doctor	Scrub nurse	Radiology assistant	Clinical neurophysiology asst.	Supplier specialist	Tot. Interviewees | cites	Factor coding[a]
1. **Intraoperative role clarity**.	**2**[b]	**2**	**2**	**3**	**1**	**1**	1	**3**	**1**	**2**	18	**Co**
Knowledge and acceptance of what each participant brings to the table.	*9*[c]	*8*	*21*	10	1	1	17	8	*10*	*12*	97	
2. **Working as a dedicated team**.	**2**	1	**2**	**3**	**1**	**1**	**2**	**3**	-	**2**	17	**Co**
Recognition of importance of familiarity with other members and sharing a goal.	*13*	4	*12*	8	3	*6*	*17*	*22*	-	5	90	
3. **Learning attitude**.	1	1	**2**	**3**	**1**	**1**	**2**	**3**	-	**2**	16	**TL**
Focus on proactive acquirement of medical skills for endovascular treatment.	2	6	*22*	14	1	*4*	*28*	12	-	10	99	
4. **Involvement of stent suppliers**.	**2**	**2**	**2**	1	**1**	-	1	**3**	-	**2**	14	**TL**
A cooperative stance of suppliers in ordering and delivery process of stents.	*23*	*13*	*16*	2	2	-	3	16	-	*25*	100	
5. **Ownership of treatment**.	**2**	**2**	**2**	-	-	-	**2**	**3**	**1**	**2**	14	**Co**
Recognition that Aorta Group is responsible for the treatment.	6	16	*18*	-	-	-	4	7	1	4	56	
6. **Cooperation perioperative**.	**2**	1	**2**	2	**1**	**1**	**2**	**3**	-	-	14	**Re**
Proactive stance towards sharing information cross-disciplinary.	*10*	1	6	12	1	*9*	4	6	-	-	49	
7. **Process improvement focus**.	1	1	1	2	**1**	**1**	**2**	**3**	-	1	13	**TL**
Focus on continuous improvement of processes that support treatment outcome.	3	6	2	2	*3*	*3*	6	*31*	-	2	58	
8. **Commitment to the team**.	1	1	**2**	**3**	-	-	**2**	2	-	2	13	**TL**
Going above and beyond job requirements to support team outcome.	4	1	12	5	-	-	*15*	8	-	5	50	

(Continues)

TABLE 3 (Continued)

	Vascular surgeon	Thoracic surgeon	Interventional radiologist	Anesthesiologist	Clinical neurophysiologist	ICU doctor	Scrub nurse	Radiology assistant	Clinical neurophysiology asst.	Supplier specialist	Tot. Interviewees | cites	Factor coding[a]
9. **Selection of team members**.	1	-	**2**	2	-	-	**2**	2	**1**	-	10	**Re**
Pride in being asked to the team, based on skills and/or personal interest.	2	-	8	5	-	-	3	8	*3*	-	29	
10. **Enjoyment of work**.	-	1	-	2	**1**	-	**2**	**3**	-	-	9	**Re**
Level of gratification members feel due to participation in treatment.	-	1	-	5	*4*	-	*17*	8	-	-	35	
11. **Innovation focus**.	1	**2**	-	-	**1**	-	1	1	-	**2**	8	**TL**
Belief that the new technology is needed to advance patient care.	6	5	-	-	2	-	2	1	-	2	18	
12. **Hierarchy in team**.	**2**	-	1	1	-	**1**	1	-	-	1	7	**Co**
Recognition of disciplinary hierarchy and concomitant responsibilities.	2	-	1	4	-	1	3	-	-	1	12	
13. **Audacity to try something new**.	1	1	1	-	**1**	**1**	1	-	-	1	7	**TL**
Willingness to start with a fundamentally different approach.	12	1	5	-	*3*	*5*	2	-	-	7	35	
14. **Trust in each other**.	**2**	-	-	1	-	-	1	**3**	-	-	7	**Re**
Willingness to be vulnerable to the behavior of others.	5	-	-	2	-	-	1	4	-	-	12	
Total = 19 interviewees, 14 factors											**740**	

[a] Abbreviations: Co, cognitive embeddedness factor; Re, relational embeddedness factor; TL, team learning.

[b] Numbers are in bold when all interviewees in this role mentioned this factor.

[c] Numbers are in italics when all interviewees in this role mentioned this factor at least three times.

- No-hurdle, cross-level, habitual telephone communication.
- Participation in preoperative briefing by all team members.
- Intraoperative culture of “thinking out loud” at main steps.
- Attendance of cross-level social gatherings by team members.

- Culture built over time of listening to other’s opinions.
- Openly sharing of (potential) problems without shame.
- Sharing of patient information without sense of entitlement.

- Differences in position and abilities between members are accepted and utilized.
- Unquestioned intraoperative hierarchical line of command.
- Voiced recognition of necessity each member’s contribution.
- Appreciation of approachability “young” medical specialists.

- At OR no other conversation except concerning the procedure.
- All present at OR during treatment are fully dedicated.
- Any unanticipated material needed will be fetched and used.
- Any delay into individual free time accepted without mention.

- Everybody always present in time for preoperative briefing.
- Everybody always stays for postoperative briefing.
- Strong sense of interdependence between team members.
- Strong sense of obligation to enable task execution others.

- All procedures, including patients’ first day and night after treatment, are discussed in detail with all stakeholders.
- Much more information than needed to perform individual tasks is shared (e.g. an unused stent was unfolded for OR support staff who are never directly involved in deployment).

- The stents represent a new technology requiring many new skills: team members learn from each other, and share information about their own improvements.
- Relevant developments in respective disciplines are explicitly shared between ETT members.

- Growing familiarity with others’ way of working and body language, improves intraoperative anticipation and interpretation of, and response to, other’s actions.
- Ongoing conversation about learning points of growing number of shared experiences.

FIGURE 6 Code aggregation diagram

invited to these meetings. Participation in the meeting is encouraged, and trainees from all disciplines are stimulated to attend these meetings.

Each patient is presented, and the diagnostic imaging is reviewed together. The team member who brought in the case will suggest a treatment option after which all of those present are invited to discuss this choice. The goal of the discussion is to share information and build toward a consensus on treatment. To the extent possible, the wishes of patients are also weighted in the discussion. The meetings in our sample all lasted between 1 and 1.5 h and 5 to 15 patients were discussed each time, with 10–20 min discussion per patient being common. Some patients are discussed multiple times.

