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ELIGIBILITY CRITERIA FOR AMBULATORY EVAR

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ABSTRACT

Objectives: The current results of the endovascular repair of abdominal aortic aneurysms (EVAR) and the generalization of the percutaneous closure systems suggest that ambulatory treatment is feasible in selected patients. The objective of this study was to evaluate the rate of eligibility to ambulatory EVAR (EVAR-Ambu) and its potential medico-economic impact.

Methods: Between January 2014 and December 2016, 245 patients were operated of an abdominal aortic aneurysm (AAA) in our center. The 128 patients whose anatomy was unfavorable with EVAR, which were operated in urgency or who were classified as ASA 4 were excluded from the study. The 117 remaining files were re-examined in order to evaluate the eligibility for EVAR-Ambu retrospectively. The patients were considered as eligible if they presented all the following criteria: (1) normal surgical risk, (2) logistic feasibility of an

ambulatory procedure (home <1h away from the hospital, available relatives) and (3) anatomical criteria of percutaneous feasibility according to angio-CT. The surgical risk was evaluated according to the French High Health Authority (HAS) and the Society for Vascular Surgery (SVS) score. The balance between costs and revenue was evaluated for each patient according to the length of stay.

Results: Among the 117 patients, 43 (37%) and 57 (49%) were eligible for EVAR-Ambu by percutaneous route according to whether the surgical risk was assessed according to the HAS or the SVS criteria. If a conventional surgical approach was considered as compatible with EVAR-Ambu, 12 (10%) and 13 (11%) additional patients were eligible according to whether the surgical risk was assessed according to the HAS or the SVS criteria, respectively. In terms of medico-economic evaluation, the cost of the initial intervention depended was mainly on the cost of the stentgraft and the operating room services. The cost spent of one night conventional hospitalization (CH) after EVAR was 603 € per day versus 490 € in the Day Surgery Unit (DSU). In comparison, the revenue for the institution was identical for DSU and a one night CH. According to our estimates, the balance between revenue and expenditures amounted to +122 € per patient for EVAR-Ambu vs. +10 € or +119 € per patient hospitalized one or two nights, respectively.

Conclusion: EVAR-Ambu is possible in a substantial proportion of patients treated for infrarenal AAA. Its medico-economic interest is real for the health system although it appears low at the individual level. The safety of this approach in clinical practice must be confirmed by a prospective study in selected patients.

INTRODUCTION

Ambulatory surgery should enable the very same day to allow the same day return home of patients whose health condition corresponds to this mode of management (articles D. 6121-301-1 and R. 6121-4 of the French Code of Public Health).¹ The delivered services are the

same in nature, complexity and required medical surveillance than those routinely conducted during conventional hospitalization (CH). The principal benefits expected from ambulatory surgery are a rapid recovery, an early resumption of activities and the control of health expenditures. Ambulatory surgery also makes it possible to significantly reduce the risk of postoperative infection.²

The rate of ambulatory surgery increases annually in France,¹ as in other countries.³ Several vascular surgeries have been considered as candidates for ambulatory surgery. It is in particular the case for varicose surgery,⁴ the creation and the maintenance of vascular accesses for hemodialysis⁵, and the angioplasties of the lower limbs.² These last years, several technical evolutions suggest the feasibility of ambulatory EVAR. The low early morbidity rates of EVAR, the advent of the percutaneous systems of closure,⁶ the miniaturization of the introducers used with the new generation stentgrafts,⁷ and a better evaluation of the operative risk⁸ lead us to suppose that EVAR is possible in a Day Surgery Unit (DSU). Limited experiences were carried out in Europe⁹ and North America^{10,11} with favorable results. Thus, the objective of our study was to evaluate the rate of eligibility to ambulatory EVAR (EVAR-Ambu) on the basis of preoperative selection criteria and to study its potential medico-economic impact.

MATERIALS AND METHODS

Population. From January 1st, 2014 to December 31st, 2016, 245 consecutive patients underwent AAA repair in our department of vascular surgery. Among them, we retrospectively selected the patients that were potentially eligible for EVAR-Ambu. With this intention, the patients operated in emergency, presenting a complex anatomy or with a compassionate indication (ASA 4) were excluded.

