University Heart Center Hamburg

GERMAN AORTIC CENTER HAMBURG

The Role Of Air RemovalFor Reduction Of Neurologic Complications During TEVAR

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University Hospital Eppendorf

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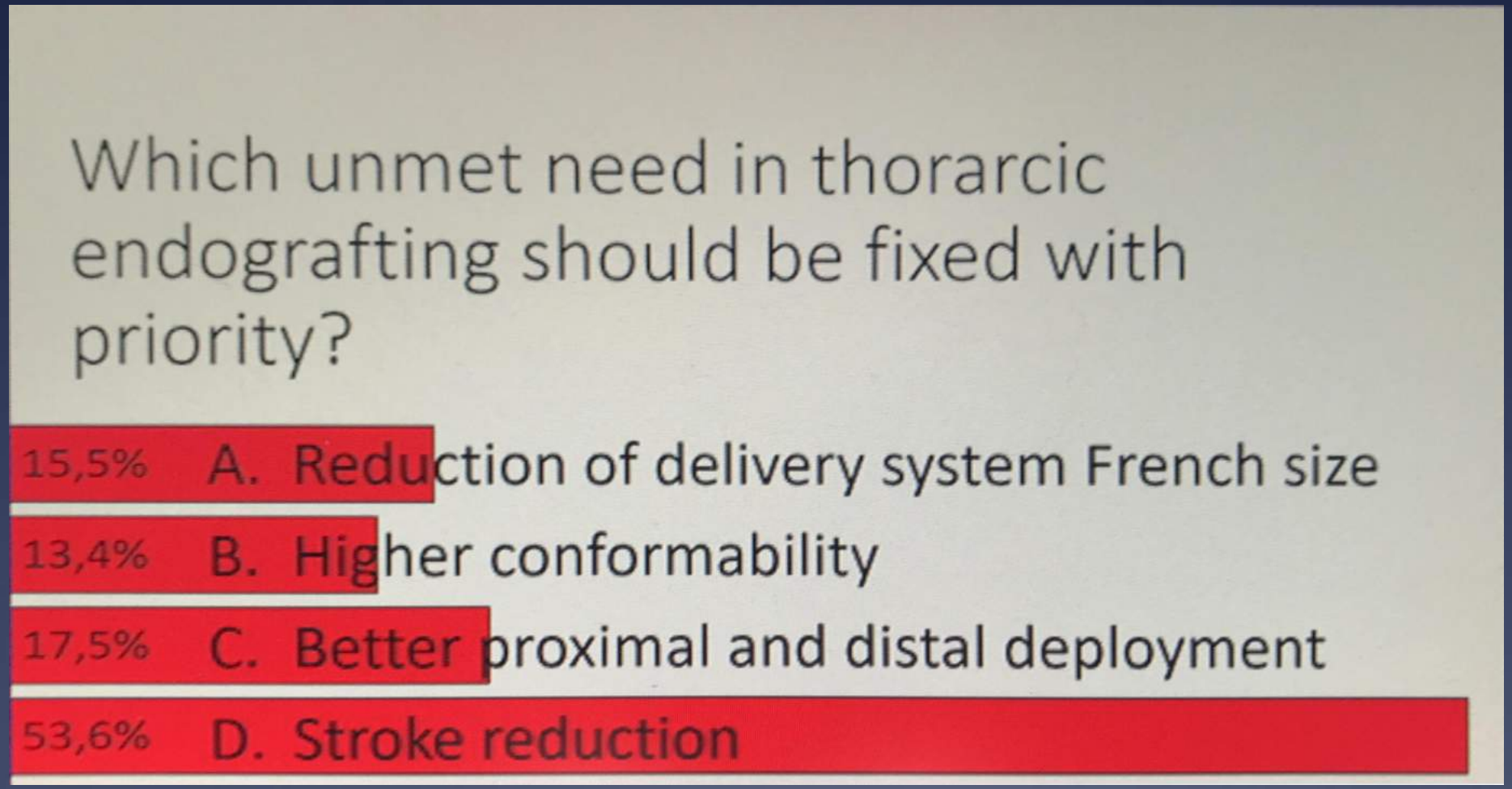
Disclosures

- Research-grants, travelling, proctoring speaking-fees, IP, royalties with Cook.
- Consultant with Philips
- Consulting, speaking-fees with Getinge
- Shareholder Mokita-Medical GmbH, Arterica
- IP, Consultant with Terumo Aortic

Vascular Communities View



Audience Poll at LINC 2020

Stroke in TEVAR

- Incidence
  - in TEVAR: 4-5%
  - in arch TEVAR: 5-20%
- Mortality 20%

Feezor et al. 2007; J Endovasc Ther 14:568-73
Böckler et al. 2016; Eur J Vasc Endovasc Surg 51:791-800
Alsafi et al. 2014; J Vasc Surg 60:1499-506
Ullery et al. 2012; J Vasc Surg 56:1510-7
Kahlert et al. 2014; Ann Thorac Surg 98:53-8
Perera et al. 2015; Br J Surg 102: s2: 5

Cook Zenith Branched Arch Endograft

Editor's Choice — Subsequent Results for Arch Aneurysm Repair with Inner Branched Endografts, ☆

R. Spear [a], S. Haulon [a,*], T. Ohki [b], N. Tsilimparis [c], Y. Kanaoka [b], C.P.E. Milne [a], S. Debus [c], R. Takizawa [b], T. Kölbel [c]

[a] Aortic Centre, CHRU Lille, France
[b] Vascular Surgery, Jikei University, Tokyo, Japan
[c] German Aortic Center, University Heart Center Hamburg, Germany

- n = 27; Hamburg, Tokio, Lille
- 4/2013- 11/2014
- Technical success 27/27
- 30d Mortality 0/27
- 1y mortality 1/27
- Stroke/TIA 3/27

