Eur J Vasc Endovasc Surg (2019) 58, 200–205

SYSTEMATIC REVIEW

Disparities in Contemporary Treatment Rates of Abdominal Aortic Aneurysms Across Western Countries

Ricardo Castro-Ferreira [a,b,*], **Mario Lachat** [c], **Peter A. Schneider** [d], **Alberto Freitas** [e], **Adelino Leite-Moreira** [a], **Sérgio M. Sampaio** [b,e]

[a] Departamento de Cirurgia e Fisiologia, Unidade de Investigação Cardiovascular, Faculdade de Medicina da Universidade do Porto, Porto, Portugal
[b] Serviço de Angiologia e Cirurgia Vascular, Centro Hospitalar Universitário de São João, Porto, Portugal
[c] Aortic and Vascular Centre, Clinic Hirslanden, Zürich, Switzerland
[d] Kaiser Foundation Hospital, Honolulu, HI, USA
[e] Centro de Investigação e Tecnologia de Informação em Sistemas de Saúde (CINTESIS) e Departamento de Ciências da Informação e da Decisão em Saúde, Faculdade de Medicina, Universidade do Porto, Porto, Portugal

WHAT THIS PAPER ADDS

A comprehensive review of the international panorama of rates of abdominal aortic aneurysm (AAA) treatment was carried out. Extreme discrepancy in rates of elective AAA repairs between countries was found, with an almost eightfold variance between the nations with the highest and lowest rates of elective surgery. Variability in intact procedure rates had little correlation with the number of ruptured AAAs, which did not show such inconsistency between states. This is the first review to assess specifically international patterns in the rate of AAA repairs.

Objective/background: Several abdominal aortic aneurysm (AAA) screening programs have demonstrated a similar prevalence of this disease in Westerns countries, ranging from 1.2% to 2.8%. However, the annual rate of AAA repair is significantly less even, and its relationship to AAA prevalence is not clear. The objective was to perform a systematic review, describing an international overview in the yearly rate of AAA repairs.

Methods: The number of elective and emergency AAA repairs was obtained via thorough review of publications indexed in PubMed and Scopus from 2010 to October 2018. Portuguese data were obtained from the national administrative database of health care. Data from the UK were extracted from the National Vascular Registry's 2015 annual report. Each country's population was assessed from published national censuses, thus allowing estimation of the number of AAAs treated per 100,000 habitants.

Results: Data from 14 countries were obtained. The yearly number of elective operations per 100,000 habitants was 2.2 in Hungary, 3.8 in Portugal, 5.3 in Spain, 5.9 in Iceland, 6.5 in Finland, 7.0 in New Zealand, 7.8 in the UK, 10.0 in Denmark, 10.2 in Sweden, 13.3 in the USA, 14.8 in Norway, 15.3 in the Netherlands, 15.6 in Italy, and 17.3 in Germany. The yearly rate of ruptured repairs was 0.5 in Hungary, 1.5 in Portugal, 1.8 in Spain, 1.7 in Iceland, 1.7 in Finland, 1.3 in New Zealand, 1.8 in the UK, 3.3 in Denmark (2013), 2.7 in Sweden (2013), 1.7 in the USA, 2.1 in Norway, 3.1 in the Netherlands, 2.3 in Italy, and 2.7 in Germany.

Conclusion: The rate of AAA treatment is highly variable, with a nearly eightfold variance between the countries with the highest and lowest rates of elective repair. Correlation between elective and ruptured repairs was not clear. A deeper understanding of the reasons for the disparities in AAA treatment among Western countries is of the utmost importance.

