

SURGICAL OUTCOMES OF ARTERIO-VENOUS FISTULA CREATION- A PROSPECTIVE STUDY

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Abstract

Background: The arteriovenous fistula (AVF) is the preferred hemodialysis access, but AVF-failure rate is high, and complications from AVF placement are rarely reported. There is no clear consensus on predictors of AVF patency. This study determined AVF outcomes and patency predictors at our centre. **Materials and Methods:** This is a prospective study which was conducted at Department of CTVS and Urology, MGM Superspeciality Hospital, Indore from August 2021 to May 2023. The AVF placement-associated primary and secondary failure rates, complications and interventions were examined. Kaplan–Meier survival curves and Cox proportional hazard models were used to determine primary and secondary patency and associated predictors. **Result:** The study population (n=200) was assessed as a whole in terms of Demographic data, Primary and Secondary Outcome Measures. The mean age of patients was found to be 45.1 years. The primary failure rate was 21% at 3 months follow up. The secondary failure rate and complications were assessed. **Conclusion:** Primary failure remains a major issue in the post–Fistula First era. Complications from AVF placement must be considered when planning AVF placement. Our data demonstrate that artery size is the main predictor of AVF patency.

INTRODUCTION

Vascular access dysfunction is a major contributor to the hospitalization of hemodialysis patients and their overall morbidity and mortality.^[1–7] Vascular access dysfunction also imposes a substantial financial burden on the patient

Arteriovenous fistula (AVF) is the desired vascular access for patients maintained on chronic hemodialysis; AVFs, in general, exhibit greater functional longevity, are less prone to infections, and are associated with decreased mortality and lower costs.^[2,8–13]

However, the outcomes for this appropriately preferred access are indubitably poor. Up to 20% of AVFs are never usable for hemodialysis, and of the AVFs that do function, 25% will fail after 2 years,^[14–18] outcomes for other accesses are also poor with patency rates of 67% and 58% for central venous catheters and AV grafts at 6 months, respectively.^[19,20] That the most favored access, the AVF, exhibits failure rates that, ironically, are among the highest for any elective surgical procedure,

underscores the enormity of the issue of hemodialysis access dysfunction.

The consequences of AVF failure are substantial and far ranging. First, such failure not only denies patients a functional access but also reduces the number of sites at which another access may be subsequently placed. Second, interventional procedures are commonly undertaken to salvage failing AVFs, thereby subjecting patients to these procedures in addition to AVF creation. Third, AVF placement is not risk-free, exposing patients to complications, including permanent ones, that may aggravate the frustration and setback in patient management incurred by AVF failure. There is thus a substantial need to identify patients at risk for AVF failure and to define the complications that may ensue after AVF placement.

This study represents one of its type observational analyses of these issues at our centre. First, many prior studies were small or performed before this initiative; second, previous studies used somewhat inconsistent or unclear outcomes; and third, many prior studies did not consistently perform Doppler mapping before AVF creation.^[16–18,21–23] We report

this retrospective cohort study from our practice that examines AVF failure rates and predictors of such failure and the complications, interventions, and hospitalizations that attend AVF placement.

MATERIALS AND METHODS

Patient Population

We performed a prospective study of AVFs done from August 2021 through May 2023 at Department of CTVS and Urology, MGM Superspeciality Hospital Indore. AVFs done in patients less than 18 years old or in patients not giving consent for research were excluded. Only the first AVF in each patient during this period was analyzed.

All of the patients were referred by a nephrologist and evaluated in our OPD. All of the patients underwent preoperative ultrasound and Doppler imaging of vessels in each arm and ultrasound examination of central veins.

