

**American College of Radiology  
ACR Appropriateness Criteria®**

**Dialysis Fistula Malfunction**

**Variant 1: Suspected dysfunction of upper or lower extremity hemodialysis access (ie, arteriovenous fistula or graft) suggested by an abnormal clinical indicator or hemodynamic indicator (ie, reduction in dialysis vascular access blood flow rate or kinetics). Initial imaging to guide interventional radiologic therapy options.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access area of interest	Usually appropriate	Strong	⊕⊕⊕ 1-10 mSv		8	8	0	1	0	0	0	0	1	8	6

References	Study Quality
3 (16813991)	4
13 (24817452)	4
18 (19304717)	2
17 (20829241)	3
16 (20942731)	4
21 (26403274)	3
7 (27622727)	4
11 (24194928)	Good
12 (16797391)	2
14 (8000128)	1
15 (23092640)	4
19 (17507428)	4
20 (15286321)	2
22 (1474770)	2
23 (16344384)	1
24 (11959724)	3

US duplex Doppler hemodialysis access area of interest	Usually appropriate	Strong	O 0 mSv	O 0 mSv [ped]	8	8	0	0	0	0	1	0	6	5	4
		References		Study Quality											
		26 (22266595)		2											
		28 (25368682)		4											
		29 (21531585)		2											
		30 (27886364)		2											
		25 (23641285)		3											
		27 (23229528)		4											
		31 (17928468)		1											
		32 (24059390)		4											
		33 (11012917)		2											
MRA extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	3	3	3	5	2	2	2	1	0	1	0
CTA extremity area of interest with IV contrast	Usually not appropriate	Limited	Varies	Varies	2	2	4	5	4	0	1	0	0	1	0
		References		Study Quality											
		18 (19304717)		2											
		17 (20829241)		3											
		11 (24194928)		Good											
MRA extremity area of interest without and with IV contrast	Usually not appropriate	Strong	O 0 mSv	O 0 mSv [ped]	2	2	7	7	1	0	0	0	0	0	0
		References		Study Quality											
		11 (24194928)		Good											
		12 (16797391)		2											
		34 (12500274)		1											
CTV extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	2	2	4	7	1	2	1	0	0	0	0
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	6	5	2	3	0	0	0	0	0

MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	6	4	3	1	0	1	1	0	0
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**Variant 2: Suspected dysfunction of the upper or lower extremity hemodialysis access (ie, arteriovenous fistula or graft) suggested by an abnormal clinical indicator or hemodynamic indicator (ie, reduction in dialysis vascular access blood flow rate or kinetics). Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access with intervention	Usually appropriate	Strong	N/A	N/A	9	9	0	0	0	0	0	0	1	5	10

References	Study Quality
3 (16813991)	4
41 (12761309)	2
39 (21840156)	2
51 (24529550)	1
46 (24794277)	1
59 (26074027)	1
62 (27514445)	1
63 (27388566)	1
61 (27353358)	1
42 (26597666)	2
60 (29622355)	1
4 (-3194799)	4
7 (27622727)	4
22 (1474770)	2
35 (25698092)	2
36 (21199430)	2
37 (16557220)	2
38 (2961397)	3
40 (19028115)	3

43 (24587906)	2
44 (27334570)	2
45 (14514827)	4
47 (26508448)	1
48 (24315548)	1
49 (29471988)	1
50 (30040057)	1
52 (25575743)	1
53 (-3194801)	4
54 (8850659)	1
55 (16371528)	2
56 (9399465)	1
57 (18256373)	2
58 (18829240)	1

US duplex Doppler hemodialysis access area of interest	Usually appropriate	Strong	O 0 mSv	O 0 mSv [ped]	7	7	0	0	0	1	3	1	5	4	1
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References	Study Quality
80 (23334852)	3
29 (21531585)	2
81 (28655388)	2
30 (27886364)	2

Surgical consultation	May be appropriate	Strong	N/A	N/A	6	6	0	1	0	1	6	2	3	1	2
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References	Study Quality
69 (23080336)	3
71 (25011092)	3
68 (29421426)	3
70 (30055242)	3
66 (22367648)	2
73 (24190074)	3
72 (26660034)	2

[illegible]

**Variant 3:** Suspected thrombosis of the upper or lower extremity hemodialysis access, marked by absent pulse and thrill on physical examination. Initial imaging to guide interventional radiologic therapy options.

