Eur J Vasc Endovasc Surg (2016) 51, 194–201

# Trends in Abdominal Aortic and Iliac Aneurysm Repairs in Norway from 2001 to 2013

**K. Wendt** [a,*], **R. Kristiansen** [b], **K. Krohg-Sørensen** [c,d], **F.A. Gregersen** [e], **E. Fosse** [a,d]

[a] The Intervention Centre, Oslo University Hospital, Rikshospitalet, P.O. Box 4950 Nydalen, N-0424 Oslo, Norway
[b] Department of Informatics, Oslo University Hospital, Rikshospitalet, P.O. Box 4950 Nydalen, N-0424 Oslo, Norway
[c] Department of Cardiothoracic and Vascular Surgery, Oslo University Hospital, Rikshospitalet, P.O. Box 4950 Nydalen, N-0424 Oslo, Norway
[d] Institute of Clinical Medicine, Medical Faculty, University of Oslo, P.O. Box 1078 Blindern, N-0316 Oslo, Norway
[e] Oslo Centre for Biostatistics and Epidemiology (OCBE), Oslo University Hospital, Rikshospitalet, P.O. Box 4950 Nydalen, N-0424 Oslo, Norway

**WHAT THIS PAPER ADDS**

To support further policy decisions regarding the organization of the provision of vascular surgery it is important to have knowledge and information about the impact the diffusion of the endovascular technique has on procedures and practices. This study demonstrates an increase in intact and ruptured abdominal aortic and iliac aneurysms treated by endovascular technology in Norway from 2001 to 2013. The number of vascular centers was reduced. The use of endovascular aneurysm repair was associated with vascular centers performing high volumes of abdominal aortic and iliac aneurysm repairs and regional health authorities organized with few centers.

**Objective/background:** The objective was to examine trends in abdominal aortic and iliac aneurysm repairs in Norway from 2001 to 2013, and study regional variations and organizational developments in this type of vascular surgery.

**Methods:** This was a retrospective study on aortic and iliac aneurysm repairs using data from the Norwegian Patient Register. The vascular centers were categorized by yearly volume of repairs into small (<18), medium (18–49) and large (≥50). Incidence rates were assessed per 100,000 ≥ 60 years. The percentage of endovascular aneurysm repairs (EVAR) was calculated among the conducted repairs at the three categories of centers and the South-Eastern, Western, Central, and Northern Norway Regional Health Authority (NRHA).

**Results:** The national incidence rates of intact repairs per 100,000 ≥ 60 years increased from 57.4 to 65.7 ($p < .01$). Ruptured repairs decreased from 19.7 to 9.2 ($p < .01$). The rate of EVAR increased from 6.0 to 29.9 ($p < .01$) in intact and from 0.4 to 2.5 ($p < .01$) in ruptured repairs. The vascular centers were reduced from 25 to 16. The rate of EVAR was 27.1% ($p < .01$) higher at large centers and 7.9% ($p < .03$) higher at medium centers compared with small centers, and from 11.1% to 15.7% higher ($p < .01$) at the Central, Western, and Northern NRHA compared with the South-Eastern NRHA, which had the most centers (also in the large category). The national increase in intact EVAR from 10.6% to 43.3% was less compared with many other Western countries.

**Conclusion:** During the study period the rates of intact repairs increased while the ruptured repairs decreased. EVAR was associated with centers performing high volumes of abdominal aortic and iliac aneurysm repairs and regional authorities organized with few centers.



Article history: Received 11 September 2014, Accepted 18 August 2015, Available online 9 October 2015

**Keywords:** Abdominal aortic aneurysm, Endovascular aneurysm repair, Open repair, Organization and administration, Vascular surgical procedures

## INTRODUCTION

There has been a rapid technological development in most medical fields, including interventional radiology and vascular surgery.[1] Endovascular aneurysm repair (EVAR) was introduced by Volodos et al. in 1985 and Parodi et al. in 1990.[2,3] Since these pioneering treatments, catheter based endovascular techniques have led to a worldwide increase in the proportion of abdominal aortic and iliac aneurysm repairs managed electively by this method.[4,5] The outcomes of the traditional open aneurysm repair (OR) and EVAR have

* Corresponding author.
*E-mail address:* kwendt@ous-hf.no (K. Wendt).