Keywords: Abdominal aortic aneurysm, Factual databases, Healthcare disparities, Registries, Review
Article history: Received 5 November 2018, Accepted 4 March 2019, Available online 11 June 2019

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a common and progressive disease that can result in rupture and death, if left untreated.[1] The majority of AAAs remain asymptomatic until rupture, which is associated with high rates of mortality.[2–4] Owing to its silent nature, diagnosis may be

* Corresponding author. Departamento de Cirurgia e Fisiologia, Faculdade de Medicina da Universidade do Porto, Alameda Prof. Hernâni Monteiro, 4200–319 Porto, Portugal.
E-mail address: cferreira.ricardo@gmail.com (Ricardo Castro-Ferreira).

https://doi.org/10.1016/j.ejvs.2019.03.007

incidental.[5] AAA prevalence increases with age, being relatively rare before 65 years of age.[6] The pathology is approximately eight times more frequent in males, but the rupture risk and associated mortality are higher in women.[7,8] AAA prevalence may be decreasing. A contemporary Swedish screening study demonstrated a prevalence of 2.2% in men aged ≥65 years,[9] which is three times lower than in the 1980s and 1990s.[10] The indications for treatment of AAA are currently well defined with both the 2018 Society for Vascular Surgery (SVS) and 2019 European Society for Vascular Surgery guidelines recommending elective repair if the maximum diameter is ≥ 5.5 cm in men and ≥5 cm in women.[11,12] For monitoring smaller AAA there is consensus that the rescreening interval is inversely related to the aneurysm diameter, but optimal surveillance intervals remain to be established.[11,12] The current SVS guidelines endorse an ultrasound scan every three years if the AAA diameter is between 3.0 and 3.9 cm, every year if it is between 4.0 and 4.9, cm and every six months if it is between 5.0 and 5.4 cm.[11] Trends in surgical treatment of AAA have shown a clear preference for endovascular aneurysm repair (EVAR) rather than open surgical repair (OSR) in the USA, and a tendency toward a similar shift in Europe. Although EVAR seems to have better short-term outcomes than OSR, significant differences have not been described in long-term outcomes and costs.[13]

There is fair homogeneity in the AAA prevalence in Western countries,[3,14] with a described prevalence in men aged ≥65 years ranging from 1.2% in the UK to 2.2% in Sweden and 2.8% in the USA.[9,15,16] However, the rate of AAA repair per 100,000 population is significantly more variable and its relationship with the disease frequency is not clear.[17–19] In addition, a correlation between elective and ruptured AAA repairs in each country remains to be established. In this regard, the present study aimed to deliver international comparative epidemiological information about treatment rates of this disease.

METHODS

A systematic literature review was performed independently by three investigators (RCF, ALM, SMS) of the PubMed and Scopus databases using the following medical subject heading keywords: “Registries” AND “Aortic Aneurysm, Abdominal”. Articles were also selected from references of relevant articles. Disagreements were resolved by consensus with the senior authors (ML, PAS). Eligible studies were full text articles that included the approximate total number of procedures in a specific geographic region or country, or where the total number of procedures could be inferred. Manuscripts related to single centres, single brands, or where the estimated total number of procedures could not be extrapolated were excluded. Data from the UK were extracted from the National Vascular Registry’s 2015 annual report.[19] Portuguese data were obtained from the national administrative database of health care, a mandatory registry for hospital reimbursement. Quality assessment of the included manuscripts was performed by RCF and SMS, with divergences resolved by consensus with senior authors (ML, PAS). As the objective of this review was not to compare treatment outcomes, standard quality measurements were not applied to the selected manuscripts. The main focus of the quality assessment was the evaluation of the percentage of procedures covered by the registry, so that only articles where the total number of operations in a given population could be audited were included. Each country population was assessed from the published national census. By using this information, the number of both intact and ruptured AAAs treated per 100,000 habitants was estimated.

RESULTS

A total of 257 articles were selected with the PubMed and Scopus strategy search, with 23 manuscripts selected for evaluation (Fig. 1). Information regarding the treatment of AAA in 14 countries was obtained: Sweden,[18,20–24] Denmark,[18,21–23] Iceland,[18,21–23] Hungary,[18,21–23,25] New Zealand,[18,21–23] Italy (Emilia-Romagna region),[26] Spain,[27] Norway,[28,29] Finland,[30] Germany,[31–33] the USA,[17,18,34,35] the Netherlands,[36–38] the UK (with the help of National Vascular Registry’s 2015 annual report),[19,39] and Portugal, by assessing the unpublished information from the national administrative database of healthcare. The published VASCUNET assessments included information on 12 countries.[18,21–23] Of these, five (Denmark, Hungary, Iceland, New Zealand, and Sweden) had an estimated coverage of >90% for aortic procedures and could be used for the scope of this manuscript.[22]

In the evaluated countries, the rate of both intact and ruptured AAA treatment is summarised in Table 1 and Fig. 2. The lowest rate of elective AAA operations per 100,000 habitants was 2.2 (Hungary)[18] and the highest 17.3 (Germany).[31] Regarding ruptured repairs, the lowest rate of repair was 0.5, also in Hungary,[18] and the highest was 3.3 (Denmark).[18] The lowest ratio of ruptured to elective repairs was 1:8, observed in USA,[17] and the highest 1:2.5, detected in Portugal.