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access area of interest	Usually appropriate	Limited	☼☼☼ 1-10 mSv		8	8	0	0	0	0	0	0	4	6	5
		References		Study Quality											
		7 (27622727)		4											

		19 (17507428)		4											
US duplex Doppler hemodialysis access area of interest	May be appropriate	Limited	O 0 mSv	O 0 mSv [ped]	5	5	0	0	1	1	7	2	0	4	0
		References		Study Quality											
		83 (27716892)		4											
		5 (32778223)		4											
		7 (27622727)		4											
CTA extremity area of interest with IV contrast	Usually not appropriate	Limited	Varies	Varies	2	2	5	8	2	0	0	0	0	0	0
		References		Study Quality											
		17 (20829241)		3											
		84 (21969710)		3											
		85 (28970522)		1											
MRA extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	7	5	3	1	0	0	0	0	0
MRA extremity area of interest without IV contrast	Usually not appropriate	Limited	O 0 mSv	O 0 mSv [ped]	2	2	5	6	3	0	1	0	1	0	0
		References		Study Quality											
		86 (25976499)		1											
		87 (26732890)		3											
CTV extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	2	2	5	4	4	0	2	0	0	0	1
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	5	5	2	2	0	1	1	0	0
MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	4	5	4	1	0	0	1	0	1

**Variant 4: Suspected thrombosis of the upper or lower extremity hemodialysis access, marked by absent pulse and thrill on physical examination. Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access with intervention	Usually appropriate	Limited	N/A	N/A	9	9	0	0	1	0	0	0	1	5	9
		References		Study Quality											
		4 (-3194799)		4											
		5 (32778223)		4											
		7 (27622727)		4											
		45 (14514827)		4											
		88 (12085386)		4											
Surgical consultation	Usually appropriate	Strong	N/A	N/A	7	7	0	1	0	0	3	2	5	3	2
		References		Study Quality											
		90 (22796333)		1											
		7 (27622727)		4											
		89 (8866409)		2											
Placement of a new tunneled dialysis catheter	May be appropriate	Limited	N/A	N/A	5	5	0	0	0	0	10	4	1	0	0
		References		Study Quality											
		5 (32778223)		4											
US duplex Doppler hemodialysis access area of interest	Usually not appropriate	Limited	O 0 mSv	O 0 mSv [ped]	3	3	1	3	5	1	4	1	0	0	1
		References		Study Quality											
		80 (23334852)		3											
		91 (29017808)		3											

**Variant 5: Failure of an upper or lower extremity arteriovenous fistula to mature within 2 months after creation. Initial imaging to guide interventional radiologic therapy options.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access area of interest	Usually appropriate	Strong	⊗⊗⊗ 1-10 mSv		9	9	0	0	0	0	1	1	2	4	8
		References		Study Quality											
		94 (22915412)		3											
		95 (18503901)		1											
		96 (10213648)		2											
		97 (11733628)		2											
		98 (12969170)		2											
		99 (17699217)		2											
US duplex Doppler hemodialysis access area of interest	Usually appropriate	Limited	O 0 mSv	O 0 mSv [ped]	8	8	0	1	0	0	1	1	5	4	4
		References		Study Quality											
		100 (24500848)		1											
		101 (25613148)		3											
		5 (32778223)		4											
		7 (27622727)		4											
		32 (24059390)		4											
		102 (22164333)		4											
		103 (17991787)		3											
MRA extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	3	3	6	1	5	1	1	1	1	0	0
MRA extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	3	3	7	1	6	0	0	0	1	0	1
CTV extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	3	3	5	3	5	0	2	0	0	0	1
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	3	3	7	1	3	3	1	0	1	0	0



