

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

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											
		33 (11012917)		2											
		32 (24059390)		4											
		31 (17928468)		1											
		30 (27886364)		2											
		29 (21531585)		2											
		28 (25368682)		4											
		27 (23229528)		4											
		26 (22266595)		2											
		25 (23641285)		3											
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
63 (27388566)	1
62 (27514445)	1
61 (27353358)	1
60 (29622355)	1
59 (26074027)	1
58 (18829240)	1
57 (18256373)	2
56 (9399465)	1
55 (16371528)	2
54 (8850659)	1
53 (-3194801)	4
52 (25575743)	1
51 (24529550)	1
50 (30040057)	1
49 (29471988)	1
48 (24315548)	1
47 (26508448)	1
46 (24794277)	1
45 (14514827)	4

44 (27334570)	2
43 (24587906)	2
42 (26597666)	2
41 (12761309)	2
40 (19028115)	3
39 (21840156)	2
38 (2961397)	3
37 (16557220)	2
36 (21199430)	2
35 (25698092)	2
22 (1474770)	2
7 (27622727)	4
4 (-3194799)	4
3 (16813991)	4

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
29 (21531585)	2
30 (27886364)	2
80 (23334852)	3
81 (28655388)	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
75 (26220504)	4
74 (28800839)	2
73 (24190074)	3
72 (26660034)	2
71 (25011092)	3
70 (30055242)	3
69 (23080336)	3

[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											
		5 (32778223)		4											
		7 (27622727)		4											
		83 (27716892)		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											
		7 (27622727)		4											
		89 (8866409)		2											
		90 (22796333)		1											
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	0 0 mSv	0 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											
		99 (17699217)		2											
		98 (12969170)		2											
		97 (11733628)		2											
		96 (10213648)		2											
		95 (18503901)		1											
		94 (22915412)		3											
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											
		5 (32778223)		4											
		7 (27622727)		4											
		32 (24059390)		4											
		103 (17991787)		3											
		102 (22164333)		4											
		101 (25613148)		3											
		100 (24500848)		1											
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
		References		Study Quality											
		17 (20829241)		3											
		85 (28970522)		1											
		104 (20173168)		4											
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

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											
		105 (14605103)		3											
		106 (17090715)		3											
		95 (18503901)		1											
		99 (17699217)		2											
Surgical consultation	Usually appropriate	Strong	N/A	N/A	8	8	0	0	0	0	2	1	2	7	4
		References		Study Quality											
		5 (32778223)		4											
		96 (10213648)		2											
		97 (11733628)		2											
		101 (25613148)		3											
		103 (17991787)		3											
		107 (30309898)		2											

		References		Study Quality												
		7 (27622727)		4												
		105 (14605103)		3												
		106 (17090715)		3												
		95 (18503901)		1												
		99 (17699217)		2												
Surgical consultation	Usually appropriate	Strong	N/A	N/A	8	8	0	0	0	0	2	1	2	7	4	
		References		Study Quality												
		5 (32778223)		4												
		96 (10213648)		2												
		97 (11733628)		2												
		101 (25613148)		3												
		103 (17991787)		3												
		107 (30309898)		2												

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													
	107 (30309898)	2													
	109 (27183858)	2													
	103 (17991787)	3													
	102 (22164333)	4													
	101 (25613148)	3													
	100 (24500848)	1													
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													
	5 (32778223)	4													
	101 (25613148)	3													
	108 (30244924)	2													

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											
		112 (25890685)		2											
		111 (23291234)		4											
		110 (21873620)		2											
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											

		17 (20829241)		3													
		18 (19304717)		2													
		84 (21969710)		3													
		104 (20173168)		4													
		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		
		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		
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		
		References		Study Quality													
		111 (23291234)		4													
		113 (17540535)		2													
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		
		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		
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		

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											
		5 (32778223)		4											
		7 (27622727)		4											
		119 (19933663)		2											
		118 (17398386)		2											
		117 (16424248)		3											
		116 (21326501)		4											
		112 (25890685)		2											
		110 (21873620)		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											
		5 (32778223)		4											
		110 (21873620)		2											
US duplex Doppler hemodialysis access area of interest	Usually not appropriate	Limited	O 0 mSv	O 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											
		5 (32778223)		4											
		122 (22633426)		4											
		121 (24502816)		3											
		120 (22673549)		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
5 (32778223)	4
132 (28341509)	3
131 (28238919)	2
130 (20175060)	3
129 (21725946)	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
127 (23058719)	2
126 (23036977)	2
125 (23934930)	2
124 (22342153)	2
123 (25154565)	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												
		129 (21725946)	4												
		130 (20175060)	3												

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												
		138 (9783790)	2												
		137 (14652830)	4												
		136 (7644631)	4												
		133 (17699402)	4												
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												
		133 (17699402)	4												
		139 (23581731)	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											
		147 (21276691)		2											
		146 (26492999)		2											
		145 (25499703)		2											
		144 (26349882)		3											
		143 (26951907)		4											
		142 (22266588)		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											
		141 (18379982)		4											
		140 (27312765)		2											

		134 (27224985)		3											
		128 (21840731)		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.