While discussions can be heated, consensus is always reached. One interviewee called the meeting “the smallest part of the hourglass,” meaning that it represented the main hurdle, or most important test, for a treatment decision. Another interviewee mentioned that anything can be voiced during these meetings, while during treatment at OR there is much less time for discussion. During the meeting, a treatment decision is reflected on from all disciplinary angles, in order to reveal all potential problems that could possibly be

TABLE 4 Endovascular treatment complexity coding scheme

Code[a]	Type of endo vascular aortic repair (EVAR)	Preparation time (min) anesthesia plus surgery
1	1 and 2 fenestration EVAR (Figure 2a)	71
3	3 and 4 fenestration EVAR (Figure 2a + 1 or 2 proximal fenestrations)	84
5	Branched EVAR (Figure 2b)	123
7	Branched and fenestrated aortic arch EVAR, and emergency cases	112

[a] 1 = less complex, 7 = most complex.

encountered. Up-to-date clinical evidence guidelines form the basis of decision-making. For a decision-to-treat to be supported by the entire Aorta Group, it must comply with all standards set by each discipline. All Aorta Group members consider it to be their responsibility to keep up with advancements in standards as well as general developments in their discipline that may be relevant for the complex aortic treatments.

The most important function of the Aorta Group meeting is that by having an open discussion, it creates support from the entire team for all treatment decisions. From our data, it became clear that some form of bias for either the open or endovascular approach cannot be prevented. In particular interventional radiologists indicated that they chose their profession because they believe in the minimal invasive approach that characterizes their daily work and will therefore be inclined toward this approach. Nevertheless, because the atmosphere is open and supportive, everyone has their say and receives input from others. Besides the bimonthly meetings, frequent, informal communication, and the trust that was built between the ETT members enabled relational embedding.

With regards to relational embedding between hospital members and stent suppliers, there is a stark contrast between endovascular and open treatment. Most important is the way in which a stent is customized for a patient. During an open procedure, the treatment team selects an off-the-shelf graft and customizes this in-situ, with the patient on the table. This includes cutting to size, sewing in branches, or cutting out fenestrations. The advantage of this approach is that customization happens on the spot and as close as possible to the anatomy of the patient at the exact moment of the operation. During an endovascular approach, a custom-made stent is designed and built before the operation, based on a CT-scan of the patient. The stent arrives folded up in a sterile deployment device, and can therefore not be adjusted anymore.

The two main supplier implications for these differences are first the costs—off-the-shelf solutions at their price of about 500 euros, are approximately 1–2% of the cost of custom-made stents, which can cost between 30,000 and 40,000 euros per procedure. Secondly, for the endovascular approach, the vascular surgeon and interventional radiologist co-design the stent together with the technicians at the stent supplier. Characterizing the difference, one of the stent suppliers referred to the supply of off-the-shelf solutions as “shifting boxes,” meaning that this is a simple purchasing function that can be executed by nonmedical staff. Co-designing and building a custom-made stent however surfaced as a highly salient process in our study. At ten weeks leadtime, it was also very clearly the bottleneck in the entire treatment process.

In the event that a custom-made stent does not reach the hospital in time, the procedure is cancelled. Such an increase in time until treatment increases the patient's risk of aneurysm rupture. Besides a huge disappointment and psychological burden for the patient and their family, cancellation also leads to a loss of operating capacity (booked OR; anesthesiologist; supporting personnel, etc.). Furthermore, rescheduling the procedure requires considerable time and logistical effort: All steps in the inset “Processing by planners” in phase 2 of Appendix B must be duplicated. The relational embeddedness factors of frequent communication and mutual trust to ensure that stents are designed correctly and arrive on time, clearly is essential to the ETT.

4.2 | Cognitive embedding

The Aorta Group functions as a crucial communication platform for all disciplines involved. Relational embedding gave rise to a culture of “listening to each other”—especially between disciplines; which subsequently enabled cognitive embedding due to shared norms, shared goals, and a sense of shared responsibility. Group members gain a full picture of the patient and their functional status and reach a decision that contributes to their shared goal of positive patient outcome. Hierarchical relations between as well as within disciplines exist, but members strive to not have those play a role in the meetings. Because of increasing “super-specialization” in modern day medicine, certain group members—although traditionally lower in the hierarchical line—can have superior experience and knowledge with regards to certain procedures or patient categories. It is paramount that this is accepted by those higher in rank in order to reach a decision which is in the patient's best interest. Key to reaching a balanced decision according to our interviewees is respect, not only for the individual, but also for the disciplines represented.

And while there is an unquestioned intraoperative hierarchical line of command, the Aorta Group explicitly calls for discussions that rise above this structure. Entitlement to patients; shame, or fear of making mistakes, are aspects associated with a traditional surgical culture that the Aorta Group explicitly aims to avoid. Important in achieving this, according to our interviewees, is that the medical specialists of the ETT are all relatively junior. According to one anesthesiologist for example, the ETT surgeons received some training in anesthesia during their clinical rounds, which led to a better understanding of, and respect for, his role during the procedure. According to this interviewee, this contrasts sharply with some of the senior surgeons—not involved in the ETT—who are known to remark that: “Back in the day we used to do anesthesia ourselves on the side,” indicating a lack of respect for his specialized knowledge according to this anesthesiologist. Likewise, one of the stent suppliers remarked:

> I have seen the acceptance of my feedback during the procedure grow over the past years. This is because of the younger generation—they accept a lot more feedback. This is because their training changed. Over the years, hierarchy in the hospital is decreasing.

In line with Ohno's statement, one team member remarked: “It's about teamwork, and not about who does the trick [of placing the stent].” During treatment, everybody is focused on the same shared goal—patient survival.

Endovascular treatment of complex aortic aneurysms is very high risk surgery, and as soon as the ETT starts with the briefing of a procedure, all team members are exclusively focused on achieving the maximum outcome for that patient by fulfilling their role to the best of their ability. One interviewee described the situation during treatment as follows:

> The team members show a strong sense of being responsible together. This is palpable. You know you can rely on them at any point. I feel comfortable when others also feel responsible.