Spear et al 2016; Eur J Vasc Endovasc Surg 51: 380-5

Bolton – Relay Branched Stentgraft

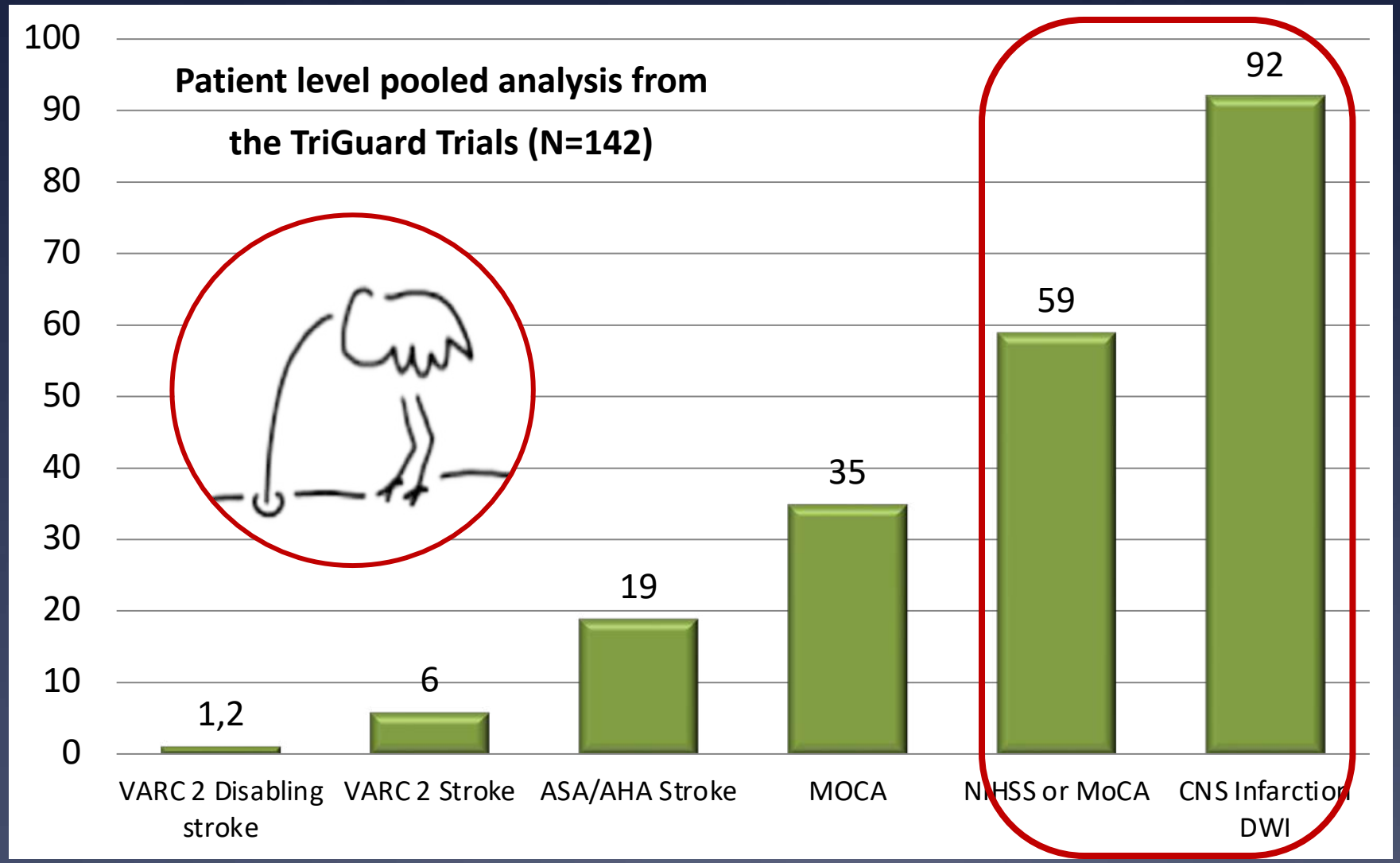
European experience

- Multicenter
- n = 15, 12 male, Age 76
- All elective
- Technical success 15/15
- Mortality 1/15 (7%)
- Stroke 3/15 (20%)

Czerny, M et al. 2018; Eur J Cardio Thorac Surg 53:1007-12

Cerebral damage is frequently overlooked on postop. visit

Stroke Rate Depends on Definition



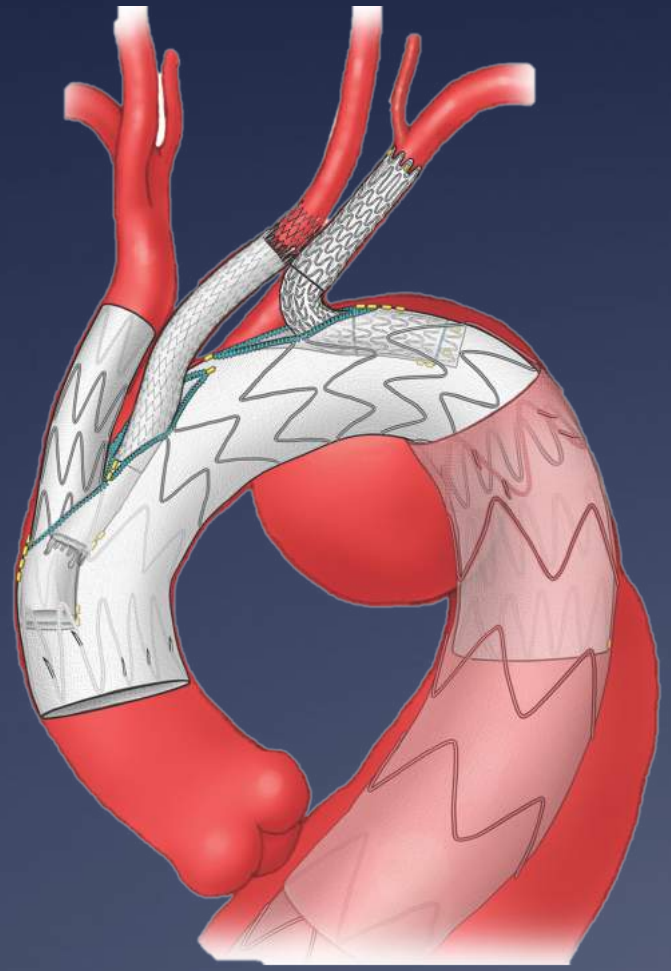
Lansky et al. 2017; JACC; 69: 679-91 Lansky et al. 2018; Eur Heart J 39:1687-97