Criteria of inclusion and non-inclusion. The criteria of inclusion were (1) asymptomatic AAA treated electively with (2) anatomical criteria favorable to the implantation of an

76 infrarenal aortic stentgraft according to the recommendations of the French High Health
77 Authority (HAS),¹² extended to the criteria of the European Society for Vascular Surgery
78 (ESVS).¹³ The criteria of not-inclusion were (1) procedures carried out in emergency in a
79 context of ruptured or painful AAA (N=20), or with systemic emboli (N=5); (2) AAAs
80 presenting an anatomy unfavorable to the implantation of an aortic stentgraft according to the
81 HAS and ESVS criteria (N=99), including « complex » AAAs extending to the thoracic aorta
82 (N=19) or with a length of proximal neck < 10mm below the lowest renal artery (N=47),
83 infrarenal AAAs presenting a « hostile » proximal neck with circumferential thrombus
84 (N=10) or a major angulation (N=2), the presence of a narrow aortic bifurcation, of extensive
85 aorto-iliac occlusive lesions and/or of common femoral stenoses requiring an associated
86 revascularization of the femoral tripod (N=18), AAAs including the iliac bifurcations
87 requiring additional techniques to protect the hypogastric flow (branched iliac stentgraft)
88 (N=3); 3) compassionate indications (all these cases were ASA 4) (N=3) ; and 4) missing data
89 (N=1). A flow chart is presented in Fig. 1.

90 ***Collection of clinical data.*** The data were collected retrospectively from the medical files in
91 an anonymized database. The demographic data included the age, the gender, the place of
92 domicile and the travel time to the hospital (more or less than an hour). When the person of
93 trust mentioned in the file was a first degree relative (father/mother, child) or a spouse, we
94 considered that at least a person of the entourage could accompany the patient the first night
95 following the intervention. In the contrary case, the entourage was judged insufficient to
96 consider EVAR-Ambu.

97 Regarding the cardiac comorbidities, coronary disease was defined by a history of
98 angina, myocardial infarction, coronary angioplasty or surgery. Respiratory comorbidities
99 included chronic obstructive bronchopneumopathy and sleep apnea. Chronic impaired renal
100 function was defined by a glomerular filtration rate (GFR) lower than 60 mL/min.¹⁴ The

operative risk of the patients was assessed in two ways in parallel, according to the criteria established by the HAS (normal operative risk vs. high-risk),¹² and the score set up by the Society for Vascular Surgery (SVS).¹⁵ This score last lies between 0 and 3, corresponding to at an absent, low, moderate, or high operative risk, respectively. The patients were thus considered as having a normal surgical risk if the SVS score was ≤ 1 and at high-risk if the score was ≥ 2 . Preoperative angio-CTs were analyzed in order to collect the principal criteria of percutaneous feasibility described in the literature:¹⁶⁻¹⁹ diameter of the common femoral artery > 5 mm, absence of anterior common femoral calcifications or scar fibrosis related to a former surgical access.

Primary endpoint. The primary endpoint was the rate of patients eligible to percutaneous EVAR-Ambu. That's why the patients had to be at low surgical risk assessed according to the criteria of the HAS and the score of the SVS, to fulfil the criteria of percutaneous feasibility (common femoral diameter < 5 mm, absence of former calcifications, absence of scar fibrosis) and the criteria of logistic feasibility (residence within one hour's drive, presence of one accompanying person).

Medico-economic data. Medico-economic data were collected from the service of Program for giving Medical Significance to Information systems (PMSI) of our center. The costs of the implanted devices and ancillaries were collected from our hospital pharmacy. It is worth noting that the direct operating room costs were not taken into account since they are fixed whatever the care pathway (DSU or CH) following the operation. Indeed, the cost differential between ambulatory management and CH lies mainly in the cost of the resources mobilized to treat the patient before and especially after the operation (post-procedural costs). Moreover, the costs of the various expense accounts (medical and paramedical staff, medico-technical resources, logistics and general management, medical logistics) as well as their respective weights in the overall costs of the Homogeneous Group of Diseases (HGD) corresponding to

EVAR in Grade 1 patients (i.e. for a patient without major comorbidity) were described from a national database (Technical Agency for Hospital Information, ATIH). Thus, we could evaluate the post-procedural daily costs according to whether the patient was treated in DSU or with a one to three nights CH. The balance between the estimated overall costs of stay and the valorization was defined by the profit margin for the hospital.

Statistical analysis. Category variables were presented as absolute and relative frequencies and continuous variables were presented as averages and standard deviations when the distribution was normal and as medians and quartiles in the contrary case. The description of the rates of eligibility to EVAR-Ambu was initially carried out exclusively in the population at good surgical risk then in the global population. Statistical analysis was carried out using the SAS 9.4 software (SAS Institute, Cary, NC, USA).

RESULTS

Descriptive analysis of the study population. Table I summarizes the initial characteristics of the 117 patients included in our study, and includes the evaluation of the initial surgical risk according to the HAS criteria and the SVS score. The study population was predominantly made up of men (95.7%). The mean age was 71.6 ± 23.5 years. Forty-six patients (35.9%) were considered at high surgical risk according to the HAS criteria. According to the SVS score, 28 patients (23.9%) were considered at high surgical risk. The 18 patients classified as having a high surgical risk according to the HAS, and not to the SVS, were all older than 80 years. None of them presented cardiac, pulmonary or renal major comorbidities.