DISCUSSION

Despite the homogeneity in terms of AAA prevalence in developed countries,[9,10,15,16] there is extraordinary variability in the rate of AAA treatment between countries, both for emergency and elective repairs. In fact, with regard to intact AAA repairs, there was a nearly eightfold variation in the numbers between the two countries with the highest and the lowest treatment rates. Hungary was the country with the lowest number of elective repairs (2.2 per 100,000 inhabitants) and Germany the country with the highest (17.3 per 100,000 inhabitants). The guidelines for AAA treatment in these countries are similar and well documented.[11] The reasons for this disparity require further evaluation but could be related to a different disease prevalence, different diagnostic strategies for the pathology, or treatment of smaller aortic diameter aneurysms in some countries.

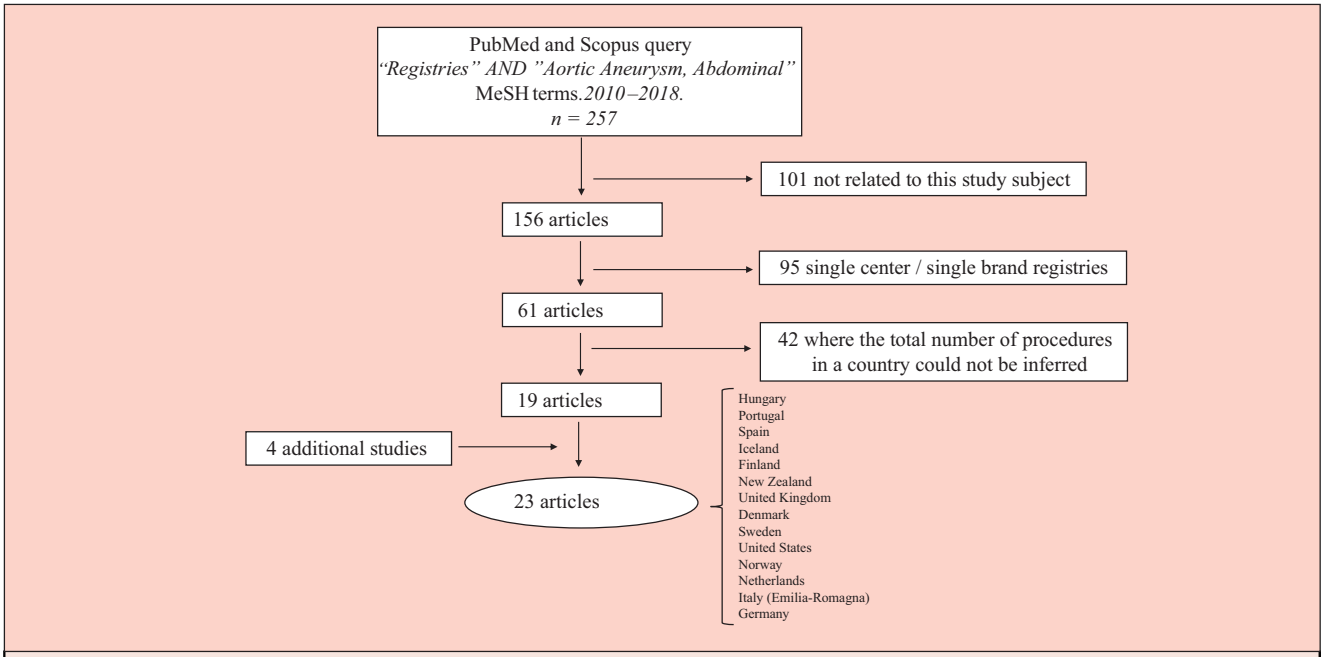

Figure 1. Study flowchart. A total of 257 articles were selected via the Scopus and PubMed algorithm search. Of these, 101 were not related to the focus of this paper and were dismissed. An additional 95 were single centre or single brand reviews and were also excluded. Of the remaining 61 studies, in 42 the approximate total number of abdominal aortic aneurysm repairs in the country could not be extrapolated and they were excluded. Four additional articles that were not selected by the search query but were previously known to the authors were included. *Note.* MeSH = medical subject heading.

