




Risk factors and prevalence of arteriovenous fistula aneurysm in hemodialysis patients: systematic review

Factores de riesgo y prevalencias del aneurisma de fístula arteriovenosa en pacientes de hemodiálisis: revisión sistemática

- ¹ Gabriela Fernanda Collaguaso Duran  <https://orcid.org/0000-0001-5904-1294>
Universidad Católica de Cuenca, Cuenca, Ecuador.
gabriela.collaguaso.40@est.ucacue.edu.ec
- ² Johanna Priscila Ávila Vinueza  <https://orcid.org/0000-0003-2264-6876>
Universidad Católica de Cuenca, Cuenca, Ecuador.
johanna.avila@ucacue.edu.ec
- ³ Rodrigo José Mendoza Rivas  <https://orcid.org/0000-0002-8563-4058>
Universidad Católica de Cuenca, Cuenca, Ecuador.
rodrigo.mendoza@ucacue.edu.ec

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Resumen

El termino aneurisma de fistula arteriovenosa se utiliza en medicina para definir que es una dilatación vascular localizada, donde participa toda la pared del vaso incrementando el diámetro vascular en un 50% o más. **Objetivo general:** Revisar en la evidencia científica sobre determinar los factores de riesgo y prevalencias del aneurisma de fístula arteriovenosa en pacientes de hemodiálisis. **Metodología:** Se trabajó con un método de enfoque descriptivo en lo que se refiere a las estrategias de búsqueda se utilizó las bases de datos científicas como, *PubMed*, *Scopus*, *Web off Science*, mediante la combinación de palabras clave lo que permitió seleccionar artículos en idioma español e inglés entre los años de publicación 2015 al 2021, se escogerán aquellos que tuvieran alguna relación con la temática a tratar. **Resultados principales:** El método empleado en la investigación será hipotético deductivo, utilizará un diseño no experimental de nivel descriptivo, que recogerá la información en un período de los 5 últimos años, cuyos resultados serán visualizados en gráfica y textualmente. **Conclusión:** La evidencia significativa para afirmar los factores observados si están asociados significativamente a la formación de aneurismas en fístula arteriovenosa, con una p -valor < 0.05 , afirmando o anulando la hipótesis planteada para dichos factores.

Abstract

The term arteriovenous fistula aneurysm is used in medicine to define that it is a localized vascular dilatation, where the entire vessel wall participates increasing the vascular diameter by 50% or more. **General objective:** To review the scientific evidence on determining the risk factors and prevalence of arteriovenous fistula aneurysm in hemodialysis patients. **Methodology:** We worked with a descriptive approach method regarding the search strategies, we used scientific databases such as *PubMed*, *Scopus*, *Web of Science*, by combining keywords which allowed us to select articles in Spanish and English between the years of publication 2015 to 2021, we chose those that had some relation with the topic to be addressed. **Main results:** The method used in the research will be hypothetical deductive, it will use a non-experimental design of descriptive level, which will collect the information in a period of the last 5 years, whose results will be visualized graphically and textually. **Conclusion:** Significant evidence to affirm the observed

factors if they are significantly associated with the formation of aneurysms in arteriovenous fistula, with a p-value < 0.05, affirming or nullifying the hypothesis posed for these factors.

Introduction

Hemodialysis (HD) is considered and accepted as a temporary treatment for patients with end-stage renal disease (ESRD) awaiting renal transplantation. Repeated access to circulation is essential to perform adequate maintenance HD (1). Many patients who are not candidates for renal transplantation or those for whom a matched donor cannot be obtained are dependent on HD for their entire life. This situation results in the need for and use of long-term dialysis vascular access. There are many short- and long-term complications that can interfere with dialysis function (2).

The lower availability of kidney donors and longer survival of patients means that most patients require a prolonged period of artificial renal support, necessitating the formation of arteriovenous fistulas (AVF). Arteriovenous fistulas are surgically created communications between the native artery and vein of an extremity. An AVF is an autologous arteriovenous access created by connecting a vein to an artery (e.g., cephalic vein attached to the radial artery) in which the vein serves as an accessible conduit (3).