Percutaneous feasibility of EVAR. Table II presents the criteria of eligibility to the percutaneous treatment in the entire population of the study. Overall, 76.9% of the patients met all the criteria of percutaneous feasibility through the femoral arteries.

Ambulatory logistic feasibility. Table III shows the rates of logistic ambulatory feasibility in the global population. Overall, 80.3% of the patients fulfilled the two logistic criteria required for ambulatory EVAR (presence of one accompanying person during the first 24 hours and residence located at less than one hour from the hospital). The geographical distance of the residence was the leading logistic cause of non-eligibility to EVAR-Ambu.

Joint analysis of the feasibility of percutaneous approach and ambulatory management in patients at normal surgical risk. Fig. 2 presents the proportions of feasibility of EVAR-Ambu in patients considered at normal operative risk according to the HAS. It was observed that 43 patients, i.e. 61% of the population at good risk and 37% of the total population, fulfilled the criteria of percutaneous feasibility and the logistic criteria for ambulatory management. If a percutaneous treatment was not possible and a conventional surgical femoral access was regarded as compatible with ambulatory management, 12 additional patients, i.e. 17% of the population at good risk and 10% of the total population, could also be treated in ambulatory surgery. In total, 47% of the patients were eligible to ambulatory management according to this assumption. Three patients fulfilled neither the criteria of percutaneous feasibility nor the logistic criteria. Fig. 3 shows the proportions of eligibility to EVAR-Ambu in patients considered at normal surgical risk according to the SVS score. When the surgical risk was assessed according to the SVS score, we observed that 57 patients, i.e. 64% of the population at good risk and 49% of the total population, fulfilled simultaneously the criteria of percutaneous feasibility and the logistic criteria for ambulatory management. If one accepts the idea that a conventional surgical access is compatible with ambulatory management, 13 additional patients i.e. 15% of the patients at good risk and 11% of the total population, could also be treated in an ambulatory setting. Overall, 60% of the patients were eligible to ambulatory management according to this hypothesis. Five patients fulfilled neither the criteria of percutaneous feasibility nor the logistic criteria.

Medico-economic cost of EVAR-Ambu. EVAR corresponds to the DGLF001 procedure code which refers to the 05K06 DRG (implantation of a vascular stentgraft, without myocardial infarction) with a level 1 severity in a patient without associated major comorbidity. The direct expenses included in the cost of stay are mainly conditioned by the average 5389.04 ± 837.7 euros (excluding tax) price of the stentgraft which is fully reimbursed by the Health insurance. The costs of the initial intervention also include the costs of operating room facilities (250 euros) and anesthesia (108 euros). We should also add the price of the ancillary equipment (370 euros pre-tax) and the additional costs of 400 euros pre-tax of the different systems of closure in the event of a totally percutaneous procedure. Let us specify that these prices were negotiated by Assistance Publique - Hôpitaux de Paris, the university hospital trust operating in Paris in its surroundings. Thus, in our center, the costs of the initial intervention are 1128 euros, but it remains the same whatever the care pathway (DSU or CH). Thus, the cost difference per patient relies primarily on the cost of the resources mobilized following the operation (post-procedural cost).

According to the data obtained from the PMSI service of our hospital, the main headings for the post-procedural expenditure in 2015 related to the personnel expenses except intensive care (€ 309 including the nursing staff (€ 265) and the medical personnel (€ 44), the medico-technic resources (€ 79 including biology (€38) and imagery (€ 41), the medical logistics (pharmacy, hygiene, € 25 euros), and overall logistics (housing and catering, administration for € 190). Thus, the post-procedural cost per patient and per night of conventional hospitalization is € 603. In the DSU, the cost per patient-day is close of € 490.

In comparison, the valorization of the ambulatory stay for HGM 05K061 is identical to that of a one night of CH in a vascular department of surgery and amounts to € 1741 per patient. If the patient is hospitalized between two and four nights, the related income is € 2453, and € 177 should be added per each additional night starting from the fifth night. Table

IV presents the balance between the average costs of the stay per patient and the revenue for the institution according to the duration of hospitalization (profit margin).

DISCUSSION

Our study shows that EVAR-Ambu is possible in 37% to 60% of the target population, according to the criteria chosen before the operation. It also shows that there would be a potential medico-economic impact for the health system.

In our country, the HAS criteria are often used to manage AAAs. They have the advantage of being simple of use since the presence of only one of the criteria classifies the patient at high-risk. However, it seems that some criteria are too restrictive, in particular an age higher than 80 years. Indeed, an age higher than 80 years is not an independent criterion of high death rate after EVAR.²¹ Thus, 21 patients of our study were considered at high-risk according to the HAS and not according to the SVS score. Their only HAS criterion of high-risk was their age > 80 years. In that sense, the SVS score which combines the assessment of several major vital functions and provides a global level of risk could be more appropriate. A redefinition of the criteria of surgical high-risk seems essential to us in our country. Moreover, the management of older patients in a DSU has the theoretical advantage to limit the postoperative risk of confusion and nosocomial infection. Obviously, this approach is possible only in the absence of cognitive disorders which would prevent the good understanding of the postoperative instructions.