Although team members from different disciplines have different tasks, these tasks are all essential to patient survival. All tasks are continuous and intense and need to be very closely coordinated with the tasks of other team members. In the case of conflicting tasks due to situational circumstances—for example, when the vascular surgeon wants the anesthesiologist to lower the blood pressure for safer stent deployment, but the anesthesiologist considers this unwise because they suspects a cardiac problem—differences are always rationally and flexibly resolved in the best interest of the patient. Just before critical steps are taken these are mentioned out loud. This gives all members who are actively participating in treatment the opportunity to clarify their position and possible worries. This short break is ended by a clearly spoken “continue.” If an emergency situation occurs, the team will work toward a stable situation in order to create time for a general discussion of the situation, led by the procedural leader. Leadership in such instances is always clearly connected to the type of emergency: a severe bleeding from the groin artery will be the responsibility of the vascular surgeon; in case of a collapsing stent causing occlusion of an artery to a kidney the interventional radiologist will be in charge; and during an intraoperative heart attack the anesthesiologist will take the lead.

During the procedures no other conversations, accept about the treatment, are held. Endovascular surgery differs fundamentally from open surgery with regards to hand-eye coordination. In open surgery, vision is connected to the position of the hands—the natural way of connecting visual input to tactile feedback. When for example the hands press a gauze on a bleeding surface, the eyes will verify position. If no change in position occurs, this function can be prolonged without visual verification, because one can trust in tactile feedback. There are many situations like this in open procedures, giving opportunity for conversation.

Endovascular surgery differs in two ways from open surgery: Firstly, there is almost no tactile feedback, resulting in higher dependency on visual input. Secondly, the visual input does not connect naturally to actions of the hands. Acquiring endovascular skills for trained open surgeons depends on their ability to redefine hand-eye coordination in the brain. This fundamentally different task creates a need for constant attention; keeping the eyes focused on the screen while the hands act. In complex endovascular surgery, there are no naturally controlled situations such as pressing a gauze without watching, which could provide opportunity for unrelated conversation.

The team members' commitment to the shared goal of patient wellbeing is further exemplified by the fact that if treatments continue beyond standard working hours, this is accepted without anyone mentioning it. Also, all dedicated team members indicated that they are available during their free time to provide information to other team members. Two senior medical specialist members of the Aorta Group, who are not a member of the ETT, both indicated that it is crucial that at all times, 24/7, one of the ETT medical specialists is responsible and available to fulfill ETT-related demands, and that they are available to support them where they can.

Our supplier interviewees indicated they were as absorbed as the other team members in securing successful patient outcome. Our interviewee from one of the stent suppliers indicated they always imagined the patient on the table was their father. Our interviewee from the other stent supplier however described an intermediate step. According to him:

> Success for the doctor is treating the patient in the right way. I have no relation to the patient. My task is to provide the doctor with tools to

> achieve success. And if the doctor achieves success, I do too.

4.3 | Team learning

All intraoperative tasks conducted by the ETT are highly interrelated. Also preoperative, close coordination is essential to ensure the team advances its knowledge. The design of custom-made stents for example is an iterative process whereby the first step entails a surgeon and interventional radiologist sending a CT scan and a first broad-brush stent design to the supplier. The supplier subsequently develops a detailed design, which is re-checked by the surgeon and the interventional radiologist against the CT scan. Successful deployment of the stent subsequently depends equally on stent design; patient condition; as well as the operating team's skills.

One example of how relational embedding—in particular frequent communication and information sharing—led to team learning is a case whereby an unused stent—an uncommon situation—was unfolded in an ad hoc session for OR support staff who are never directly involved in deploying a stent. The two scrub nurses who we interviewed both indicated that this was a turning point in their interest in the procedure, as well as their feeling of commitment to the team. One of them remarked:

> [A vascular surgeon] came to us to show a stent, its markers. Normally you don't get to see those things of I don't know how many euros. So I thought: "*That* is what they are talking about, and that's how it's folded up, and if they do this, it deploys like that." It was so much more insightful for me from then on. Before, I would simply get lost at one point. Now I finally understood what they were trying to do and why they have to be so concentrated.

It should be noted that the main intraoperative task of scrub nurses is assisting in opening and closing the groin. For most of the procedure, they retreat to the visitors' area, which is behind a glass wall (see Figure 3b). However, their improved understanding of the other team members' behavior during endovascular treatment had a positive effect on the overall team atmosphere. The "dry" deployment of an unused stent provided a shared learning experience that increased their understanding and interest.

According to our interviews, growing familiarity with others' way of working and body language improves intraoperative anticipation and interpretation of, and response to, other's actions. According to one support staff interviewee:

> It matters whether you know each other. If you know somebody's body language, you can recognize if the procedures is difficult or not. And vice versa, because you trust each other, the surgeon may think: "Last time she was doing [her task] with a smile on her face, but now she seems to be in trouble." If it was a new [support staff] each time, they [the specialists] may also think: "Can she really do this, is this not too difficult for her?"

Team learning involving a stent supplier can be illustrated by the following example: Patient A had a suprarenal aneurysm (Figure 1c) for which a custom-made stent was produced. During the procedure massive blood loss occurred due to a defective deployment system. This presented a life threatening situation for which there was no obvious solution available—retracting or quickly deploying the device was technically impossible. The situation was temporarily controlled by sealing the deployment system with sterile wax (used in orthopedic surgery), which created time for an on-site discussion between the vascular surgeon, the interventional radiologist, the anesthesiologist, and the stent supplier. Because no simple solution could be agreed upon, live contact was established between the treatment team, an experienced proctor working in another country at that moment, and the technical planning center of the supplier firm in yet another country. In this ad hoc multiparty discussion, a way to safely dismantle the deployment device against instructions for use (IFU) was agreed upon, creating the possibility to close off the defect valve and still be able to accurately and safely deploy the stent. This cross-functional and cross border discussion took 25 min, after which the sterile wax was removed and the operation successfully continued.