Silent Brain Infarcts: Not So Silent!

- Postoperative confusion
- Cognitive dysfunction
- Future stroke
- Impaired mobility
- Depression
- Dementia
- Parkinson disease
- Alzheimer disease

Gupta et al. 2016; Stroke 47:719-25
Vermeer et al. 2007; Lancet Neurol 6:611-9
Ghanem et al. 2017; PLoS ONE 12: e0168852

Air-Embolism in Branched Arch TEVAR



Stroke by Air-Embolism in TEVAR

Air bubbles are released by thoracic endograft deployment: An in vitro experimental study

Kamuran Inci[1], Giasemi Koutouzi[2], Valery Chernoray[3], Anders Jeppsson[4], Håkan Nilsson[3] and Mårten Falkenberg[2]

100μm Air-bubble

Inci et al. 2016 Sage Open Med 4:1-5

40μm Air-bubble in Human Cerebral Capillary after CPB

Moody et al.1990; Ann Neurol 28:477-86

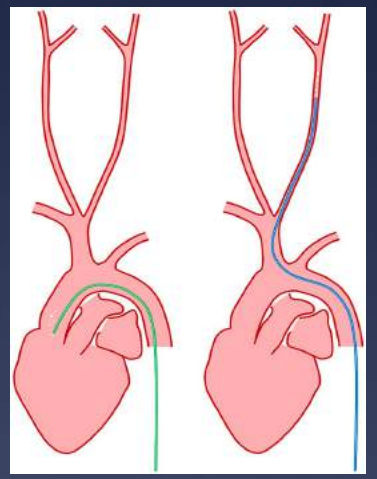
Animal Model of Endovascular Air Embolism

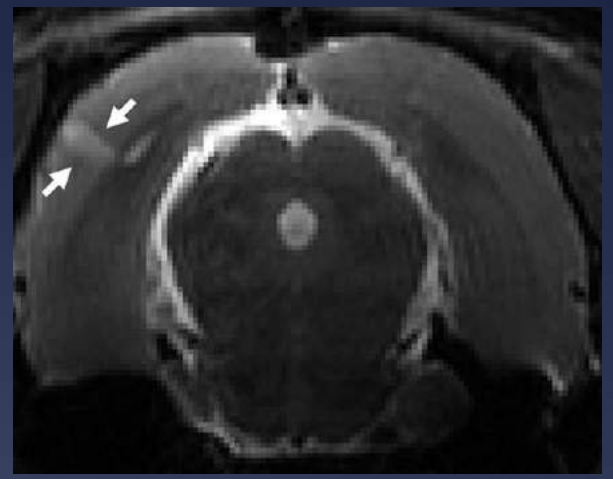
Investigation of Experimental Endovascular Air Embolisms Using a New Model for the Generation and Detection of Highly Calibrated Micro Air Bubbles

Journal of Endovascular Therapy
1–10

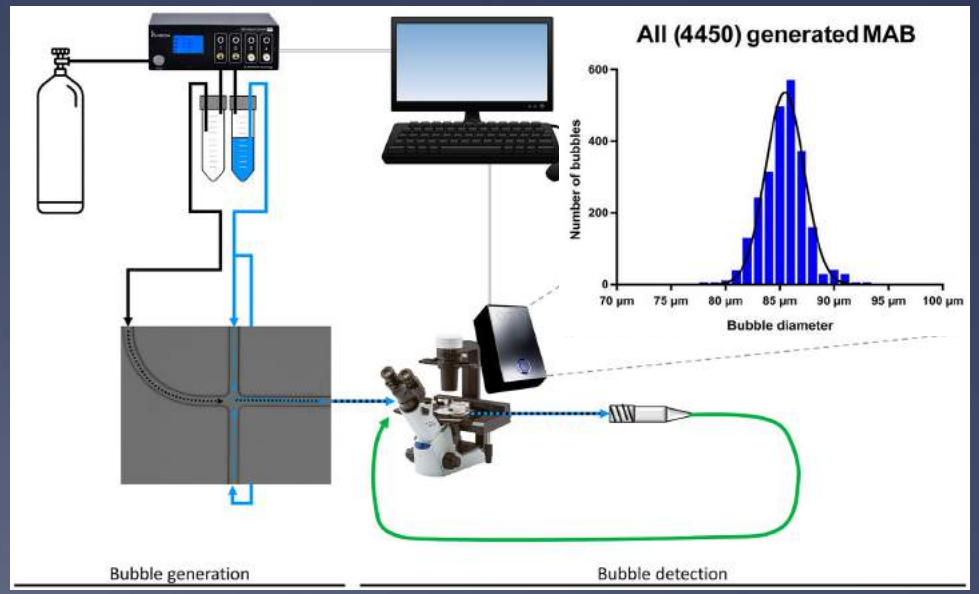
DOI: 10.1177/15266028221082010
www.jevt.org
SAGE