CTA extremity area of interest with IV contrast	Usually not appropriate	Limited	Varies	Varies	2	2	6	4	4	1	0	0	0	0	0	0	0
		References		Study Quality													
		104 (20173168)		4													
		17 (20829241)		3													
		85 (28970522)		1													
MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	6	8	1	0	0	0	0	0	0	0	0

**Variant 6: Failure of an upper or lower extremity arteriovenous fistula to mature within 2 months after creation. Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access with intervention	Usually appropriate	Strong	N/A	N/A	9	9	0	0	1	0	0	0	3	3	9
		References		Study Quality											
		7 (27622727)		4											
		95 (18503901)		1											
		99 (17699217)		2											
		105 (14605103)		3											
		106 (17090715)		3											
Surgical consultation	Usually appropriate	Strong	N/A	N/A	8	8	0	0	0	0	2	1	2	7	4
		References		Study Quality											
		107 (30309898)		2											
		101 (25613148)		3											
		5 (32778223)		4											
		96 (10213648)		2											
		97 (11733628)		2											
		103 (17991787)		3											

US duplex Doppler hemodialysis access area of interest	Usually appropriate	Strong	0 0 mSv	0 0 mSv [ped]	8	8	0	0	0	0	2	1	4	5	3
	References	Study Quality													
	100 (24500848)	1													
	109 (27183858)	2													
	107 (30309898)	2													
	101 (25613148)	3													
	102 (22164333)	4													
	103 (17991787)	3													
Placement of a new tunneled dialysis catheter	May be appropriate	Moderate	N/A	N/A	6	6	0	0	0	0	5	4	4	2	1
	References	Study Quality													
	101 (25613148)	3													
	108 (30244924)	2													
	5 (32778223)	4													

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access area of interest	Usually appropriate	Strong	☼☼☼ 1-10 mSv		8	8	0	0	0	0	0	0	2	7	7
		References		Study Quality											
		110 (21873620)		2											
		112 (25890685)		2											
		111 (23291234)		4											
CTA extremity area of interest with IV contrast	Usually not appropriate	Strong	Varies	Varies	2	2	5	7	3	0	0	0	0	0	0
		References		Study Quality											

		18 (19304717)		2													
		104 (20173168)		4													
		17 (20829241)		3													
		84 (21969710)		3													
		114 (16242563)		1													
		115 (16247148)		3													
MRA extremity area of interest without and with IV contrast	Usually not appropriate	Limited	0 0 mSv	0 0 mSv [ped]	2	2	7	6	2	0	0	0	0	0	0	0	
		References		Study Quality													
		11 (24194928)		Good													
MRA extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	7	3	4	0	2	0	0	0	0	0	
US duplex Doppler hemodialysis access area of interest	Usually not appropriate	Limited	0 0 mSv	0 0 mSv [ped]	2	2	4	5	3	1	1	1	0	0	0	0	
		References		Study Quality													
		113 (17540535)		2													
		111 (23291234)		4													
CTV extremity area of interest with IV contrast	Usually not appropriate	Limited	Varies	Varies	2	2	5	6	2	0	0	0	1	1	0	0	
		References		Study Quality													
		5 (32778223)		4													
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	7	5	2	0	0	1	0	0	0	0	
MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	7	5	3	0	0	0	0	0	0	0	

**Variant 8: Clinical suspicion of central venous stenosis or occlusion suggested by swelling (ie, soft tissue edema) of the extremity ipsilateral to the upper or lower extremity hemodialysis access, with or without the development of venous collaterals. Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access with intervention	Usually appropriate	Strong	N/A	N/A	9	9	0	0	0	0	0	0	2	5	9
		References		Study Quality											
		110 (21873620)		2											
		5 (32778223)		4											
		7 (27622727)		4											
		117 (16424248)		3											
		116 (21326501)		4											
		112 (25890685)		2											
		119 (19933663)		2											
		118 (17398386)		2											
Continued hemodialysis access use with surveillance	May be appropriate	Limited	N/A	N/A	4	4	2	1	5	3	3	1	0	1	0
		References		Study Quality											
		110 (21873620)		2											
		5 (32778223)		4											
US duplex Doppler hemodialysis access area of interest	Usually not appropriate	Limited	0 0 mSv	0 0 mSv [ped]	3	3	3	3	7	0	1	1	1	0	0
		References		Study Quality											
		17 (20829241)		3											
Surgical consultation	Usually not appropriate	Limited	N/A	N/A	2	2	3	6	2	1	2	0	1	0	0
		References		Study Quality											
		120 (22673549)		4											
		5 (32778223)		4											
		121 (24502816)		3											
		122 (22633426)		4											