Study Outcomes

The primary outcome was secondary patency, which was the time from AVF creation to access abandonment. Other outcomes included suitability for hemodialysis, primary failure, secondary failure, and primary patency. Suitability for hemodialysis required AVF usage with two needles and maintenance of blood flow >300 ml/min for at least eight hemodialysis sessions over 1 month. Primary failure was the permanent failure of the AVF before hemodialysis suitability. This definition includes inadequate maturation, thrombosis, failure of first and subsequent cannulations, and other complications leading to nonfunctional AVFs. Secondary failure was permanent failure after the AVF met dialysis suitability criteria with subsequent abandonment. Primary patency was the intervention-free access survival defined as the time from AVF creation to any intervention to maintain patency or the date of final patency assessment.^[18,24]

Outcome data were obtained through manual chart review. The ending date of AVF follow-up (date of abandonment) was recorded, and Kaplan–Meier survival curves were created to illustrate AVF patency despite differential follow-up. Patency outcomes were compared between patients who received dialysis at our centre or at different place to determine any facility bias.

Complications and hospitalizations associated with AVF placement were also identified. The dismissal diagnoses from all hospitalizations at our centre. Complications included bleeding, thrombosis (non-AVF vessels), infection, arterial steal syndrome, nerve injury, seroma, and subclavian vein stenosis. AVF thrombosis was considered when determining patency and not included among these complications. Demographic, Clinical, and AVF Characteristics

Information recorded at the time of AVF creation included: age, gender, etiology of renal disease, time on hemodialysis, body mass index (BMI), BP, and previous catheter use. The following conditions were

noted if documented by our residents: diabetes, coronary artery disease, congestive heart failure, peripheral vascular disease, cerebrovascular disease, and thromboembolic disease.

Statistical Analyses

Kaplan–Meier survival analysis was used to calculate primary and secondary patency rates, and the log-rank test was used to compare patency rates. Spearman and Pearson correlation coefficients were obtained for all potential predictor variables to look for confounding. A univariate analysis was done with variables considered relevant to AVF patency. All variables with a P value <0.05 were included in the multivariate analysis. Multivariate Cox proportional hazards models were used to determine factors associated with reduced AVF patency. Test results were presented as hazard ratios (HR) with 95% confidence intervals (CIs), and two-sided P < 0.05 was considered statistically significant.

RESULTS

From August 2021, through May 2023, 200 patients underwent procedures for AVF creation. The patients' mean age was 45.1 ± 14.8 years (mean ± SD), 124 patients were male (62%), and 76 patients were females (38%) (Table 1). Diabetic nephropathy (34.8%) was the most common kidney disease. The most common AVF was the brachiocephalic (68.2%). The ultrasound-determined vessel diameters used for AVF creation were 4.4 ± 1.2 and 3.5 ± 1.3 mm for artery and vein, respectively.

[Table 1] Baseline Characteristics of patients during study time period.

AVF Outcomes

After excluding the AVFs unused because of death (2.0%, 4 of 200), no hemodialysis initiation during follow-up (13.0%, 26 of 200), kidney transplantation (0.7%, 2 of 200), or indeterminate outcome (12.5%, 25 of 200), 49.0% (103 of 200) of the remaining AVFs were unsuitable for hemodialysis within a reasonable time. A reasonable time was defined as: (1) within 1 month after hemodialysis initiation if the AVF was created more than 6 months before hemodialysis initiation or (2) within 6 months after placement if the AVF was placed after hemodialysis initiation (data not shown).

[Figure 1] shows all AVF outcomes at the end of follow-up. We also examined AVF outcomes at the end of follow-up for patients who required hemodialysis at some time, did not die, or did not receive a transplant before AVF use (Figure 2). Figures 3 and 4 are the Kaplan–Meier survival curves for primary and secondary fistula patency. The 3-, 6-, 12-, and 15-month event-free survival rates were 67%, 50%, 41%, and 30%, respectively, for primary patency, and 92%, 86%, 77%, and 73%, respectively, for secondary patency.