Tabea C. Schaefer[1,2], Svenja Greive[1], Sabine Heiland, MD[1], Martin Kramer, MD[2], Martin Bendszus, MD[1], and Dominik F. Vollherbst, MD[1]





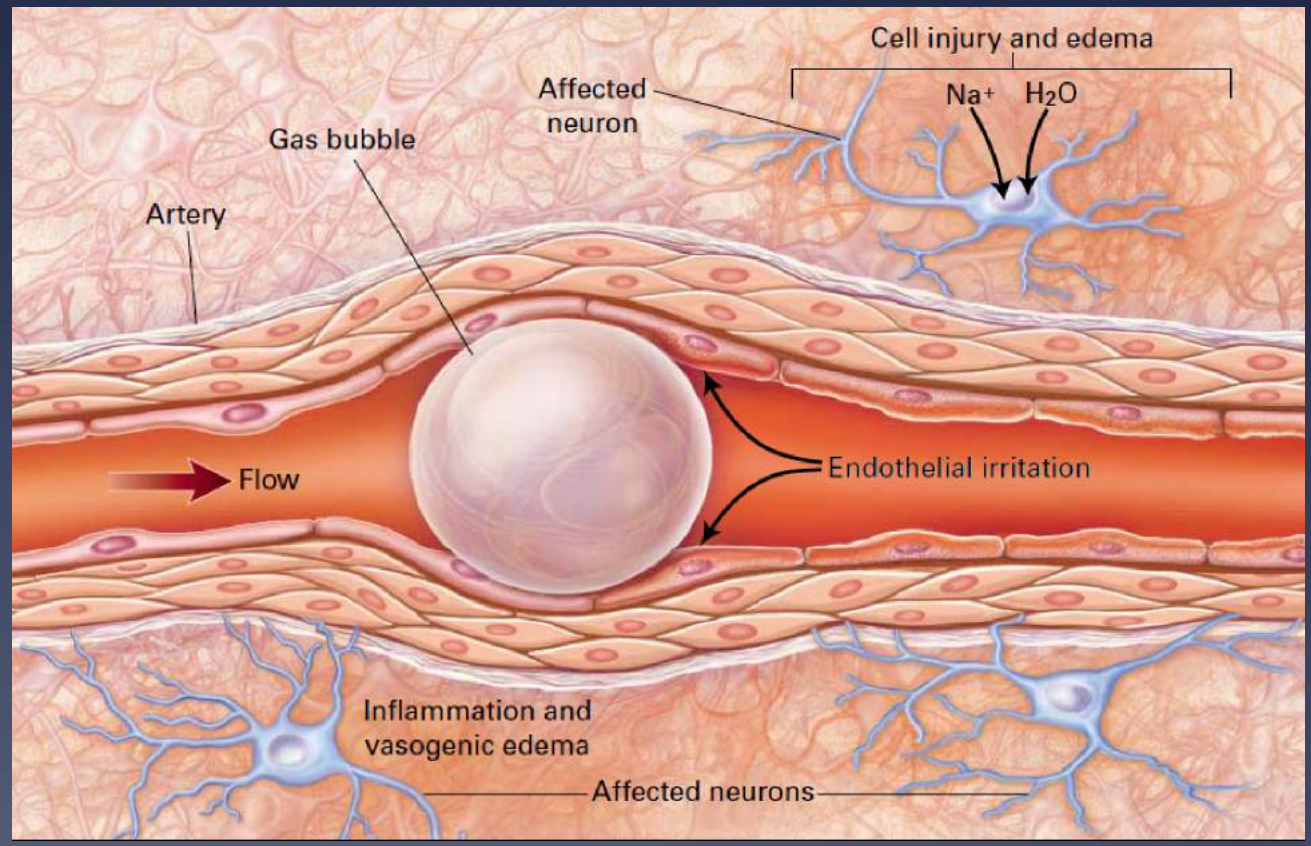
- Small animal model (male Wistar rats)
- 85micron air bubble by automated generator
- DW-MRI showed corresponding lesions