Both stent suppliers stressed the importance of team familiarity. One stent supplier mentioned that from the surgeons on the team, he only needed "half a word" to understand what they need during a procedure. Both supplier interviewees indicated that their personal connection with the ETT's medical specialists provides an important platform for information exchange: The supplier learns from use in practice, while medical specialists learn from the technical knowledge of supplier representatives. The following example illustrates this team learning process: Patient B had an aneurysm, which contained two compartments. The main compartment was treated with an off-the-shelf stent. To close off the second compartment, a new type of custom-made plug device, separate from the main stent, was used. A proctor of Supplier 1 was present during the procedure to give advice on the implementation of the device. In addition, a senior technician of the R&D department of Supplier 1, who had been directly involved in designing the device, was present. His presence was not called for by the ETT, but requested by the stent supplier firm. The technician's intraoperative role was giving advice complementary to the

TABLE 5 Treatment complexity and patient demographics

		Juxtarenal and suprarenal treatments				Thoracoabdominal treatment			
		Open	Endo	Percentage treatments endovascular	Average complexity endovascular	Open	Endo	Percentage treatments endovascular	Average complexity endovascular
Phase I	2013	8	1	11%	1	9	0	0%	-
	2014	7	1	13%	1	7	3	20%	5
	2015	8	4	33%	2	7	2	13%	5
Phase II	2016	4	7	64%	2.7	1	9	69%	5.4
	2017	7	11	61%	2.5	10	8	42%	5.7
Average BMI phase I		26.9	26.0[a]			24.9	29.7		
Average age phase I		71.2	72.5			63.0	73.0		
Average BMI phase II		25.5	27.2			24.7	25.2		
Average age phase II		71.4	74.8			64.4	69.8		
Total treatments		34	24			34	22		

[a] This value in Phase I is against the expected trend. However, numbers here are particularly small.

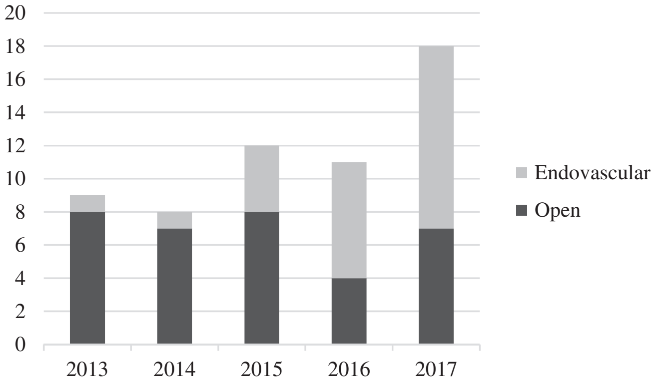


CHART 1 Juxtarenal and suprarenal treatments

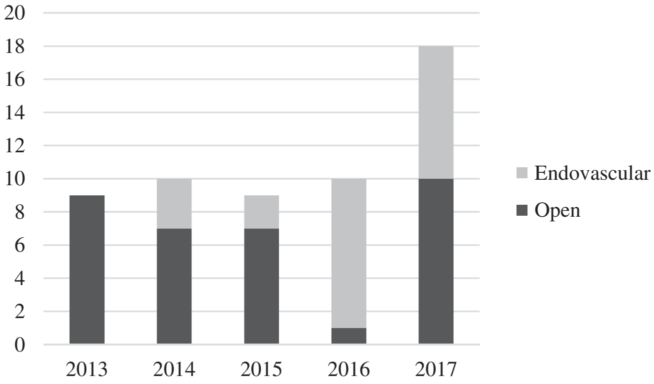


CHART 2 Thoracoabdominal treatment

proctor's advice, but more importantly, he was keen to learn from the live device performance that he had codesigned.

4.4 | Achieving ETT goals

The ETT's goal are (1) treating more patients; (2) offering more tailor-made care; (3) providing endovascular treatment in emergency situations, and ultimately, (4) offering patient-centered care. In our attempt to understand the team's success in achieving these goals, we looked at the treatment date, patient age, and BMI, as well as complexity of all 46 treatments. While the numbers are too small to perform meaningful statistical analysis, our descriptive overview of treatments (Table 5 and related Chart 1 and 2), show that the ETT is successfully achieving goal 1: Treating more patients.

From our interview and treatment findings, two periods in the team's learning process emerged: Phase I (2013–2015): Start-up; and Phase II (2016–2017): Scale-up. Table 5 indicates that during Phase II, Goal 2: Offering more tailor-made care is being achieved. Patients receiving endovascular treatment in this period are on average heavier and older than those receiving open treatment. Particularly open thoracoabdominal treatment entails high risk for the former group. In Phase II Goal 3: Performing emergency endovascular treatments is also achieved as the ETT conducts three emergency endovascular reconstructions.

Reaching a level of equally strong skills in both technologies—open and endovascular—should ultimately lead to an increase of patient involvement in their own care path by offering more choice, known as patient-centered care. After our data collection finished in July 2017, the ETT started Phase III: Maturity, characterized by more active patient involvement. During this phase, the team felt sufficiently comfortable in its endovascular reconstruction skills to involve the patient in the decision whether to treat their aortic disease open or endovascularly. Starting in July

2017, patients with complex aortic disease visiting the outpatient clinic, in addition to face-to-face explanation by the lead physician, also received a leaflet to take home (designed by the second author, and rewritten for a nonmedical audience by the first author of this article) detailing the benefits and drawbacks of both approaches. More active involvement of patients in their own care path is widely recognized as an important road to improved health care delivery.

5 | DISCUSSION

In this article, we address the question how a multidisciplinary health care team can successfully implement a new technology that profoundly impacts individual team members' roles. As our outcome measure, we take the goals that the team set itself: (1) treating more patients; (2) providing tailor-made care; (3) performing emergency endovascular treatment; and ultimately; (4) providing patient-centered care. While high-level performance metrics often used in health care team studies—such as blood loss and mortality—are clearly important for the ETT, they are not the ultimate goal the team is striving for. We echo the call of Lemieux-Charles and McGuire (2006) that health care team scholars should look at what teams themselves identify as their goals.

Essential to the interpretation of our findings is that first and foremost, the technology we studied is new and high-risk, and therefore cannot be "prototyped." However advanced lab-testing will become, it is never identical to a living human being. And once actual patients are treated using new devices or equipment, there is absolutely no leeway for testing or trying. There also never is a counterfactual (the same patient receiving another treatment).

