

ACC/AHA/ASE 2003 年关于超声心动图临床应用指南的更新：纲要

ACC/AHA 专案组关于实践指南的报告

(ACC/AHA/ASE 对 1997 年超声心动图临床应用指南的更新)

Guideline Update for the Clinical Application of Echocardiography: Summary Article

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总论和适用范围

关于超声心动图应用的前一版指南是在 1997 年 3 月发布的。从那以后，超声心动图技术有了很大改进，临床应用范围和科学依据日益增加，推荐如何合理应用超声心动图成为必然。

表格内的证据每一部分内容都进行了审阅和更新，并适当在规范里进行了改动。新增的章节-术中经食管超声心动图的应用，已被添加更新在美国麻醉医师协会和心血管麻醉医师协会发表的指南中。指南有大幅度的修改，特别是在缺血性心脏病；充血性心衰，心肌病和左室功能评价；筛查和超声心动图在危重症中的应用等章节。缺血性心肌病表格内的证据有了很大修改，并加了新的证据表。

由于篇幅限制，此文中只有新推荐的内容和证据表印成了纸质版，当改动较少，如从 IIa 组调至 I 组，则改动的这一部分将会印刷，其他不变的内容没有印刷。那些仍然处于临床研究阶段的新进展，如心肌造影剂应用、三维超声心动图等，在此不进行讨论。

1997 年的指南中是基于 1990 年到 1995 年 5 月 Medline 上能检索到的英文文献制定的。委员会回顾了搜索到的超过 3000 篇的文献。当前指南的更新内容则是建立在 1995 年到 2001 年 9 月的 Medline, EM-BASE, Best Evidence 和考克兰图书馆中英语发表的荟萃分析文章和系统性文献综述基础上的。对于以下话题还对成人先天性心脏病超声心动图、急诊胸痛超声心动图评价及术中超声最新的临床研究进行了进一步检索。一共检索了 1000 多篇文献，撰写委员会均进行了阅读。

该指南中既包括成人也包括小儿超声心动图内容。小儿超声心动图指南也包括了胎儿超声心动图这一日渐被重视的领域。指南中既包括特殊心血管疾病超声心动图诊断，也包括对那些具有常见心血管症状、体征和现病史或是呼吸困难、胸部不适、心脏杂音的病人的评价。因此，该指南为内科医生应用超声心动图来评价这些常见临床问题提供了帮助。

指南中规定超声心动图在哪些情况下所采取的分级系统（如：I，II，III）是和其他 ACC/AHA 指南一样的。

I 级：有证据和/或有共识表明某一操作或治疗是有效果的

II 级：对某一操作或是治疗是否有效存在相互矛盾的证据和或意见不统一

IIa 级：证据或意见倾向于有效

IIb 级：证据或意见认为某一操作或治疗不那么有效

III 级：有证据和/或有共识表明某一操作或治疗是无效的，有时甚至是有害的

评价某一个诊断试验，如超声心动图的临床应用价值远较评价某种治疗是否有效更为困难。因为诊断试验永远无法对病人的生存或病情恢复产生相同的、直接的影响。不管怎样，还是有一系列公认的、不同等级的标准用来评价其价值。

超声心动图评估分级标准

技术性能

诊断性能

对诊断和预后判断的影响

对治疗产生的影响

保健有关结局

因为从本质上来讲，并没有针对诊断试验对健康结局影响的随机试验，所以委员会没有对已有科学依据进行 A、B、C 式的分类（就像其他 ACC/AHA 的发表的声明一样），而是将依据以表格形式体现。该表格进行了很多修订和更新。因此所有推荐都基于观察性研究所获得的依据或是委员会的专家共识。

本文中的超声心动图定义的应用包括多普勒分析、M 型超声心动图、二维经胸超声心动图及经食管超声心动图。血管内超声并未包括其中，但其出现在 ACC/AHA 的经皮冠脉介入术的指南中（<http://www.acc.org/clinical/guidelines/percutaneous/dirIndex.htm>）和血管内超声临床专家共识文件中

（<http://www.acc.org/clinical/consensus/standards/standard12.htm>）。患有心血管疾病而又不做心脏手术的病人的超声心动图评价在 ACC/AHA 指南非心脏手术围手术期心血管评价有介绍。三维超声心动图技术依旧处于发展阶段，在这就不讨论了。那些仍然在快速演变和提高新的技术，如彩色多普勒成像和数字化超声心动图等超声多普勒技术，本指南就不单独介绍了。脉冲和彩色组织多普勒成像可以用来检测心肌收缩和室壁运动所产生的高能、低速的多普勒频移信号，对评价心肌收缩和舒张功能很有帮助。但这些技术也不在给临床推荐的指南中讨论了。超声心动图造影可以定量风险心肌和评价心肌灌注，本文也不予介绍。

指南中提出了超声心动图检查应间隔多长时间的建议。如果检查频次减少，而又没有负面影响保健质量，其产生的经济上的节约是非常重要的。作为非侵入性、无副作用的检查，重复进行不必要检查的可能是存在的。知道什么时候不需要再做超声心动图检查比知道什么时候以及该做多少次超声心动图检查要容易一些，因为文献中没有研究回答这个问题。多久做一次超声心动图需要根据病人的具体情况，由临床医师来判断，除非有一天有循证数据能回答这个问题。

ACC/AHA/ASE2003年的指对超声心动图临床应用进行了更新，在建议和论据上做了一些大的改动。在这篇文章中，我们列出了更新的内容和对一些更新内容的评论。建议中所有新的和修订的内容都用黑体字表示。文章只包括了支持新的建议的参考文献。读者可在American College of Cardiology (www.acc.org), American Heart Association (www.americanheart.org), and American Society for Echocardiography (www.asecho.org)等网站从指南完整版获得有关这些改动合理性的详尽阐述。

II-B 部分：自然瓣膜狭窄

瓣膜狭窄超声心动图建议

注：新的参考文献^{6, 7}。

IIb 级

2. 低压力差性主动脉狭窄和心室功能不全病人，多巴酚丁胺超声心动图评价

II-C 部分：自然瓣膜返流

关于自然瓣膜返流的超声心动图建议

注：关于减肥药对瓣膜影响的文献和主动脉瓣、二尖瓣手术后预超声心动图预测指标的参考文献已经加上。

I 级

7. 应对药物对瓣膜返流和心室代偿功能严重程度产生的影响进行评估，尤其是当关乎到是否需要改变治疗方案时。

8. 对于使用过减肥药或用其他任何可能会影响瓣膜的药物、有症状、可听到心脏杂音或者听诊结果不够可靠的病人，进行瓣膜形态和返流的评估。

III 级

2. 对于过去服用减肥药物超声心动图检查正常或哟与轻微的瓣膜异常者，进行常规群进行超声心动图复查。

II-F 部分：感染性心内膜炎：自然瓣膜

感染性心内膜炎：自然瓣膜超声心动图建议：

注：增加了诊断感染性心内膜炎的 Duke 标准，也增加了当临床高度怀疑有感染性心内膜炎或置换瓣膜受累而经胸超声心动图检查结果阴性时 TEE 的价值。^{11, 12}

I 级

6. 如果经胸超声心动图检查结果模棱两可，用 TEE 评价未知来源的葡萄球菌血症。

IIa 级

1. 未知来源的**持续性非葡萄球菌血症**的评价。*

III 级

1. **一过性发热而无细菌感染证据或出现新的杂音**的评价

※经食管超声心动图**经常**能提供较经胸超声更多有用信息。经食管超声心动图作为一线检查的价值还有待进一步研究。

II-G 部分. 人工心脏瓣膜

瓣膜性心脏病以及人工瓣膜超声心动图建议

I 级

超声心动图（特别是经食管超声心动图）在**指导瓣膜性疾病介入和手术**（瓣膜球囊切开术和瓣膜修补手术）中的应用

IV-A 部分. 急性缺血综合征

关于超声心动图诊断急性心肌缺血综合征的建议

注：建议从 IIa 级换到 I 级，描述上几乎无变化。

急性心肌缺血综合征中风险评估，预后判断好治疗效果评价超声心动图应用建议

I 级

4. 需要界定血管再通后可能效果时，评估心肌存活性。*

IIa 级

2. 并入 I 级(见上)

IIb 级

1. 对**晚期**预后的评价（急性心肌梗死后 2 年或 2 年以上）。

* 多巴酚丁胺负荷超声心动图。

IV-B 部分. 慢性缺血性心脏病

关于超声心动图在慢性心肌缺血综合征诊断和预后方面的建议

注：新增了：负荷超声心动图在移植心脏中冠脉疾病检测和女性冠脉疾病检测中的应用。有一项新的 I 级建议，三项新的 IIa 级建议。为了清晰明白，重新编了号。

I 级

1. 负荷超声心动图诊断一些有冠心病心肌缺血可能的病人（那些由于使用地高辛、心电图评价不太可靠的病人；左室肥大或静息状态下心电图 ST 段压低 1mm 以上的病人；患有期前收缩【预激综合症】的病人；完全性左束支传导阻滞的病人）。

IIa 级

1. 一些病人(心电图评估不太可靠的病人)心肌缺血心电图有如下异常时的预后评估：预激综合征，electronically paced 心室律，静息状态下 ST 段压低 1mm 以上，完全左束支传导阻滞。*
2. 检测心脏移植病人的冠状动脉病变。[†]
3. 检查前有低或中度冠心病可能性的女性心肌缺血检测。*

IIb 级

1. 移至 IIa 级

*运动或药物负荷超声心动图。

[†]多巴酚丁胺负荷超声心动图。

关于超声心动图评价慢性缺血性心脏病介入治疗的建议

增加了一个新的 IIa 级建议

IIa 级

1. 对之前患有心肌梗死的、存在或怀疑左室功能不全，需要引导下置入可植入除颤器(ICD)病人的左室功能评估。

表 1-6 是有关的冠心病的新表格。

V-B 部分. 局部左室功能

对呼吸困难、水肿或心肌病病人超声心动图建议

I 级

1. 有临床症状心脏病的呼吸困难。

II 级

1. 对于确诊心肌病患者，当其临床状态未变，但检查结果可能改变其治疗方案时的再次评估

表 1. 慢性冠状动脉疾病和左室收缩功能不全病人多巴酚丁胺负荷超声心动图（DSE）评价心肌活性，检测顿抑心肌

First Author, Year	Ref.	Stress	Total Patients	Criteria	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Marzullo, 1993	13	LD-DSE	14	Imp. WM*	82	92	95	73	85
Cigarroa, 1993	14	LD-DSE	25	Imp. WM†	82	86	82	86	84
Alfieri, 1993	15	LD-DSE	14	Imp. WM*	91	78	92	76	88
La Canina, 1994	16	LD-DSE	33	Imp. WM*	87	82	90	77	85
Chamey, 1994	17	LD-DSE	17	Imp. WM*	71	93	92	74	81
Afidi, 1995	18	DSE	20	Imp. WM†	80	90	89	82	85
Perrone-Filardi, 1995	19	LD-DSE	18	Imp. WM*	88	87	91	82	87
Senior, 1995	20	LD-DSE	22	Imp. WM*	87	82	92	73	86
Haque, 1995	21	LD-DSE	26	Imp. WM*	94	80	94	80	91
Arnese, 1995	22	LD-DSE	38	Imp. WM*	74	96	85	93	91
deFilippi, 1995	23	LD-DSE	23	Imp. WM*	97	75	87	93	89
Iliceto, 1996	24	LD-DSE	16	Imp. WM*	71	88	73	87	83
Varga, 1996	25	LD-DSE	19	Imp. WM*	74	94	93	78	84
Baer, 1996	26	LD-DSE	42	Imp. WM†	92	88	92	88	90
Vanoverschelde, 1996	27	LD-DSE	73	Imp. WM†	88	77	84	82	84
Gerber, 1996	28	LD-DSE	39	Imp. WM*	71	87	89	65	77
Bax, 1996	29	LD-DSE	17	Imp. WM*	85	63	49	91	70
Perrone-Filardi, 1996	30	LD-DSE	18	Imp. WM*	79	83	92	65	81
Qureshi, 1997	31	LD-DSE	34	Imp. WM*	86	68	51	92	73
Qureshi, 1997	31	DSE	34	Biphasic resp*	74	89	72	89	85
Nagueh, 1997	32	LD-DSE	18	Imp. WM*	91	66	61	93	75
Nagueh, 1997	32	DSE	18	Biphasic resp*	68	83	70	82	77
Furukawa, 1997	33	LD-DSE	53	Imp. WM*	79	72	76	75	76
Cornel, 1997	34	LD-DSE	30	Imp. WM*	89	82	74	93	85