The percutaneous approach for EVAR would make it possible to optimize the ambulatory management because of its minimally invasive nature, subject to a strict compliance to the instructions for use. Several studies,^{18,19} including a randomized controlled study,¹⁶ showed that the use of the percutaneous closure systems (PCS) reduced the operating time, to decrease the rate of local complications and the length of hospital stay after EVAR. The strict respect of the instructions of use of PCSs is of paramount importance.^{6,22} We should

underline that we considered that obesity with a BMI > 40 was a counter-indication to PCSs. However, that did not affect any of the patients included in the analysis. In our experience, as in the literature,^{9,16,17} the failures of PCSs were observed during the procedure and immediately corrected by a surgical suture. The risk of complication due to the use of a PCS seems low once patient comes out of the operating room. However, a learning curve is necessary with PCSs and totally percutaneous ambulatory EVAR should be considered only by experienced surgeons.²³

In our study, 20% of the patients eligible to EVAR-Ambu did not present all the anatomical conditions required to use PCSs. Thirteen patients were thus non eligible to percutaneous EVAR among the 71 patients at good surgical risk according to the SVS score and fulfilling the logistic criteria of ambulatory. The percentage was similar for the HAS criteria). In these patients the surgical closure of the femoral arteries could be the first choice during EVAR-Ambu. The conventional surgical closure of the femoral arteries is a standardized procedure, not very invasive which can even be done under local anesthesia.²⁴ That would allow proposing EVAR-Ambu to 10-11% additional patients among the candidates for EVAR. In prospect, the miniaturization of the introducers of stentgrafts should make it possible to increase the success of PCSs.²⁵

Some frequent but generally benign complications of EVAR should be reduced to the minimum to develop EVAR-Ambu. Firstly, a post-implantation syndrome (PIS) occurs in up to 60% of the patients after EVAR.²⁶ It increases the duration of hospitalization.²⁷ This syndrome is generally benign and does not seem to constitute a limit to ambulatory management since the patients are informed before the operation and receive precise instructions about what they should do in the event of persistent or significantly (information notice provided). Polyester stentgrafts have been reported as associated with an increased risk of PIS compared with the polytetrafluoroethylene stentgrafts (PTFE).^{28,29} Thus, the use of

PTFE stentgrafts could prove to be preferable for EVAR-Ambu. Secondly, acute impaired renal function is frequent after EVAR. It occurs in 3 to 19% of the patients.³⁰ The major determinants of postoperative impaired renal function are preoperative chronic renal disease³¹ and the injected dose of contrast medium.³² The existence of a preoperative chronic renal disease must thus lead to the prescription of a specific protocol of hydration.³¹ According to Goldfarb et al., if the preoperative GFR lies between 30 and 60 mL/min, hydration must be prescribed one hour before and continued for four hours after the procedure.³³ On the other hand, if the GFR is < 30 mL/min, hydration is recommended for 24 hours and an hospitalization of at least 24 hours is necessary. Thus, the presence of a preoperative severe chronic disease renal constitutes a logical contraindication to ambulatory management.

The anesthetic strategy would also make it possible to optimize ambulatory EVAR. Local anesthesia with conscious sedation tends to develop in our center and elsewhere.³⁴ It permits to reduce the operating time and the duration of hospitalization compared to general or loco-regional anesthesia.³⁵ The rate of postoperative complications, in particular pulmonary, is lower.³⁶ However, the success of this type of anesthesia strongly depends on the skills of the anesthetic team and the level of co-operation of the patient. General anesthesia, on the other hand, allows a better comfort for the patient and the operator, and would allow more percutaneous procedures.³⁵ However, in their study, Hanley et al. specify that the use to general anesthesia was a predictive factor of failure of EVAR-Ambu.¹¹

Our results concerning the feasibility of ambulatory EVAR are comparable with the few data already reported in the literature.⁹⁻¹¹ Hanley et al. actually showed that 40% of the patients were eligible to EVAR-Ambu based on criteria similar to ours.¹¹ Among the 110 patients who underwent ambulatory operations, 79% could return home the same day. No difference was found in terms of complication, reintervention, readmission or 30-day mortality between the patients treated in DSU versus CH. Moreover, the authors did not

consider the percutaneous feasibility of EVAR as an essential prerequisite to ambulatory surgery, even if a large majority of the patients (89%) were treated by a totally percutaneous approach. In our practice, we consider that the use of PCSs must strictly respect the criteria of feasibility (femoral diameter > 5mm, absence of anterior calcifications or scar fibrosis). Otherwise, the surgical access of the femoral arteries remains not very invasive and wound care could be realized by a nurse at home the very next day after the intervention.