The observed disparities do not appear to be related to differences in AAA prevalence, as it is described to be 1.18% in the UK,[15] and 1.7% in Sweden,[40] while a recent population based screening in Portugal showed a 2.1% prevalence in men ≥65 years of age.[41] Different older population proportions could partially help to explain the observed variance. However, this should not be the case as the available data show that the proportion of the population ≥65 years of age varies from 18% in Hungary to 21% in Germany.[42,43]

Regarding the possibility of different diagnostic strategies for the pathology, it is interesting to see that countries with established national AAA screening programs, such as Sweden and the UK, have significantly lower treatment rates than countries without screening programs, such as Norway, Italy, the Netherlands, and Germany. In that regard, the number of abdominal screening scans requested by general practitioners and non-vascular specialists may be of great importance. A lower diagnostic rate may be significant

Table 1. International data for elective and ruptured abdominal aortic aneurysm (AAA) repairs

	Intact AAA number (publication year)	Ruptured AAA number (publication year)	Population	Incidence of elective treatments per 100,000 citizens	Incidence of emergency treatments per 100,000 citizens	Ratio of ruptured vs. intact AAA
Hungary[18,21–23,25]	235 (2013)	52 (2013)	10,520,000	2.2	0.5	1:4.5
Portugal[a]	376 (2015)	151 (2015)	9,840,000[b]	3.8	1.5	1:2.5
Spain[27]	2,358 (2011)	816 (2011)	44,500,000[b]	5.3	1.8	1:2.9
Iceland[18,21–23]	19 (2013)	5.3 (2013)	322,000	5.9	1.7	1:3.6
Finland[30]	357 (2014)	91 (2014)	5,500,000	6.5	1.7	1:3.9
New Zealand[18,21–23]	304 (2013)	55 (2013)	4,370,000	7.0	1.3	1:5.5
United Kingdom[19,39]	5,058 (2014)	1,135 (2014)	64,600,000	7.8	1.8	1:4.5
Denmark[18,21–23]	560 (2013)	187 (2013)	5,615,000	10.0	3.3	1:3.0
Sweden[18,20–24]	973 (2013)	260 (2013)	9,556,000	10.2	2.7	1:3.7
United States[17,18,34,35]	41,222 (2010)	5,130 (2010)	309,350,000	13.3	1.7	1:8.0
Norway[28,29]	753 (2013)	105 (2013)	5,100,000	14.8	2.1	1:7.2
Netherlands[36–38,44]	2,586 (2015)	520 (2015)	16,900,000	15.3	3.1	1:5.0
Italy (Emilia-Romagna)[26]	706 (2011)	104 (2011)	4,500,000	15.6	2.3	1:6.8
Germany[31–33]	14,205 (2015)	2,180 (2015)	82,180,000	17.3	2.7	1:6.5

Note. [a]Data from the Portuguese national administrative database, a mandatory registry for hospital compensation (unpublished). [b]Population covered by the registry.