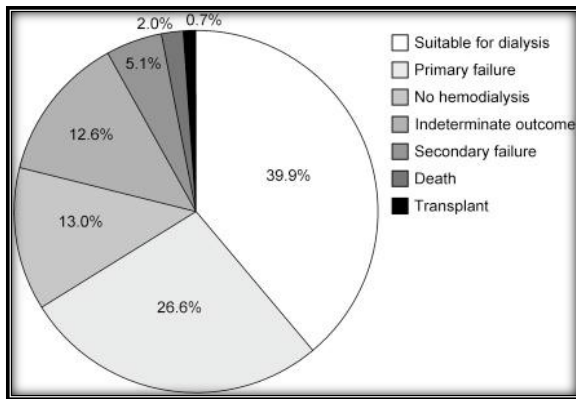


Figure 1: AVF outcomes at the end of follow-up (median, 259 days; interquartile range, 116 to 683 days). At the end of follow-up, 40% (80 of 200) of the AVFs were suitable for dialysis, but 26.5% (53 of 200) had primary failure, 13.0% (26 of 200) were not used because hemodialysis was not needed, 12.5% (25 of 200) had an indeterminate outcome, 5% (10 of 200) had secondary failure, 2.0% (4 of 200) were not used because the patients died before use, and 0.7% (2 of 200) were not used because the patients received a transplant before use.

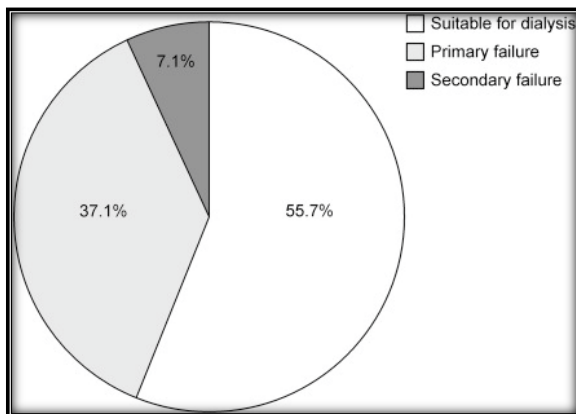


Figure 2: AVF outcomes for the patients who were on hemodialysis at some time during the study, had a known AVF outcome, and did not die or receive a transplant before AVF use (71.5%, 143 of 200). Primary failure occurred in 37.1% (74 of 200) of these AVFs. Approximately 55.7% (111 of 200) of the AVFs became suitable for dialysis at some point and did not fail, whereas 7.1% (15 of 200) of these AVFs had secondary failure.

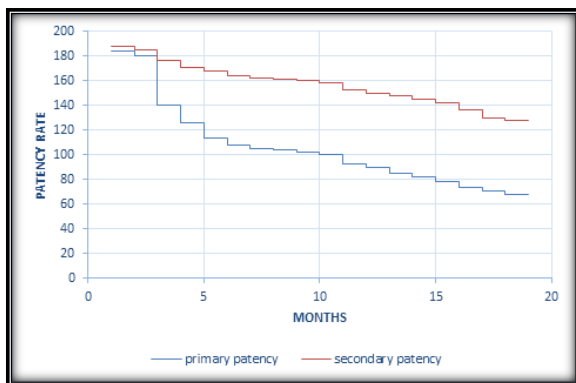


Figure 3: Kaplan-Meier survival curve for primary and secondary AVF patency. The 3-, 6-, 12-, and 18-month

event-free survival rates were 70%, 54%, 45%, and 34%, respectively, for primary patency, and 88%, 82%, 75%, and 64%, respectively, for secondary patency.

Complications after AVF Creation

Complications resulting from AVF creation occurred in 21% (42 of 200) of patients. Specifically, 16% (32 of 200) of AVFs had only one complication, 4% (8 of 200) had two complications, and 1% (2 of 200) had three or four complications. Complications included bleeding (33.0%, 27 of 84), infection (26.8%, 22 of 84), steal syndrome (18.3%, 15 of 84), aneurysm (8.5%, 7 of 84), thrombosis (4.9%, 4 of 84), seroma (4.9%, 4 of 84), subclavian stenosis (2.4%, 2 of 84), and nerve injury (1.2%, 1 of 84). Among the 78 AVFs with primary failure, 24.4% resulted in at least one complication.