Beyond its safety, the passage to EVAR-Ambu raises the question of its medico-economic relevance. In their study, Moscato et al. allotted 80% of the overall costs of EVAR to the procedure itself, including 58% due to the stentgraft and 3% to the percutaneous closure systems.³⁷ Seven percent of the overall costs were mobilized for anesthesia and intensive care. Only 13% of the overall costs were allotted to the nursing care, the biological tests, imagery and pharmacy. Our analysis found similar results. The cost of the stentgraft represents nearly 50% of the overall costs per patient, but is covered by the health insurance. The resources used in the operating room account for approximately 20% of the overall costs and only 15% were due to the medical and paramedical resources mobilized following the intervention. The markup over the costs for the institution was +7.5% for ambulatory vs. +.5% for a one night CH. It becomes negative after a second night of CH. This reflects the pricing policy for ambulatory implemented in our country since 2005, which led to a 7% increase of ambulatory surgery between 2006 and 2013³⁸ with a substantial economy for our health system.

Several limits deserve to be mentioned. First of all, this was of a descriptive cross-sectional study, with a low level of evidence.³⁹ Moreover, we included only the isolated infrarenal AAAs fulfilling strictly the HAS and ESVS favorable anatomy criteria for EVAR. We considered that more complex morphologies, like those of aorto-iliac aneurysms including the bifurcation or juxta-renal aneurysms would not be eligible to ambulatory. However, in the study of Lachat et al.,⁹ nearly half of the AAAs were of this type, including

juxtarenal aneurysms. Moreover, the evaluation of the social environment of the patients was evaluated in a theoretical way according to the trustworthy person consigned in the medical file. In real life settings, even if family members are unavailable, friends or neighbours could act as accompanying persons. However, this evaluation could overestimate the capacity of the entourage to be present the first postoperative night. Moreover, the medico-economic evaluation cannot take into account the possible complications, the visits to the emergency service or the readmissions. Indeed, only a prospective study could make it possible to evaluate the real costs.

In prospect, the current development of medical stays located near the health care institutions, so called “hospital hotels”, could allow to optimize the feasibility of ambulatory.⁴⁰ This system is designed for autonomous patients who do not require continuous medical or paramedical supervision. Our study showed that 20% of additional patients, who were not initially eligible to ambulatory for logistic reasons (geographical distance, social isolation) could benefit from this type of housing.

CONCLUSION

EVAR-Ambu is possible in a substantial proportion of patients with infrarenal AAA. Its medico-economic interest is real for the health system although low at the individual level. Its clinical safety must be confirmed by a prospective study in a selected population.

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REFERENCES

1. Instructions et circulaires récentes | Legifrance [Internet]. [cité 17 janv 2018]. Disponible sur:
<http://circulaire.legifrance.gouv.fr/index.php?action=afficherCirculaire&hit=1&r=40158>
2. Hauguel A, Maurel B, Bague N, Gouaillier-Vulcain F, Costargent A, Chaillou P, et al. Management of ambulatory (day case) endovascular procedures for peripheral arterial disease. *J Cardiovasc Surg (Torino)* 2017;58:293-304.
3. Day Surgery: Making it Happen [Internet]. 2017 [cité 17 janv 2018]. Disponible sur:
<http://www.euro.who.int/en/about-us/partners/observatory/publications/policy-briefs-and-summaries/day-surgery-making-it-happen>
4. Gemayel G, Christenson JT. Can bilateral varicose vein surgery be performed safely in an ambulatory setting? *Eur J Vasc Endovasc Surg* 2012;43:95-9.
5. Hicks CW, Bronsert M, Hammermeister KE, Henderson WG, Gibula DR, Black JH, et al. Temporal Trends, Determinants, and Outcomes of Inpatient versus Outpatient Arteriovenous Fistula Operations. *Ann Vasc Surg* 2018;46:65-74.e1.
6. Vierhout BP, Pol RA, El Moumni M, Zeebregts CJ. Editor's Choice - Arteriotomy Closure Devices in EVAR, TEVAR, and TAVR: A Systematic Review and Meta-analysis of Randomised Clinical Trials and Cohort Studies. *Eur J Vasc Endovasc Surg* 2017;54:104-15.
7. Kontopodis N, Papadopoulos G, Galanakis N, Tsetis D, Ioannou CV. Improvement of patient eligibility with the use of new generation endografts for the treatment of abdominal aortic aneurysms. A comparison study among currently used endografts and literature review. *Expert Rev Med Devices* 2017;14:245-50.
8. King EG, Farber A, Rybin D, Doros G, Kalish JA, Eslami MH, et al. Preoperative Risk Factors Predict Protracted Hospital Length of Stay after Elective Endovascular Abdominal Aortic Aneurysm Repair. *Ann Vasc Surg* 2017;43:73-8.