DSE, 多巴酚丁胺负荷超声心动图（低剂量和高剂量灌注多巴酚丁胺）；CAD, 冠状动脉疾病；LV, 左室；Ref. 文献序号；Stress, 多巴酚丁胺负荷超声心动图药物负荷的标准用法；Total Patients, 多巴酚丁胺负荷超声心动图研究中分析冠状动脉疾病和左室功能不全总病人数；标准（Criteria），DSE 上被认为是具有活性的“阳性”指标的表现；PPV, 阳性预测值（DSE 检测心肌有活性，提示血管再通后机能恢复的可能性；NPV, 阴性预测值（DSE 检测心肌无活性，提示血管再通后功能无法恢复的可能）；LD-DSE, 低剂量 DSE；Imp. WM, 之前无运动节段多巴酚丁胺负荷试验后室壁运动改善多巴酚丁胺灌注之前室壁运动不协调的节段运动改善；Biphasic resp, biphasic response, 双期反应，定义为低剂量多巴酚丁胺灌注时室壁运动改善，高剂量多巴酚丁胺灌注时室壁运动变差。这些病人 DSE 做完后，才能做经皮血管再通的介入或手术治疗。那些静态经胸超声心动图随访表现出室壁运动改善的病人，其左室功能减低是由于心肌冬眠所致；而那虽然进行

了血管再通治疗，但静态经胸超声心动图随访左室壁运动仍无改善者其左室功能减低是由于心肌坏死所致。

III级

2. 临床稳定、治疗方案不变或是检查结果不影响治疗方案的病人的常规复查。

IX部分. 肺疾病

超声心动图在肺及肺血管疾病应用的建议

注：一项建议从I级移入IIa级。为更清晰，IIa级重新排了号。增加了应用超声心动图诊断严重非栓塞的有关内容。¹²²

I级

3. 移入IIa级（见下方）。

IIa级

1. 右房、室或主肺动脉分支内的栓子或可疑血凝块。*

*经胸超声心动图不能确诊时，需进行经食管超声心动图。

XII部分. 心律失常和心悸

超声心动图在心律失常以及心悸中应用的建议

注：增加了一个IIb级建议，是关于超声心动图在除颤手术（Maze procedure）应用中的建议。

IIa级

2. TEE或心腔内超声射频消融引导。

表2. 负荷超声心动图在各类疾病人群中的预测价值*

First Author, Year	Reference	Stress	Total Pts	Avg F/U, mo	Events	Annualized Event Rate, %		
						Ischemia	No Ischemia	Normal
Chronic ischemic heart disease								
Picano, 1989	35	DIP†	539	36	D, MI	2.3	0.7	...
Sawada, 1990	36	NL TME	148	28.4	D, MI	...	...	0.6
Mazeika, 1993	37	DSE†	51	24	D, MI, UA	16	3.8	...
Krivokapich, 1993	38	TME†	360	≈12	D, MI	10.8	3.1	...
Afridi, 1994	39	DSE†	77	10	D, MI	48	8.9	3
Poldermans, 1994	40	DSE†	430	17	D, MI	6.6	3.4	...
Coletta, 1995	41	DIP†	268	16	D, MI	17.9	1.4	...
Kamaran, 1995	42	DSE†	210	8	D, MI	69	1	...
Williams, 1996	43	DSE†	108	16	D, MI, Re	32.6	7.3	...
Anthopoulos, 1996	44	DSE†	120	14	D, MI	13.6	0	...
Marcovitz, 1996	45	DSE†	291	15	D, MI	12.8	8.2	1.1
Heupler, 1997	46	TME†	508w	41	D, MI, Re	9.2	1.3	...
McCully, 1998	47	NL TME	1325	23	D, MI	...	...	0.5
Chuah, 1998	48	DSE‡	860	24	D, MI	6.9	6.3	1.9
Cortigiani, 1998	49	DSE or DIP†	456w	32	D, MI	2.9	0.3	...
Davar, 1999	50	NL DSE	72w	13	D, MI	...	...	0
After cardiac transplantation								
Ciliberto, 1993	51	DIP‡	80	9.8	D, MI, CHF	26.2	0	...
Lewis, 1997	52	DSE‡	63	8	D, MI, CHF	28.6	3.6	...

Annualized Event Rate，年度事件率，是指随访过程中每年至少发生一次不良事件的病人的百分比，取决于负荷超声心动图是否诱导出缺血（年度事件率也适用于那些静息和负荷超声检查均正常的系列检测的病人）；Stress，负荷超声心动图流程；Total Pts，所有病人数，进行负荷超声心动图检查之后又进行不良事件发生（包括死亡，非致命性的心肌梗死，血管再通或是不稳定性心绞痛；移植术后的病人，严重充血性心力衰竭）随访的病人数；Avg F/U，负荷超声心动图之后随访的平均时间；DIP，潘生丁负荷超声心动图；

D, 死亡; MI, 非致死性心肌梗死; NI, 负荷超声心动图检测结果正常的受检者的随访描述; TME, 蹬车负荷超声心动图; DSE, 多巴酚丁胺负荷超声心动图; UA, 不稳定性心绞痛; Re, 再通必要性; w, 该系列病人都是女性; CHF, 严重充血性心力衰竭。

*慢性缺血性心脏病和心脏移植术后病人，采用不同形式的负荷超声心动图检测可诱导性的缺血的预测价值。

†对于可诱导的缺血，出现新的室壁运动异常，为“阳性”

‡任何室壁运动异常（静息或是负荷状态下）认为是“阳性”

IIb级

3. 对除颤手术（Maze procedure）病人术后评估，监测心房功能。

复律前超声心动图建议

IIb级

2. 复律前长期服用治疗水平的抗凝药的二尖瓣疾病或是肥厚性心肌病病人，除非还有其他需要抗凝的原因（例如之前有过栓塞或之前TEE发现有血栓）。*

*只是TEE。

表3. 低剂量多巴酚丁胺负荷超声心动图检测存活（顿抑）心肌的预测值以及血管再通影响

First Author, Year	Ref.	Stress	Total Pts	Avg F/U, mo	Adverse Events	Annualized Event Rate, %		
						Viable, +Re	Viable, -Re	Not Viable
Meluzin, 1998	53	LD-DSE	133	20	Death, MI	4.1	...	9.5
Afidi, 1998	54	LD-DSE	353	18	Death	4	20	19

LD-DSE, 低剂量多巴酚丁胺负荷超声心动图; Ref., 文献数量; Stress, 负荷超声心动图流程; Total Pts, 低剂量多巴酚丁胺负荷超声心动图研究所包括的慢性缺血性心脏病和左室收缩功能受损病人数量，这些病人还进行了不良事件发生的随访（不良事件包括死亡，非致命性心肌梗死）; Avg F/U, 低剂量多巴酚丁胺负荷超声心动图后随访平均时间; Annualized Event Rate, 年度事件率，低剂量的多巴酚丁胺负荷超声心动图检查随访中每年发生不良事件的病人百分比; Viable, +Re, 血管再通后低剂量多巴酚丁胺负荷超声心动图显示心肌存活（收缩储备）并进行了随访的病人数; Viable, -Re, 未进行血管再通治疗的低剂量多巴酚丁胺负荷超声心动图显示心肌存活（收缩储备）并进行了随访的病人数; Not Viable, 低剂量多巴酚丁胺负荷超声心动图显示心肌无收缩储备进行不良事件随访的病人; MI, 非致死性心肌梗死。

The annualized rate of death or MI is tabulated in patients with viable myocardium by LD-DSE depending on whether they did or did not undergo revascularization and also in those patients without viable myocardium.

慢性缺血性心脏病和左室收缩功能受损病人低剂量多巴酚丁胺负荷超声心动图检测收缩储备能力的预测价值。表中列出了血管再通或未通情况下，低剂量多巴酚丁胺负荷超声心动图显示有存活心肌患者以及没有存活心肌患者的年死亡率或心梗发生情况。

