



National Basketball Association

Required Protocol for the Identification of Cardiovascular Disease

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Cardiovascular screening is to be conducted in accordance with the scientific statement of the American Heart Association as set forth in “Recommendations and Considerations Related to Preparticipation Screening for Cardiovascular Abnormalities in Competitive Athletes: 2007 Update” (attached for reference). Accordingly, at a minimum, such screening must include:

Detailed Medical History

1. Assess for symptoms of exertional chest pain/discomfort
2. Assess for unexplained syncope or near-syncope
3. Assess for excessive/out of proportion shortness of breath with exercise
4. Ask if there has been any personal history of a heart murmur or high blood pressure
5. Take a detailed personal medical history with particular emphasis on cardiac illnesses that could potentially cause injury to young athletes (AHA recommendations attached as a guideline reference)¹

Physical Exam

1. Assess for the presence of a heart murmur
2. Assess femoral pulses to exclude aortic coarctation
3. Assess for physical stigmata of Marfan Syndrome
4. Brachial artery blood pressure in the sitting position

Objective Data

1. Standard 12 lead electrocardiogram. Refer to the “International Criteria” reference on normal and abnormal ECG findings in athletes² (attached as a guideline reference)
2. Follow NBA protocols for two-dimensional echocardiogram with Doppler and stress (attached)
3. Interpretation: Consider against guideline for echocardiogram and Echocardiographic Screening Guidelines for Professional Basketball Players (attached as a guideline reference)

Lipid Panel/Blood Glucose

1. Test to include total cholesterol, LDL, HDL, triglycerides
2. Interpretation: Abnormal values justify further consideration and evaluation in context of coronary artery disease and risk factors

¹ (1) Maron BJ, Friedman RA, Kligfield P et al.; on behalf of the American Heart Association Council on Clinical Cardiology et al. Assessment of the 12-lead ECG as a screening test for detection of cardiovascular disease in healthy general populations of young people (12–25 years of age): a scientific statement from the American Heart Association and the American College of Cardiology. *Circulation*. 2014;130:1303–1334.; (2) Chandra N, Bastiaenen R, Papadakis M, Sharma S. Sudden Cardiac Death in Young Athletes: Practical Challenges and Diagnostic Dilemmas. *J Am Coll Cardiol*. 2013;61(10):1027-1040. Doi:10.1016/j.jacc.2012.08.1032.

² Sharma S, Drezner JA, Baggish A et al. International Recommendations for Electrocardiographic Interpretation in Athletes. *J Am Coll Cardiol*. 2017; 69(8): 1057-1075

Table 1. The 14-Element AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes

Medical history*

Personal history

1. Chest pain/discomfort/tightness/pressure related to exertion
2. Unexplained syncope/near-syncope†
3. Excessive and unexplained dyspnea/fatigue or palpitations, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Prior restriction from participation in sports
7. Prior testing for the heart, ordered by a physician

Family history

8. Premature death (sudden and unexpected, or otherwise) before 50 y of age attributable to heart disease in ≥ 1 relative
9. Disability from heart disease in close relative <50 y of age
10. Hypertrophic or dilated cardiomyopathy, long-QT syndrome, or other ion channelopathies, Marfan syndrome, or clinically significant arrhythmias; specific knowledge of genetic cardiac conditions in family members

Physical examination

11. Heart murmur‡
 12. Femoral pulses to exclude aortic coarctation
 13. Physical stigmata of Marfan syndrome
 14. Brachial artery blood pressure (sitting position)§
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AHA indicates American Heart Association.

*Parental verification is recommended for high school and middle school athletes.