DISCUSSION

The AVF failure rate at our center is consistent with previous studies.^[16,18,22,26] However, we found differences in predictors of patency.^[16,18,21,22,27] The major predictor of primary and secondary patency in our cohort was artery size, and indeed, with a 1-mm increase in arterial diameter, the risk of AVF abandonment decreased by 30% over a median follow-up of 259 days. A history of diabetes predicted reduced primary patency and intervention-free survival but not secondary patency. We did not observe a predictive effect of age, gender, vascular disease, BMI, catheter use, or time on hemodialysis, factors linked to AVF patency.^[7,12,14,18,21-23,28-36] vein size was also not predictive, probably because the average vein size (3.5 mm) was greater than the recommended standard (2.5 mm).

This effect of artery size may reflect four factors. First, blood flow is proportional to the fourth power of the arterial radius, and thus small increments in size may substantially increase flow. Second, larger arteries may exhibit a greater vasorelaxant response, thereby accommodating greater blood flow during AVF maturation. Third, AVF thrombosis may be less likely with larger arteries, and, interestingly, we found a possible relationship between secondary AVF patency and thromboembolic disease. Fourth, creating AVFs with larger arteries may be a less challenging procedure.

Prior studies examining access-associated morbidity do not address complications and hospitalizations associated with AVFs,^[4,5,27,37] such analyses are limited to few studies.^[18] In our study, complications and hospitalization occurred in 21.2% and 12.3% of patients, respectively, outcomes more likely in patients with primary AVF failure. The effect of such sequelae is insufficiently addressed in current attempts to increase the number of functional AVFs, and yet it is an important consideration when planning for and counseling patients about access placement.

Our finding that age was not associated with poor AVF patency may not imply that AVFs should be employed indiscriminately in elderly patients; rather, each patient should be considered individually, including the desired quality of life.^[38] The 1-year mortality for octogenarians starting dialysis is approximately 50%, and in older patients with chronic kidney disease, the risk of death is similar or greater than that for initiating dialysis.^[39–43] The need for hemodialysis in the near future or in the patient's lifetime is thus relevant, and notably, some 16.4% of our patients did not initiate hemodialysis within the first year. In elderly patients, placement of AVFs that are neither needed nor functional, as well as AVF-salvaging procedures, may compromise the quality of remaining life.

Our analyses may be subject to similar issues encountered by other studies in this field. The difficulty in determining AVF failure in patients not initiated on hemodialysis during follow-up may underestimate AVF failure rate. Bias may have occurred in patients referred for AVF creation, especially those with multiple comorbidities and those considered at high risk for AVF failure.

CONCLUSION

We conclude that whereas the fundamental premise of Fistula First—the overarching superiority of the AVF—is unassailable, issues such as the complications incurred, the procedures needed, the price paid, and the overall adverse effect on the quality of life should be considered as we endeavor to maximize the number of patients with functional AVFs. Such issues may be particularly relevant in ill or elderly patients with limited life expectancy and are germane to the recent cogent questioning of the uniform primacy of the AVF in all subsets of patients with chronic kidney disease.^[44]