In the chronic or acute renal patient, vascular access for hemodialysis is essential, both because of its associated morbidity and mortality and its impact on quality of life. The process that goes from the creation and maintenance of vascular access to the treatment of its complications constitutes a challenge for decision making due to the complexity of the existing pathology and the diversity of specialties involved (4).

Chronic kidney disease has a prevalence of 650 patients per million inhabitants, with an estimated increase of 10% per year, according to the Pan American Health Organization and Latin American Society of Nephrology in a study conducted in 2013 (5).

This research is based on one of the continuous complications in relation to vascular accesses in this type of patients, such as aneurysm.

The rate of formation of arteriovenous fistula aneurysms is high, with a significant rate of morbidity and mortality (6).

At the level of Ecuador, studies were found where they cite prevalence, in Esmeraldas in hemodialysis clinics in the period May - October 2015, of all complications the highest

percentage was in infection with 21.6%, followed by aneurysm with 19.8% and finally arterial hypotension with 17.1% throughout the investigation (5).

Another study was observational correlation. Measurements were performed from September 29, 2016, to January 30, 2017, in the Hemodialysis Unit of the "José Carrasco Arteaga" Hospital in Cuenca. Fifty-seven patients participated; the prevalence of aneurysms was 10.5% (7).

In Cuba aneurysms occur (3-5%) in areas of repetitive puncture and can be avoided by rotating the puncture site and avoiding repeated traumas that damage the arterial or venous wall (8).

In Spain, venous aneurysms in arteriovenous fistulas are frequent, between 5% to 60% depending on the series and the definition of aneurysm used, being in most cases secondary to weakening of the vessel wall by repeated punctures. They are true dilatations of the vessel, which preserves all its layers, unlike pseudoaneurysms, in which there is a rupture of the wall (9).

Adequate vascular access (VA) is essential for the successful treatment of patients with end-stage renal disease (ESRD) on hemodialysis (HD). With increasing average age, vascular territory depletion, and diabetes as the main cause of renal etiology, establishing, and preserving an adequate VA has become a major challenge. A functional VA is the lifeline (10), allowing patients to undergo HD as renal function replacement therapy, enabling their survival and maintenance of an acceptable quality of life. In contrast, preservation and maintenance of an uncomplicated VA remains the Achilles heel (11). Moreover, vascular access dysfunctions remain the main cause of comorbidities and hospitalizations (12) in ESRD patients.

The choice of cannulation technique (CT) and vascular access cannulation are the most important aspects in dialysis (13), and it is the responsibility of the nursing staff to constantly update their knowledge and skills in this area.

Among the systematic review some authors take as the main risk factor predisposing to aneurysm formation in arteriovenous fistulas, the puncture technique, emphasizing the zone technique. On the other hand, other authors state that more risk factors can also be associated, such as vessel weakness associated with entities such as Allport syndrome or polycystic kidney disease. The presence of proximal stenosis also benefits the appearance and growth of aneurysms (14).

Therefore, the general objective was to review the scientific evidence on determining the risk factors and prevalence of arteriovenous fistula aneurysm in hemodialysis patients. Based on this objective, the following specific objectives were derived: a) Review the literature worldwide on the prevalence of arteriovenous fistula aneurysm in hemodialysis

patients and b) examine the risk factors of arteriovenous fistula aneurysm in hemodialysis patients.

Methodology

Type of research

It was a descriptive study, based on a literature review of the literature published in various sources of information in databases, the risk factors that are subject to the formation of aneurysms were cited in detail, taking into consideration the most relevant, to document the information selected for the review, the recommendations of the PRISMA (15), method were followed.

Search strategies

For the search we used the library of the Catholic University of Cuenca and the databases Scopus, PubMed, and Web of Science, in the period between the end of 2015 2021. We selected those related to vascular access, arteriovenous fistulas, the keywords related to the desired objectives, according to the terms Mesh and Decs: Hemodialysis - arteriovenous fistula - aneurysm - prevalence - risk factors, and connections were made with Boolean connectors "AND" and "OR". After a first search we proceeded to review each article according to title and abstract, those that had the description of the clinical variables and the morbidity and mortality in complications of vascular access were included. However, in those cases in which the study methodology was not clear and the results were not precise, the article was excluded.