- 347 9. Lachat ML, Pecoraro F, Mayer D, Guillet C, Glenck M, Rancic Z, et al. Outpatient
348 endovascular aortic aneurysm repair: experience in 100 consecutive patients. *Ann Surg*
349 2013;258:754-8.
- 350 10. Dosluoglu HH, Lall P, Blochle R, Harris LM, Dryjski ML. Ambulatory percutaneous
351 endovascular abdominal aortic aneurysm repair. *J Vasc Surg* 2014;59:58-64.
- 352 11. Hanley SC, Steinmetz O, Mathieu ES, Obrand D, Mackenzie K, Corriveau M-M, et
353 al. Safety and feasibility of endovascular aortic aneurysm repair as day surgery. *J Vasc Surg*
354 2018;67:1709-1715.
- 355 12. Haute Autorité de Santé - Evaluation des Endoprothèses Aortiques Abdominales
356 utilisées pour le traitement des anévrismes de l'aorte abdominale sous-rénale [Internet]. [cité
357 31 août 2017]. Disponible sur: [https://www.has-sante.fr/portail/jcms/c_874335/fr/evaluation-](https://www.has-sante.fr/portail/jcms/c_874335/fr/evaluation-des-endoprotheses-aortiques-abdominales-utilisees-pour-le-traitement-des-anevrismes-de-l-aorte-abdominale-sous-renale)
358 [des-endoprotheses-aortiques-abdominales-utilisees-pour-le-traitement-des-anevrismes-de-l-](https://www.has-sante.fr/portail/jcms/c_874335/fr/evaluation-des-endoprotheses-aortiques-abdominales-utilisees-pour-le-traitement-des-anevrismes-de-l-aorte-abdominale-sous-renale)
359 [aorte-abdominale-sous-renale](https://www.has-sante.fr/portail/jcms/c_874335/fr/evaluation-des-endoprotheses-aortiques-abdominales-utilisees-pour-le-traitement-des-anevrismes-de-l-aorte-abdominale-sous-renale)
- 360 13. Moll FL, Powell JT, Fraedrich G, Verzini F, Haulon S, Waltham M, et al.
361 Management of abdominal aortic aneurysms clinical practice guidelines of the European
362 society for vascular surgery. *Eur J Vasc Endovasc Surg* 2011;41 Suppl 1:S1-58.
- 363 14. Levey AS, de Jong PE, Coresh J, El Nahas M, Astor BC, Matsushita K, et al. The
364 definition, classification, and prognosis of chronic kidney disease: a KDIGO Controversies
365 Conference report. *Kidney Int* 2011;80:17-28.
- 366 15. Chaikof EL, Fillinger MF, Matsumura JS, Rutherford RB, White GH, Blankensteijn
367 JD, et al. Identifying and grading factors that modify the outcome of endovascular aortic
368 aneurysm repair. *J Vasc Surg* 2002;35:1061-6.
- 369 16. Nelson PR, Kracjer Z, Kansal N, Rao V, Bianchi C, Hashemi H, et al. A multicenter,
370 randomized, controlled trial of totally percutaneous access versus open femoral exposure for
371 endovascular aortic aneurysm repair (the PEVAR trial). *J Vasc Surg* 2014;59:1181-93.

- 372 17. Lee WA, Brown MP, Nelson PR, Huber TS. Total percutaneous access for
373 endovascular aortic aneurysm repair (« Preclose » technique). *J Vasc Surg* 2007;45:1095-101.
- 374 18. Malkawi AH, Hinchliffe RJ, Holt PJ, Loftus IM, Thompson MM. Percutaneous
375 Access for Endovascular Aneurysm Repair: A Systematic Review. *Eur J Vasc Endovasc Surg*
376 2010;39:676-82.
- 377 19. Eisenack M, Umscheid T, Tessarek J, Torsello GF, Torsello GB. Percutaneous
378 endovascular aortic aneurysm repair: a prospective evaluation of safety, efficiency, and risk
379 factors. *J Endovasc Ther* 2009;16:708-13.
- 380 20. Lijftogt N, Luijnenburg TWF, Vahl AC, Wilschut ED, Leijdekkers VJ, Fiocco MF, et
381 al. Systematic review of mortality risk prediction models in the era of endovascular
382 abdominal aortic aneurysm surgery. *Br J Surg* 2017;104:964-76.
- 383 21. Majd P, Ahmad W, Galas N, Brunkwall JS. Patients Older Than 80 Years Can Reach
384 Their Normal Life Expectancy After Abdominal Aortic Aneurysm Repair: A Comparison
385 Between Endovascular Aneurysm Repair and Open Surgery. *J Endovasc Ther* 2018;25:247-
386 51.
- 387 22. O'Brien-Irr MS, Harris LM, Dosluoglu HH, Cherr GS, Rivero M, Noor S, et al.
388 Factors that affect cost and clinical outcome of endovascular aortic repair for abdominal
389 aortic aneurysm. *J Vasc Surg* 2017;65:997-1005.
- 390 23. Bechara CF, Barshes NR, Pisimisis G, Chen H, Pak T, Lin PH, et al. Predicting the
391 learning curve and failures of total percutaneous endovascular aortic aneurysm repair. *J Vasc*
392 *Surg* 2013;57:72-6.
- 393 24. Setacci F, Sirignano P, Kamargianni V, Galzerano G, de Donato G, Biandolino P, et
394 al. Inguinal field block for femoral artery exposure during endovascular aneurysm repair. *J*
395 *Endovasc Ther* 2013;20:655-62.
- 396 25. Pratesi G, Pratesi C, Chiesa R, Coppi G, Scheinert D, Brunkwall JS, et al. The

