

doi: 10.3978/j.issn.2095-6959.2017.12.017

View this article at: http://dx.doi.org/10.3978/j.issn.2095-6959.2017.12.017

对危重患者行床旁超声心动图检查的可行性

王佳佳¹, 叶加宝², 雷伟¹, 陈成¹, 苏楠¹, 苗玉珠³, 穆传勇¹, 朱晔涵¹, 黄建安¹

(1. 苏州大学附属第一医院呼吸与危重症医学科, 江苏 苏州 215005; 2. 苏州市立医院东区心血管内科, 江苏 苏州 215002; 3. 苏州大学附属第一医院心脏超声科, 江苏 苏州 215005)

[摘要] 目的: 评估呼吸科医师主导的床旁经胸廓超声心动图(transthoracic echocardiography, TTE)在危重患者心血管疾病诊断中的准确率, 分析导致TTE操作失败的主要因素。方法: 在熟悉TTE相关理论和正常超声影像的基础上开始为期2周的床旁TTE现场学习。由1名呼吸科医师对106例危重患者进行床旁TTE检查, 观察胸骨旁长轴切面、胸骨旁短轴切面、心尖四腔心切面、肋下四腔心切面及肋缘下下腔静脉切面超声影像。记录各切面所见异常, 并以正规TTE报告为金标准进行对比。结果: 呼吸科医师顺利完成94例患者床旁TTE检查, 所需时间(10.5±4.2) min, 42%患者合并两种以上异常TTE影像。呼吸科医师主导的床旁TTE对于心包积液、心室扩张、三尖瓣返流压差增高、下腔静脉异常诊断的准确率均在100%, 对瓣膜返流、左心室节段性室壁活动减弱、左心室整体收缩功能下降及室间隔矛盾运动诊断的准确率分别为92.6%, 95.7%, 96.8%, 96.8%。12例TTE操作失败的患者中, 单纯有创机械通气2例, 皮下水肿4例, 有创机械通气+气胸3例, 气胸、胸廓畸形及被动体位各1例。结论: 经过短期床旁TTE现场学习, 呼吸科医师可以相对系统性地完成危重患者床旁TTE检查, 能够可靠地解释心脏各切面所提示的信息, 从而为危重患者的紧急诊治提供一定指导。有创机械通气、皮下水肿、气胸是导致呼吸科床旁TTE操作失败的主要原因。同时该研究也为临床医师学习床旁TTE提供一种新的思路。

[关键词] 超声心动图; 危重患者; 准确率

Feasibility of using bedside transthoracic echocardiography in diagnosing cardiovascular diseases of critically ill patients

WANG Jiajia¹, YE Jiabao², LEI Wei¹, CHEN Cheng¹, SU Nan¹, MIAO Yuzhu³, MU Chuanyong¹, ZHU Yehan¹, HUANG Jian'an¹

(1. Department of Respiratory and Intensive Care Medicine, First Affiliated Hospital of Soochow University, Suzhou Jiangsu 215005;

2. Department of Cardiovascular Medicine, East District of Suzhou Municipal Hospital, Suzhou Jiangsu 215002;

3. Department of Echocardiography, First Affiliated Hospital of Soochow University, Suzhou Jiangsu 215005, China)

收稿日期 (Date of reception): 2017-10-11

通信作者 (Corresponding author): 黄建安, Email: huang_jian_an@163.com

基金项目 (Foundation item): 国家自然科学基金 (81300026); 江苏省“科教强卫工程”医学青年人才 (QNRC2016747); 苏州市临床医学中心 (Szzx201502)。This work was supported by the National Natural Science Foundation (81300026), the Youth Medical Talent of Jiangsu Province Science and Education to Enhance Sanitary Project (QNRC2016747), and the Clinical Medicine Center of Suzhou (Szzx201502), China.