Inclusion criteria

The study included all documents that were freely accessible, related to the subject of the study or whose information was considered relevant. The selection of articles was made as follows:

- Languages: studies in Spanish, English, Italian, German, and French were included, because the subject of vascular access and arteriovenous aneurysms has been widely studied, for which translators specialized in the medical area were used.
- Year of publication: between the end of 2015 and the beginning of 2021.
- Population-based articles of patients receiving hemodialysis in which they were compared according to the presence of renal failure.
- Quantitative studies.
- Quality of the articles.

Exclusion criteria

We discarded all documents that were not freely accessible, those that were not related to the subject of the study or whose information was not considered relevant. We excluded from the study articles that were not of the year of publication sought.

- Clinical cases
- Case series
- Qualitative studies
- Narrative literature reviews.
- Systematic literature reviews.
- Meta-analysis.
- Studies with unexplained methodologies.
- Letters to the editor.
- Inability to retrieve the full text of the article.
- Repeated article from a previous search.

Research and selection of studies

For the selection, we worked initially by identifying the relevance of each study, using DeCS and MeSH terms, Boolean operators, and the combination of keywords, which were used in the following databases.

The research strategy (keywords and search sequence) for each database was:

- Medline (50 articles): ("Arteriovenous Fistula/complications"[Mesh] OR "Arteriovenous Fistula/epidemiology"[Mesh]) Date of publication: (From 2015-2021/11/20).
- Scopus (30 articles): (vascular AND access AND devices AND aneurysm AND hemodialysis) AND PUBYEAR > 2015 AND PUBYEAR < 2021
- Web of Science (20 articles): aneurysm Arteriovenous Fistula (All Fields) and 2021, 2020, 2019, 2019, 2018, 2017, 2016, or 2015 (Publication Years) and Articles (Document Types) and English or Spanish (Languages)
Publication years: [2015/11/01-2021/11/20].

Procedure

To begin with, the research topic was raised from which the following questions are broken down: What is the prevalence and risk factors associated with the formation of aneurysms in arteriovenous fistulas, What is the factor of health care influences the presence of aneurysm in arteriovenous fistulas, What is the factor of human biology

influences the presence of aneurysm in arteriovenous fistulas, What is the factor of human biology influences the presence of aneurysm in arteriovenous fistulas, And how many prevalence of aneurysm in arteriovenous fistulas in hemodialysis patients were found in the last 5 years? And how much prevalence of aneurysm in arteriovenous fistulas in hemodialysis patients were found in the last 5 years, where the data obtained were summarized in tables, in which the prevalence and risk factors of aneurysm in arteriovenous fistulas were exposed. The following steps were followed, in the first stage, the subject was identified, and the research question was formulated through the strategy Prevalence or incidence /PEO (Population, exposure and observation), What is the prevalence and risk factor that predispose to the presence of aneurysm in arteriovenous fistulas in hemodialysis?

In the second stage, the inclusion criteria were applied as original articles related to aneurysm in arteriovenous fistulas, published in Spanish, English, Italian, German and French; with full text and online. The exclusion criteria were clinical cases, case series, qualitative studies, narrative literature reviews, systematic literature reviews, meta-analysis, studies with unexplained methodologies, letters to the editor.