REFERENCES

1. Dhingra RK, Young EW, Hulbert-Shearon TE, Leavey SF, Port FK: Type of vascular access and mortality in U.S. hemodialysis patients. *Kidney Int* 60: 1443–1451, 2001 [PubMed] [Google Scholar]
2. Ishani A, Collins AJ, Herzog CA, Foley RN: Septicemia, access and cardiovascular disease in dialysis patients: The USRDS Wave 2 study. *Kidney Int* 68: 311–318, 2005 [PubMed] [Google Scholar]
3. Oliver MJ, Rothwell DM, Fung K, Hux JE, Lok CE: Late creation of vascular access for hemodialysis and increased risk of sepsis. *J Am Soc Nephrol* 15: 1936–1942, 2004 [PubMed] [Google Scholar]
4. Pastan S, Soucie JM, McClellan WM: Vascular access and increased risk of death among hemodialysis patients. *Kidney Int* 62: 620–626, 2002 [PubMed] [Google Scholar]
5. Polkinghorne KR, McDonald SP, Atkins RC, Kerr PG: Vascular access and all-cause mortality: A propensity score analysis. *J Am Soc Nephrol* 15: 477–486, 2004 [PubMed] [Google Scholar]
6. Xue JL, Dahl D, Ebben JP, Collins AJ: The association of initial hemodialysis access type with mortality outcomes in elderly Medicare ESRD patients. *Am J Kidney Dis* 42: 1013–1019, 2003 [PubMed] [Google Scholar]

7. Allon M: Current management of vascular access. *Clin J Am Soc Nephrol* 2: 786–800, 2007 [PubMed] [Google Scholar]
8. Collins AJ, Foley RN, Herzog CA, Chavers BM, Gibertson D, Ishani A, Kasiske BL, Liu J, Mau L, Mcbean M, Murray A, St. Peter W, Guo H, Li Q, Li S, Li S, Peng Y, Qiu Y, Roberts T, Skeans M, Snyder J, Solid C, Wang C, Weinhandl E, Zaun D, Arko C, Chen S, Dalleska F, Daniels F, Dunning S, Ebben J, Frazier E, Hanzlik C, Johnson R, Sheets D, Wang X, Forrest B, Constantini E, Everson S, Eggers PW, Agodoa L: Excerpts from the US Renal Data System 2009 Annual Data Report: Costs of ESRD. *American Journal of Kidney Diseases*. 2010. pp S335–S342 [PMC free article] [PubMed] [Google Scholar]
9. Arteriovenous Fistula First AVF: The first choice for hemodialysis. *Fistula First Breakthrough Initiative*, 2009. <http://www.fistulafirst.org/>
10. Allon M: Dialysis catheter-related bacteremia: treatment and prophylaxis. *Am J Kidney Dis* 44: 779–791, 2004 [PubMed] [Google Scholar]
11. Allon M, Robbin ML: Increasing arteriovenous fistulas in hemodialysis patients: Problems and solutions. *Kidney Int* 62: 1109–1124, 2002 [PubMed] [Google Scholar]
12. Lok CE: Fistula first initiative: Advantages and pitfalls. *Clin J Am Soc Nephrol* 2: 1043–1053, 2007 [PubMed] [Google Scholar]
13. Pisoni RL, Young EW, Dykstra DM, Greenwood RN, Hecking E, Gillespie B, Wolfe RA, Goodkin DA, Held PJ: Vascular access use in Europe and the United States: Results from the DOPPS. *Kidney Int* 61: 305–316, 2002 [PubMed] [Google Scholar]