http://dx.doi.org/10.1016/j.ejvs.2015.08.015

been compared in previous research. Peri-operative mortality is lower with EVAR, although secondary interventions are common. Long-term outcomes, including quality of life and cost-effectiveness, are similar. Also, repair of ruptured aneurysms is feasible with EVAR, given the presence of favorable anatomy, adequate skills, and appropriate facilities.[6,7]

The introduction and use of new medical technology in a Western healthcare system affects and challenges established systems.[1] The developments in endovascular technology necessitate new medical equipment, education of staff, and organization models, with cooperation and potential conflict between medical specialties. Endovascular aneurysm treatment was introduced in Norway in 1995,[8] and is usually performed with vascular surgeons and interventional radiologists working together. The first hybrid room in the country was established at the Intervention Centre at Rikshospitalet in Oslo in 1996.[1] Since then, treatment sites have been rebuilt or modernized as the utilization of hybrid rooms with fixed imaging has been associated with improved efficiency and safety for EVAR.[9]

To assess the trends in abdominal aortic and iliac aneurysm repairs at the various vascular centers and regional health authorities in Norway, the volume and distribution of open and endovascular repairs from 2001 to 2013 were studied.

## MATERIAL AND METHODS

The material was based on retrospective, anonymous data extracted from the Norwegian Patient Register, according to the specified procedure and diagnosis codes presented in Table 1.[10,11] This register was established in 1997 and is an independent administrative register of all patient treatments in the public healthcare of Norway, owned by the Norwegian Ministry of Health and Care Services.

Permission to use the anonymous data from the Norwegian Patient Register was obtained from the Norwegian Directorate of Health.

Intact and ruptured repairs were analyzed separately. Ruptured repairs were identified by the diagnosis codes 171.0, 171.3, and 171.8.[11] A small number of hybrid operations, a combination of EVAR and OR, was added to the endovascular procedures in the analysis. As the majority of the patients were ≥60 years, this age group was used for calculation of annual incidence rates per 100,000. Information was obtained from Statistics Norway for the per capita calculations.[12] Intact repairs were standardized for sex, and all groups were presented in a national and regional overview. For transparency, the age groups <60 years and ≥60 years were compared regarding the procedure codes of intact and ruptured repairs. Since 2002 hospitals in Norway have been organized into different health trusts, which, again, are organized in regional health authorities. In 2007 the number of regional health authorities was reduced from five to four as the South and Eastern Norway Regional Health Authority (NRHA) merged. For practical reasons, the current organizational model with the South-Eastern, Western, Central, and Northern NRHA was used in the study. To the authors' knowledge, there is as yet no standardized way of classifying high and low volume centers. Cut offs were therefore made on the basis of the Leapfrog Group volume categories of abdominal aortic aneurysms (AAA) that were developed before the endovascular era and cut offs used in a similar study to the present one.[13,14] Thus, the vascular centers were categorized by yearly volume of abdominal aortic and iliac aneurysm repairs, into small (<18 repairs), medium (18–49 repairs) and large (≥50 repairs). Some of the vascular centers in the study belonged to the same health trust. However, all centers were regarded as separate units as long as they had a different geographical location.

**Table 1.** Specified procedure and diagnosis codes.

| Abdominal aortic and iliac aneurysm open repair | Abdominal aortic and iliac aneurysm endovascular repair |
|---|---|
| PCG 10 Operation for aneurysm of supracoeliac or juxtarenal abdominal aorta | PCQ 10 Insertion of stent into suprarenal abdominal aorta |
| PDG 10 Operation on infrarenal abdominal aorta for aneurysm | PDQ 10 Insertion of stent into infrarenal abdominal aorta |
| PDG 20 Bypass from aorta to iliac artery for aneurysm | Combined with the following diagnosis codes: 171.0, I71.3, I71.4, I71.8, I71.9, I72.3, I72.8, I72.9 |
| PDG 21 Bypass from aorta to bilateral iliac arteries for aneurysm | PDQ 30 Insertion of stent into iliac artery |
| PDG 22 Bypass from aorta to iliac and contralateral femoral artery for aneurysm | Combined with the following diagnosis codes: 171.0, I71.3, I71.4, I71.8, I71.9, I72.3, I72.8, I72.9 |
| PDG 23 Bypass from aorta to femoral artery for aneurysm | |
| PDG 24 Bypass from aorta to bilateral femoral arteries for aneurysm | |
| PDG 30 Operation on iliac artery for aneurysm | |
| PDG 35 Bypass from iliac to femoral artery for aneurysm | |
| PDG 99 Other operation for aneurysm of infrarenal abdominal aorta and iliac arteries | |