Schaefer et al. 2022, J Endovasc Ther, epub

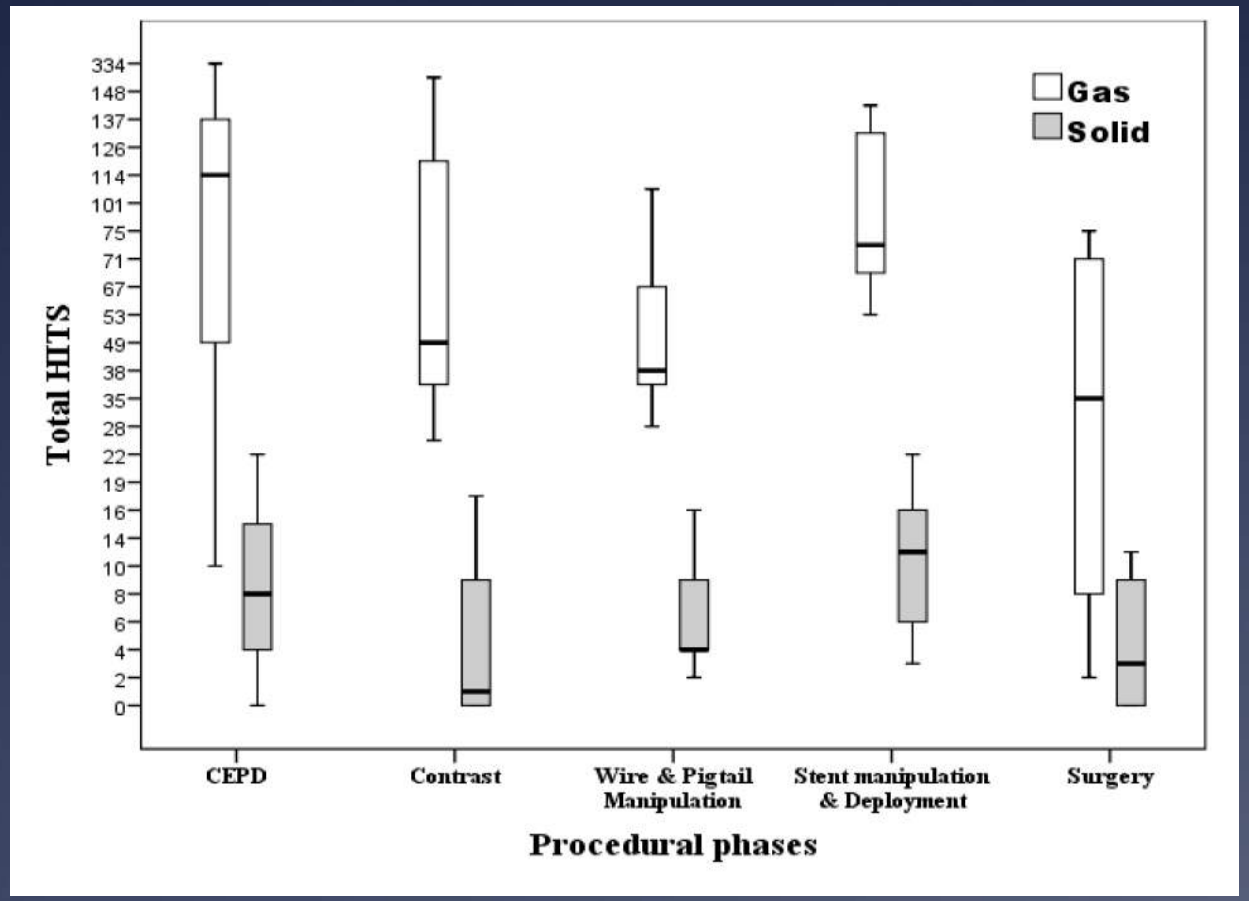
Pathophysiology of Air-Embolism

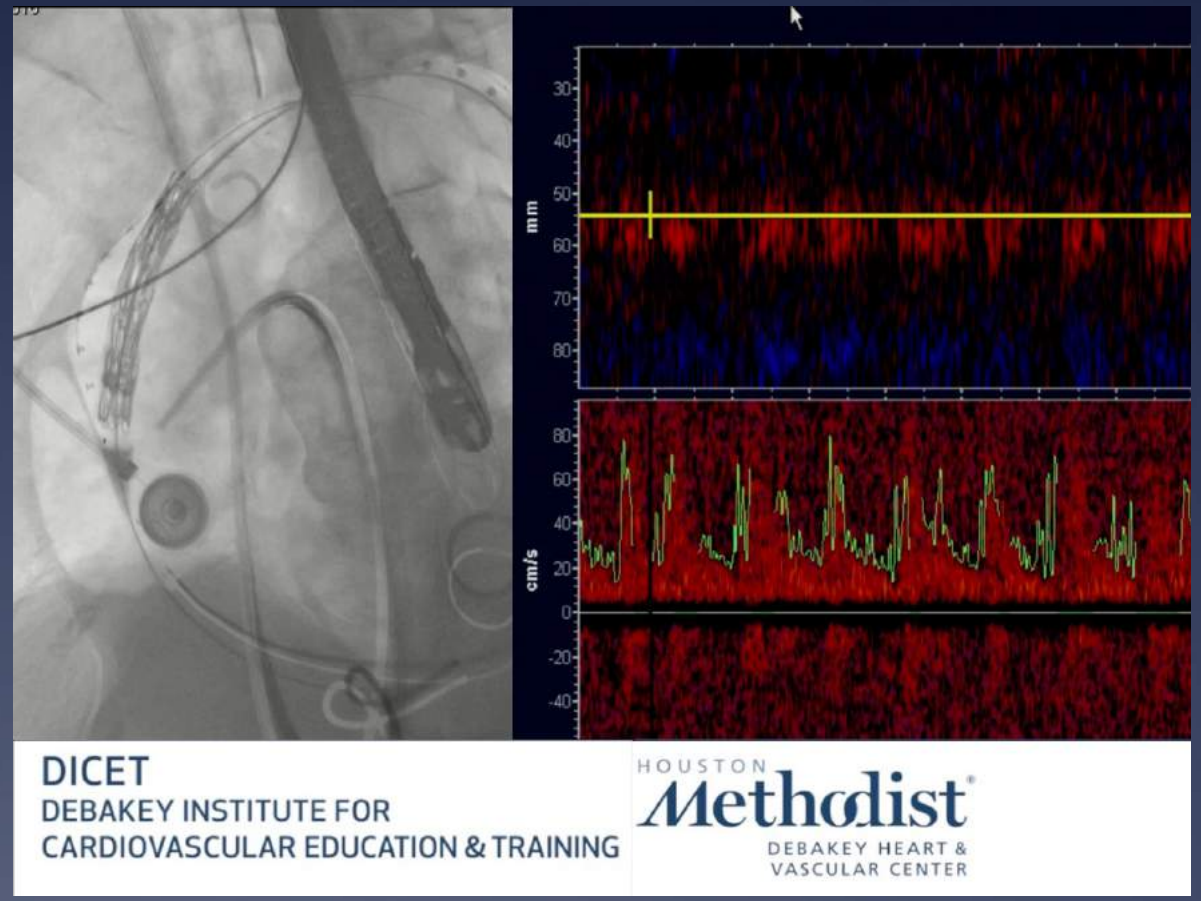
- Ischemia by arterial blockage
- Shear-stress of passing bubbles
- Inflammatory response
- Brain metabolism ⬇
- Nerval function ⬇
- Blood-brain barrier damage
- Cerebral blood flow ⬇
- Disturbance of blood distribution
- Intracranial pressure ⬆