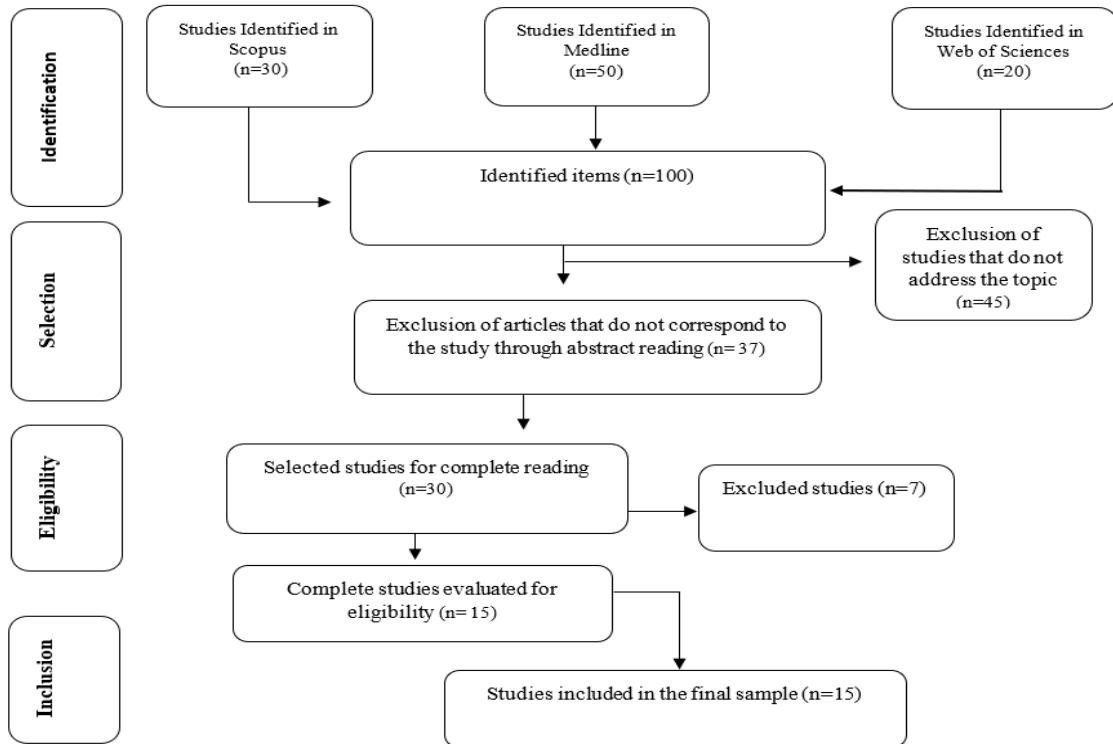
In the third stage, the selection previously exposed at the time of the review of the articles was conducted, if after reading the abstract the article was chosen, it was reviewed in depth.

Then, in the fourth and fifth stages, the evaluation of the studies and the interpretation of the results obtained was carried out with more criteria, to reach the sixth stage where the discussion and synthesis of knowledge took shape; the summary of the data was placed in a matrix elaborated by the author, finally the data obtained were compared with those of other investigations in order to structure the definitive review article.

Results

Figure 1.

Flow diagram



Initially, the number of articles found in the different databases related to the topic under study and considered relevant for the use of the work.

Table 1.

Selected articles.

| Code | Base | Journal | Author | Year | Title | Country | Type of study | Number of participants |
|------|----------------|---|--------------------------|------|---|--------------|---------------|------------------------|
| 1 | Web Of Science | Journal of Family Medicine and Primary Care | Majed Mansour et al. (2) | 2020 | Complications of arteriovenous fistula in dialysis patients: Incidence and risk factors in Taif city, KSA | Arabia Saudi | Quantitative | 196 |

Table 1.

Selected articles. (continued)

| Code | Base | Journal | Author | Year | Title | Country | Type of study | Number of participants |
|------|----------------|---|------------------------------|------|--|------------|---------------|------------------------|
| 2 | Web Of Science | International Journal of Environmental Research and Public Health | Peralta et al. (3) | 2021 | Cannulation Technique of Vascular Access in Haemodialysis and the Impact on the Arteriovenous Fistula Survival: Protocol of Systematic Review. A systematic review and individual patient data meta-analysis | Suiza | Qualitative | 32 |
| 3 | Scopus | Journal of Vascular Surgery | Florian A. Wenzl et al. (11) | 2021 | of heart failure as a rare complication of traumatic arteriovenous fistulas | Huntington | Quantitative | 274 |
| 4 | Web Of Science | CASE REPORT | Rui Abreu et al. (12) | 2020 | A Very High-flow Arteriovenous Fistula with Added Bleeding Risk: One Solution for Two Problems Direction- and Angle-Assisted Buttonhole Cannulation of Arteriovenous | Portugal | Quantitative | 85 |
| 5 | Scopus | Kidney Medicine | Marit.Rønnning et al. (13) | 2022 | Fistula in Hemodialysis Patients: A Multicenter Randomized Controlled Trial | Norway | Quantitative | 83 |

Table 1.