Placement of a new tunneled dialysis catheter	Usually not appropriate	Limited	N/A	N/A	2	2	5	3	4	2	0	0	1	0	0
		References	Study Quality												
		5 (32778223)	4												
		111 (23291234)	4												

**Variant 9: Abnormal skin changes associated with the upper or lower extremity hemodialysis access cannulation site, including marked thinning, ulceration, eschar formation, spontaneous bleeding, pseudoaneurysm formation, superficial or deep infection. Initial imaging to guide interventional radiologic therapy options.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
US duplex Doppler hemodialysis access area of interest	Usually appropriate	Limited	O 0 mSv	O 0 mSv [ped]	7	7	0	1	0	0	4	2	5	1	3
		References	Study Quality												
		5 (32778223)	4												
Fluoroscopy fistulography hemodialysis access area of interest	May be appropriate	Limited	⊕⊕⊕ 1-10 mSv		5	5	0	1	1	3	6	3	0	0	1
		References	Study Quality												
		123 (25154565)	2												
MRA extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	3	3	5	3	5	1	1	0	0	1	0
CTV extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	3	3	4	4	5	0	2	0	0	0	1
CTA extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	2	2	6	7	2	0	0	0	0	0	0
MRA extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	5	5	4	0	1	0	0	1	0
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	5	4	3	1	1	1	0	1	0

MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	O 0 mSv	O 0 mSv [ped]	2	2	6	5	3	0	0	0	1	1	0
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**Variant 10: Abnormal skin changes associated with the upper or lower extremity hemodialysis access cannulation site, including marked thinning, ulceration, eschar formation, spontaneous bleeding, pseudoaneurysm formation, superficial or deep infection. Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Surgical consultation	Usually appropriate	Moderate	N/A	N/A	8	8	0	0	0	0	1	1	4	4	6

References	Study Quality
132 (28341509)	3
130 (20175060)	3
129 (21725946)	4
131 (28238919)	2
5 (32778223)	4

Placement of a new tunneled dialysis catheter	Usually appropriate	Moderate	N/A	N/A	7	7	1	0	0	1	4	2	7	0	1
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References	Study Quality
108 (30244924)	2

Fluoroscopy fistulography hemodialysis access with intervention	May be appropriate	Strong	N/A	N/A	5	5	0	0	1	1	8	4	0	0	1
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References	Study Quality
128 (21840731)	4
124 (22342153)	2
123 (25154565)	2
127 (23058719)	2
126 (23036977)	2
125 (23934930)	2

Continued hemodialysis access use with surveillance	Usually not appropriate	Limited	N/A	N/A	2	2	5	5	4	0	2	0	0	0	0
		References	Study Quality												
		130 (20175060)	3												
		129 (21725946)	4												

**Variant 11: Suspected vascular steal syndrome (upper or lower extremity), suggested by cardiac failure or ischemic symptoms. Initial imaging to guide interventional radiologic therapy options.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Fluoroscopy fistulography hemodialysis access area of interest	Usually appropriate	Limited	⊕⊕⊕ 1-10 mSv		8	8	1	0	0	0	1	0	2	7	5
		References	Study Quality												
		133 (17699402)	4												
		136 (7644631)	4												
		137 (14652830)	4												
		138 (9783790)	2												
US duplex Doppler hemodialysis access area of interest	Usually appropriate	Limited	○ ○ mSv	○ ○ mSv [ped]	7	7	0	0	0	0	1	2	5	5	2
		References	Study Quality												
		139 (23581731)	4												
		133 (17699402)	4												
CTA extremity area of interest with IV contrast	May be appropriate	Limited	Varies	Varies	5	5	0	0	1	0	10	2	2	0	0
		References	Study Quality												
		133 (17699402)	4												
CTV extremity area of interest with IV contrast	Usually not appropriate	Expert Consensus	Varies	Varies	3	3	5	3	4	2	2	0	0	0	0