表4. 经冠脉造影证实有冠状动脉疾病的病人运动负荷超声心动图诊断的准确率（没有对转诊偏倚进行校正）

First Author, Year	Ref.	Exercise	Significant CAD	Total Pts	Sensitivity, %	Sens		Specificity, %	PPV, %	NPV, %	Accuracy, %
						1-VD, %	Sens MVD, %				
Limacher, 1983	55	TME	Greater than 50%	73	91	64	98	88	96	76	90
Armstrong, 1986	56	TME	Greater than or equal to 50%	96	88	...	...	87	97	57	87
Armstrong, 1987	57	TME	Greater than or equal to 50%	123	88	81	93	86	97	61	88
Ryan, 1988	58	TME	Greater than or equal to 50%	64	78	76	80	100	73	86	
Labowitz, 1989	59	TME	Greater than or equal to 70%	56	76	...	...	100	100	74	86
Sawada, 1989	60	TME or UBE	Greater than or equal to 50%	57	86	88	82	86	86	86	86
Sheikh, 1990	61	TME	Greater than or equal to 50%	34	74	74	...	91	94	63	79
Pozzoli, 1991	62	UBE	Greater than or equal to 50%	76	71	61	94	96	97	64	80
Crouse, 1991	63	TME	Greater than or equal to 50%	228	97	92	100	64	90	87	89
Gakuti, 1991	64	UBE	Greater than or equal to 70%	53	93	93	92	96	96	93	94
Marwick, 1992	65	TME	Greater than or equal to 50%	160	84	79	96	86	96	63	86
Quinones, 1992	66	TME	Greater than or equal to 50%	112	74	59	89	88	96	51	78
Sahota, 1992	67	BE	Greater than or equal to 50%	44	87	87	...	86	93	76	86
Amanullah, 1992	68	UBE	Greater than or equal to 50%	27	82	...	...	80	96	60	81
Hecht, 1993	69	SBE	Greater than or equal to 50%	180	93	84	100	86	96	79	91
Ryan, 1993	70	UBE	Greater than or equal to 50%	309	91	86	96	78	90	81	87
Mertes, 1993	71	SBE	Greater than or equal to 50%	79	84	87	89	86	91	76	86
Hoffmann, 1993	72	SBE	Greater than 70%	66	80	79	81	88	96	68	82
Cohen, 1993	73	SBE	Greater than 70%	52	78	63	90	87	94	62	81
Marwick, 1994	74	BE	Greater than 50%	86	88	82	91	80	89	77	86
Roger, 1994	75	TME	Greater than or equal to 50%	160	91	...	...	...	...	...	...
Manzelli, 1994	76	TME	Greater than or equal to 75%	80	89	76	97	91	93	86	90
Baleslin, 1994	77	TME	Greater than or equal to 50%	136	88	88	91	82	97	60	88
Williams, 1994	78	UBE	Greater than 50%	70	88	89	86	84	83	89	86
Roger, 1996	79	TME	Greater than or equal to 50%	127	88	...	...	72	93	60	...
Dagianti, 1996	80	SBE	Greater than 70%	60	76	70	80	94	90	86	87
Marwick, 1996	81	TME or UBE	Greater than or equal to 50%	161	80	76	86	81	71	91	81
Bjornstad, 1996	82	UBE	Greater than or equal to 50%	37	84	78	86	67	93	44	81
Marwick, 1996	83	TME	Greater than 50%	147	71	63	80	91	86	81	82
Tava, 1996	84	TME	Greater than 70%	46	94	...	...	83	94	83	91
Luotolahti, 1996	85	UBE	Greater than or equal to 50%	118	94	94	93	70	97	60	92
Tan, 1996	86	TME	Greater than 50%	46	88	91	86	93	97	76	89
Roger, 1997	87	TME	Greater than or equal to 50%	340	78	...	...	41	79	40	69

CAD, 冠状动脉疾病; Ref., 参考文献数量; Exercise, 与经胸超声心动图联合应用的运动实验; Significant CAD, 选择性冠状动脉造影显示的冠状动脉直径狭窄率, 代表冠心病严重程度; Total Pts, 每一系列中做过选择性冠脉造影同时进行运动负荷超声心动图和室壁运动分析的病人的数目; Sens 1-VD, 单一血管病变冠心病检测结果阳性百分比; Sens MVD, 多支血管病变冠心病检测结果阳性百分比; PPV, 阳性预测值 (运动负荷超声心动图诱导出心肌缺血、造影检查有可能有严重冠状动脉疾病的可能性); NPV, 阴性预测值 (运动负荷超声心动图无可诱导的心肌缺血造影检查没有严重冠状动脉疾病的可能性); TME, 蹬车实验; UBE, 直立自行车肌力测试; BE, 自行车肌力测试; SBE, 仰卧自行车肌力测试。

负荷试验出现新的或原室壁运动异常加剧被认为是结果阳性。

III级

2. 在心脏转律前, 无二尖瓣疾病或肥厚性心肌病, 长期服用治疗水平的抗凝药的病人, 除非有其他需要抗凝的原因 (例如: 之前有过栓塞或之前TEE发现有血栓)。*

*只是TEE。

XIIa部分. 筛查

应用超声心动图筛查心血管疾病的建议

注: 增加了分子遗传学部分, 识别了具有家族遗传性的心肌病, 包括扩张型心肌病, 肥厚性心肌病和右室发育不良。由于这些心肌病可能有遗传学基础, 因此需要对其一级亲属进行超声心动图筛查。

表5. 经冠脉造影证实有冠状动脉疾病的病人经多巴酚丁胺负荷超声心动图诊断的准确率 (没有对转诊偏移进行校正)

Author, Year	Ref	Protocol	Significant CAD	Total Pts	Sensitivity		Sens 1-VD		Sens MVD		Specificity	PPV	NPV	Accuracy
					%	%	%	%	%	%				
Bertha, 1986	88	DSE 5-40	Greater than or equal to 50%	30	86	...	86	88	86	88	87	87	87	87
Sawada, 1991	89	DSE 2.5-30	Greater than or equal to 50%	66	89	81	100	86	91	81	74	87	87	87
Sawada, 1991	89	DSE 2.5-30	Greater than or equal to 50%	41	81	...	81	87	91	72	87	87	87	87
Previtali, 1991	90	DSE 5-40	Greater than or equal to 70%	36	68	60	92	100	100	44	83	89	89	89
Cohen, 1991	91	DSE 2.5-40	Greater than 70%	70	86	69	94	96	98	72	89	89	89	89
Martin, 1992	92	DSE 10-40	Greater than 50%	34	76	...	...	44	79	40	68	71	71	71
McNeill, 1992	93	DASE 10-40	Greater than or equal to 50%	28	71	...	...	...	...	...	71	71	71	71
Segur, 1992	94	DSE 5-30	Greater than or equal to 50%	88	96	...	...	82	94	86	92	92	92	92
Mazeika, 1992	96	DSE 5-20	Greater than or equal to 70%	60	78	60	92	93	97	62	82	82	82	82
Marcovitz, 1992	96	DSE 5-30	Greater than or equal to 50%	141	96	96	98	66	91	84	89	89	89	89
McNeill, 1992	97	DASE 10-40	Greater than or equal to 50%	80	70	...	...	88	89	67	78	78	78	78
Sabstia, 1992	98	DSE 5-40	Greater than or equal to 50%	46	79	...	...	78	86	70	78	78	78	78
Marwick, 1993	99	DSE 5-40	Greater than or equal to 50%	97	86	84	86	82	88	78	84	84	84	84
Forster, 1993	100	DASE 10-40	Greater than 50%	21	76	...	...	89	90	73	81	81	81	81
Gunalp, 1993	101	DSE 5-30	Greater than 50%	27	83	78	89	89	94	73	86	86	86	86
Marwick, 1993	102	DSE 5-40	Greater than or equal to 50%	217	72	66	77	83	89	61	76	76	76	76
Hoffmann, 1993	72	DASE 5-40	Greater than 70%	64	79	78	81	81	93	67	80	80	80	80
Previtali, 1993	103	DSE 5-40	Greater than 50%	80	79	63	91	83	92	61	80	80	80	80
Takeuchi, 1993	104	DSE 5-30	Greater than or equal to 50%	120	86	73	97	93	96	80	88	88	88	88
Cohen, 1993	73	DSE 2.5-40	Greater than 70%	62	86	76	96	87	94	72	87	87	87	87
Ostojic, 1994	106	DSE 5-40	Greater than or equal to 50%	160	76	74	81	79	96	31	76	76	76	76
Marwick, 1994	74	DSE 5-40	Greater than 50%	86	64	36	66	83	86	49	64	64	64	64
Beleslin, 1994	77	DSE 5-40	Greater than or equal to 50%	136	82	82	82	76	96	38	82	82	82	82
Sharp, 1994	106	DSE 5-60	Greater than or equal to 50%	64	83	69	89	71	89	69	80	80	80	80
Pellikka, 1996	107	DSE 5-40	Greater than or equal to 50%	67	98	...	...	66	84	94	87	87	87	87
Ho, 1996	108	DSE 5-40	Greater than or equal to 50%	64	93	100	92	73	93	73	89	89	89	89
Daoud, 1996	109	DSE 5-30	Greater than or equal to 50%	76	92	91	93	73	96	62	89	89	89	89
Dagianti, 1996	80	DSE 5-40	Greater than or equal to 70%	60	72	60	80	97	96	83	87	87	87	87
Pingitore, 1996	110	DASE 5-40	Greater than or equal to 50%	110	84	78	88	89	97	62	86	86	86	86
Schroder, 1996	111	DASE 10-40	Greater than or equal to 50%	46	76	71	90	88	97	44	78	78	78	78
Anthopoulos, 1996	44	DASE 5-40	Greater than or equal to 50%	120	87	74	90	84	94	68	86	86	86	86
Ling, 1996	112	DASE 5-40	Greater than or equal to 50%	183	93	...	...	62	96	64	90	90	90	90
Takeuchi, 1996	113	DASE 5-40	Greater than or equal to 50%	70	76	78	73	92	79	90	87	87	87	87
Minardi, 1997	114	DASE 5-40	Greater than or equal to 50%	47	76	81	67	67	97	16	74	74	74	74
Dionisopoulos, 1997	115	DASE 5-40	Greater than or equal to 50%	288	87	80	91	89	96	71	87	87	87	87
Elhendy, 1997	116	DASE 5-40	Greater than or equal to 50%	306	74	69	83	86	94	60	76	76	76	76
Ho, 1998	117	DSE 5-40	Greater than or equal to 50%	61	93	89	96	82	87	90	88	88	88	88

CAD, 冠状动脉疾病; Ref., 参考值; Protocol, 多巴酚丁胺负荷流程, 包括起始和峰值灌注率 (用微克/每公斤每分钟来表示); Significant CAD, 选择性冠状动脉造影显示冠状动脉直径狭窄率, 代表严重的CAD; Total Pts, 每一组做过选择性冠脉造影的病人中同时做过多巴酚丁胺负荷超声心动图和室壁运动分析的病人的数目; Sens 1-VD, 只有一根血管检查结果是阳性的病人; Sens MVD, 多根血管检查结果是阳性的病人; PPV, 阳性预测值 (药物负荷超声心动图可诱导的心肌缺血病人造影检查有严重冠状动脉疾病的可能性); NPV, 阴性预测值 (药物负荷超声心动图无可诱导的心肌缺血病人造影检查没有严重冠状动脉疾病的可能性); DSE, 多巴酚丁胺负荷超声心动图; DASE, 多巴酚丁胺/阿托品负荷超声心动图。

由负荷试验诱导出的新的或恶化的局部室壁运动异常被认为是阳性的结果。

I级

4. 不明原因的扩张型心肌病人的一级亲属 (包括父母, 兄弟姐妹, 孩子)。

表6. 经冠脉造影证实有冠状动脉疾病的女性病人负荷超声心动图诊断的准确率 (没有对转诊偏倚进行校正)

First Author, Year	Ref.	Protocol	Significant CAD	Total Pts	Sensitivity, %	Sens		Specificity, %	PPV, %	NPV, %	Accuracy, %
						1-VD, %	MVD, %				
Masini, 1988	118	DIP	Greater than or equal to 70%	83	79	...	...	93	91	84	87
Sawada, 1989	60	TME or UBE	Greater than or equal to 50%	57	86	88	82	86	86	86	86
Severi, 1994	119	DIP	Greater than or equal to 75%	122	68	...	...	96	90	86	87
Williams, 1994	78	UBE	Greater than 50%	70	88	89	86	84	83	89	86
Marwick, 1995	81	TME or UBE	Greater than or equal to 50%	161	80	75	85	81	71	87	81
Takeuchi, 1996	113	DASE	Greater than or equal to 50%	70	75	78	73	92	79	90	87
Roger, 1997	87	TME or UBE	Greater than or equal to 50%	96	79	...	...	37	66	54	63
Dionisopoulos, 1997	115	DASE	Greater than or equal to 50%	101	90	79	94	79	90	79	86
Laurienzo, 1997	120	DS-TEE	Greater than or equal to 70%	84	82	...	...	100	100	94	95
Elhendy, 1997	116	DASE	Greater than or equal to 50%	96	76	64	92	94	96	68	82
Ho, 1998	117	DSE	Greater than or equal to 50%	51	93	89	95	82	87	90	88
Studies accounting for referral bias											
Lewis, 1999 (by design)	121	DSE	Greater than or equal to 50%	92	40	40	60* 82†	81	71	84	70
Roger, 1997 (by adjustment)	87	TME	Greater than or equal to 50%	1714	32	2431 (2V) 43 (3V)		86	66		