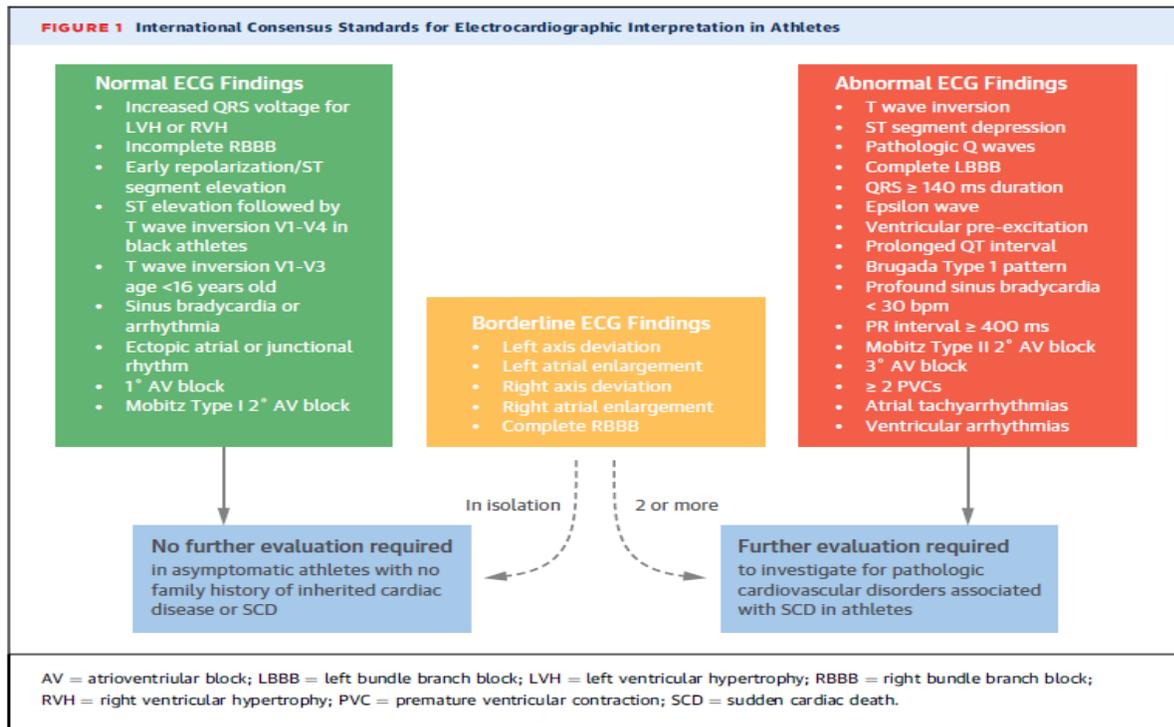
†Judged not to be of neurocardiogenic (vasovagal) origin; of particular concern when occurring during or after physical exertion.

‡Refers to heart murmurs judged likely to be organic and unlikely to be innocent; auscultation should be performed with the patient in both the supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.

§Preferably taken in both arms.

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Electrocardiographic Interpretation in Athletes: the International Recommendations[§]



Definitions

ECG finding

Left atrial enlargement
 Right atrial enlargement
 Left axis deviation
 Right axis deviation
 Right ventricular hypertrophy
 ST depression
 Pathologic Q waves
 Ventricular pre-excitation
 T wave inversions

Definition

Negative portion of P wave in V1 ≥ 1 mm in depth and ≥ 40 ms in duration
 P wave amplitude ≥ 2.5 mm in leads II, III, or aVF
 -30° to -90°
 >115°
 Sum of R wave in V1 + S wave in V5 or V6 ≥ 10.5 mm
 ≥ 0.5 mm deep in 2 or more leads
 Q/R ratio ≥ 0.25 or ≥ 40 ms in duration (excluding II and aVR)
 PR interval < 120 ms with delta wave
 ≥ 1 mm in depth in 2 or more leads (excludes III, aVR, V1)

*For players with T wave inversions (TWI) affecting the lateral leads (I, aVL, V5 and/or V6) further evaluation with cardiac MRI with gadolinium or echocardiography using IV contrast should be considered if imaging of all LV wall segments, including the LV apex, by standard echocardiography is not diagnostic. For players with lateral TWI and upper limits of LV wall thickness (13-15 mm) Holter monitoring should be considered. Players with lateral TWI should be evaluated on a prioritized basis on annual preseason cardiac examinations.

[§]Sharma S, Drezner JA, Baggish A et al. International Recommendations for Electrocardiographic Interpretation in Athletes. *J Am Coll Cardiol.* 2017; 69(8): 1057-1075

NBA Protocol: Two-dimensional echocardiogram with Doppler

General Requirements:

- Obtain name, age, height and weight
- Record BP, HR
- Upload study (all images obtained during the test) and study report to NBA's Cerner electronic medical records system; all files must be DICOM type and may not be .avi, .wmv or other similar video files.
- Strain calculations are not required to be made by teams or their medical personnel

Parasternal Views:

1. 2D PLAX (ALL CLIPS to be ≥ 3 beats)
2. PLAX measurements:
 - a. LV (diastolic and systolic measurements)
 - b. LV wall thickness
 - c. LA
 - d. Ao root
 - i. Annulus
 - ii. Sinus of Valsalva
 - iii. Sino-tubular junction
 - iv. Prox asc ao
 - v. Additional 2D PLAX of aortic root if >4 cm at sinus of Valsalva
3. 2D PLAX of ascending aorta (move up an intercostal space if needed)
 - a. Additional 2D PLAX of ascending aorta if >4 cm
4. PLAX with color box around both mitral and aortic valves (aliasing velocity >60 cm/sec)
 - a. If MR, measure vena contracta
5. Tricuspid valve inflow view
6. Tricuspid valve inflow view with color flow (aliasing velocity >60 cm/sec)
7. Measure TR jet velocity for RVSP
8. Pulmonic valve outflow view showing PA bifurcation if possible
9. Pulmonic valve outflow PW and CW
10. Pulmonic valve outflow view with color flow (aliasing velocity >60 cm/sec)
11. 2D PSAX at level of base of heart showing leaflets of AV in short axis
12. 2D PSAX at level of base of heart with color box on aortic valve
13. 2D PSAX at level of mitral valve
14. 2D PSAX at level of base of heart with color box on mitral valve
15. 2D PSAX level of papillary muscle
16. 2D PSAX level of papillary muscles - obtain one additional 3 beat clip at frame rates > 40 fps for strain imaging (if not already obtained)
17. 2D PSAX at apical level

Apical Views:

1. 2D Apical 4 chamber view

Apical 4 chamber view measurements:

- a. LV volumes and EF (use Simpson's biplane), LA volume (biplane)
- b. Images for strain:
 - i. Obtain one additional 3 beat clip of the LVC at frame rate >40 fps for strain imaging (if not already obtained)
 - ii. Obtain one additional 3 beat clip of the RV at frame rate > 40 fps for strain imaging (if not already obtained)

Other 2D Apical 4 chamber view images

- c. 2D Apical 4 chamber view with color box on MV (aliasing velocity >60cm/sec)
 - i. If >mild MR, PISA measurements (measure in apical view where PISA is best seen)
 - d. PW of MV at leaflet tips (measure peak E, Peak A, Decel time)
 - e. 2D Apical 4 chamber view to show pulm veins
 - f. Tissue Doppler at lateral and medial annulus (measure E')
 - i. Tissue Doppler of the Tricuspid annulus
 - ii. TAPSE (use M-mode)
 - g. Apical 4 chamber view with color box on TV (aliasing velocity >60cm/ssec)
 - i. CW of TR for RVSP
2. 2D Apical 5 chamber view
 - a. Apical 5 chamber view with color box on AV (aliasing velocity >60cm/sec)
 - b. PW at LV outflow tract
 - c. CW of AV
 - d. Pressure ½ time of AR if AR >mild
 - e. Isovolumic relaxation time view (simultaneous Doppler of MV inflow and aortic outflow)
 3. 2D Apical 2 chamber view
 - a. Apical 2 chamber view measurements:
 - i. Measure LV volume and EF (using biplane Simpson's)
 - ii. Measure LA volume (using biplane)
 - iii. Obtain one additional 3 beat clip of the LV at frame rate >40 fps for strain imaging (if not already obtained)
 - b. Apical 2 chamber view with color box on MV
 4. 2D apical 3 chamber view
 - a. Obtain 3 chamber view
 - b. Obtain one additional 3 beat clip of the LV at frame rate >40 fps for strain imaging (if not already obtained)
 - c. Apical 3 chamber view with color box on MV and AV
 - i. PISA measurements if MR >mild (measure in apical view where PISA is best seen)
 - d. PW and CW of aortic outflow tract
 - e. Pressure ½ time of AR if AR >mild

Subcostal Views:

1. 4 chamber view to assess RV wall thickness
2. Additional short axis view of LV if PLAX views not adequate
3. IVC with and without color flow
4. IVC with sniff to measure RA pressure
5. Measure diameter of abdominal aorta

Suprasternal Notch Views:

1. View of aortic arch in both long and short axis view
 - a. Measure diameter of aortic arch
2. Color flow view of aortic arch

NBA Protocol: Stress Echocardiogram

General requirements

- Upload study (all images obtained during the test) and study report to NBA's Cerner electronic medical records system; all files must be DICOM type and may not be .avi, .wmv or other similar video file