Abstract **Objective:** To evaluate the accuracy rate of transthoracic echocardiography (TTE) conducted by respiratory physicians in diagnosing cardiovascular diseases of critically ill patients and analyze the associated causes of operation failure. **Methods:** We introduced a 2-week of comprehensively onsite TTE study under the guidance of echocardiographers on the basis of being familiar with the associated theory and normal echocardiography imaging. A total of 106 critically ill patients who hospitalized in our department were enrolled in this study. The parasternal long axis view, parasternal short axis view, apical four chamber view, subcostal four-chamber view, and the subcostal inferior vena cava view were performed by one specific physician. All of the information obtained from the five views were recorded and compared to formal echocardiography. **Results:** The bedside TTE was successfully performed by respiratory physicians in 94 cases. The operation time was (10.5±4.2) minutes and 42% patients showed two more abnormal TTE imagings. The accuracy rate of diagnosis in pericardial effusion, ventricular dilation, elevated tricuspid regurgitation pressure gradient value, and the abnormal inferior vena cava were all 100%. The accuracy rate of valvular regurgitation, regional ventricular wall motion abnormalities, reduction of left ventricular systolic function, and septal dyskinesia were 92.6%, 95.7%, 96.8%, and 96.8% respectively. The reasons for the twelve patients with failed operation was recognized as follows: invasive mechanical ventilation (MV) in two cases, cutaneous dropsy in four cases, pneumothorax combined with invasive MV in three cases, simple pneumothorax, thoracocyllosis and positioning limitations in one case respectively. **Conclusion:** Respiratory physician could accomplish the TTE systematically through short-term learning and give the reliable interpretation for interested views which would be beneficial for clinical diagnosis and treatment in emergency conditions. Invasive MV, cutaneous dropsy, and pneumothorax were considered as the main reasons for operation failure in respiratory department. Furthermore, this study demonstrated a possibly new thought of TTE study for clinicians.

Keywords echocardiography; critically ill patient; accuracy rate

床旁经胸廓超声心动图 (transthoracic echocardiography, TTE) 在评估危重患者心脏功能及血容量状态方面有重要的作用, 由于其能够准确、迅速地提供有价值的信息, 并且减少搬动危重患者, 所以床旁TTE在急诊科及ICU病房有着重要的临床应用价值^[1-2]。由于既往的床旁TTE主要依赖心脏超声专科医师, 无法满足临床24 h需要, 故急诊科与重症医学科医师主导的床旁TTE在临床逐渐得到应用, 为患者的快速诊治提供了一定的指导^[3-5]。目标导向TTE旨在选用特定的切面快速评估患者心脏功能, 存在一定程度的漏诊^[3,6], 临床使用有一定的局限性。近年来目标导向TTE的适应证已扩大, 以尽量满足临床诊治的需要^[7-8]。

由于呼吸科危重患者本身易合并心血管疾病, 肺部疾病的加重也会导致原有心脏疾病恶化或者出现新的心血管并发症^[9-10]。此外, 心功能恶化的临床表现往往被呼吸道症状所掩盖, 延误疾病的诊治, 所以床旁TTE在呼吸科危重患者中的使用价值尤为突出。既往传统的目标导向TTE不能满足呼吸科危重患者紧急诊治的需要, 本研究通过采用M型超声、连续多普勒、彩色多普勒等检查手

段, 较为系统地评估心功能, 并与正规的TTE结果进行对比, 初步分析呼吸科医师主导的床旁TTE在紧急情况下对于危重患者心血管疾病诊断的准确率及干扰因素。

1 对象与方法

1.1 对象

采用前瞻性观察研究, 本研究共纳入2014年5月至2015年2月在苏州大学附属第一医院呼吸科重症监护病房住院患者106例。其中男75例, 女31例, 年龄(61.7±19.5)岁。基础疾病为慢性阻塞性肺疾病63例, 社区获得性肺炎11例, 支气管扩张10例, 肺动脉栓塞8例, 间质性肺炎9例, 肺恶性肿瘤晚期5例。患者主要因为以下临床症状行床旁TTE: 1)胸闷气急; 2)血流动力学不稳定; 3)外周血氧饱和度恶化, 不能用肺部原发疾病加重来解释; 4)不明原因心动过速; 5)心电图异常; 6)心肌损伤标志物异常。为避免患者近期TTE结果对呼吸科医师的判断产生影响, 要求所有入组患者半年内均未行TTE检查。本研究得到医院伦理委员会

批准, 并获得患者本人或家属同意。

1.2 超声学习过程

利用1个月时间自行学习TTE相关理论及正常影像表现, 后跟随心脏超声专科医师开始为期2周的床旁TTE现场学习。学习内容包括患者体位要求、操作者位置、探头的操控手法、心脏标准切面的选择、图像质量的优化及对图像内容的解释。