CAD, 冠状动脉疾病; Ref., 参考文献数量; Protocol, 与经胸超声心动图联合使用的运动或药物负荷流程; Significant CAD, 选择性冠状动脉造影显示冠状动脉直径狭窄率, 代表严重的CAD; Total Pts, 每一组做过选择性冠脉造影的女性病人中同时做过负荷超声心动图和室壁运动分析的病人的数目; Sens 1-VD, 只有一根血管检查结果是阳性的病人; Sens MVD, 多根血管检查结果是阳性的病人; PPV, 阳性预测值 (药物负荷超声心动图可诱导的心肌缺血病人造影检查有严重冠状动脉疾病的可能性); NPV, 阴性预测值 (药物负荷超声心动图无可诱导的心肌缺血病人造影检查没有严重冠状动脉疾病的可能性); DIP, 潘生丁负荷超声心动图; TME, 蹬车试验; UBE, 直立自行车肌力测试; DASE, 多巴酚丁胺/阿托品负荷超声心动图。DS-TEE, 经食管超声心动图多巴酚丁胺负荷试验; DSE, 多巴酚丁胺负荷超声心动图。

由负荷试验诱导出的新的或恶化的局部室壁运动异常被认为是阳性的结果。

*包括所有病人。

†排除不确定的病人。

III级

2. 对心血管史、ECG和体检都正常的参与竞技项目的病人的常规超声心动图筛查。

XIII部分. 超声心动图在危重患者中的应用

超声心动图在危重患者中的应用建议

注: 这一部分改动较大。增加了超声心动图在肺栓塞检测中的应用, 比较了危重患者中TEE和TTE的应用价值。还增加了超声心动图在钝性主动脉创伤中的应用价值。表格内的证据进行了大幅度的修订和更新。¹³⁹⁻¹⁶⁴

III级

1. 可疑心肌挫伤患者, ECG正常, 血流动力学稳定, 心脏/胸部体格检查无异常并且缺乏可能引起心血管挫伤的损伤机制。

XIV部分. 成人先天性心脏病二维超声心动图应用

超声心动图在成人先天性心脏病中应用的建议

注: 增加了以下方面的内容: 某些先天性心脏病变无需导管仅超声检查即可准确诊断并进行

手术。超声心动图在介入治疗过程中是有帮助的。

I级

5. 对于有先天性心脏病的病人，监测其肺动脉压力很重要（例如，**血流动力学有意义的中等或较大室间隔缺损**，房间隔缺损，单心室或以上任何一种疾病伴有其他增加肺动脉高压风险因素的疾病）。

6. 做过先天性心脏病修补术（或姑息手术）的病人出现以下情况时需进行定期超声心动图检查：临床症状发生变化，或临床怀疑有残余缺损、管道或引流管道有梗阻，或是必须监测左、右室功能，或是有肺动脉高压病史，或血流动力学有发展为肺动脉高压可能时。

8. **识别冠状动脉起源的部位和基本走行（一些病人可能需要TEE检查）。***

*显示成人中冠脉走行可能必须TEE检查。

XV-E部分. 新生儿中后天获得性心血管疾病

新生儿超声心动图建议

注：这一部分仅做了微小变化。增加了两项I级建议和一项III级建议。¹⁷⁷⁻¹⁹⁴一项IIb级建议移入IIa级建议。为更加清晰，I级建议重新编了号。

I级

12. **肺动脉高压药物治疗开始和终止需进行再评估。**

13. **启用或移除体外心肺循环支持时，都要进行再评估。**

IIa级

3. **存在高发先天性心脏疾病的某种综合征，没有心血管异常发现，不需急诊治疗决策。**

IIb级

1. 移入IIa级（见上方）。

III级

2. **上下肢末端血氧饱和度正常的手足发绀。**

XV-F部分. 婴儿、儿童和青少年先天性心血管疾病

有关婴儿、儿童和青少年先天性心血管疾病的建议

注：新增两项I级建议，为清晰显示，重新编了号。^{6,195-200}

I级

5. **血管内装置的选择、放置、通畅性检测和实时监测，以及心脏介入术前、术中和术后心内或血管内分流检测**

6. **经皮心脏导管介入术后即刻评价。**

10. **存在心血管疾病有关的综合征，伴有显性遗传或家族成员多名受累（例如，**马凡综合征或是Ehlers-Danlos综合征**）。**

删除：

马凡综合征或是Ehlers-Danlos综合征的表型。

先天性心脏病发生率高但没发现相关心血管异常的综合征。

“非典型的”、无其他原因的“非血管减压性晕厥”。

XV-G部分. 心律失常/传导异常

心律失常/传导阻滞的儿科患者超声心动图检查建议

注：射频导管消融术后超声心动图可酌情使用。成功消融后或是有效药物控制心率后，心室持续性扩大提示可能为一种致心律失常型心肌病。

IIa级

2. ECG显示期前收缩，同时有症状。

IIb级

3. 射频消融后立即检查。

XV-H部分. 后天获得性心血管疾病

小儿后天获得性心血管疾病超声心动图建议

注：移植后第一年内致死的主要原因是移植导致的冠状动脉疾病。负荷超声心动图检测发现了亚临床缺血的证据。

I级

3. 接受有心脏毒性化疗药物的病人基础检查和复查。

5. 伴或不伴系统性高血压的严重肾疾病患者。

III级

1. 心脏体检正常的参与竞技活动的参与者，进行超声心动图常规筛查。

XV-I部分. 小儿后天获得性心肺疾病

小儿后天获得性心肺疾病超声心动图建议

注：超声心动图检查有无肺动脉高压，并通过右室扩张和/或肥大、三尖瓣或肺动脉瓣瓣膜返流和多普勒评估右室收缩压力等方法判断肺动脉高压严重程度。

I级

2. 肺动脉高压手术治疗或是开始口服和/或肠外血管扩张治疗时，进行超声心动图再评价。

3. 撤除体外心肺支持时再评价。

XV-K部分. 经食管超声心动图

有关小儿患者经食管超声心动图检查的建议

注：经食管超声心动图对引导导管法封闭房间隔缺损的装置的释放特别有用。经食管超声心动图对于确保装置放于缺损合适位置是必要的，对于残余分流、装置是否堵塞了经静脉回流入心房的血液以及是否侵犯房室瓣膜的评价是必不可少的。同样的，当心内畸形时TEE能帮助置入心律失常通路射频消融导管。²¹⁶⁻²²²

I级

2. 心胸手术时监测引导。

8. 存在右房到肺动脉的Fontan连接病人，识别心房血栓。

IIa级

1. 进行了侧向通道Fontan姑息术的病人。

XVI部分. 术中超声心动图

有关术中超声心动图的建议

注：这一部分是新的。1996年，ASA/SCA专案组发表了围手术期TEE应用指南。这一指南是基于循证医学基础上，主要关注的是围手术期TEE在提高临床预后方面的价值。那时回顾了1844篇文献，其中588篇与围手术期相关。较新的文献检索检出了另外118篇文献，是关于术中超声心动图的应用。当今的文章仅使用后者参考文献。但是本指南中提供的术中超声的适应证是同时基于最开始的ASA/SCA指南和最新的信息。

关于对这一主题详细的讨论，在ACC，AHA和ASE网站上有全文公布。

I级

1. 评价急性，持续性和有生命威胁的血流动力学紊乱，心室功能及其影响因素不确定，且对治疗无反应。
2. 瓣膜损伤的外科修复，梗阻性肥厚型心肌病和可能影响主动脉瓣膜的主动脉夹层。
3. 评价复杂性瓣膜置换术，可能需要同种移植和冠脉再移植的，如Ross手术。
4. 外科修复先天性心脏异常，需要体外循环的。
5. 心内膜炎外科手术治疗，术前检查不足够或累及到瓣周组织的。
6. 心腔内装置放置，在接口处或其他心脏手术介入时监测装置位置。
7. 心脏后方或是有分隔心包积液病人的心包开窗术评价。

IIa级

1. 心肌缺血危险、心肌梗死或血流动力学紊乱风险增加病人的外科手术。
2. 评价瓣膜置换，主动脉粥样硬化疾病，Maze手术，心脏室壁瘤修复，心脏肿瘤摘除，心腔内血栓和肺栓子切除术的评价。
3. 心切术、心脏置换术和直立位神经外科手术中气栓检测。

IIb级

1. 可疑心脏外伤，修复瓣膜未受累的急性胸主动脉夹层，心脏和/肺移植吻合口处情况评价。
2. 心脏不停跳，冠状动脉旁路移植手术术中及术后局部心肌功能的评价。
3. 心包切除术，心包积液和心包手术的评价。
4. 心肌灌注，冠状动脉解剖移植血管通畅性的评价。
5. 多巴酚丁胺负荷试验检测可诱导的缺血，或预测血管再通术后心功能变化。
6. 动脉导管未闭结扎术后残余导管分流的评价。

III级

1. 简单类型房间隔缺损的外科修复。

ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography: Summary Article

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines for the Clinical Application of Echocardiography)

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The ACC/AHA Task Force on Practice Guidelines makes every effort to avoid any actual or potential conflicts of interest that might arise as a result of an outside relationship or personal interest of a member of the writing panel. Specifically, all members of the writing panel are asked to provide disclosure statements of all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the parent task force, reported orally to all members of the writing panel at the first meeting, and updated as changes occur. The relationship with industry information for the writing committee members is posted on the ACC and AHA World Wide Web sites with the full-length version of the update.

When citing this document, the American College of Cardiology, American Heart Association, and the American Society of Echocardiography request that the following citation format be used: Cheitlin MD, Armstrong WF, Aurigemma GP, Beller GA, Bierman FZ, Davis JL, Douglas PS, Faxon DP, Gillam LD, Kimball TR, Kussmaul WG, Pearlman AS, Philbrick JT, Rakowski H, Thys DM. ACC/AHA/ASE 2003 guideline update for the clinical application of echocardiography—summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines on the Clinical Application of Echocardiography). *J Am Coll Cardiol* 2003;42:954–70.

This document and the full text guideline are available on the World Wide Web sites of the American College of Cardiology (www.acc.org), the American Heart Association (www.americanheart.org), and the American Society of Echocardiography (www.asecho.org). To obtain a single copy of this summary article published in the September 3, 2003, issue of the *Journal of the American College of Cardiology*, the September 2, 2003, issue of *Circulation*, or the October 2003 issue of the *Journal of the American Society of Echocardiography*, call 1-800-253-4636 or write to the American College of Cardiology Foundation, Resource Center, 9111 Old Georgetown Road, Bethesda, MD 20814-1699, and ask for reprint number 71-0263. To purchase additional reprints: up to 999 copies, call 1-800-611-6083 (US only) or fax 413-665-2671; 1000 or more copies, call 214-706-1466, fax 214-691-6342, or e-mail pubauth@heart.org.