Selected articles. (continued)

| Code | Base | Journal | Author | Year | Title | Country | Type of study | Number of participants |
|------|--------|--------------------------------|-----------------------------|------|--|----------------|---------------|------------------------|
| 6 | Scopus | BMC Nephrology | Zhao et al. (16) | 2022 | Thrombocytopenia predicts mortality in Chinese hemodialysis patients- an analysis of the China DOPPS | China | Quantitative | 1427 |
| 7 | PudMed | BMC Nephrology | Vajdič Trampuž et al. (17) | 2021 | A national cohort study on hemodialysis arteriovenous fistulas after kidney transplantation - long-term patency, use and complications | Ljubljana | Qualitative | 626 |
| 8 | PudMed | The Journal of Vascular Access | Grant et al. (18) | 2021 | Carpal tunnel syndrome in patients with arteriovenous fistula for hemodialysis: A narrative review of the current literature | Estados Unidos | Qualitative | 170 |
| 9 | PudMed | The Journal of Vascular Access | Lindhard et al. (19) | 2021 | Stable incidence and survival of arteriovenous fistulas over 39 years: A long-term national cohort study | Denmark | Quantitative | 4221 |
| 10 | PudMed | Enfermería nefrológica | Delgado Ramírez et al. (20) | 2016 | Factores que influyen en la supervivencia de la fístula arteriovenosa interna y su relación con la técnica de punción | España | Quantitative | 35 |

Table 1.

Selected articles. (continued)

| Code | Base | Journal | Author | Year | Title | Country | Type of study | Number of participants |
|------|----------------|-----------------------------|------------------------------|------|---|------------------|---------------|------------------------|
| 11 | Web Of Science | Journal of Vascular Surgery | Barrionuevo et al. (21) | 2019 | A systematic review and meta-analysis of the management of visceral artery aneurysms Cannulation technique and complications in | Newcastle Ottawa | Qualitative | 100 |
| 12 | Web Of Science | BMC Nephrology volume | Staaf et al. (22) | 2020 | arteriovenous fistulas: a Swedish Renal Registry-based cohort study Prognosis of Vascular Access in | Suecia | Quantitative | 1328 |
| 13 | Web Of Science | Scientific Reports | Lee et al. (23) | 2020 | Haemodialysis Patients with Autosomal Dominant Polycystic Kidney Disease Prevalence, clinical characteristics, and predictors of peripheral arterial disease in | Taiwan | Quantitative | 4268 |
| 14 | Scopus | BMC Nephrology | Aščerić et al. (24) | 2019 | hemodialysis patients: a cross-sectional study Translational Sciences in | Belgrade, Serbia | Quantitative | 100 |
| 15 | Web Of Science | Annals of Vascular Surgery | Syeda Anum Zahra et al. (25) | 2021 | Cardiac Failure Secondary to Arteriovenous Fistula in Hemodialysis Patients | Blackburn, UK | Quantitative | 120 |

Total prevalence of the 15 analyzed articles

Discussion

Fifteen articles are selected to perform the analysis on Risk factors and prevalence of arteriovenous fistula aneurysm in hemodialysis patients, therefore, Zhao et al. (16), in China states that the prevalence of PT was 11.2%. Patients with PT tended to have a longer time on dialysis, lower BMI, lower probability of having residual renal function (higher proportion of patients with diuresis < 200 ml/day), lower Alb, lower leukocyte count and higher probability of having hepatitis and liver cirrhosis.

On the contrary, according to Vajdič Trampuž et al. (17), the main cause of failure there is a correlation between multiple cannulations and the development of central venous stenosis. Progressive stenosis of the vein eventually leads to venous thrombosis. In a study of 57 patients after dialysis catheter placement, 28% of patients developed central venous thrombosis and 14% developed brachiocephalic vein stenosis, at a mean of 21 days follow-up.

While, citing Grant et al. (18), in their study in the United States, the evolution of carpal tunnel syndrome in hemodialysis patients with an arteriovenous fistula revealed that the frequency of carpal tunnel syndrome associated with an arteriovenous fistula in hemodialysis ranged from 10.4% to 42.6%. An association between the duration of hemodialysis with arteriovenous fistula and the development of carpal tunnel syndrome was also observed. Surgical carpal tunnel release provided complete relief of paresthesia in all patients treated in the examination, demonstrating symptom relief and improved hand function and quality of life in patients with an arteriovenous fistula. However, the etiology and risk factors for the development of carpal tunnel syndrome remain unclear, and further studies should attempt to elucidate the pathophysiology of this occurrence in the presence of arteriovenous fistulas

On the other hand, Lindhard et al. (19), venous cannulation creates an area of vascular injury that, upon healing, leads to an area of fibrosis. Points within the vessel that are in repeated contact with the catheter may also be injured. In addition, the rapid blood flows associated with hemodialysis create areas of turbulent flow beyond the catheter tip, which stimulates endothelial proliferation, potentially contributing to venous stenosis. Most central vein stenoses are initially asymptomatic, but stenosis may manifest after the creation of a peripheral arteriovenous fistula in the ipsilateral extremity. Symptoms consist of edema and elevated venous pressure on dialysis.