1.3 主要设备

LOGIQ e便携式超声诊断仪配备6S-RS心脏超声探头与VIVID i心脏便携式彩超配备10S-RS心脏超声探头均购自美国通用电气公司。

1.4 方法

首先由心脏超声专业医师对纳入患者完成床旁TTE(采用VIVID i心脏便携式彩超), 并根据超声报告决定是否调整治疗方案。20 min内再由1名呼吸科医师(整个研究皆为同一位医师)对同一患者行床旁TTE检查(采用LOGIQ e便携式超声诊断仪), 要求该呼吸科医师在对正式TTE报告内容及治疗方案不知晓的情况下, 描述和解释LOGIQ e便携式超声诊断仪上各心脏切面影像, 并记录最终超声诊断, 然后将该超声诊断与正式TTE报告进行对比。左心收缩功能减弱以射血分数 $<45\%$ 为标准^[11]; 左心室舒张末期内径女性 >5.3 cm、男性 >5.9 cm定义为左心室扩张^[12]; 正常下腔静脉内径的宽度为1.3~2.2 cm, 超出该范围定义为下腔静脉内径异常, 下腔静脉塌陷度 $<50\%$ 视为活动度异常^[13]; 室间隔矛盾运动表现为左室舒张期室间隔平坦, 呈“D”型改变^[8]; 右心室内径/左心室内径 >0.6 cm代表右心室扩张^[7]; 室壁节段性活动减弱定义为室壁局部增厚率 $<30\%$ ^[14]。

1.5 初步资质认证要求

熟悉超声检查时患者及操作者体位, 能够较为熟练地操控探头。能够独立获取80%以上患者的胸骨旁长轴切面、胸骨旁短轴切面、心尖二腔切面、心尖四腔切面、肋下四腔切面及肋缘下下腔静脉切面超声影像, 并对图像质量进行优化。掌握初步的超声理论知识, 能识别上述各心脏切面的解剖结构并对常见的异常超声影像进行解释。要求对异常影像给出定性描述, 描述的主要范围包括: 心房、心室体积、瓣膜功能、左心室收缩

功能、三尖瓣返流压差、心包积液、下腔静脉内径及塌陷度。除射血分数及三尖瓣返流压差外, 对于其他心功能参数不作要求。

2 结果

呼吸科医师顺利完成94例床旁TTE检查, 所需时间 (10.5 ± 4.2) min。瓣膜返流、三尖瓣返流压差增高、下腔静脉异常及左心室整体收缩能力下降是呼吸科危重患者最常见的异常超声表现(表1), 42%的患者合并2种以上异常TTE影像。呼吸科医师主导的床旁TTE在瓣膜返流、左心室收缩能力减弱、室间隔矛盾运动等指标判断上存在误诊, 容易将瓣膜口混杂血流频谱误认为轻度返流, 并且容易低估房颤合并快速心室率患者左心室实际收缩功能。对于左心室节段性室壁活动减弱存在漏诊, 漏诊部位主要集中在室间隔(图1)。总体上呼吸科医师主导的床旁TTE对心包积液、心室扩张、三尖瓣返流压差增高、下腔静脉异常诊断的准确率均在100%, 对瓣膜返流、左心室局部活动减弱、左心室整体收缩功能下降及室间隔矛盾运动诊断的准确率分别为92.6%, 95.7%, 96.8%, 96.8%。12例床旁TTE操作失败的患者中, 单纯有创机械通气2例, 皮下水肿4例, 有创机械通气+气胸3例, 单纯气胸、胸廓畸形及被动体位各1例(图2)。

表1 呼吸科医师主导的床旁TTE与正规TTE结果对比
Table 1 Comparison of echocardiogram imagings gained by respiratory physician and echocardiographers

异常指标	呼吸科医师 主导 TTE	正规 TTE
心包积液	10	10
心室扩张	13	13
瓣膜返流	57	50
左心室节段性活动 减弱	9	13
左心室收缩减弱	25	22
三尖瓣返流压差 增高	36	36
室间隔矛盾运动	15	12
下腔静脉内径或活 动度异常	22	22