14. Dixon BS: Why don't fistulas mature? *Kidney Int* 70: 1413–1422, 2006 [PubMed] [Google Scholar]
15. Schwab SJ, Harrington JT, Singh A, Roher R, Shohaib SA, Perrone RD, Meyer K, Beasley D: Vascular access for hemodialysis. *Kidney Int* 55: 2078–2090, 1999 [PubMed] [Google Scholar]
16. Feldman HI, Joffe M, Rosas SE, Burns JE, Knauss J, Brayman K: Predictors of successful arteriovenous fistula maturation. *Am J Kidney Dis* 42: 1000–1012, 2003 [PubMed] [Google Scholar]
17. Lacson E, Jr, Lazarus JM, Himmelfarb J, Ikizler TA, Hakim RM: Balancing fistula first with catheters last. *Am J Kidney Dis* 50: 379–395, 2007 [PubMed] [Google Scholar]
18. Huijbrechts HJ, Bots ML, Wittens CH, Schrama YC, Moll FL, Blankestijn PJ: Hemodialysis arteriovenous fistula patency revisited: Results of a prospective, multicenter initiative. *Clin J Am Soc Nephrol* 3: 714–719, 2008 [PMC free article] [PubMed] [Google Scholar]
19. Maya ID, Allon M: Outcomes of tunneled femoral hemodialysis catheters: Comparison with internal jugular vein catheters. *Kidney Int* 68: 2886–2889, 2005 [PubMed] [Google Scholar]
20. Huber TS, Carter JW, Carter RL, Seeger JM: Patency of autogenous and polytetrafluoroethylene upper extremity arteriovenous hemodialysis accesses: A systematic review. *J Vasc Surg* 38: 1005–1011, 2003 [PubMed] [Google Scholar]
21. Lok CE, Allon M, Moist L, Oliver MJ, Shah H, Zimmerman D: Risk equation determining unsuccessful cannulation events and failure to maturation in arteriovenous fistulas (REDUCE FTM I). *J Am Soc Nephrol* 17: 3204–3212, 2006 [PubMed] [Google Scholar]
22. Miller PE, Tolwani A, Luscly CP, Deierhoi MH, Bailey R, Redden DT, Allon M: Predictors of adequacy of arteriovenous fistulas in hemodialysis patients. *Kidney Int* 56: 275–280, 1999 [PubMed] [Google Scholar]
23. Zeebregts C, van den Dungen J, Bolt A, Franssen C, Verhoeven E, van Schilfgaarde R: Factors predictive of failure of Brescia-Cimino arteriovenous fistulas. *Eur J Surg* 168: 29–36, 2002 [PubMed] [Google Scholar]
24. Sidawy AN, Gray R, Besarab A, Henry M, Ascher E, Silva M, Jr, Miller A, Scher L, Trerotola S, Gregory RT, Rutherford RB, Kent KC: Recommended standards for reports dealing with arteriovenous hemodialysis accesses. *J Vasc Surg* 35: 603–610, 2002 [PubMed] [Google Scholar]
25. Gray RJ, Sacks D, Martin LG, Trerotola SO: Reporting standards for percutaneous interventions in dialysis access. *J Vasc Interv Radiol* 14: S433–S442, 2003 [PubMed] [Google Scholar]