I. GENERAL CONSIDERATIONS AND SCOPE

The previous guideline for the use of echocardiography was published in March 1997. Since that time, there have been significant advances in the technology of echocardiography and growth in its clinical use and in the scientific evidence leading to recommendations for its proper use.

Each section has been reviewed and updated in evidence tables, and where appropriate, changes have been made in recommendations. A new section on the use of intraoperative transesophageal echocardiography (TEE) is being added to update the guidelines published by the American Society of Anesthesiologists and the Society of Cardiovascular Anesthesiologists. There are extensive revisions, especially of the sections on ischemic heart disease; congestive heart failure, cardiomyopathy, and assessment of left ventricular (LV) function; and screening and echocardiography in the critically ill. There are new tables of evidence and extensive revisions in the ischemic heart disease evidence tables.

Because of space limitations, only those sections and evidence tables with new recommendations

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will be printed in this summary article. Where there are minimal changes in a recommendation grouping, such as a change from Class IIa to Class I, only that change will be printed, not the entire set of recommendations. Advances for which the clinical applications are still being investigated, such as the use of myocardial contrast agents and three-dimensional echocardiography, will not be discussed.

The original recommendations of the 1997 guideline are based on a Medline search of the English literature from 1990 to May 1995. The original search yielded more than 3000 references, which the committee reviewed. For this guideline update, literature searching was conducted in Medline, EMBASE, Best Evidence, and the Cochrane Library for English-language meta-analyses and systematic reviews from 1995 through September 2001. Further searching was conducted for new clinical trials on the following topics: echocardiography in adult congenital heart disease, echocardiography for evaluation of chest pain in the emergency department, and intraoperative echocardiography. The new searches yielded more than 1000 references that were reviewed by the writing committee.

This document includes recommendations for the use of echocardiography in both adult and pediatric patients. The pediatric guidelines also include recommendations for fetal echocardiography, an increasingly important field. The guidelines include recommendations for the use of echocardiography in both specific cardiovascular disorders and the evaluation of patients with frequently observed cardiovascular symptoms and signs, common presenting complaints, or findings of dyspnea, chest discomfort, and cardiac murmur. In this way, the guidelines will provide assistance to physicians regarding the use of echocardiographic techniques in the evaluation of such common clinical problems.

The recommendations concerning the use of echocardiography follow the indication classification system (eg, Class I, II, and III) used in other American College of Cardiology/American Heart Association (ACC/AHA) guidelines:

- Class I:** Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
- Class II:** Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.
 - IIa:** Weight of evidence/opinion is in favor of usefulness/efficacy.
 - IIb:** Usefulness/efficacy is less well established by evidence/opinion.
- Class III:** Conditions for which there is evidence and/or general agreement that the pro-

cedure/treatment is not useful/effective and in some cases may be harmful.

Evaluation of the clinical utility of a diagnostic test such as echocardiography is far more difficult than assessment of the efficacy of a therapeutic intervention because the diagnostic test can never have the same direct impact on patient survival or recovery. Nevertheless, a series of hierarchical criteria are generally accepted as a scale by which to judge worth.¹⁻³

Hierarchical Levels of Echocardiography Assessment

- Technical capacity
- Diagnostic performance
- Impact on diagnostic and prognostic thinking
- Therapeutic impact
- Health-related outcomes

Because there are essentially no randomized trials assessing health outcomes for diagnostic tests, the committee has not ranked the available scientific evidence in an A, B, and C fashion (as in other ACC/AHA documents) but rather has compiled the evidence in tables. The evidence tables have been extensively revised and updated. All recommendations are thus based on either this evidence from observational studies or on the expert consensus of the committee.

The definition of echocardiography used in this document incorporates Doppler analysis, M-mode echocardiography, two-dimensional transthoracic echocardiography (TTE), and, when indicated, TEE. Intravascular ultrasound is not considered but is reviewed in the ACC/AHA Guidelines for Percutaneous Coronary Intervention¹ (available at <http://www.acc.org/clinical/guidelines/percutaneous/dirIndex.htm>) and the Clinical Expert Consensus Document on intravascular ultrasound² (available at <http://www.acc.org/clinical/consensus/standards/standard12.htm>). Echocardiography for evaluating the patient with cardiovascular disease for noncardiac surgery is considered in the ACC/AHA Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery.³ The techniques of three-dimensional echocardiography are still in the developmental stages and are not considered here. New techniques that are still rapidly evolving and improvements that are purely technological in echocardiography, such as color Doppler imaging and digital echocardiography, are not going to be separately discussed in the clinical recommendations addressed in this document. Tissue Doppler imaging, both pulsed and color, which detects low Doppler shift frequencies of high energy generated by the contracting myocardium and consequent wall motion, are proving very useful in evaluating systolic and diastolic myocardial function. However, these technological advances will also not be sepa-

rately discussed in the clinical recommendations.^{4,5} Echocardiographic-contrast injections designed to assess myocardial perfusion to quantify myocardium at risk and perfusion beds also were not addressed.

These guidelines address recommendations about the frequency with which an echocardiographic study is repeated. If the frequency with which studies are repeated could be decreased without adversely affecting the quality of care, the economic savings realized would likely be significant. With a noninvasive diagnostic study and no known complications, the potential for repeating the study unnecessarily exists. It is easier to state when a repeat echocardiogram is not needed than when and how often it should be repeated, because no studies in the literature address this question. How often an echocardiogram should be done depends on the individual patient and must be left to the judgment of the physician until evidence-based data addressing this issue are available.

The ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography includes several significant changes in the recommendations and in the supporting narrative portion. In this summary, we list the updated recommendations, as well as commentary on some of the changes. All new or revised language in recommendations appears in boldface type. Only the references supporting the new recommendations are included in this article. The reader is referred to the full-text version of the guidelines posted on the American College of Cardiology (www.acc.org), American Heart Association (www.americanheart.org), and American Society for Echocardiography (www.asecho.org) World Wide Web sites for a more detailed exposition of the rationale for these changes.

SECTION II-B. NATIVE VALVULAR STENOSIS

Recommendations for Echocardiography in Valvular Stenosis

Comment: New references.^{6,7}

Class IIb

2. **Dobutamine echocardiography for the evaluation of patients with low-gradient aortic stenosis and ventricular dysfunction.**

SECTION II-C. NATIVE VALVULAR REGURGITATION

Recommendations for Echocardiography in Native Valvular Regurgitation

Comment: Literature on valvular effects of anorectic drugs and references to echocardiographic predic-

tors of prognosis after aortic and mitral valve surgery have been added.⁶⁻¹⁰

Class I

7. Assessment of the effects of medical therapy on the severity of regurgitation and ventricular compensation and function **when it might change medical management.**
8. **Assessment of valvular morphology and regurgitation in patients with a history of anorectic drug use, or the use of any drug or agent known to be associated with valvular heart disease, who are symptomatic, have cardiac murmurs, or have a technically inadequate auscultatory examination.**

Class III

2. **Routine repetition of echocardiography in past users of anorectic drugs with normal studies or known trivial valvular abnormalities.**

SECTION II-F. INFECTIVE ENDOCARDITIS: NATIVE VALVES

Recommendations for Echocardiography in Infective Endocarditis: Native Valves

Comment: The Duke Criteria for the diagnosis of infective endocarditis have been added, as well as the value of TEE in the setting of a negative transthoracic echocardiogram when there is high clinical suspicion or when a prosthetic valve is involved.^{11,12}

Class I

6. If TTE is equivocal, TEE evaluation of **staphylococcus bacteremia without a known source.**

Class IIa

1. Evaluation of **persistent nonstaphylococcus bacteremia without a known source.***

Class III

1. Evaluation of **transient fever without evidence of bacteremia or new murmur.**

*TEE may frequently provide incremental value in addition to information obtained by TTE. The role of TEE in first-line examination awaits further study.

SECTION II-G. PROSTHETIC VALVES

Recommendations for Echocardiography in Valvular Heart Disease and Prosthetic Valves

Class I

3. Use of echocardiography (especially TEE) in **guiding the performance of** interventional techniques **and surgery** (eg, balloon valvotomy **and valve repair**) for valvular disease.

SECTION IV-A. ACUTE ISCHEMIC SYNDROMES

Recommendations for Echocardiography in the Diagnosis of Acute Myocardial Ischemic Syndromes

Comment: Movement of a recommendation from Class IIa to Class I and minor wording change.

Recommendations for Echocardiography in Risk Assessment, Prognosis, and Assessment of Therapy in Acute Myocardial Ischemic Syndromes

Class I

4. Assessment of myocardial viability when **required to define potential efficacy of revascularization.***

Class IIa

2. Moved to Class I (see above).

Class IIb

1. Assessment of **late** prognosis (greater than or equal to 2 years after acute myocardial infarction).

*Dobutamine stress echocardiography.

SECTION IV-B. CHRONIC ISCHEMIC HEART DISEASE

Recommendations for Echocardiography in Diagnosis and Prognosis of Chronic Ischemic Heart Disease

Comment: There are new sections on stress echocardiography in the detection of coronary disease in the transplanted heart and stress echocardiography in the detection of coronary disease in women. There is one new Class I recommendation and three new Class IIa recommendations. Recommendations have been renumbered for clarity.

Class I

2. Exercise echocardiography for diagnosis of myocardial ischemia in selected patients (those for whom ECG assessment is less reliable because of digoxin use, LVH or with more than 1 mm ST depression at rest on the baseline ECG, those with pre-excitation [Wolff-Parkinson-White] syn-

drome, complete left bundle-branch block) with an intermediate pretest likelihood of CAD.

Class IIa

1. Prognosis of myocardial ischemia in selected patients (those in whom ECG assessment is less reliable) with the following ECG abnormalities: pre-excitation (Wolff-Parkinson-White) syndrome, electronically paced ventricular rhythm, more than 1 mm of ST depression at rest, **complete left bundle-branch block.***
2. Detection of coronary arteriopathy in patients who have undergone cardiac transplantation.†
3. Detection of myocardial ischemia in women with a low or intermediate pretest likelihood of CAD.*

Class IIb

1. Moved to Class IIa.

*Exercise or pharmacological stress echocardiogram.

†Dobutamine stress echocardiogram.

Recommendations for Echocardiography in Assessment of Interventions in Chronic Ischemic Heart Disease

One new Class IIa recommendation has been added.

Class IIa

1. Assessment of LV function in patients with previous myocardial infarction when needed to guide possible implantation of implantable cardioverter-defibrillator (ICD) in patients with known or suspected LV dysfunction.

Tables 1 through 6 are new tables that relate to CAD.