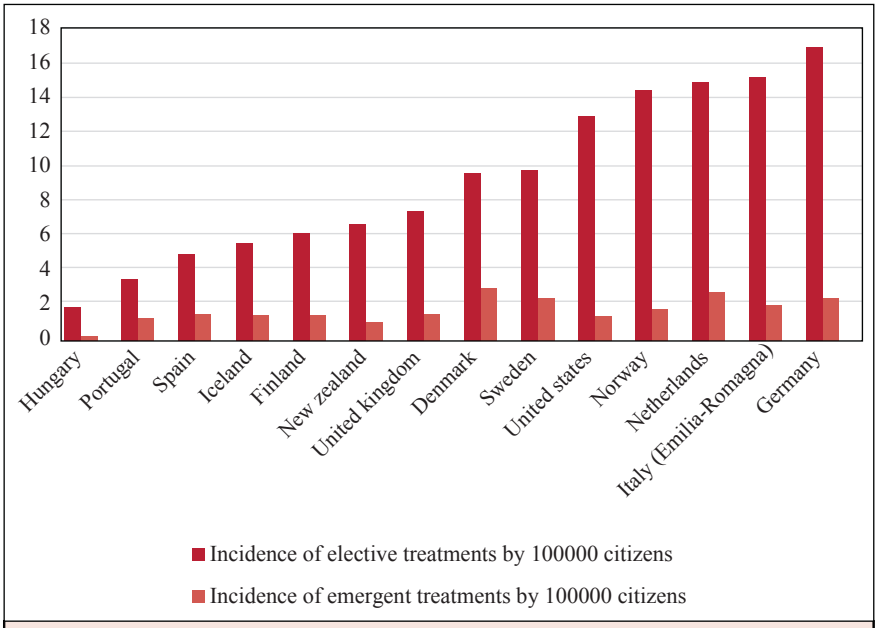

Figure 2. Incidence of abdominal aortic aneurysm (AAA) repairs by country. The yearly number of elective AAA repairs per 100,000 persons was 2.2 in Hungary, 3.8 in Portugal, 5.3 in Spain, 5.9 in Iceland, 6.5 in Finland, 7.0 in New Zealand, 7.8 in the United kingdom, 10.0 in Denmark, 10.2 in Sweden, 13.3 in the United States, 14.8 in Norway, 15.3 in the Netherlands, 15.6 in Italy (Emilia-Romagna region), and 17.3 in Germany. For ruptured AAA repairs, the yearly number of treatments per 100,000 persons was 0.5 in Hungary, 1.5 in Portugal, 1.8 in Spain, 1.7 in Iceland, 1.7 in Finland, 1.3 in New Zealand, 1.8 in the UK, 3.3 in Denmark, 2.7 in Sweden, 1.7 in the USA, 2.1 in Norway, 3.1 in the Netherlands, 2.3 in Italy (Emilia-Romagna region), and 2.7 in Germany.

in countries like Portugal, where a large proportion of the population lives in areas without vascular departments. A recent survey revealed that as many as 85% of the population have never heard of AAAs.[41] In fact, the low rate of diagnosis may be a major reason for the extremely low elective AAA repair rate in Portugal and can at least partly justify some of the disparities in intact AAA operations found in this study.

A major reason for the treatment disparities can be attributed to the number of AAA repairs <55 mm diameter (Fig. 3). The latest VASCUNET publications are particularly enlightening, providing novel information regarding the number of smaller AAA treated in several countries.[18,22] Interestingly, Germany, the country with highest rate of elective AAA repairs also has the highest percentage of smaller aneurysms being treated, with approximately 50% repaired before reaching the 55 mm threshold,[22] closely followed by the USA, with approximately 40%.[18] This is more than twice the percentage found in Sweden (21%),[22] Norway (22%),[22] New Zealand (22%),[22] or the Netherlands (15%),[44] and five times higher than the rate described in the UK (9.2%)[19,22] or Iceland (8.0%).[22] This rationale does not seem to apply to Hungary, where, despite being the country with the lowest treatment rate, nearly 30% of the elective AAAs are treated before reaching 55 mm. There is no information regarding the proportion of smaller AAAs being treated in Denmark, Spain, Portugal, or Italy. There is a growing discussion regarding the benefit of treating AAAs in their early stages.[34] An interesting study by Tomee et al. concluded that in the USA alone,[34] despite reducing mortality treatment before reaching the 55 mm threshold increased health costs by $300 million during the eight year observation period, corresponding to approximately $1 million per prevented rupture related death.[34] Additional studies are needed to clarify the risk/benefit and cost effectiveness of this approach.