Within this order of ideas, from the point of view of Delgado Ramírez et al. (20), it is described, on the one hand, the maintenance and self-care of vascular access, and on the other, vigilance and assertiveness to protect the vascular access of the providers. Regarding maintenance and self-care of vascular access, patients reported having received little information on vascular access care: "They did not give me many

instructions about the fistula...", "I do know what they said you needed to check it twice a day to see that it was beating. Now I don't know what would happen if it wasn't beating." He also refers those patients have the idea that they do not feel anything at the vascular access site when it is working properly "If you don't feel anything, then everything is fine.... it is the fact that you do not feel anything that you must keep inspecting it regularly to make sure everything is okay"

At the same time Barrionuevo et al. (21), at Newcastle Ottawa data for 2845 aneurysms, comprising 1279 of the renal arteries, 775 of the splenic arteries, 359 of the hepatic arteries, 226 of the pancreatic duodenal and gastroduodenal arteries, 95 of the superior mesenteric arteries, 87 of the celiac arteries, 15 of the ileal and colic arteries, and 9 of the gastric and gastroepiploic arteries. Differences in mortality between open and endovascular approaches were not statistically significant. Surgeons used the endovascular approach more frequently. The endovascular approach was associated with shorter hospital stay and lower rates of cardiovascular complications, but higher rates of reoperation. Postembolization syndrome rates ranged from 9% (renal) to 38% (splenic). Coil migration ranged from 8% (splenic) to 29% (renal). Otherwise, access site complications were rare (<5%). Pseudoaneurysms tended to have higher mortality and reoperation rates

In this regard Staaf et al. (22), BH is the most common cannulation technique in Sweden. It has been used in 55% of AVFs at some point in their functional patency. BHb (29%), RL (13%) and AP (3%) have been used less frequently. BHb had the lowest risk of complications compared to the other techniques, and a significantly lower risk of stenosis, infiltration and cannulation difficulties compared to RL and BH. Cannulation difficulties were significantly more frequent using AP compared to BHs, and BHb. Infections were not significantly increased with the buttonhole technique. BHb had the lowest risk of complications. Infections were not significantly increased with the buttonhole technique. Dialysis units with a low infection rate can continue to use the buttonhole technique, as the risk of complications is lower. This systematic review provides event rates for important outcomes for patients with OABV. Despite the low certainty warranted by the evidence, these rates, along with surgical experience and anatomic feasibility, may assist patients and surgeons in shared decision making.

In this framework, as Lee et al. (23), point out, self-care behaviors according to the ASBHD-AVF scale (Assessment of Self-care Behaviors Hemodialysis Arteriovenous Fistula) or Assessment of Self-care Behaviors with Hemodialysis Arteriovenous Fistula scale are collected in Taiwan. As a result, they obtained that the frequency of self-care behaviors of arteriovenous fistula is positively influenced by the following characteristics: being female, being hypertensive, having polycystic kidneys with other renal disease and the duration of arteriovenous fistula; and it is negatively influenced by

the following characteristics: previous arteriovenous fistula and by the physician as a provider of information about the fistula

Conclusions

- At the conclusion of this systematic review, we conclude that our systematic review protocol aims to set out the intended method for reviewing information on the benefits and risks associated with each technique of AVF cannulation in HD patients. It is a feasible means of synthesizing the extensive evidence available on the topic, and the systematic review allows the results of RCTs and observational studies to be interpreted within the evidence. By summarizing all related studies, it improves understanding of inconsistencies in the evidence. In addition to identifying research gaps, the review will help provide evidence-based knowledge translation, so that the outcome will be used for clinical practice and HD course curricula.