SECTION V-B. REGIONAL LV FUNCTION

Recommendations for Echocardiography in Patients With Dyspnea, Edema, or Cardiomyopathy

Class I

1. Dyspnea with clinical signs of heart disease.

Class IIb

1. Re-evaluation of patients with established cardiomyopathy when there is no change in clinical status **but when the results might change management.**

Table 1 Evaluation of myocardial viability with DSE in patients with chronic CAD and impaired systolic LV function to detect hibernating myocardium

First Author, Year	Ref.	Stress	Total Patients	Criteria	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Marzullo, 1993	13	LD-DSE	14	Imp. WM*	82	92	95	73	85
Cigarroa, 1993	14	LD-DSE	25	Imp. WM†	82	86	82	86	84
Alfieri, 1993	15	LD-DSE	14	Imp. WM*	91	78	92	76	88
La Canna, 1994	16	LD-DSE	33	Imp. WM*	87	82	90	77	85
Charney, 1994	17	LD-DSE	17	Imp. WM*	71	93	92	74	81
Afridi, 1995	18	DSE	20	Imp. WM†	80	90	89	82	85
Perrone-Filardi, 1995	19	LD-DSE	18	Imp. WM*	88	87	91	82	87
Senior, 1995	20	LD-DSE	22	Imp. WM*	87	82	92	73	86
Haque, 1995	21	LD-DSE	26	Imp. WM*	94	80	94	80	91
Arnese, 1995	22	LD-DSE	38	Imp. WM*	74	96	85	93	91
deFilippi, 1995	23	LD-DSE	23	Imp. WM*	97	75	87	93	89
Iliceto, 1996	24	LD-DSE	16	Imp. WM*	71	88	73	87	83
Varga, 1996	25	LD-DSE	19	Imp. WM*	74	94	93	78	84
Baer, 1996	26	LD-DSE	42	Imp. WM†	92	88	92	88	90
Vanoverschelde, 1996	27	LD-DSE	73	Imp. WM†	88	77	84	82	84
Gerber, 1996	28	LD-DSE	39	Imp. WM*	71	87	89	65	77
Bax, 1996	29	LD-DSE	17	Imp. WM*	85	63	49	91	70
Perrone-Filardi, 1996	30	LD-DSE	18	Imp. WM*	79	83	92	65	81
Qureshi, 1997	31	LD-DSE	34	Imp. WM*	86	68	51	92	73
Qureshi, 1997	31	DSE	34	Biphasic resp*	74	89	72	89	85
Nagueh, 1997	32	LD-DSE	18	Imp. WM*	91	66	61	93	75
Nagueh, 1997	32	DSE	18	Biphasic resp*	68	83	70	82	77
Furukawa, 1997	33	LD-DSE	53	Imp. WM*	79	72	76	75	76
Cornel, 1997	34	LD-DSE	30	Imp. WM*	89	82	74	93	85

DSE indicates dobutamine stress echocardiography (dobutamine infused at both low and high doses); CAD, coronary artery disease; LV, left ventricular; Ref. reference number; Stress, DSE protocol used for pharmacological stress; Total Patients, number of patients with chronic CAD and LV dysfunction in whom DSE studies were analyzed; Criteria, findings on DSE considered as a "positive" indicator of viability; PPV, positive predictive value (likelihood that presence of viability by DSE is indicative of subsequent functional recovery after revascularization); NPV, negative predictive value (likelihood that absence of viability by DSE is indicative of lack of functional recovery after revascularization); LD-DSE, low dose DSE; Imp. WM, improved wall motion during dobutamine stress in a previously asynergic segment; and Biphasic resp, biphasic response, defined as improvement in wall motion during LD-DSE followed by worsening at high dose. In these patients, percutaneous or surgical revascularization was performed after DSE testing. Those patients demonstrating improved wall motion on follow-up resting transthoracic echocardiography were considered to have had impaired LV function due to hibernating myocardium, whereas those demonstrating no improvement despite revascularization were considered to have had impaired LV function due to necrotic myocardium.

*Wall motion analyzed by segment; †wall motion analyzed by patient.

Class III

2. Routine re-evaluation in clinically stable patients in whom no change in management is contemplated **and for whom the results would not change management.**

SECTION IX. PULMONARY DISEASE

Recommendations for Echocardiography in Pulmonary and Pulmonary Vascular Disease

Comment: One recommendation was moved from Class I to Class IIa. Class IIa recommendations have been renumbered for clarity. Evidence was added concerning the diagnosis of severe pulmonary embolism by echocardiography.¹²²

Class I

2. Moved to Class IIa (see below).

Class IIa

1. **Pulmonary emboli and suspected clots in the right atrium or ventricle or main pulmonary artery branches.***

*TEE is indicated when TTE studies are not diagnostic.

SECTION XII. ARRHYTHMIAS AND PALPITATIONS

Recommendations for Echocardiography in Patients With Arrhythmias and Palpitations

Comment: An additional Class IIb recommendation was made concerning the use of echocardiography in the Maze procedure.¹²³⁻¹²⁹

Class IIa

2. **TEE or intracardiac ultrasound guidance of radiofrequency ablative procedures.**

Table 2 Prognostic value of stress echocardiography in various patient populations*

First Author, Year	Reference	Stress	Total Pts	Avg F/U, mo	Events	Annualized Event Rate, %		
						Ischemia	No Ischemia	Normal
Chronic ischemic heart disease								
Picano, 1989	35	DIP†	539	36	D, MI	2.3	0.7	...
Sawada, 1990	36	NL TME	148	28.4	D, MI	...	...	0.6
Mazeika, 1993	37	DSE†	51	24	D, MI, UA	16	3.8	...
Krivokapich, 1993	38	TME†	360	≈12	D, MI	10.8	3.1	...
Afridi, 1994	39	DSE†	77	10	D, MI	48	8.9	3
Poldermans, 1994	40	DSE†	430	17	D, MI	6.6	3.4	...
Coletta, 1995	41	DIP†	268	16	D, MI	17.9	1.4	...
Kamaran, 1995	42	DSE†	210	8	D, MI	69	1	...
Williams, 1996	43	DSE†	108	16	D, MI, Re	32.6	7.3	...
Anthopoulos, 1996	44	DSE†	120	14	D, MI	13.6	0	...
Marcovitz, 1996	45	DSE†	291	15	D, MI	12.8	8.2	1.1
Heupler, 1997	46	TME†	508w	41	D, MI, Re	9.2	1.3	...
McCully, 1998	47	NL TME	1325	23	D, MI	...	...	0.5
Chuah, 1998	48	DSE‡	860	24	D, MI	6.9	6.3	1.9
Cortigiani, 1998	49	DSE or DIP†	456w	32	D, MI	2.9	0.3	...
Davar, 1999	50	NL DSE	72w	13	D, MI	...	...	0
After cardiac transplantation								
Ciliberto, 1993	51	DIP‡	80	9.8	D, MI, CHF	26.2	0	...
Lewis, 1997	52	DSE‡	63	8	D, MI, CHF	28.6	3.6	...

Annualized Event Rate indicates the percentage of patients per year who developed at least 1 adverse event during follow-up, depending on whether inducible ischemia was or was not demonstrated by stress echocardiography (the annualized event rate is also tabulated for those series describing patients who had normal resting and normal stress results); Stress, stress echocardiography protocol; Total Pts, number of patients studied with stress echocardiography and subsequently followed up for the development of adverse events (including death, nonfatal myocardial infarction, revascularization, or unstable angina; in posttransplant patients, development of severe congestive heart failure was also considered an adverse event); Avg F/U, average period of follow-up after stress echocardiography; DIP, dipyridamole stress echocardiography; D, death; MI, nonfatal myocardial infarction; NL, series describing follow-up only in subjects with normal stress echocardiography test results; TME, treadmill stress echocardiography; DSE, dobutamine stress echocardiography; UA, unstable angina; Re, revascularization necessary; w, patients in these series were all women; and CHF, development of severe congestive heart failure.

*Prognostic value of inducible ischemia, detected with different forms of stress echocardiography, in patients with chronic ischemic heart disease and patients after cardiac transplantation.

†New wall motion abnormality considered "positive" for inducible ischemia.

‡Any wall motion abnormality (at rest or with stress) considered "positive."

Class IIb

3. Postoperative evaluation of patients undergoing the Maze procedure to monitor atrial function.

Recommendations for Echocardiography Before Cardioversion

Class IIb

2. Patients with mitral valve disease or hypertrophic cardiomyopathy who have been on long-term anticoagulation at therapeutic levels before cardioversion unless there are other reasons for anticoagulation (eg, prior embolus or known thrombus on previous TEE).*

*TEE only.

Table 3 Prognostic value of viable (hibernating) myocardium by LD-DSE and influence of revascularization

First Author, Year	Ref.	Stress	Total Pts	Avg F/U, mo	Adverse Events	Annualized Event Rate, %		
						Viable, +Re	Viable, -Re	Not Viable
Meluzin, 1998	53	LD-DSE	133	20	Death, MI	4.1	...	9.5
Afridi, 1998	54	LD-DSE	353	18	Death	4	20	19

LD-DSE indicates low-dose dobutamine stress echocardiography; Ref., reference number; Stress, stress echocardiography protocol; Total Pts, number of patients with chronic ischemic heart disease and impaired left ventricular systolic function studied with LD-DSE and subsequently followed up for the development of an adverse event (death or nonfatal myocardial infarction); Avg F/U, average period of follow-up after LD-DSE; Annualized Event Rate, percentage of patients per year who developed an adverse event during follow-up after LD-DSE; Viable, +Re, patients with viability (contractile reserve) demonstrated by LD-DSE who underwent revascularization and were then followed up; Viable, -Re, patients with viability (contractile reserve) demonstrated by LD-DSE who did not undergo revascularization and were then followed up; Not Viable, patients without contractile reserve by LD-DSE who were followed up for adverse events; and MI, nonfatal myocardial infarction.

Prognostic value of contractile reserve detected with LD-DSE in patients with chronic ischemic heart disease and impaired left ventricular systolic function. The annualized rate of death or MI is tabulated in patients with viable myocardium by LD-DSE depending on whether they did or did not undergo revascularization and also in those patients without viable myocardium.