397 INNOVATION Trial: four-year safety and effectiveness of the INCRAFT® AAA Stent-Graft
 398 System for endovascular repair. *J Cardiovasc Surg (Torino)* 2017;58:650-7.

399 26. Arnaoutoglou E, Kouvelos G, Koutsoumpelis A, Patelis N, Lazaris A, Matsagkas M.
 400 An Update on the Inflammatory Response after Endovascular Repair for Abdominal Aortic
 401 Aneurysm. *Mediators Inflamm* 2015;945035.

402 27. Arnaoutoglou E, Kouvelos G, Papa N, Kallinteri A, Milionis H, Koulouras V, et al.
 403 Prospective Evaluation of Post-implantation Inflammatory Response After EVAR for AAA:
 404 Influence on Patients' 30 Day Outcome. *Eur J Vasc Endovasc Surg* 2015;49:175-77.

405 29. Voûte MT, Bastos Gonçalves FM, van de Luijtgarden KM, Klein Nulent CGA,
 406 Hoeks SE, Stolker RJ, et al. Stent graft composition plays a material role in the
 407 postimplantation syndrome. *J Vasc Surg* 2012;56:1503-9.

408 30. Saratzis A, Melas N, Mahmood A, Sarafidis P. Incidence of Acute Kidney Injury
 409 (AKI) after Endovascular Abdominal Aortic Aneurysm Repair (EVAR) and Impact on
 410 Outcome. *Eur J Vasc Endovasc Surg* 2015;49:534-40.

411 31. Saratzis A, Nduwayo S, Sarafidis P, Sayers RD, Bown MJ. Renal Function is the Main
 412 Predictor of Acute Kidney Injury after Endovascular Abdominal Aortic Aneurysm Repair.
 413 *Ann Vasc Surg* 2016;31:52-9.

414 32. Pisimisis GT, Bechara CF, Barshes NR, Lin PH, Lai WS, Kougias P. Risk factors and
 415 impact of proximal fixation on acute and chronic renal dysfunction after endovascular aortic
 416 aneurysm repair using glomerular filtration rate criteria. *Ann Vasc Surg* 2013;27:16-22.

417 33. Goldfarb S, McCullough PA, McDermott J, Gay SB. Contrast-induced acute kidney
 418 injury: specialty-specific protocols for interventional radiology, diagnostic computed
 419 tomography radiology, and interventional cardiology. *Mayo Clin Proc* 2009;84:170-9.

420 34. Krajcer Z, Ramaiah VG, Henao EA, Metzger DC, Nelson WK, Moursi MM, et al.
 421 Perioperative Outcomes From the Prospective Multicenter Least Invasive Fast-Track EVAR

(LIFE) Registry. J Endovasc Ther 2018;25:6-13.

35. Karthikesalingam A, Thrumurthy SG, Young EL, Hinchliffe RJ, Holt PJE, Thompson MM. Locoregional anesthesia for endovascular aneurysm repair. J Vasc Surg 2012;56:510-9.

36. Edwards MS, Andrews JS, Edwards AF, Ghanami RJ, Corriere MA, Goodney PP, et al. Results of endovascular aortic aneurysm repair with general, regional, and local/monitored anesthesia care in the American College of Surgeons National Surgical Quality Improvement Program database. J Vasc Surg 2011;54:1273-82.

37. Moscato VP, O'Brien-Irr MS, Dryjski ML, Dosluoglu HH, Cherr GS, Harris LM. Potential clinical feasibility and financial impact of same-day discharge in patients undergoing endovascular aortic repair for elective infrarenal aortic aneurysm. J Vasc Surg 2015;62:855-61.