Furlow et al. 1982; Stroke 13: 847-52 vHulst et al. 2003; Clin Physiol Funct Imaging 23: 237-46 Muth et al. 2000; N Engl J Med 342: 476-82

TCD: 90% of HITs during TEVAR are Gaseous





Courtesy of Carlos Bechara, Alan Lumsden, Houston Methodist Center

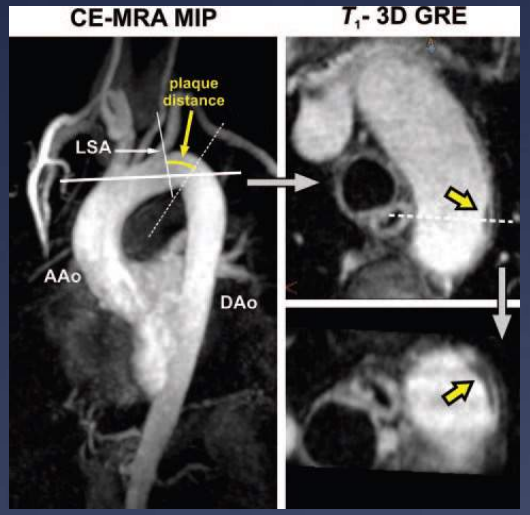
Grover et al. 2018; J Vasc Surg 68:1656-66

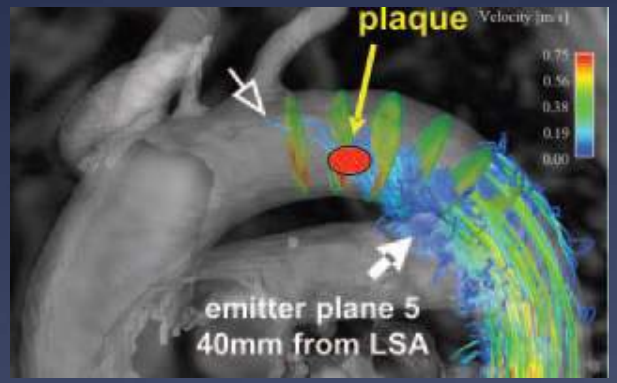
Embolization Pathways in Cryptogenic Stroke

Retrograde Embolism From the Descending Aorta

Visualization by Multidirectional 3D Velocity Mapping in Cryptogenic Stroke

Andreas Harloff, MD; Christoph Strecker, MD; Patrick Dudler, MD; Andrea Nuβbaumer; Alex Frydrychowicz, MD; Manfred Olschewski, MS; Jelena Bock, MS; Aurelien F. Stalder, MS; Anna L. Stroh, MD; Cornelius Weiller, MD; Jürgen Hennig, PhD; Michael Markl, PhD



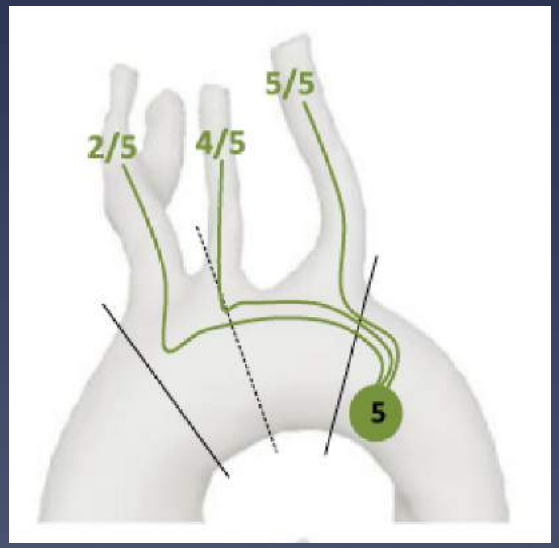


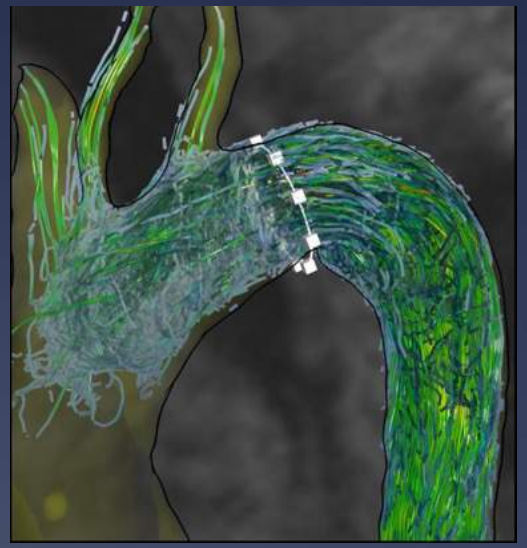
Conclusions: *Substantial diastolic retrograde flow originating from complex plaques in the descending aorta was detected by multidirectional 3D MRI velocity mapping and constitutes a stroke mechanism...*

Harloff et al. 2009; Stroke 40:1505-8

Aortic atheroma as a source of stroke – assessment of embolization risk using 3D CMR in stroke patients and controls

Thomas Wehrum[1,2*], Iulius Dragonu[1,2,6], Christoph Strecker[1,2], Florian Schuchardt[1,2], Anja Hennemuth[3], Johann Drexl[3], Thomas Reinhard[4,2], Daniel Böhringer[4,2], Werner Vach[5,2], Jürgen Hennig[6,2] and Andreas Harloff[1,2]