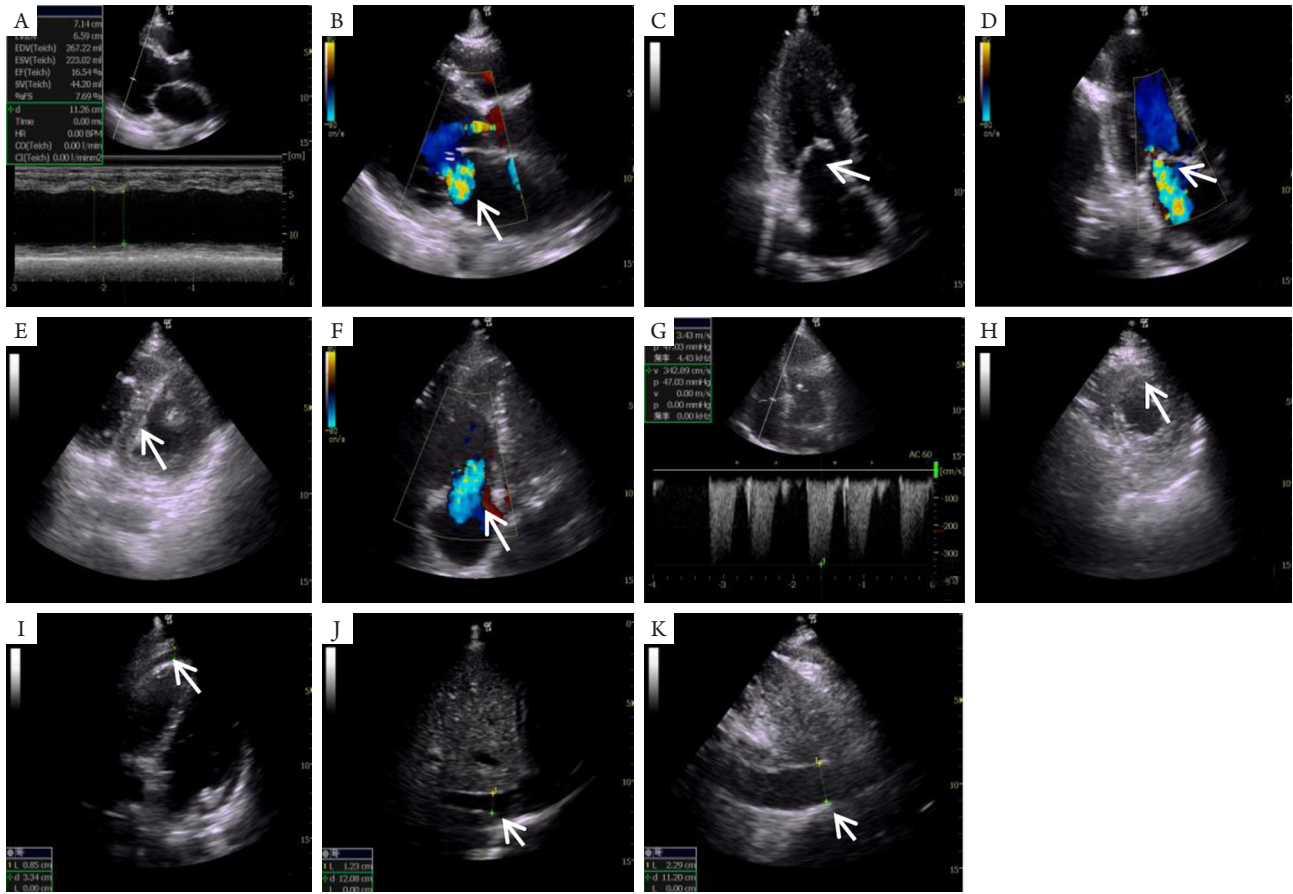


图1 呼吸科医师主导的床旁TTE图谱

Figure 1 Bedside TTE imaging gained by a respiratory physician

病例1左心室长轴切面：(A)左心室舒张末期内径7.14 cm，EF值16.54%；(B)二尖瓣中度返流(箭头)。病例2心尖二腔切面：(C)二尖瓣增厚、开放受限，考虑风湿性心脏病；(D)二尖瓣轻中度返流(箭头)。病例3左心室短轴切面：(E)左室舒张期可见室间隔活动受限，整个左心室呈“D”型改变(箭头)；心尖四腔切面：(F)三尖瓣中度返流(箭头)；(G)三尖瓣返流压差为47.03 mmHg(1 mmHg=0.133 kPa)。病例4左心室短轴切面：(H)室间隔收缩期活动减弱(箭头)。病例5剑突下四腔切面：(I)心包积液，液性暗区0.85 cm(箭头)。病例6剑突下下腔静脉切面：(J)下腔静脉内径1.23 cm。病例7剑突下下腔静脉切面：(K)剑腔静脉内径2.29 cm。