26. Dember LM, Beck GJ, Allon M, Delmez JA, Dixon BS, Greenberg A, Himmelfarb J, Vazquez MA, Gassman JJ, Greene T, Radeva MK, Braden GL, Ikizler TA, Rocco MV, Davidson LJ, Kaufman JS, Meyers CM, Kusek JW, Feldman HI: Effect of clopidogrel on early failure of arteriovenous fistulas for hemodialysis: a randomized controlled trial. *JAMA* 299: 2164–2171, 2008 [PMC free article] [PubMed] [Google Scholar]
27. Rayner HC, Pisoni RL, Gillespie BW, Goodkin DA, Akiba T, Akizawa T, Saito A, Young EW, Port FK: Creation, cannulation and survival of arteriovenous fistulae: Data from the Dialysis Outcomes and Practice Patterns Study. *Kidney Int* 63: 323–330, 2003 [PubMed] [Google Scholar]
28. Hernandez T, Saudan P, Berney T, Merminod T, Bednarkiewicz M, Martin PY: Risk factors for early failure of native arteriovenous fistulas. *Nephron Clin Pract* 101: c39–c44, 2005 [PubMed] [Google Scholar]
29. Huijbregts HJ, Bots ML, Moll FL, Blankestijn PJ: Hospital specific aspects predominantly determine primary failure of hemodialysis arteriovenous fistulas. *J Vasc Surg* 45: 962–967, 2007 [PubMed] [Google Scholar]
30. Kats M, Hawxby AM, Barker J, Allon M: Impact of obesity on arteriovenous fistula outcomes in dialysis patients. *Kidney Int* 71: 39–43, 2007 [PubMed] [Google Scholar]
31. Koksoy C, Demirci RK, Balci D, Solak T, Kose SK: Brachio basilic versus brachiocephalic arteriovenous fistula: A prospective randomized study. *J Vasc Surg* 49: 171–177 e5, 2009 [PubMed] [Google Scholar]
32. Lazarides MK, Georgiadis GS, Antoniou GA, Staramos DN: A meta-analysis of dialysis access outcome in elderly patients. *J Vasc Surg* 45: 420–426, 2007 [PubMed] [Google Scholar]
33. Parmar J, Aslam M, Standfield N: Pre-operative radial arterial diameter predicts early failure of arteriovenous fistula (AVF) for haemodialysis. *Eur J Vasc Endovasc Surg* 33: 113–115, 2007 [PubMed] [Google Scholar]
34. Saran R, Dykstra DM, Pisoni RL, Akiba T, Akizawa T, Canaud B, Chen K, Piera L, Saito A, Young EW: Timing of first cannulation and vascular access failure in haemodialysis: An analysis of practice patterns at dialysis facilities in the DOPPS. *Nephrol Dial Transplant* 19: 2334–2340, 2004 [PubMed] [Google Scholar]
35. Wong V, Ward R, Taylor J, Selvakumar S, How TV, Bakran A: Factors associated with early failure of arteriovenous fistulae for haemodialysis access. *Eur J Vasc Endovasc Surg* 12: 207–213, 1996 [PubMed] [Google Scholar]
36. Lok CE, Oliver MJ, Su J, Bhola C, Hannigan N, Jassal SV: Arteriovenous fistula outcomes in the era of the elderly dialysis population. *Kidney Int* 67: 2462–2469, 2005 [PubMed] [Google Scholar]
37. Ravani P, Brunori G, Mandolfo S, Cancarini G, Imbasciati E, Marcelli D, Malberti F: Cardiovascular comorbidity and late referral impact arteriovenous fistula survival: A prospective multicenter study. *J Am Soc Nephrol* 15: 204–209, 2004 [PubMed] [Google Scholar]
38. Kurella Tamura M, Covinsky KE, Chertow GM, Yaffe K, Landefeld CS, McCulloch CE: Functional status of elderly adults before and after initiation of dialysis. *N Engl J Med* 361: 1539–1547, 2009 [PMC free article] [PubMed] [Google Scholar]
39. Agarwal R, Bunaye Z, Bekele DM, Light RP: Competing risk factor analysis of end-stage renal disease and mortality in chronic kidney disease. *Am J Nephrol* 28: 569–575, 2008 [PubMed] [Google Scholar]
40. Jassal SV, Trpeski L, Zhu N, Fenton S, Hemmelgarn B: Changes in survival among elderly patients initiating dialysis from 1990 to 1999. *CMAJ* 177: 1033–1038, 2007 [PMC free article] [PubMed] [Google Scholar]
41. Kurella M, Covinsky KE, Collins AJ, Chertow GM: Octogenarians and nonagenarians starting dialysis in the United States. *Ann Intern Med* 146: 177–183, 2007 [PubMed] [Google Scholar]
42. Letourneau I, Ouimet D, Dumont M, Pichette V, Leblanc M: Renal replacement in end-stage renal disease patients over 75 years old. *Am J Nephrol* 23: 71–77, 2003 [PubMed] [Google Scholar]
43. O'Hare AM, Choi AI, Bertenthal D, Bacchetti P, Garg AX, Kaufman JS, Walter LC, Mehta KM, Steinman MA, Allon M, McClellan WM, Landefeld CS: Age affects outcomes in chronic kidney disease. *J Am Soc Nephrol* 18: 2758–2765, 2007 [PubMed] [Google Scholar]
44. Allon M, Lok CE: Dialysis fistula or graft: The role for randomized clinical trials. *Clin J Am Soc Nephrol* 5: 2348–2354, 2010 [PubMed] [Google Scholar]