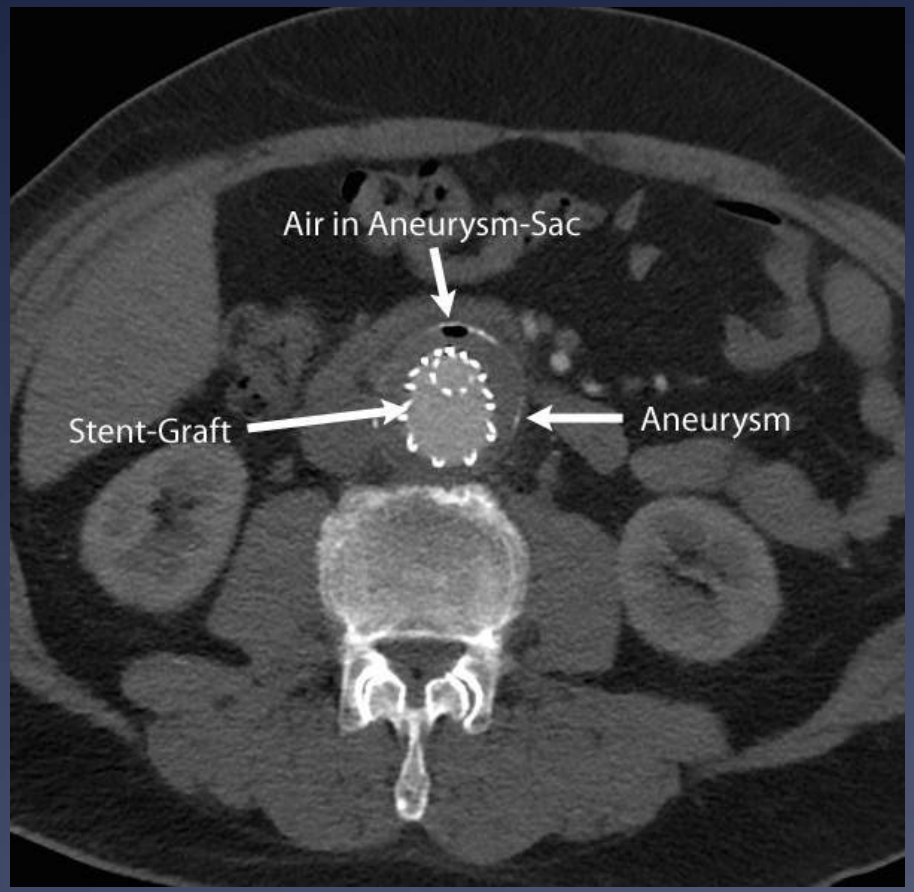




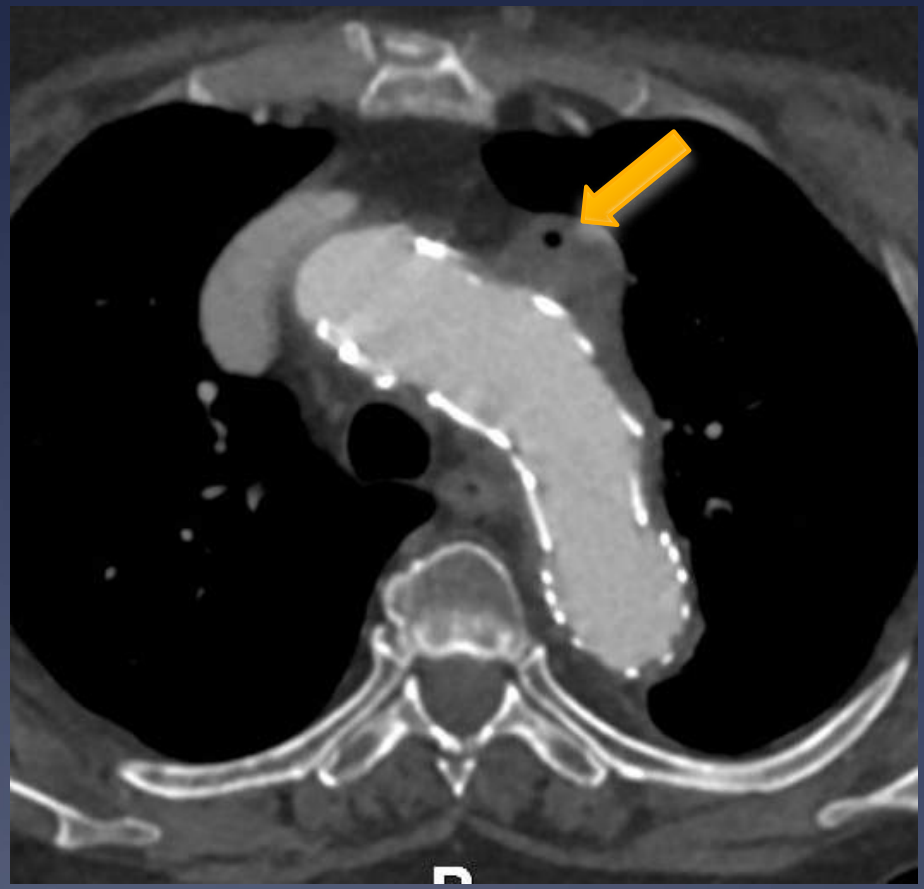
which can only in part be assessed by TEE. Furthermore, plaques of the distal arch (i.e. the proximal descending aorta) which are located downstream of the left subclavian artery were identified as a potential source of stroke in patients with otherwise cryptogenic stroke etiology [4].