MRA extremity area of interest without and with IV contrast	Usually not appropriate	Limited	0.0 mSv	0.0 mSv [ped]	2	2	4	5	3	2	1	0	0	0	0
		References		Study Quality											
		12 (16797391)		2											
MRA extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0.0 mSv	0.0 mSv [ped]	2	2	6	5	3	1	0	0	0	0	0
MRV extremity area of interest without and with IV contrast	Usually not appropriate	Expert Consensus	0.0 mSv	0.0 mSv [ped]	2	2	8	2	5	0	1	0	0	0	0
MRV extremity area of interest without IV contrast	Usually not appropriate	Expert Consensus	0.0 mSv	0.0 mSv [ped]	2	2	7	5	3	0	1	0	0	0	0

**Variant 12: Suspected vascular steal syndrome (upper or lower extremity), suggested by cardiac failure or ischemic symptoms. Treatment and procedures.**

Procedure	Appropriateness Category	SOE	Adults RRL	Peds RRL	Rating	Median	Final Tabulations								
							1	2	3	4	5	6	7	8	9
Surgical consultation	Usually appropriate	Strong	N/A	N/A	9	9	0	0	0	0	0	2	2	3	9
		References		Study Quality											
		134 (27224985)		3											
		142 (22266588)		2											
		146 (26492999)		2											
		144 (26349882)		3											
		145 (25499703)		2											
		143 (26951907)		4											
		147 (21276691)		2											
Fluoroscopy fistulography hemodialysis access with intervention	May be appropriate	Limited	N/A	N/A	5	5	0	0	0	1	7	3	3	0	1
		References		Study Quality											
		134 (27224985)		3											
		128 (21840731)		4											



		140 (27312765)		2											
		141 (18379982)		4											
Continued hemodialysis access use with surveillance	May be appropriate	Expert Consensus	N/A	N/A	5	5	0	3	0	2	10	0	0	0	0
Placement of a new tunneled dialysis catheter	May be appropriate	Moderate	N/A	N/A	5	5	0	0	0	2	12	0	1	0	0
		References		Study Quality											
		108 (30244924)		2											
US duplex Doppler hemodialysis access area of interest	Usually not appropriate	Expert Consensus	0 0 mSv	0 0 mSv [ped]	2	2	4	5	5	0	0	0	0	1	1

## Appendix Key

A more complete discussion of the items presented below can be found by accessing the supporting documents at the designated hyperlinks.

**Appropriateness Category:** The panel's recommendation for a procedure based on the assessment of the risks and benefits of performing the procedure for the specified clinical scenario.

**SOE:** Strength of Evidence. The assessment of the amount and quality of evidence found in the peer reviewed medical literature for an appropriateness recommendation.

- **References:** The citation number and PMID for the reference(s) associated with the recommendation.
- **Study Quality:** The assessment of the quality of an individual reference based on the number of study quality elements described in the reference.

**RRL:** Relative Radiation Level. A population based assessment of the amount of radiation a typical patient may be exposed to during the specified procedure.

**Rating:** The final rating (1-9 scale) for the procedure as determined by the panel during rating rounds.

**Median:** The median rating (1-9 scale) for the procedure as determined by the panel during rating rounds.

**Final tabulations:** A histogram showing the number of panel members who rated the procedure as noted in the column heading (ie, 1, 2, 3, etc.).

Additional supporting documents about the AC methodology and processes can be found at [www.acr.org/ac](http://www.acr.org/ac).