Parasternal long axis view of case 1: (A) internal diameter of left ventricular end-diastole is 7.14 cm and value of ejection fraction is 16.54%; (B) moderate mitral regurgitation (arrowhead). Apical two chamber view of case 2: (C) thickening of mitral valve with limitation of motion, a diagnosis of rheumatic heart disease was considered; (D) moderate mitral regurgitation (arrowhead). Parasternal short axis view of case 3: (E) limited motion of interventricular septum during left ventricular end-diastole and the appearance of whole left ventricular is similar to a character “D”; apical four chamber view: (F) moderate tricuspid regurgitation (arrowhead), (G) pressure gradient of tricuspid regurgitation is 47.03 mmHg (1 mmHg = 0.133 kPa). Parasternal short axis view of case 4: (H) limited motion of interventricular septum during left ventricular systole (arrowhead). Subcostal four chamber view of case 5: (I) pericardial effusion with a diameter of liquid dark area is 0.85 cm. Subcostal inferior vena cava view of case 6: (J) a diameter of inferior vena cava is 1.23 cm. Subcostal inferior vena cava view of case 7: (K) a diameter of inferior vena cava is 2.29 cm.

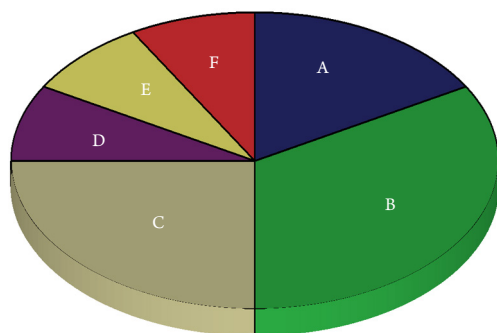


图2 导致床旁TTE操作失败因素饼状图

Figure 2 Pie chart of main reasons for operation failure

(A)有创机械通气(2例); (B)皮下软组织水肿(4例); (C)有创机械通气+气胸(3例); (D)为气胸(1例); (E)胸廓畸形(1例); (F)体位限制(1例)。

(A) Invasive ventilation (two cases); (B) soft tissue dropsy (four cases); (C) invasive ventilation and pneumothorax (three cases); (D) pneumothorax (one case); (E) thoracocyllosis (one case); (F) passive posture (one case).

3 讨论

危重患者易合并心脏并发症, 研究^[15]表明: 467例非心源性疾病导致的危重患者中出现1种及2种心脏异常的比例分别为36%与14%。床旁TTE在危重患者心功能的评估及液体的管理上起重要的作用。长期以来, 危重患者的床旁TTE多依赖心脏超声专业医师完成, 由此导致危重患者心血管功能短时间内重复监测、及时评估的需要难以满足。上个世纪90年代开始以急诊与重症医学科医师主导的床旁目标导向TTE在国外逐渐得到运用。目前该类型TTE在急诊与ICU使用的可行性及临床价值已得到认可, 对心血管疾病的快速诊治起着重要作用^[3-4,16]。Manasia等^[3]使用便携式TTE对90例外科危重患者行左心室功能评估, 结果表明TTE在94%的患者中成功操作, 84%能够解读, 为37%的患者的诊治提供指导。国内的一项临床研究^[17]也证实了目标导向超声心动图在重症医学科使用的可行性及临床价值。然而, 急诊与重症医学科医师主导的目标导向TTE主要是用二维超声来排除心包积液、明确左心整体收缩功能及血容量状态, 对于肺源性心脏病、节段性室壁活动异常及瓣膜返流等疾病往往存在漏诊^[3,6]。由于心肺疾病相互影响及使用呼吸机的关系, 呼吸科危重患者心血管疾病的发生率与病种特点不同于急诊科及其他专科ICU, 单纯采用二维超声来评