Pre-exercise

- Resting vital signs data obtained, printed, and reviewed prior to exercise:
 - o Supine blood pressure
 - o 12 lead EKG (with standard modified stress lead placement)
- Echocardiographic imaging sequence:
 - o Turn on the SVHS recording so that there is imaging back up on VHS tapes
 - o Maximize 2-D 4 Chamber view, optimize and acquire images
 - o Rotate transducer to Apical 2 Chamber view, optimize and acquire images
 - o Maximize 2-D Parasternal Long Axis view, optimize and acquire images
 - o Rotate to Parasternal Short Axis view, optimize and acquire images
 - o Review the stored baseline images for quality, reproducibility, and any regional wall motion abnormalities
 - o Explain thoroughly post image acquisition "breath hold"; instructions to the patient
 - o Demonstrate and have patient practice post-exercise transition from treadmill to scanning bed for understanding, safety, and compliance
 - o If significant EKG or echocardiographic findings are noted with baseline acquired data, consult with the physician(s) for direction before proceeding with the stress portion (unless physician is performing the test)

Exercise phase EKG and blood pressure data

- The Bruce protocol (3 min stages) will be utilized during the exercise phase
- Blood pressure and 12 lead EKG will be obtained, printed, and reviewed at the following intervals:
 - o At beginning of test, standing
 - o Blood pressure obtained during the 3rd minute of each stage
 - o 12 lead EKG obtained every minute of exercise
 - o Blood pressure and EKG will be obtained anytime throughout the exercise phase if/when clinically warranted
 - o Peak exercise when heart rate is at or above target
- All arrhythmias will be recorded, printed, reviewed, and monitored throughout the exercise phase

Peak exercise images

- Peak images are obtained at any of the following scenarios:
 - o Unable to continue exercising due to fatigue, dyspnea, or other symptoms
 - o The target heart rate is achieved
 - o Significant EKG changes occur
 - o Hypertensive or hypotensive blood pressure response occurs
 - o Progressively worsening chest pain
 - o Any other significant symptoms

- Once the treadmill is brought to a complete stop, re-orient the patient on a rapid/safe transition back to the scanning bed
- Imaging sequence
 - o Turn on the SVHS recording so that there is imaging back up on VHS tapes
 - o Optimize 2-D 4 Chamber view and acquire images
 - o Optimize 2-D 2 Chamber view and acquire images
 - o Optimize 2-D Parasternal Long Axis view and acquire images
 - o Optimize 2-D Parasternal Short Axis view and acquire images
 - o Repeat imaging sequence if deemed necessary or when heart rate is still above target
- Review and select the best post-exercise stress images
- Review and side-by-side compare Rest and Post-exercise images

Recovery phase EKG and blood pressure data

- 12 lead EKG will be obtained, recorded, and printed at the following intervals:
 - o 1 minute post exercise
 - o 2 minutes post exercise
 - o 3 minutes post exercise
 - o 4 minutes post exercise
 - o 5 minutes post exercise
 - o At any point when clinically warranted
- Blood pressure will be measured and documented at the following intervals
 - o 1 minute post exercise
 - o 3 minutes post exercise
 - o 5 minutes post exercise
 - o At any point when clinically warranted
- When symptoms exist, blood pressure and EKG data will be collected and documented at the following intervals
 - o At the point in time when symptoms subside
 - o EKG changes return to baseline
 - o Echocardiographic changes return to baseline

If EKG changes, ischemic symptoms, hypo/hypertensive response, or echocardiographic wall motion abnormality is present at rest or with exercise, recovery echocardiographic images need to be obtained.

Study Conclusion

- Disconnect 12 lead EKG electrodes from the patient
- Provide towel or hand towel to the patient for removal of any remaining AquaSonic Gel

Scenarios to consult with the physician(s) once the stress echo is completed (unless physician is performing the test)

- Symptoms during and after exercise
- Abnormal EKG or blood pressure response to exercise
- Newly identified wall motion abnormality before/after exercise
- Abnormal hemodynamic response



Echocardiographic Screening Guidelines for Professional Basketball Players

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David Engel, MD, Nick Homma, MD, Allan Schwartz, MD