38. Cazenave-Lacroutz A, Yilmaz E. Évaluation du dispositif d'incitation tarifaire à la chirurgie ambulatoire. Rev DÉpidémiologie Santé Publique 2016;64:S12.

39. Haute Autorité de Santé - Niveau de preuve et gradation des recommandations de bonne pratique - État des lieux [Internet]. [cité 1 sept 2017]. Disponible sur: https://www.has-sante.fr/portail/jcms/c_1600564/fr/niveau-de-preuve-et-gradation-des-recommandations-de-bonne-pratique-etat-des-lieux

40. Bouam S, Gaucher S, Matrella F, Cappiello F, Frenkiel J, Béthoux J-P. Increasing ambulatory surgery potential by non-medicalized accommodation: matched comparison of the 2011 national hospital activity data to 66 local stays. J Vasc Surg 2014;151:263-8.

LEGEND OF FIGURES

Fig. 1. Flow chart of the study population.

445 Fig. 2. Repartition diagram of the patients according to percutaneous feasibility and the
446 possibility of an ambulatory logistics for EVAR in patients at normal operative risk according
447 to the HAS (N=71).

448 Fig. 3. Repartition diagram according to percutaneous feasibility and the possibility of an
449 ambulatory logistics for EVAR in patients at normal surgical risk according to the SVS
450 (N=89).

451

**245 AAA surgeries between
2014 and 2016**

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graph TD; A[245 AAA surgeries between 2014 and 2016] --> B[25 emergent procedures]; A --> C[117 elective AAA surgeries with an anatomy allowing a standard EVAR device implantation]; C --> D[99 AAA with an anatomy precluding the use of a standard EVAR device]; C --> E[3 patients ASA 4 (compassionate)]; C --> F[1 dossier manquant];
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25 emergent procedures

**99 AAA with an anatomy
precluding the use of a
standard EVAR device**

**3 patients ASA 4
(compassionate)**

1 dossier manquant

**117 elective AAA surgeries
with an anatomy allowing a
standard EVAR device
implantation**

- Ambulatory + Percutaneous +
- Ambulatory + Percutaneous -
- Ambulatory - Percutaneous +
- Ambulatory - Percutaneous -

- Ambulatory + Percutaneous +
- Ambulatory + Percutaneous -
- Ambulatory - Percutaneous +
- Ambulatory - Percutaneous -

Table I. Initial characteristics of the study population (total population, n=117)

Variable		N (%)
Age (years, mean $\pm$ standard deviation)		71.6 $\pm$ 23.5
Male gender		112 (95.7)
Coronary insufficiency		40 (34.2)
Positive cardiac stress testing		21 (18)
Preoperative coronary revascularization		4 (3.4)
High blood pressure		93 (79.5)
Dyslipidemia		92 (78.6)
Actual smoking		43 (36.7)
Diabetes		23 (19.7)
Obesity		19 (16)
Obstructive chronic pulmonary disease		34 (29)
Chronic kidney disease		29 (24.8)
Long-term anticoagulant therapy		
	AVK	15 (12.8)
	NOAC	9 (7.7)
ASA		
	1	1 (0.8)
	2	50 (42.7)
	3	66 (56.4)
Normal surgical risk		
	HAS	71 (60.7)
	SVS	89 (76.1)
AAA morphological data		
Maximal diameter (mm, mean $\pm$ standard deviation)		53.1 $\pm$ 7.4
Proximal neck length (mm, mean $\pm$ standard deviation)		27.7 $\pm$ 10.9
Proximal neck diameter (mm, mean $\pm$ standard deviation)		22 $\pm$ 3.4

ASA: American society of anesthesiologists; AAA: abdominal aortic aneurysm; AVK: Antivitamin K; NOAC: new oral anticoagulants.

Table II. Criteria of eligibility to femoral percutaneous approach (total population, n=117)

Variable	N (%)
Femoral diameter > 5 mm	111 (94.9)
No anterior common femoral calcifications	96 (82)
No previous groin approach	111 (94.9)
Respect of the 3 criteria	90 (76.9)

Table III. Logistical criteria of eligibility to ambulatory management (total population, n=117)

Variable	N (%)
Residence at less than an hour from the hospital	99 (84.6)
Relatives at home during the first 24 hours	110 (94)
Presence of both criteria	94 (80.3)

Table IV. Balance costs/revenue per patient according to the length of stay

Type of hospitalisation	Average cost (euros)*	Associated revenue (euros)	Margin over costs [euros (%)]
Ambulatory	1618	1741	+ 122 (+7.5)
Conventional			
1 night	1731	1741	+10 (+0.5)
2 nights	2334	2453	+ 119 (+5)
3 nights	2937	2453	- 484 (-16)
4 nights	3540	2453	- 1087 (-30)

**Costs of the initial intervention (1128 euros) + post-procedural costs according to the duration of hospitalization*