估左心室功能、排除心包积液及明确血容量状态显然不能满足危重患者病情恶化时紧急诊治的需要。所以本研究在设计初尝试加入M型超声、连续多普勒超声、彩色多普勒超声以期获得更为全面的超声信息。结果表明: 该类型超声能够在88.7%(94/106)的患者中顺利完成, 并且整体获得了较为理想的研究结果, 在瓣膜返流、三尖瓣返流压差增高、右心室扩张、左心室壁节段性活动减弱及室间隔矛盾运动等诊断方面也有较高的准确率, 从而为瓣膜疾病、肺动脉栓塞、肺源性心脏病、急性心肌梗死等疾病的诊断与鉴别诊断提供一定的依据。本研究对于瓣膜返流诊断的准确率最低(92.6%), 主要是轻度返流存在较多误诊, 考虑可能与图像过度增益及机器性能不同有关, 然而对这部分指标的误诊, 一般不会对患者整体诊治有重大影响。本研究采用射血分数来评估左心室整体收缩功能, 一定程度上可以避免单纯靠肉眼观察导致的判别错误, 并且采用连续多普勒超声来测量三尖瓣返流压差具体数值, 对于明确右心后负荷严重程度及评估治疗效果均有重要意义。床旁TTE在本研究中的完成率为88.7%, 较其他研究^[3,17]低, 考虑可能与呼吸科危重患者有创机械通气、气胸及皮下水肿所占比例较高有关, 这些因素导致无法获得清晰图像致使操作失败。此外, M型超声、彩色多普勒超声及连续多普勒超声技术的运用增加了操作的难度, 一定程度上也影响了整个操作的顺利进行。

国外近年发表了一系列关于心脏超声培训的专家共识^[18-19], 这些专家共识较以往在很大程度上拓展了目标导向TTE的使用范围, 培训及资质认证过程更加细化、严格^[20-21]。国内目前尚无目标导向床旁TTE的培训指南或专家共识可供参考, 由于长期以来缺少专门针对重症医学医师及急诊医师的TTE培训计划, 目前国内目标导向TTE在临床的使用尚未广泛开展起来。当前, 国内非心脏超声医师主导的目标导向TTE资质认证没有统一的标准, 并且没有得到相关权威机构的官方认可。本组研究中的资质认证要求高于其他临床研究^[16-17], 但仍缺乏细化的考核指标及考核流程。

考虑到需要行床旁TTE检查的患者与能够在心脏超声室完成检查的患者在一般情况及心血管疾病类型的总体分布上存在一定差异, 床旁TTE的实际操作及对图像的观察分析更加贴近我们临床工作的实际需求, 所以本研究尝试跟随心脏超声专

科医师前往各个会诊科室现场学习床旁TTE的操作和解读。研究表明:本次床旁TTE的学习过程虽然不同于国外目标导向TTE的培训,但也取得了较为理想的研究结果,而整个学习过程所花费的时间与费用较低,为临床医师学习床旁TTE提供一定的参考价值。

本研究只是初步将各指标分类、定性,获得了较高的诊断准确率,后续的研究中将各量化指标与正规TTE进行相关性分析以明确两者之间数据的一致性。虽然本研究中呼吸科医师主导的床旁TTE在一定程度上指导了危重患者病情恶化时的紧急诊治,但临床上仍应尽快行正规TTE。