Echo and ECG Guidelines

	Priority Review	Needs Evaluation	Priority Review	Needs Evaluation
LVEDD (mm)	≥ 67	≥ 71	ST Depressions ≥ 0.5 mm in 2 or more leads	WPW (Pre-Excitation)
Max LV Wall Thickness (mm)	≥ 14	≥ 15	T wave inversions inferior leads or beyond V4	Any IVCD with QRS > 140 msec
LVEF (%)	≤ 52	≤ 45		LBBB
LA Diameter (mm)	≥ 47	≥ 50		QTc > 500 msec
LAVI (mL/m ²)	≥ 44	≥ 50		
Aortic Root Diameter (mm)	≥ 40	≥ 43		

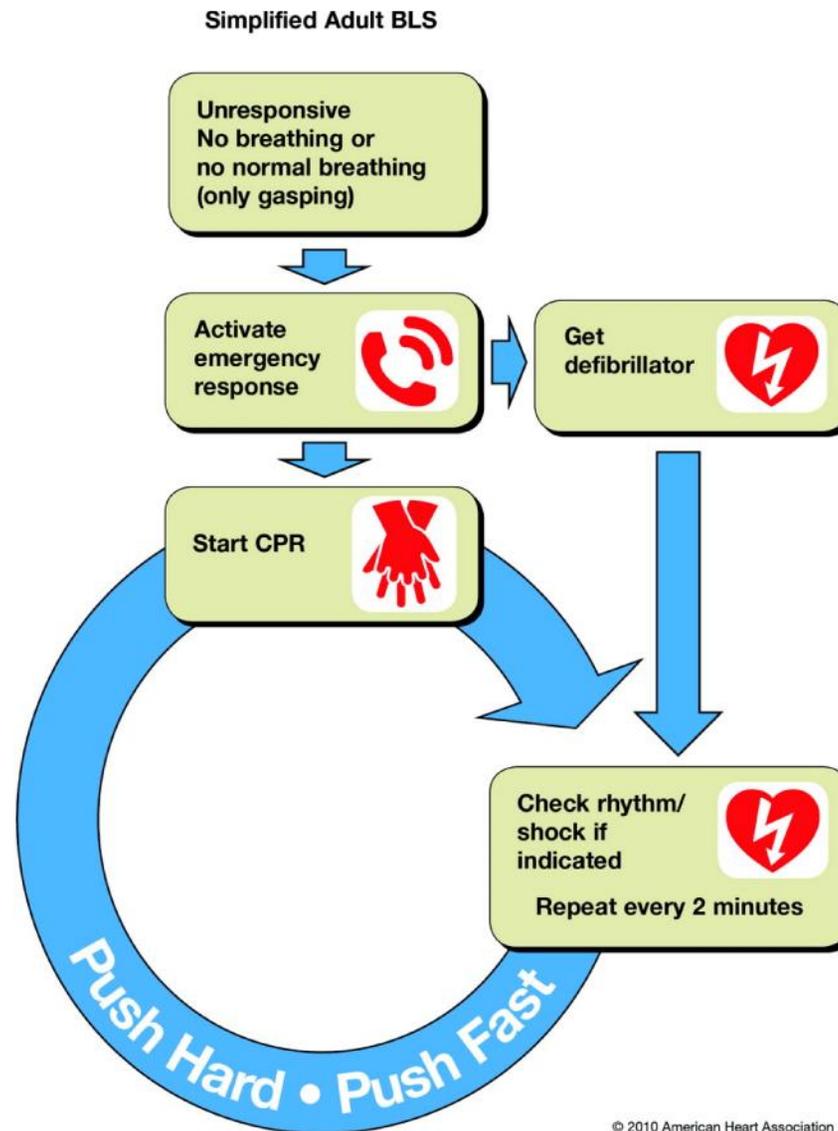
Next Steps

Priority Review	Needs Evaluation
<ul style="list-style-type: none"> Medical team physician must email league (attn. dweiss@nba.com) Medical team physician, in consultation with team cardiologist, to discuss recommendation for serial echocardiographic screening continuing after NBA playing career with any player whose aortic root diameter is ≥ 40 mm Review will be prioritized by Columbia 	<ul style="list-style-type: none"> Medical team physician must email league (attn. dweiss@nba.com) Medical team physician to coordinate with team cardiologist to conduct complete evaluation and discuss findings with player (and as described at left, review aortic root screening recommendations for players ≥ 40 mm) Medical team physician, in consultation with team cardiologist, to review echo/ECG and clinical data with Columbia, and if necessary, other specialists

- Columbia cardiac consultants are available to teams at any time to discuss clinical cardiac data: attn. David Engel – 212-326-8920 (o) | de165@cumc.columbia.edu | 914-629-7324 (m); or if Dr. Engel is unavailable: Allan Schwartz – 212-305-5367 (o) | as20@cumc.columbia.edu | 646-240-9535 (m)

Adult Basic Life Support Protocol

Simplified adult BLS algorithm.