Secondly, there are no fixed and validated external guidelines with regards to which devices or equipment should be used. Individual treatment teams mostly have the discretion to choose what they would and would not like to use. Reputation in the field amongst peers is important, but also illusive. Not until a very large group of patients has been treated using the new technology, who were subsequently able to continue their daily life for a fair amount of time, will there be outcome measures to meaningfully compare different team learning approaches to technology implementation. As it stands, that point has not yet been reached.

Thirdly, there are mostly no fixed guidelines as to what exactly has to be in place—materially and also with regards to the treatment team's hard as well as soft skills—to make implementation a success.

This context justifies the methodology we adopted: an in-depth, longitudinal case. We found that relational and cognitive embeddedness factors supported team learning, which was instrumental in the ETT achieving its goals. Relational embedding at the ETT is exemplified by no-hurdle, frequent communication, and high attendance at the Aorta Group meetings. Intraoperatively, the members of the ETT share specialist knowledge and feel free to reflect on potential problems. Important cognitive embeddedness factors are the shared norms regarding roles and behavior during treatment at the OR that encourage members to go the extra mile. ETT members feel a sense of belonging to the ETT that inspires them to learn from others, as well to share their own experience.

While norms and shared mental modes have also been found to *directly* impact health care team outcomes (Temkin-Greener, Diane, Kunitz, & Dana, 2004), our findings suggest that embeddedness factors particularly impact health care outcomes through their enabling impact on team learning.

5.1 | Implications and future research

The absence of performance data regarding complex endovascular aortic reconstruction makes an evaluation of the ETT's medical outcomes impossible. Technology implementation must be: (1) "first-time-right" because there are no "test" patients; (2) internally judged and validated, and; (3) learned "on-the-job" because there is hardly access to external learning. In addition to our findings regarding team learning, we also gleaned insights from the value chain that includes the management of the LUMC and the two supplier firms. Zooming out to this level, several potential hurdles to achieving the ETT's goals came into view.

Firstly, our interview data indicate that important improvements can be made with regards to organizational dynamics at the hospital. How many custom-made stents the ETT can plan depends on how much budget is allocated for this by the surgery department and indirectly the hospital management. This is based on historical precedent. The budget for stents is subsequently allocated by the Aorta Group to their patients on a rolling basis. Requests to increase the budget during the year are negotiated informally at the initiative of medical specialists. These negotiations are difficult because, according to one of our interviewees:

> You can't say for all cases: "This is objectively the best treatment." And this provides a window for underlying political considerations and decision-making at the hospital level to impact treatment decisions. But this shouldn't be the case. *Only* the Aorta Group should carry the treatment decision together on *their* shoulders.

We found that the self-image, as well as assumed capability of medical specialists is linked to their qualitative but also quantitative output. For medical specialists in Dutch academic hospitals, treatment decisions are never linked to personal financial gain. However, status can play a role. According to one stent supplier:

> For a vascular surgeon this [complex stents] is about the nicest trick he can do. So surgeons think: “Well, let me try this. It's new, and if it works, I'll be on stage at the next conference.”

Absent treatment outcome data that can be meaningfully compared, the status of hospitals is largely based on the volume of complex procedures that are conducted. And while suppliers are clearly keen on the successful outcome of treatments for which their materials are used—in the Netherlands procedure outcome and producer of stent are registered centrally—the standing of hospitals vis-à-vis suppliers is based on the volume they purchase. Both stent suppliers informed us that they do not record patient outcome of the stents they supply, nor do they report device success rates in their yearly reports. Only financial results are extensively recorded and reported.

One stent supplier interviewee described another decision variable unrelated to individual patients. This interviewee explained that with the unfolding of a stent in an actual aorta, the precise shape of the aorta can be slightly changed, meaning that the fit of even a CT-scan-based, custom-made stent is never 100% perfect. However, if a supplier is in doubt whether an off-the-shelf endovascular stent or custom-made stent is better, financial considerations are known to sway the decision toward a more expensive custom-made stent. This inclination however may be intuited, and therefore counterbalanced, by the medical specialists on the ETT.

However, our other stent supplier interviewee described a decision variable that is much harder to detect by the hospital-based ETT members. According to this interviewee, a small part of their personal reward system is based on sales volume. Because stent suppliers have a crucial role in deciding whether an endovascular approach is possible, we asked the question whether their personal reward system based on volume could sway a decision when an evaluation period is drawing to a close. Our interviewee could imagine that indeed this may be possible.

Considering these findings, we find it surprising that an interorganizational angle on the notion of embedding in health care value chains has not been taken more extensively (for an exception see Gittell & Weiss, 2004). Particularly considering the fact that supplying industries such as the medical device industry or pharmaceutical industry have come under increased societal scrutiny for their focus on shareholder interests. Shared goals, as part of cognitive embedding, appeared to enhance team learning. The above however suggests that the hospital-based ETT members mostly have different goals than the stent supplier.

According to de Vries and Huijsman (2011), there are many potential barriers related to relational embedding that need to be leveled when implementing supply chain partnering in health care. McCutcheon and Stuart (2000) identified power differentials and diverging interests as hurdles to the integration and coordination of processes along the health care supply chain. Our findings indicate that the insights gained from the decades of research conducted on buyer–supplier coordination in the OM literature, may be fruitfully applied to the interface between health care providers and their supplying industries.

Another promising avenue for future research is the salience of generational differences that we find as one enabler of our cognitive embedding construct. This finding is in line with Tasselli (2015) who concludes that junior doctors in an Italian hospital were better positioned to acquire and transfer knowledge than their senior counterparts.

5.2 | Limitations

Case studies are well-suited to understand the relationship between contextual factors and organizational strategies—in particular to address impediments to goal alignment (Malhotra & Sharma, 2002). The main limitation of such studies is scope. Our inductive case design focused on one specific team, giving rise to questions of external validity. We aimed to address this concern by being as transparent as possible about our methods, enabling replication of our study. We further addressed questions regarding internal validity by triangulating our interview data with details about the 114 consecutive treatments we studied, as well as patient demographics. Due to the sensitive nature of the topic of our study, we were only able to report these at an aggregate level.

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CONFLICTS OF INTEREST

None.