Table 4 Diagnostic accuracy of exercise echocardiography in detecting angiographically proved CAD (without correction for referral bias)

First Author, Year	Ref.	Exercise	Significant CAD	Total Pts	Sensitivity, %	Sens	Sens	Specificity, %	PPV, %	NPV, %	Accuracy, %
						1-VD, %	MVD, %				
Limacher, 1983	55	TME	Greater than 50%	73	91	64	98	88	96	75	90
Armstrong, 1986	56	TME	Greater than or equal to 50%	95	88	...	...	87	97	57	87
Armstrong, 1987	57	TME	Greater than or equal to 50%	123	88	81	93	86	97	61	88
Ryan, 1988	58	TME	Greater than or equal to 50%	64	78	76	80	100	73	86	
Labovitz, 1989	59	TME	Greater than or equal to 70%	56	76	...	...	100	100	74	86
Sawada, 1989	60	TME or UBE	Greater than or equal to 50%	57	86	88	82	86	86	86	86
Sheikh, 1990	61	TME	Greater than or equal to 50%	34	74	74	...	91	94	63	79
Pozzoli, 1991	62	UBE	Greater than or equal to 50%	75	71	61	94	96	97	64	80
Crouse, 1991	63	TME	Greater than or equal to 50%	228	97	92	100	64	90	87	89
Galanti, 1991	64	UBE	Greater than or equal to 70%	53	93	93	92	96	96	93	94
Marwick, 1992	65	TME	Greater than or equal to 50%	150	84	79	96	86	95	63	85
Quinones, 1992	66	TME	Greater than or equal to 50%	112	74	59	89	88	96	51	78
Salustri, 1992	67	BE	Greater than or equal to 50%	44	87	87	...	85	93	75	86
Amanullah, 1992	68	UBE	Greater than or equal to 50%	27	82	...	...	80	95	50	81
Hecht, 1993	69	SBE	Greater than or equal to 50%	180	93	84	100	86	95	79	91
Ryan, 1993	70	UBE	Greater than or equal to 50%	309	91	86	95	78	90	81	87
Mertes, 1993	71	SBE	Greater than or equal to 50%	79	84	87	89	85	91	75	85
Hoffmann, 1993	72	SBE	Greater than 70%	66	80	79	81	88	95	58	82
Cohen, 1993	73	SBE	Greater than 70%	52	78	63	90	87	94	62	81
Marwick, 1994	74	BE	Greater than 50%	86	88	82	91	80	89	77	85
Roger, 1994	75	TME	Greater than or equal to 50%	150	91	...	...	...	...	...	...
Marangelli, 1994	76	TME	Greater than or equal to 75%	80	89	76	97	91	93	86	90
Beleslin, 1994	77	TME	Greater than or equal to 50%	136	88	88	91	82	97	50	88
Williams, 1994	78	UBE	Greater than 50%	70	88	89	86	84	83	89	86
Roger, 1995	79	TME	Greater than or equal to 50%	127	88	...	...	72	93	60	...
Dagianti, 1995	80	SBE	Greater than 70%	60	76	70	80	94	90	85	87
Marwick, 1995	81	TME or UBE	Greater than or equal to 50%	161	80	75	85	81	71	91	81
Bjornstad, 1995	82	UBE	Greater than or equal to 50%	37	84	78	86	67	93	44	81
Marwick, 1995	83	TME	Greater than 50%	147	71	63	80	91	85	81	82
Tawa, 1996	84	TME	Greater than 70%	45	94	...	...	83	94	83	91
Luotolahti, 1996	85	UBE	Greater than or equal to 50%	118	94	94	93	70	97	50	92
Tian, 1996	86	TME	Greater than 50%	46	88	91	86	93	97	76	89
Roger, 1997	87	TME	Greater than or equal to 50%	340	78	...	...	41	79	40	69

CAD indicates coronary artery disease; Ref., reference number; Exercise, type of exercise testing used in conjunction with transthoracic echocardiographic imaging; Significant CAD, % coronary luminal diameter narrowing, demonstrated by selective coronary angiography, considered to represent significant CAD; Total Pts, number of patients in each series undergoing selective coronary angiography in whom exercise echocardiographic studies and wall motion analysis were also performed; Sens 1-VD, test results positive in patients with single-vessel CAD; Sens MVD, test results positive in patients with multivessel disease; PPV, positive predictive value (likelihood of angiographically significant CAD in patients with inducible wall motion abnormalities by exercise echocardiography); NPV, negative predictive value (likelihood of absence of angiographically significant CAD in patients without inducible wall motion abnormalities by exercise echocardiography); TME, treadmill exercise; UBE, upright bicycle ergometry; BE, bicycle ergometry; and SBE, supine bicycle ergometry. A new or worsening regional wall motion abnormality induced by stress generally was considered a "positive" result.

Class III

- Patients who have been on long-term anticoagulation at therapeutic levels and who do not have mitral valve disease or hypertrophic cardiomyopathy before cardioversion **unless there are other reasons for anticoagulation (eg, prior embolus or known thrombus on previous TEE).***

*TEE only.

SECTION XIIa. SCREENING

Recommendations for Echocardiography to Screen for the Presence of Cardiovascular Disease

Comment: A section has been added on the molecular genetics work that has identified a familial basis for many forms of cardiomyopathy, including dilated congestive cardiomyopathy, hypertrophic cardiomy-

Table 5 Diagnostic accuracy of dobutamine stress echocardiography in detecting angiographically proved CAD (without correction for referral bias)

Author, Year	Ref.	Protocol	Significant CAD	Total Pts	Sensitivity, %	Sens		Specificity, %	PPV, %	NPV, %	Accuracy, %
						1-VD, %	MVD, %				
Berthe, 1986	88	DSE 5-40	Greater than or equal to 50%	30	85	...	85	88	85	88	87
Sawada, 1991	89	DSE 2.5-30	Greater than or equal to 50%	55	89	81	100	85	91	81	74
Sawada, 1991	89	DSE 2.5-30	Greater than or equal to 50%	41	81	...	81	87	91	72	87
Previtali, 1991	90	DSE 5-40	Greater than or equal to 70%	35	68	50	92	100	100	44	83
Cohen, 1991	91	DSE 2.5-40	Greater than 70%	70	86	69	94	95	98	72	89
Martin, 1992	92	DSE 10-40	Greater than 50%	34	76	...	...	44	79	40	68
McNeill, 1992	93	DASE 10-40	Greater than or equal to 50%	28	71	...	...	...	...	...	71
Segar, 1992	94	DSE 5-30	Greater than or equal to 50%	88	95	...	...	82	94	86	92
Mazeika, 1992	95	DSE 5-20	Greater than or equal to 70%	50	78	50	92	93	97	62	82
Marcovitz, 1992	96	DSE 5-30	Greater than or equal to 50%	141	96	95	98	66	91	84	89
McNeill, 1992	97	DASE 10-40	Greater than or equal to 50%	80	70	...	...	88	89	67	78
Salustri, 1992	98	DSE 5-40	Greater than or equal to 50%	46	79	...	...	78	85	70	78
Marwick, 1993	99	DSE 5-40	Greater than or equal to 50%	97	85	84	86	82	88	78	84
Forster, 1993	100	DASE 10-40	Greater than 50%	21	75	—	—	89	90	73	81
Gunalp, 1993	101	DSE 5-30	Greater than 50%	27	83	78	89	89	94	73	85
Marwick, 1993	102	DSE 5-40	Greater than or equal to 50%	217	72	66	77	83	89	61	76
Hoffmann, 1993	72	DASE 5-40	Greater than 70%	64	79	78	81	81	93	57	80
Previtali, 1993	103	DSE 5-40	Greater than 50%	80	79	63	91	83	92	61	80
Takeuchi, 1993	104	DSE 5-30	Greater than or equal to 50%	120	85	73	97	93	95	80	88
Cohen, 1993	73	DSE 2.5-40	Greater than 70%	52	86	75	95	87	94	72	87
Ostojic, 1994	105	DSE 5-40	Greater than or equal to 50%	150	75	74	81	79	96	31	75
Marwick, 1994	74	DSE 5-40	Greater than 50%	86	54	36	65	83	86	49	64
Beleslin, 1994	77	DSE 5-40	Greater than or equal to 50%	136	82	82	82	76	96	38	82
Sharp, 1994	106	DSE 5-50	Greater than or equal to 50%	54	83	69	89	71	89	59	80
Pellikka, 1995	107	DSE 5-40	Greater than or equal to 50%	67	98	...	...	65	84	94	87
Ho, 1995	108	DSE 5-40	Greater than or equal to 50%	54	93	100	92	73	93	73	89
Daoud, 1995	109	DSE 5-30	Greater than or equal to 50%	76	92	91	93	73	95	62	89
Dagianti, 1995	80	DSE 5-40	Greater than or equal to 70%	60	72	60	80	97	95	83	87
Pingitore, 1996	110	DASE 5-40	Greater than or equal to 50%	110	84	78	88	89	97	52	85
Schroder, 1996	111	DASE 10-40	Greater than or equal to 50%	46	76	71	90	88	97	44	78
Anthopoulos, 1996	44	DASE 5-40	Greater than or equal to 50%	120	87	74	90	84	94	68	86
Ling, 1996	112	DASE 5-40	Greater than or equal to 50%	183	93	...	...	62	95	54	90
Takeuchi, 1996	113	DASE 5-40	Greater than or equal to 50%	70	75	78	73	92	79	90	87
Minardi, 1997	114	DASE 5-40	Greater than or equal to 50%	47	75	81	67	67	97	15	74
Dionisopoulos, 1997	115	DASE 5-40	Greater than or equal to 50%	288	87	80	91	89	95	71	87
Elhendy, 1997	116	DASE 5-40	Greater than or equal to 50%	306	74	59	83	85	94	50	76
Ho, 1998	117	DSE 5-40	Greater than or equal to 50%	51	93	89	95	82	87	90	88

CAD indicates coronary artery disease; Ref., reference number; Protocol, dobutamine stress protocol, including initial and peak infusion rates (expressed in micrograms per kilogram per minute); Significant CAD, % coronary luminal diameter narrowing, demonstrated by selective coronary angiography, considered to represent significant CAD; Total Pts, number of patients in each series undergoing selective coronary angiography in whom dobutamine stress echocardiographic studies and wall motion analysis were also performed; Sens 1-VD, test results positive in patients with single-vessel CAD; Sens MVD, test results positive in patients with multivessel CAD; PPV, positive predictive value (likelihood of angiographically significant CAD in patients with inducible wall motion abnormalities by pharmacological stress echocardiography); NPV, negative predictive value (likelihood of absence of angiographically significant CAD in patients without inducible wall motion abnormalities by pharmacological stress echocardiography); DSE, dobutamine stress echocardiography; and DASE, dobutamine/atropine stress echocardiography.

A new or worsening regional wall motion abnormality induced by stress generally was considered a "positive" result.

opathy, and right ventricular (RV) dysplasia. A possible genetic basis for these cardiomyopathies supports echocardiographic screening of first-degree relatives.¹³⁰⁻¹³⁸

Class I

5. First-degree relatives (parents, siblings, children) of patients with unexplained

Table 6 Diagnostic accuracy of stress echocardiography in detecting angiographically proved CAD in women (generally without correction for referral bias)

First Author, Year	Ref.	Protocol	Significant CAD	Total Pts	Sensitivity, %	Sens 1-VD, %	Sens MVD, %	Specificity, %	PPV, %	NPV, %	Accuracy, %
Masini, 1988	118	DIP	Greater than or equal to 70%	83	79	...	...	93	91	84	87
Sawada, 1989	60	TME or UBE	Greater than or equal to 50%	57	86	88	82	86	86	86	86
Severi, 1994	119	DIP	Greater than or equal to 75%	122	68	...	...	96	90	86	87
Williams, 1994	78	UBE	Greater than 50%	70	88	89	86	84	83	89	86
Marwick, 1995	81	TME or UBE	Greater than or equal to 50%	161	80	75	85	81	71	87	81
Takeuchi, 1996	113	DASE	Greater than or equal to 50%	70	75	78	73	92	79	90	87
Roger, 1997	87	TME or UBE	Greater than or equal to 50%	96	79	...	...	37	66	54	63
Dionisopoulos, 1997	115	DASE	Greater than or equal to 50%	101	90	79	94	79	90	79	86
Laurienzo, 1997	120	DS-TEE	Greater than or equal to 70%	84	82	...	...	100	100	94	95
Elhendy, 1997	116	DASE	Greater than or equal to 50%	96	76	64	92	94	96	68	82
Ho, 1998	117	DSE	Greater than or equal to 50%	51	93	89	95	82	87	90	88
Studies accounting for referral bias											
Lewis, 1999 (by design)	121	DSE	Greater than or equal to 50%	92	40	40	60*	81	71	84	70
Roger, 1997 (by adjustment)	87	TME	Greater than or equal to 50%	1714	32	2431 (2V)	43 (3V)	86	66		

CAD indicates coronary artery disease; Ref., reference number; Protocol, exercise or pharmacological protocol used in conjunction with transthoracic echocardiographic imaging; Significant CAD, % coronary luminal diameter narrowing, documented by selective coronary angiography, considered to represent significant CAD; Total Pts, number of women in each series undergoing selective coronary angiography in whom stress echocardiographic studies and wall motion analysis were also performed; Sens 1-VD, test results positive in patients with single-vessel CAD; Sens MVD, test results positive in patients with multivessel CAD; PPV, positive predictive value (likelihood of angiographically significant CAD in patients with inducible wall motion abnormalities by stress echocardiography); NPV, negative predictive value (likelihood of absence of angiographically significant CAD in patients without inducible wall motion abnormalities by stress echocardiography); DIP, dipyridamole stress echocardiography; TME, treadmill stress echocardiography; UBE, upright bicycle stress echocardiography; DASE, dobutamine/atropine stress echocardiography; DS-TEE, dobutamine stress transesophageal echocardiography; and DSE, dobutamine stress echocardiography.