参考文献

1. Beaulieu Y. Bedside echocardiography in the assessment of the critically ill[J]. *Crit Care Med*, 2007, 35(S Suppl): S235-S249.
2. Marcão I, Teixeira H, Longo S, et al. Echocardiography in emergency[J]. *Rev Port Cardiol*, 2004, 23(1): 81-92.
3. Manasia AR, Nagaraj HM, Kodali RB, et al. Feasibility and potential clinical utility of goal-directed transthoracic echocardiography performed by noncardiologist intensivists using a small hand-carried device (SonoHeart) in critically ill patients[J]. *J Cardiothorac Vasc Anesth*, 2005, 19(2): 155-159.
4. Melamed R, Sprenkle MD, Ulstad VK, et al. Assessment of left ventricular function by intensivists using hand-held echocardiography[J]. *Chest*, 2009, 135(6): 1416-1420.
5. Briggs J, Carle C, Roscoe A. Should echocardiography become a core skill for intensivists?[J]. *Br J Hosp Med (Lond)*, 2011, 72(1): 58.
6. Alexander JH, Peterson ED, Chen AY, et al. Feasibility of point-of-care echocardiography by internal medicine house staff[J]. *Am Heart J*, 2004, 147(3): 476-481.
7. Walley PE, Walley KR, Goodgame B, et al. A practical approach to goal-directed echocardiography in the critical care setting[J]. *Crit Care*, 2014, 18(6): 681.
8. Repessé X, Charron C, Vieillard-Baron A. Intensive care ultrasound: V. Goal-directed echocardiography[J]. *Ann Am Thorac Soc*, 2014, 11(1): 122-128.
9. 王金祥, 曾燕荣, 姜霄鹰, 等. 慢性阻塞性肺疾病患者左室结构和功能改变的研究[J]. *中国呼吸与危重监护杂志*, 2012, 11(5): 428-431.
WANG Jinxiang, ZENG Yanrong, JIANG Xiaoying, et al. The changes in structure and function of left ventricular in COPD patients[J]. *Chinese Journal of Respiratory and Critical Care Medicine*, 2012, 11(5): 428-431.
10. 许小毛, 叶晓华, 乔立松, 等. 致死性肺栓塞导致心脏骤停两例并文献复习[J]. *中国呼吸与危重监护杂志*, 2016, 15(2): 166-170.
XU Xiaomao, YE Xiaohua, QIAO Lisong, et al. Cardiac arrest due to fatal pulmonary thromboembolism: two cases report and literature review[J]. *Chinese Journal of Respiratory and Critical Care Medicine*, 2016, 15(2): 166-170.
11. Kanji HD, McCallum J, Sirounis D, et al. Limited echocardiography-guided therapy in subacute shock is associated with change in management and improved outcomes[J]. *J Crit Care*, 2014, 29(5): 700-705.
12. Lang RM, Bierig M, Devereux RB, et al. Recommendations for chamber quantification: a report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology[J]. *J Am Soc Echocardiogr*, 2005, 18(2): 1440-1463.
13. Besli F, Kecebas M, Caliskan S, et al. The utility of inferior vena cava diameter and the degree of inspiratory collapse in patients with systolic heart failure[J]. *Am J Emerg Med*, 2015, 33(5): 653-657.
14. Oki T, Tabata T, Yamada H, et al. Right and left ventricular wall motion velocities as diagnostic indicators of constrictive pericarditis[J]. *Am J Cardiol*, 1998, 81(4): 465-470.
15. Bossone E, Marcovitz PA, Bach DS, et al. Occult cardiac abnormalities are not uncommon in critically ill patients: echocardiographic evaluation of 467 consecutive patients admitted to a medical intensive care unit[J]. *J Am Coll Cardiol*, 2007, 29(5): 438A.
16. Randazzo MR, Snoey ER, Levitt MA, et al. Accuracy of emergency physician assessment of left ventricular ejection fraction and central venous pressure using echocardiography[J]. *Acad Emerg Med*, 2003, 10(9): 973-977.
17. 张丽娜, 艾宇航, 刘志勇, 等. 重症医学医师主导的床旁目标导向超声心动图检查在ICU应用的可行性研究[J]. *中国危重病急救医学*, 2012, 24(12): 739-741.
ZHANG Li'na, AI Yuhang, LIU Zhiyong, et al. Feasibility of focused transthoracic echocardiography in intensive care unit performed by intensivists[J]. *Chin Crit Care Med*, 2012, 24(12): 739-741.
18. Spencer KT, Kimura BJ, Korcarz CE, et al. Focused cardiac ultrasound: recommendations from the American Society of Echocardiography[J]. *J Am Soc Echocardiogr*, 2013, 26(6): 567-581.
19. Expert Round Table on Echocardiography in ICU. International consensus statement on training standards for advanced critical care

- echocardiography[J]. Intensive Care Med, 2014, 40(5): 654-666.
20. Mayo PH, Beaulieu Y, Doelken P, et al. American College of Chest Physicians/La Société de Réanimation de Langue Française statement on competence in critical care ultrasonography[J]. Chest, 2009, 135(4): 1050-1060.
21. Expert Round Table on Ultrasound in ICU. International expert statement on training standards for critical care ultrasonography[J]. Intensive Care Med, 2011, 37(7): 1077-1083.

本文引用: 王佳佳, 叶加宝, 雷伟, 陈成, 苏楠, 苗玉珠, 穆传勇, 朱晔涵, 黄建安. 对危重患者行床旁超声心动图检查的可行性[J]. 临床与病理杂志, 2017, 37(12): 2611-2617. doi: 10.3978/j.issn.2095-6959.2017.12.017

Cite this article as: WANG Jiajia, YE Jiabao, LEI Wei, CHEN Cheng, SU Nan, MIAO Yuzhu, MU Chuanyong, ZHU Yehan, HUANG Jian'an. Feasibility of using bedside transthoracic echocardiography in diagnosing cardiovascular diseases of critically ill patients[J]. Journal of Clinical and Pathological Research, 2017, 37(12): 2611-2617. doi: 10.3978/j.issn.2095-6959.2017.12.017