ENDNOTE

[1] Information on whether hospitals perform this procedure is not easily obtained.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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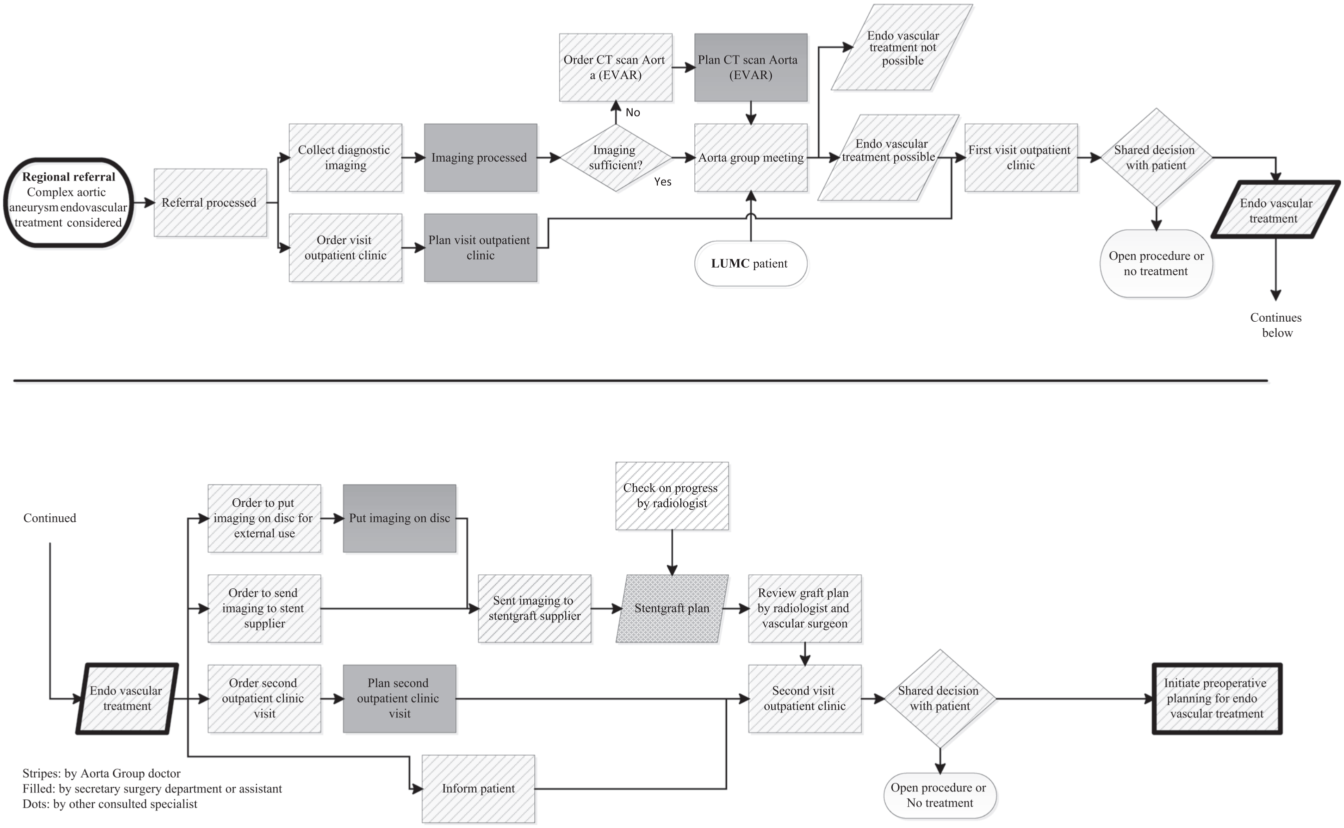
APPENDIX A: INTERVIEW QUESTIONS

1. Why are endovascular technologies adopted at LUMC?
2. Can you describe how, for complex aortic disease, the transition from offering open reconstruction only, to open and endovascular reconstruction took place?
3. What was needed to get the ETT started?
4. What was particularly important to get the ETT started?
5. [Showing a schematic overview of the endovascular treatment process, Figure 4] Where in this process do you play a role?
6. [Showing a drawing of team roles, Figure 5] What other roles are needed for you to successfully fulfill your task?
7. What could you say about your learning process with regards to endovascular treatment?
8. Does the culture at LUMC play a role in the implementation of endovascular treatment?
9. Do work processes at LUMC play a role in the implementation of endovascular treatment?
10. Are these different from other hospitals? [Due to cross-hospital collaborations, and previous work experience, most team members can compare with other hospitals]
11. How do people get selected to the ETT?
12. Are sufficient people involved in the ETT?
13. How is decided who gets trained for endovascular treatment?
14. Can people with an intrinsic interest in endovascular treatment ask to be trained?
15. Are there sufficient people in the LUMC with adequate skills in endovascular treatment?
16. How do you keep your knowledge about endovascular treatment up-to-date?
17. Are sufficient people available to participate in endovascular treatment?
18. How does the scheduling of endovascular treatment work?
19. How are decisions made during the Aorta Group meetings?
20. Did you change your work routine with regards to endovascular treatment?
21. When did you feel the ETT reached the next level in terms of its capabilities and coordination?
22. What is the most important factor in deciding how many patients receive endovascular treatment?
23. How did radiologists react to the involvement of vascular surgeons in endovascular treatment [endovascular treatment historically belongs to radiology]?
24. How are decisions made during endovascular treatment at the OR?
25. Do you feel free to speak up during the Aorta Group meetings?
26. Do you feel free to speak up during endovascular treatment at the OR?
27. Do you feel free to approach the lead physician outside of the OR in case you have questions or comments?
28. Do you agree beforehand who executes exactly which step?
29. What information do you need during endovascular treatment at the OR?
30. Can you decide which assistants or scrub nurses get assigned to complex endovascular treatment?