It could be hypothesised that the countries with higher rates of elective AAA treatment would have fewer ruptured AAA repairs. Interestingly, no such a correlation was observed in this study. In fact, the country with the lowest number of elective treatments (Hungary) also has the lowest rate of emergency repairs (0.5 per 100,000). However, the nation with highest number of repairs for rupture (Denmark: 3.3 per 100,000) was intermediate in terms of intact repairs, with a significantly lower rate of elective cases than Norway, Germany, or Italy. Interestingly Germany, with the highest rate of intact repairs, was also one of the countries with a higher number of ruptured AAAs (2.7 per 100,000). The differences in the ruptured aortic cases were however, less marked than those detected for elective repairs. This can be related to a number of factors. There may be inequality in the transportation time to vascular departments capable of dealing with aortic rupture, which could lead to an increased mortality rate before getting to surgery. This can be particularly important in countries like Portugal, where vast numbers of the population do not have nearby access to specialised vascular surgery departments. Of the evaluated countries only

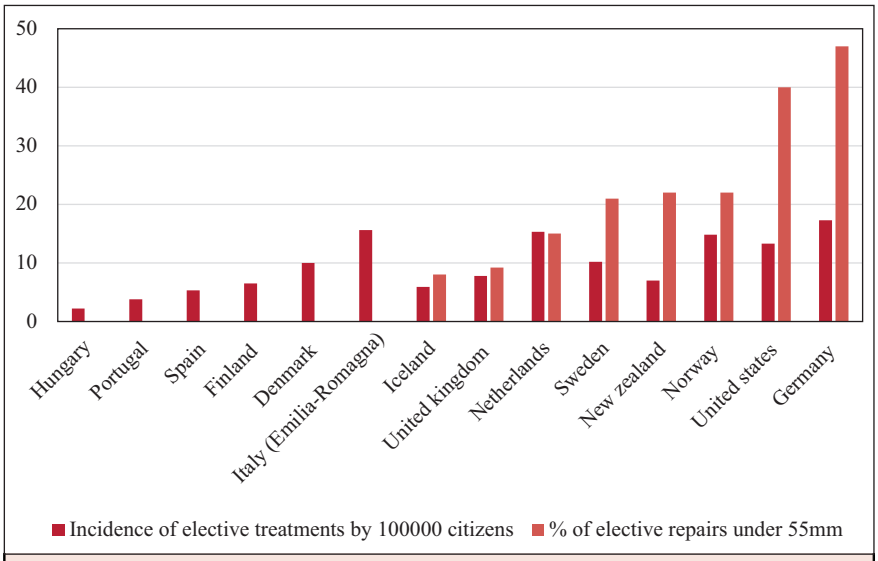

Figure 3. Incidence of elective repair vs. abdominal aortic aneurysm (AAA) diameter. Germany, the country with highest incidence of elective AAA repairs is also has the highest percentage of smaller aneurysms being treated, with approximately 50% repaired before reaching the 55 mm threshold, closely followed by the United States, with approximately 40% of the repairs carried out when the diameter was < 55 mm. This is more than twice the percentage found in Sweden (20.5%), Norway (22.4%), New Zealand (21.8%), and the Netherlands (15%), and five times higher than that described in the United Kingdom (9.2%) or Iceland (8.0%). In Hungary, despite being the country with lowest incidence of treatment, nearly 30% of elective AAAs are treated before reaching 55 mm diameter. There was no information regarding the percentage of smaller AAAs being treated in Denmark, Spain, Portugal, or Italy.

Finland has specific data on the number of deaths prior to hospital care: 52.5% of all patients with a ruptured AAA.[30] Another possible contributor to the disparities observed might be differences in the turndown rate for emergency repair. Despite scarce information regarding this subject, the detailed Finish report states that these cases comprised 13.4% of the total number of patients with ruptured AAA that arrive at a hospital.

Limitations

This review is based on information provided by published national registries. These databases can suffer from both registration and selection bias. To the best of the authors' knowledge this review includes data from all countries with AAA numbers published in indexed journals; however, an incomplete search cannot be excluded.

CONCLUSION

This study highlights the heterogeneity in the AAA treatment rate in Western countries. A deeper understanding of the reasons for this treatment discrepancy is of the utmost importance, as it may lead to the development of mechanisms for national improvement in the approach to the disease, which seems to be particularly important to countries like Hungary, Portugal, and Spain.

CONFLICT OF INTEREST

None.

FUNDING

None.

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