Wehrum et al. 2017; J Cardiovasc Magn Res Imag 19:67

Air Embolism in EVAR//TEVAR



5 days after EVAR



2 days after TEVAR

CO^2 - Flushing

Carbon Dioxide Flushing Technique to Prevent Cerebral Arterial Air Embolism and Stroke During TEVAR

Journal of Endovascular Therapy
1–3

DOI: 10.1177/1526602816633705
www.jevt.org
SAGE

- 2014-2015: n=36
- All complex arch TEVAR:
  - Branched arch
  - Fenestrated arch
  - Ascending TEVAR
- All zone 0 -1
- Stroke: 1/36 (3%)
  - minor non-disabling stroke

Kölbel et al 2016; J Endovasc Surg 23: 393-5

CO^2-Flushing

CO2-Flushing Becoming Standard of Care

Received: 1 December 2017 | Revised: 14 March 2019 | Accepted: 4 May 2019
DOI: 10.1002/joom.1034

RESEARCH ARTICLE

WILEY

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

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Handling Editors: Lawrence Fredendall, Anand Nair, Jeffery Smith and Anita Tucker

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

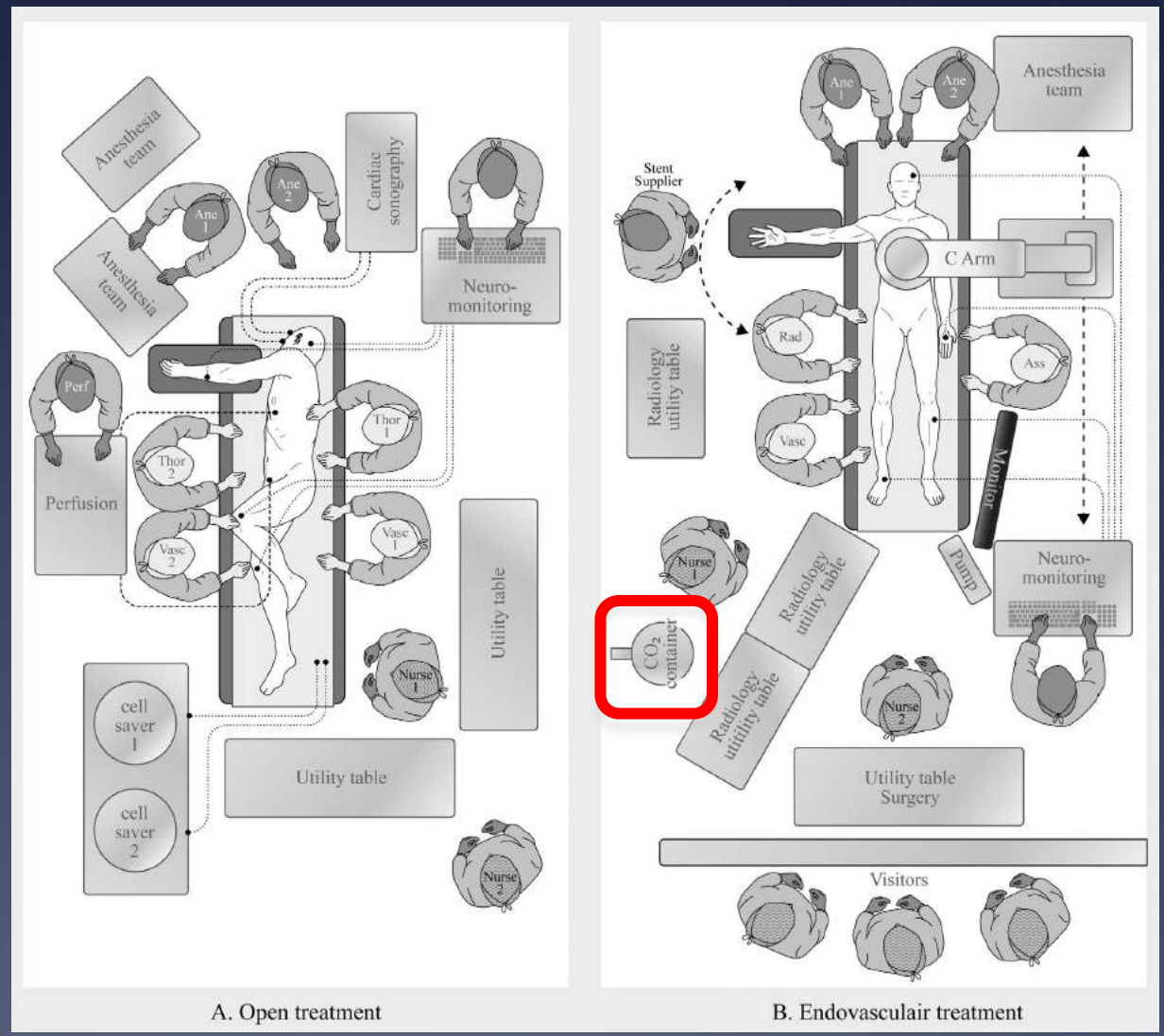
1 | INTRODUCTION

> *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



A. Open treatment

B. Endovasculair treatment

Stevens et al. 2020; J Oper Manag 66:112-34

TEVAR with CO^2 Flushing

Results: Neurological and DW-MRI outcomes

- No difference in clinical stroke
- Significant reduction in the incidence of new DW-MRI infarcts with CO_2 flushing
- Significant reduction in the total number of new DW-MRI infarcts
- Significant reduction in the surface area of new DW-MRI infarcts

Characteristic	Saline (n=112)	CO_2 (n=75)	P-value
Incidence of new infarction on any cerebral imaging	57/77 (74)	28/65 (43)	0.0002
Clinical stroke	14(13)	5(7)	0.196
Incidence of new infarction on DW-MRI	53/73 (73)	28/65(43)	0.0004
Median total number of DW-MRI infarcts (range)	2(0-25)	0(0-31)	0.0003

FEWER and SMALLER DW-MRI infarcts with CO_2 flushing

Richard Gibbs, Imperial College, presented at CX Aortic Vienna, October, 7th 2021

Conclusion

- Stroke and SBI during TEVAR is relevant and needs to be avoided.
- Silent brain infarctions (SBI) during TEVAR are a frequent finding and associated with neurologic symptoms and cognitive dysfunction.
- The source of stroke and SBI during TEVAR is multifactorial.
- Carbondioxide flushing is the best available technique to reduce cerebral air-embolisation