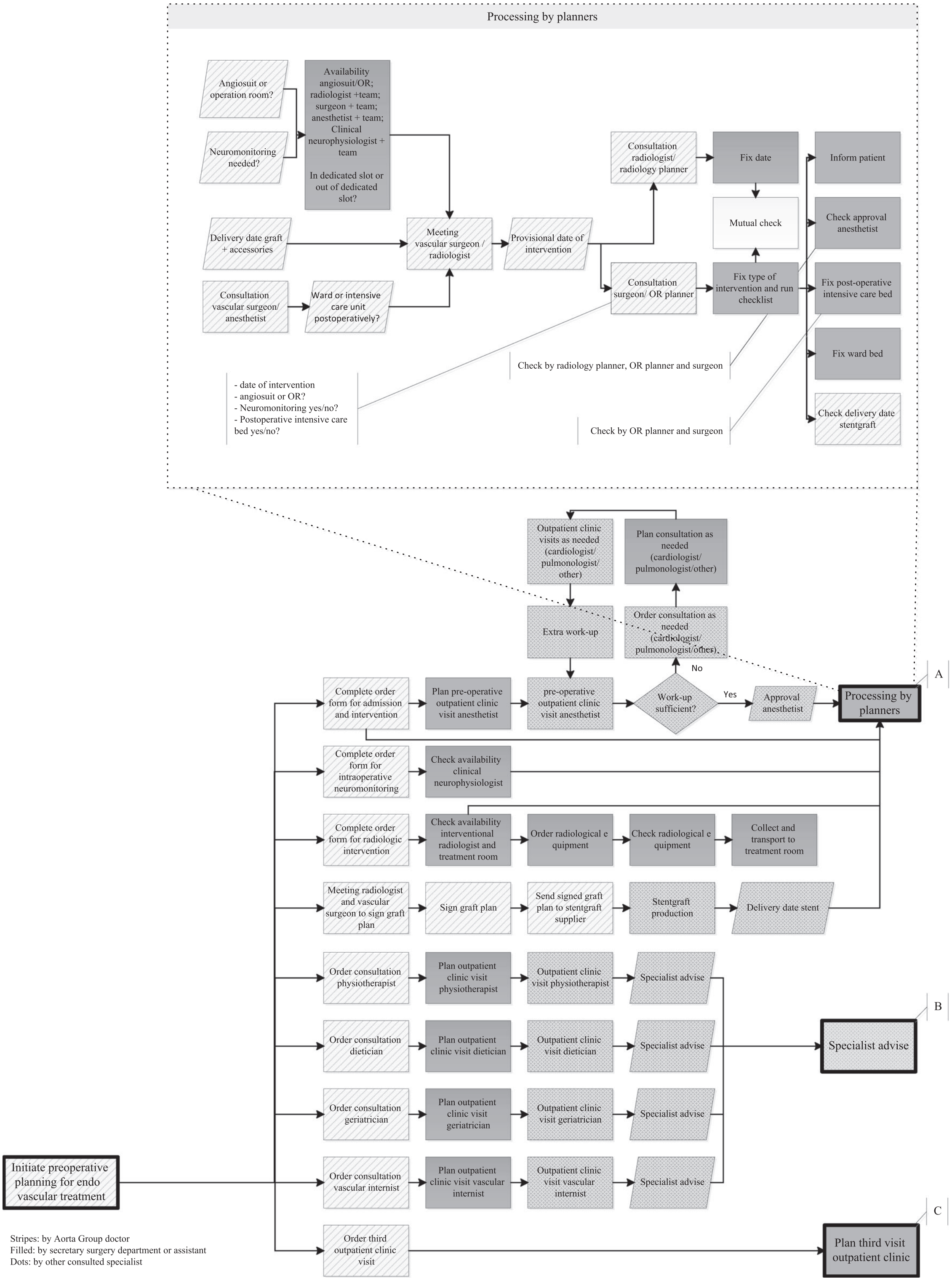
(Continues)