Reference Bibliography

- Morales Mercado GM, Vera Zavala LR. Prevalence of infectious endocarditis in patients with renal replacement therapy attended at the Hospital Teodoro Maldonado Carbo during the period of 2017-2020. 202. Available from: <http://repositorio.ucsg.edu.ec/handle/3317/16731>
- Aljuaid MM, Alzahrani NN, Alshehri AA, Alkhalidi LH, Alosaimi FS, Aljuaid NW, et al. Complications of arteriovenous fistula in dialysis patients: Incidence and risk factors in Taif city, KSA. *J Fam Med Prim Care*. 2020;9(1):407. Available from: https://doi.org/10.4103/jfmpc.jfmpc_848_19
- Peralta R, Sousa L, Cristóvão AF. Cannulation Technique of Vascular Access in Haemodialysis and the Impact on the Arteriovenous Fistula Survival: Protocol of Systematic Review. *Int J Environ Res Public Health*. 2021;18(23):12554. Available from: <https://doi.org/10.3390/ijerph182312554>
- Al-Jaishi A, Liu AR, Lok CE, Zhang JC, Moist LM. Complications of the arteriovenous fistula: A systematic review. *J Am Soc Nephrol*. 2017;28(6):1839–50. Available from: <https://doi.org/10.1681/asn.2016040412>
- Muñoz S. Complications of arteriovenous fistulas in patients with renal function replacement therapy in hemodialysis clinics in the city of Esmeraldas. Vol. 3. Pontificia Universidad Católica del Ecuador; 2015. Available from: <https://repositorio.pucese.edu.ec/bitstream/123456789/660/1/MU%C3%91OZ%20CHILA%20%20SAIDA%20LORETTA.pdf>

- Al-Thani H, El-Menyar A, Al-Thani N, Asim M, Hussein A, Sadek A, et al. Characteristics, Management, and Outcomes of Surgically Treated Arteriovenous Fistula Aneurysm in Patients on Regular Hemodialysis. *Ann Vasc Surg.* 2017; 41:46–55. Available from: <https://doi.org/10.1016/j.avsg.2016.08.046>
- Mora F. Correlation between arteriovenous fistula flow with extracorporeal flow. Vol. 53, *Occupational Medicine.* University of Cuenca; 2017. Available from: <https://doi.org/10.1093/ndt/gfm549>
- Franco N, Valdés C, Savigne W, Concepción D. Possible causes of arteriovenous fistula aneurysm and pseudoaneurysm in patients with renal insufficiency. *Rev Cuba angirol cir vasc.* 2015;16(2):205–15. Available from: <https://www.medigraphic.com/pdfs/revcubangcirvas/cac-2015/cac152h.pdf>
- Jiménez P, Pila U, Gruss E, Lasala M, Rueda U, Colás E, et al. Juxtaanastomotic venous aneurysms in arteriovenous fistulas for hemodialysis. *Nephrology.* 2015;8(4):454–7. Available from: <https://www.revistanefrologia.com/en-juxtaanastomotic-venous-aneurysms-in-arteriovenous-articulo-S2013251418300646>
- Lopes JRA, Marques AL de B, Correa JA. The influence of a doppler ultrasound in arteriovenous fistula for dialysis failure related to some risk factors. *Brazilian J Nephrol.* 2020; 42:147–52. Available from: <https://doi.org/10.1590/2175-8239-jbn-2019-0080>
- Wenzl FA, Miljkovic SS, Dabestani PJ, Kessler II JJ, Kotaru TR, Kalamchi LD, et al. A systematic review and individual patient data meta-analysis of heart failure as a rare complication of traumatic arteriovenous fistulas. *J Vasc Surg.* 2021;73(3):1087–94. Available from: <https://doi.org/10.1016/j.jvs.2020.08.138>
- Rui Abreu MD, Joaquin Vallespin MD, José Ibeas MD. A Very High-flow Arteriovenous Fistula with Added Bleeding Risk: One Solution for Two Problems. *Vasc Dis Manag.* 2020;17(9): E179–82. Available from:
- Rønning MI, Benschop P, Øvrehus MA, Hultstrøm M, Hallan SI. Direction and Angle-Assisted Buttonhole Cannulation of Arteriovenous Fistula in Hemodialysis Patients: A Multicenter Randomized Controlled Trial. *Kidney Med.* 2021. Available from: <https://www.hmpgloballearningnetwork.com/site/vdm/content/very-high-flow-arteriovenous-fistula-added-bleeding-risk-one-solution-two-problems>
- Pasklinsky G, Meisner R, Labropoulos N, Leon L, Gasparis A, Landau D, et al. Management of true aneurysms of hemodialysis access fistulas. *J Vasc Surg.* 2011;53(5):1291–7. Available from: <https://doi.org/10.1016/j.jvs.2010.11.100>