Robert A. Berg et al. *Circulation*. 2010;122:S685-S705



BLS healthcare provider algorithm.

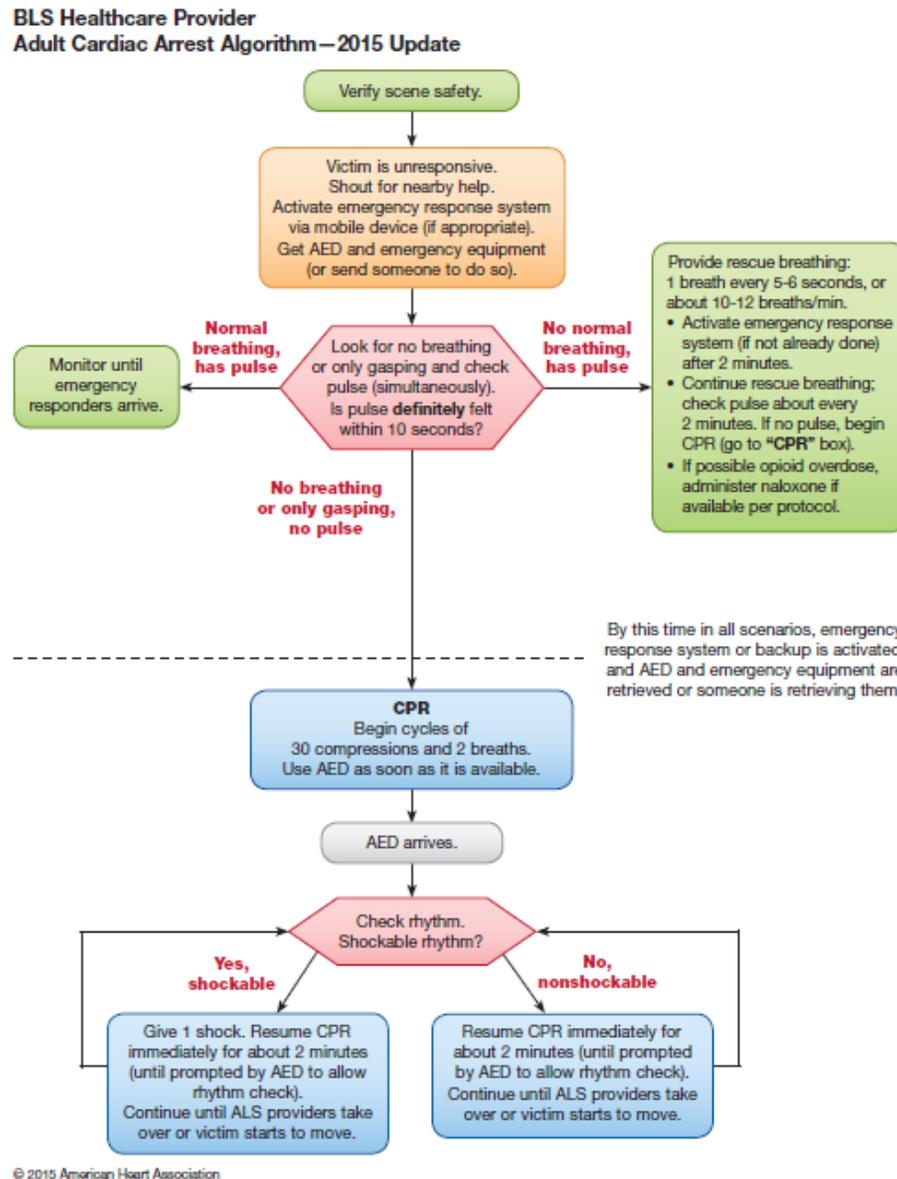


Figure 1. BLS Healthcare Provider Adult Cardiac Arrest Algorithm—2015 Update.



Monica E. Kleinman et al. *Circulation*. 2015;132(suppl 2):S414–S435.