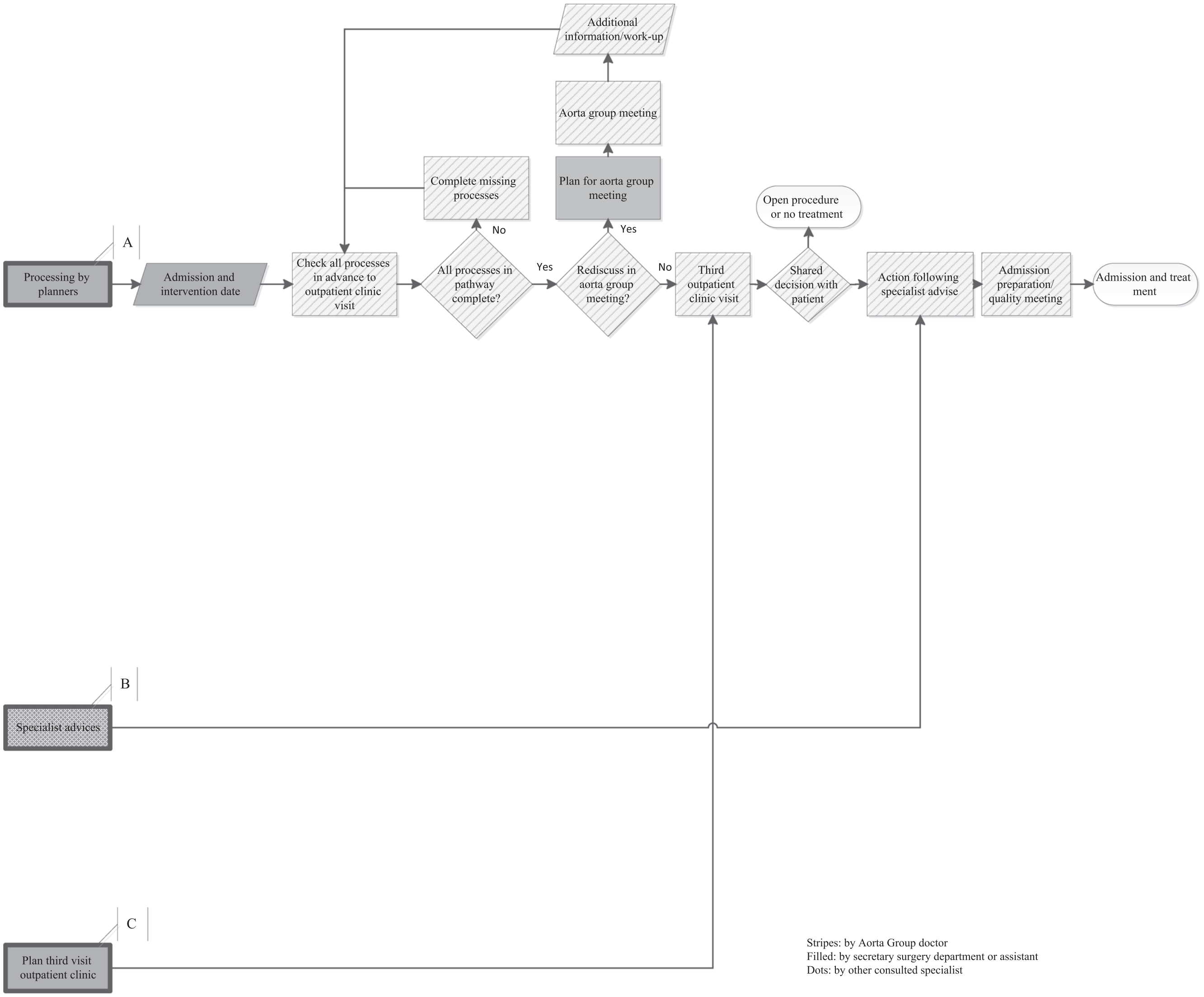
31. Do you have a preference with regards to whom fulfills a certain role during endovascular treatment at the OR?
32. Did you ever feel you had to give in to somebody else's decision?
33. Is it important to have experience working together as a team?
34. What is the atmosphere like during endovascular treatment at the OR?
35. Do you feel valued by others during endovascular treatment at the OR?
36. Do interpersonal relations play a role during endovascular treatment at the OR?
37. Does the personality of others play a role during endovascular treatment at the OR?
38. Can you say something about the patients that get selected for endovascular treatment?
39. How does the selection process work?
40. Does the team decide who has the final responsibility for each patient? Is this recorded?
41. Do you consider your involvement with patients to be sufficient?
42. How do you view the relationship with stent suppliers?
43. What do you think about the role of the industry [stent suppliers] in this program?
44. How important is a proctor? Do you prefer them to be present during endovascular treatment at the OR?
45. Do stents by various suppliers differ?
46. How important is it to have experience with a stent from a specific supplier?
47. Would it be doable for you to use stents from different suppliers?
48. How do suppliers find out that you are able to successfully use a stent?
49. How do suppliers decide to deliver the first stent to a hospital?
50. Do you ever consider the price of stents?
51. Is the budget allocated to the endovascular program by the surgery and radiology units sufficient?
52. Do you have all the necessary devices and equipment at your availability during endovascular treatment at OR?
53. Are there any additional devices or equipment you would like to have at your availability?
54. Who makes sure that all necessary devices and equipment are available during endovascular treatment?
55. Looking back, should anything have been done differently?
56. Looking forward, are there any points for improvement?
57. If another hospital wants to start this endovascular treatment, what advice would you give them?

APPENDIX B: PROCESS MAP



Stripes: by Aorta Group doctor
Filled: by secretary surgery department or assistant
Dots: by other consulted specialist


Processing by planners
Angiosuit or operation room?
Neuromonitoring needed?
Availability angiosuit/OR; radiologist +team; surgeon + team; anesthetist + team; Clinical neurophysiologist + team
In dedicated slot or out of dedicated slot?
Delivery date graft + accessories
Meeting vascular surgeon / radiologist
Provisional date of intervention
Consultation vascular surgeon/ anesthetist
Ward or intensive care unit postoperatively?
Consultation radiologist/ radiology planner
Consultation surgeon/ OR planner
Fix date
Mutual check
Fix type of intervention and run checklist
Inform patient
Check approval anesthetist
Fix post-operative intensive care bed
Fix ward bed
Check delivery date stentgraft
Check by radiology planner, OR planner and surgeon
Check by OR planner and surgeon
- date of intervention
- angiosuit or OR?
- Neuromonitoring yes/no?
- Postoperative intensive care bed yes/no?
Outpatient clinic visits as needed (cardiologist/ pulmonologist/ other)
Plan consultation as needed (cardiologist/ pulmonologist/other)
Extra work-up
Order consultation as needed (cardiologist/ pulmonologist/others)
Complete order form for admission and intervention
Plan pre-operative outpatient clinic visit anesthetist
pre-operative outpatient clinic visit anesthetist
Work-up sufficient?
No
Yes
Approval anesthetist
Processing by planners
A
Complete order form for intraoperative neuromonitoring
Check availability clinical neurophysiologist
Complete order form for radiologic intervention
Check availability interventional radiologist and treatment room
Order radiological e quipment
Check radiological e quipment
Collect and transport to treatment room
Meeting radiologist and vascular surgeon to sign graft plan
Sign graft plan
Send signed graft plan to stentgraft supplier
Stentgraft production
Delivery date stent
Order consultation physiotherapist
Plan outpatient clinic visit physiotherapist
Outpatient clinic visit physiotherapist
Specialist advise
Order consultation dietician
Plan outpatient clinic visit dietician
Outpatient clinic visit dietician
Specialist advise
B
Specialist advise
Order consultation geriatrician
Plan outpatient clinic visit geriatrician
Outpatient clinic visit geriatrician
Specialist advise
Initiate preoperative planning for endo vascular treatment
Order consultation vascular internist
Plan outpatient clinic visit vascular internist
Outpatient clinic visit vascular internist
Specialist advise
Order third outpatient clinic visit
C
Plan third visit outpatient clinic
Stripes: by Aorta Group doctor
Filled: by secretary surgery department or assistant
Dots: by other consulted specialist


A
Processing by planners
Admission and intervention date
Check all processes in advance to outpatient clinic visit
All processes in pathway complete?
No
Complete missing processes
Yes
Rediscuss in aorta group meeting?
Yes
Plan for aorta group meeting
Aorta group meeting
Additional information/work-up
No
Third outpatient clinic visit
Shared decision with patient
Open procedure or no treatment
Action following specialist advise
Admission preparation/ quality meeting
Admission and treat ment
B
Specialist advices
C
Plan third visit outpatient clinic
Stripes: by Aorta Group doctor
Filled: by secretary surgery department or assistant
Dots: by other consulted specialist