A new or worsening regional wall motion abnormality induced by stress generally was considered a "positive" result.

*Including all patients.

†Excluding patients with indeterminate studies.

dilated cardiomyopathy in whom no etiology has been identified.

Class III

2. Routine screening echocardiogram for participation in competitive sports in patients with normal cardiovascular history, ECG, and examination.

SECTION XIII. ECHOCARDIOGRAPHY IN THE CRITICALLY ILL

Recommendations for Echocardiography in the Critically Ill

Comment: This section has been revised extensively. A discussion has been added on the echocardiographic detection of pulmonary embolism and the usefulness of TEE versus TTE in the critically ill patient. A section on the value of echocardiography in blunt aortic trauma has also been added. The

evidence tables have been extensively revised and updated.¹³⁹⁻¹⁶⁴

Class III

1. Suspected myocardial contusion in the hemodynamically stable patient with a normal ECG who has no abnormal cardiac/thoracic physical findings and/or lacks a mechanism of injury that suggests cardiovascular contusion.

SECTION XIV. TWO-DIMENSIONAL ECHOCARDIOGRAPHY IN THE ADULT PATIENT WITH CONGENITAL HEART DISEASE

Recommendations for Echocardiography in the Adult Patient With Congenital Heart Disease

Comment: A section has been added on the accuracy of echocardiography to allow surgery to proceed

without catheterization in some congenital heart lesions. Echocardiography is useful in the performance of interventional therapeutic procedures.¹⁶⁵⁻¹⁷⁷

Class I

5. Patients with known congenital heart disease in whom it is important that pulmonary artery pressure be monitored (eg, patients with **hemodynamically important, moderate, or large** ventricular septal defects, atrial septal defects, single ventricle, or any of the above with an additional risk factor for pulmonary hypertension).
6. Periodic echocardiography in patients with repaired (or palliated) congenital heart disease with the following: change in clinical condition or clinical suspicion of residual defects, **obstruction of conduits and baffles**, or LV or RV function that must be monitored, or when there is a possibility of hemodynamic progression or a history of pulmonary hypertension.
8. **Identification of site of origin and initial course of coronary arteries (TEE may be indicated in some patients).***

*TEE may be necessary to image both coronary origins in adults.

SECTION XV-E. ACQUIRED CARDIOVASCULAR DISEASE IN THE NEONATE

Recommendations for Neonatal Echocardiography

Comment: Only minor changes have been made in this section. Two new Class I recommendations and one Class III recommendation have been added.¹⁷⁷⁻¹⁹⁴ One recommendation has moved from Class IIb to Class IIa. Class I recommendations have been renumbered for clarity.

Class I

12. **Re-evaluation after initiation or termination of medical therapy for pulmonary artery hypertension.**
13. **Re-evaluation during initiation or withdrawal of extracorporeal cardiopulmonary support.**

Class IIa

3. **Presence of a syndrome associated with a high incidence of congenital heart disease for which there are no abnormal cardiac findings and no urgency of management decisions.**

Class IIb

1. Moved to Class IIa (see above).

Class III

2. **Acrocyanosis with normal upper- and lower-extremity pulsed oximetry oxygen saturations.**

SECTION XV-F. CONGENITAL CARDIOVASCULAR DISEASE IN THE INFANT, CHILD, AND ADOLESCENT

Recommendations for Echocardiography in the Infant, Child, and Adolescent

Comment: There are two new Class I recommendations, which have been renumbered for clarity.^{6,195-200}

Class I

5. **Selection, placement, patency, and monitoring of endovascular devices, as well as identification of intracardiac or intravascular shunting before, during, and subsequent to interventional cardiac catheterization.**
6. **Immediate assessment after percutaneous interventional cardiac catheterization procedure.**
10. **Presence of a syndrome associated with cardiovascular disease and dominant inheritance or multiple affected family members (eg, Marfan syndrome or Ehlers-Danlos syndrome).**

Deleted:

Phenotypic findings of Marfan syndrome or Ehlers-Danlos syndrome.

Presence of a syndrome associated with high incidence of congenital heart disease when there are no abnormal cardiac findings.

"Atypical," "nonvasodepressor" syncope without other causes.

SECTION XV-G. ARRHYTHMIAS/CONDUCTION DISTURBANCES

Recommendations for Echocardiography in Pediatric Patients With Arrhythmias/Conduction Disturbances

Comment: Echocardiography is discretionary after radiofrequency catheter ablation. Persistent ventricular dilatation after successful ablation or effective medical control of the heart rate may indicate an arrhythmogenic primary cardiomyopathy.²⁰¹⁻²⁰³

Class IIa

2. Evidence of pre-excitation on ECG with symptoms.

Class IIb

3. Examination immediately after radiofrequency ablation.

**SECTION XV-H. ACQUIRED
CARDIOVASCULAR DISEASE**

**Recommendations for Echocardiography in
Pediatric Acquired Cardiovascular Disease**

Comment: The leading cause of death after the first posttransplant year is transplant-related CAD. There is evidence that stress echocardiography identifies subclinical ischemia.²⁰⁴⁻²¹³

Class I

3. Baseline and re-evaluation examinations of patients receiving cardiotoxic chemotherapeutic agents.
5. Patients with severe renal disease and/or systemic hypertension.

Class III

1. Routine screening echocardiogram for participation in competitive sports in patients with normal cardiovascular examination.

**SECTION XV-I. PEDIATRIC ACQUIRED
CARDIOPULMONARY DISEASE**

**Recommendations for Echocardiography in
Pediatric Acquired Cardiopulmonary
Disease**

Comment: Echocardiography provides documentation of pulmonary artery hypertension and estimation of severity by the presence of RV dilation and/or hypertrophy, the presence of tricuspid or pulmonic valvular regurgitation, and Doppler estimation of RV systolic pressure.^{214,215}

Class I

2. Re-evaluation after surgical intervention or initiation of oral and/or parenteral vasodilator therapy for pulmonary artery hypertension.
3. Re-evaluation during withdrawal of extracorporeal cardiopulmonary support.

**SECTION XV-K. TRANSESOPHAGEAL
ECHOCARDIOGRAPHY**

**Recommendations for TEE in Pediatric
Patients**

Comment: TEE has become particularly helpful in guiding placement of catheter-deployed devices used in closing atrial septal defects. It is essential in ensuring proper positioning of the device in the defect and assessing for residual shunts and abnormal device occlusion of venous inflow into the atria or encroachment on the atrioventricular valves. Likewise, placement of catheters for radiofrequency ablation of arrhythmogenic pathways can be facilitated by TEE when there are intracardiac abnormalities.²¹⁶⁻²²²

Class I

2. Monitoring and guidance during cardiothoracic surgical procedures.
8. Patients with right atrial to pulmonary artery Fontan connection, for identification of atrial thrombus.

Class IIa

1. Patients with lateral tunnel Fontan palliation.

**SECTION XVI. INTRAOPERATIVE
ECHOCARDIOGRAPHY**

**Recommendations for Intraoperative
Echocardiography**

Comment: This section is new. In 1996, a task force of the American Society of Anesthesiologists/Society of Cardiovascular Anesthesiologists (ASA/SCA) published practice guidelines for perioperative TEE. The guidelines were evidence based and focused on the effectiveness of perioperative TEE in improving clinical outcomes. A literature search conducted at that time retrieved 1844 articles, of which 588 were considered relevant to the perioperative setting. A more recent literature search identified an additional 118 articles related to the intraoperative use of echocardiography. The current text makes reference only to the latter. However, the indications for intraoperative echocardiography that are provided in these guidelines are based on both the initial ASA/SCA guidelines and the newer information.²²³⁻²⁶⁰

For a detailed discussion of this topic, please see the full-text version of the guidelines posted on the ACC, AHA, and American Society of Echocardiography (ASE) World Wide Web sites.

Class I

1. Evaluation of acute, persistent, and life-threatening hemodynamic disturbances in which ventricular function and its determinants are uncertain and have not responded to treatment.
2. Surgical repair of valvular lesions, hypertrophic obstructive cardiomyopathy, and aortic dissection with possible aortic valve involvement.
3. Evaluation of complex valve replacements requiring homografts or coronary reimplantation, such as the Ross procedure.
4. Surgical repair of most congenital heart lesions that require cardiopulmonary bypass.
5. Surgical intervention for endocarditis when preoperative testing was inadequate or extension to perivalvular tissue is suspected.
6. Placement of intracardiac devices and monitoring of their position during port-access and other cardiac surgical interventions.
7. Evaluation of pericardial window procedures in patients with posterior or loculated pericardial effusions.

Class IIa

1. Surgical procedures in patients at increased risk of myocardial ischemia, myocardial infarction, or hemodynamic disturbances.
2. Evaluation of valve replacement, aortic atheromatous disease, the Maze procedure, cardiac aneurysm repair, removal of cardiac tumors, intracardiac thrombectomy, and pulmonary embolectomy.
3. Detection of air emboli during cardiomy, heart transplant operations, and upright neurosurgical procedures.

Class IIb

1. Evaluation of suspected cardiac trauma, repair of acute thoracic aortic dissection without valvular involvement, and anastomotic sites during heart and/or lung transplantation.
2. Evaluation of regional myocardial function during and after off-pump coronary artery bypass graft procedures.
3. Evaluation of pericardiectomy, pericardial effusions, and pericardial surgery.
4. Evaluation of myocardial perfusion, coronary anatomy, or graft patency.
5. Dobutamine stress testing to detect inducible demand ischemia or to predict func-

tional changes after myocardial revascularization.

6. Assessment of residual duct flow after interruption of patent ductus arteriosus.

Class III

1. Surgical repair of uncomplicated secundum atrial septal defect.

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