- Urrútia G, Bonfill X. PRISMA declaration: A proposal to improve the publication of systematic reviews and meta-analyses. *Med Clin (Barc)*. 2010;135(11):507–11. Available from: <https://doi.org/10.1016/j.medcli.2010.01.015>
- Zhao X, Niu Q, Gan L, Hou FF, Liang X, Ni Z, et al. Thrombocytopenia predicts mortality in Chinese hemodialysis patients-an analysis of the China DOPPS. *BMC Nephrol*. 2022;23(1):1–9. Available from: <https://doi.org/10.1186/s12882-021-02579-5>
- Vajdič Trampuž B, Arnol M, Gubenšek J, Ponikvar R, Buturović Ponikvar J. A national cohort study on hemodialysis arteriovenous fistulas after kidney transplantation-long-term patency, use and complications. *BMC Nephrol*. 2021;22(1):1–9. Available from: <https://doi.org/10.1186/s12882-021-02550-4>
- Grant Y, Freilich S, Horwitz MD, Shemesh D, Crane J. Carpal tunnel syndrome in patients with arteriovenous fistula for haemodialysis: a narrative review of the current literature. *J Vasc Access*. 2021;22(5):795–800. Available from: <https://doi.org/10.1177/1129729820948690>
- Lindhard K, Hansen D, Lindegaard Pedersen B, Rix M, Hansen HP, Jensen BL, et al. Stable incidence, and survival of arteriovenous fistulas over 39 years: A long-term national cohort study. *J Vasc Access*. 2021;11297298211046102. Available from: <https://doi.org/10.1177/11297298211046102>
- Delgado Ramírez A, Ruiz García E, Latorre López LI, Crespo Montero R. Factors influencing internal arteriovenous fistula survival and their relationship to puncture technique. *Nephrological nursing*. 2016;19(3):215–30. Available from: https://www.revistasden.org/files/Revistas_245_ompleta81048.pdf
- Barrionuevo P, Malas MB, Nejm B, Haddad A, Morrow A, Ponce O, et al. A systematic review and meta-analysis of the management of visceral artery aneurysms. *J Vasc Surg*. 2020;72(1):40S–45S. Available from: <https://doi.org/10.1016/j.jvs.2019.02.024>
- StAAF K, Fernström A, Uhlin F. Cannulation technique and complications in arteriovenous fistulas: a Swedish Renal Registry-based cohort study. *BMC Nephrol*. 2021;22(1):1–12. Available from: <https://doi.org/10.1186/s12882-021-02458-z>
- Lee T-L, Chen C-F, Tan AC, Chan C-H, Ou S-M, Chen F-Y, et al. Prognosis of vascular access in haemodialysis patients with autosomal dominant polycystic kidney disease. *Sci Rep*. 2020;10(1):1–7. Available from: <https://doi.org/10.1038/s41598-020-58441-5>
- Aščerić R, Dimković N, Trajković R, Janković A, Durić P, Ilijevski N. Prevalence, clinical characteristics, and predictors of peripheral arterial disease in

hemodialysis patients: A cross-sectional study. *BMC Nephrology*. 2019;20(1): 1-9. Available from: <https://doi.org/10.1186/s12882-019-1468-x>

Zahra SA, Choudhury RY, Basharat K, Tran T, Begum M, Abotabekh A, et al. Translational Sciences in Cardiac Failure Secondary to Arteriovenous Fistula in Hemodialysis Patients. *Ann Vasc Surg*. 2021; 74:431–49. Available from: <https://doi.org/10.1016/j.avsg.2021.01.071>



Conflict of interests

The authors do not present conflict of interests.

Declaration of authors' contribution

All named authors have contributed sufficiently to the work.

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