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1. REPORT DATE (DD-MM-YYYY) 18-02-2014		2. REPORT TYPE Final		3. DATES COVERED (From - To) Mar 2012 - Jan 2014		
4. TITLE AND SUBTITLE Quality of cardiopulmonary resuscitation when directing the area of maximal compression by transesophageal echocardiography during cardiac arrest in swine (sus scrofa).				5a. CONTRACT NUMBER 5b. GRANT NUMBER FWH20110158A 5c. PROGRAM ELEMENT NUMBER 5d. PROJECT NUMBER FWH20110158A 5e. TASK NUMBER 5f. WORK UNIT NUMBER		
6. AUTHOR(S) Kenton L Anderson Maria G Castaneda Susan M Boudreau Toni E Vargas LeeAnn Zarzabal Joe Sontgerath Vikhyat S Bebarta				8. PERFORMING ORGANIZATION REPORT NUMBER FWH20110158A		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) 59th Medical Operations Squadron Wilford Hall Ambulatory Surgical Center 2200 Bergquist Drive, Bldg 4550 Lackland AFB, TX 78236				10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of the Air Force Surgeon General Directorate for Modernization, SGRS 5201 Leesburg Pike, Suite 1206 Falls Church, VA 22401				12. DISTRIBUTION/AVAILABILITY STATEMENT Distribution A. Approved for public release; distribution unlimited.		
13. SUPPLEMENTARY NOTES						
14. ABSTRACT Background: There have been no studies to determine ideal location of chest compressions during CPR, and standard hand placement is often not directly over the heart; chest compressions are often over the ascending thoracic aorta. Hypothesis: Chest compressions located over left ventricle (LV) will result in improved CPP or ROSC in a swine model of cardiac arrest. Methods: Transthoracic echo was used to mark the location of the aortic root and center of LV on animals (n=26) which were randomized to chest compressions in one of two locations. After 10mins of VFib, BLS with mechanical CPR was performed for 10mins followed by ACLS for an additional 10mins. During BLS the area of maximal compression was verified using TEE. CPP was recorded every 2mins. Results: CPP was higher in the LV group at mins 24 (p=0.003), 28 (p=0.049), and 30 (p=0.002) which were during ACLS. 9 of the LV group (69%) achieved ROSC compared to 0 of the aortic root group (p<0.001). Conclusion: In our swine model, chest compressions performed directly over LV resulted in an increase in CPP during ACLS and a greater proportion of animals with ROSC.						
15. SUBJECT TERMS cardiac arrest, traumatic arrest, chest compressions, transesophageal echocardiography, coronary perfusion pressure, return of spontaneous circulation, survival, swine, sus scrofa, animal testing alternatives, animal welfare						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT		18. NUMBER OF PAGES	
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U	SAR		19a. NAME OF RESPONSIBLE PERSON Kenton L. Anderson 19b. TELEPHONE NUMBER (Include area code) 210-724-0654	

1. Protocol Number: FWH20110158A

2. Type of Research: Animal Research

3. Title: Quality of cardiopulmonary resuscitation when directing the area of maximal compression by transesophageal echocardiography during cardiac arrest in swine (sus scrofa).

4. Principal Investigator (PI):

Name	Rank	Date of IACUC Training	Branch of Service/ Corps	Staff Resident Fellow Civilian	Department / Office Symbol	Email (if other than WHASC Outlook)	Phone	Pager
Kenton Anderson	O-3	June 2011	USAF	Staff	59 EMDS/SGOE D	kentonlanderson@gmail.com	WP: 292-3408 FAX: 292-7649	Cell 210-724-0654

5. Purpose:

The purpose of this study is to evaluate how performing chest compressions directly over the left ventricle of the heart affects the quality of CPR. Quality of CPR will be determined by measuring the coronary perfusion pressure (CPP) during cardiac arrest while compressions are performed in the traditional location on the chest as compared to compressions that are located directly over the left ventricle as directed by TEE.

6. Results:

Our group identified that by guiding chest compressions over the left ventricle using transthoracic echocardiography (TTE), there was a significant increase in coronary perfusion pressure (CPP) during advanced cardiac life support (ACLS) as well as an increase in the number of animals with return of spontaneous circulation (ROSC). Our findings suggest that compression of the left ventricle may be the most important determining factor in whether a victim survives cardiac arrest. We verified the location of these compressions using transesophageal echocardiography (TEE) during CPR.

Figure 1. CPP trends: Standard CPR vs. Left Ventricle CPR

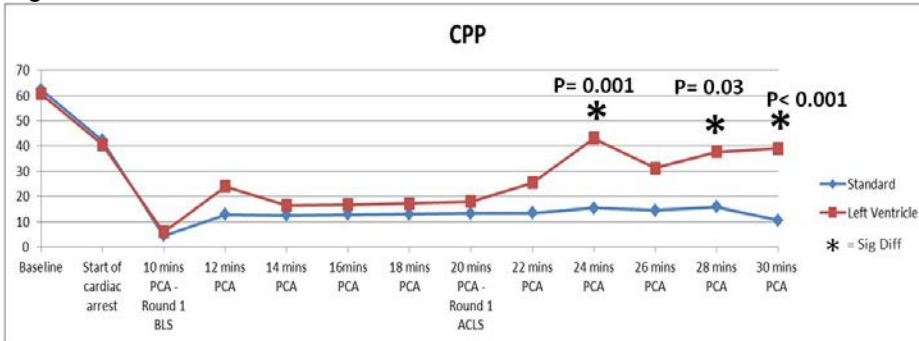


Figure 2. Difference in ROSC between Standard CPR and Left Ventricle CPR

	Standard CPR	Left Ventricle CPR
ROSC (%)	0	69

P< 0.001

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Copy to Budget? Yes No BIRDS Agenda Who Signed? PI Co-PI Auth AI

For Review Purposes Only

Eligible for Expedited Approval? Yes No Signature _____ Date: _____

7. How may your findings benefit the Air Force?

Our findings demonstrate that chest compressions directed over the left ventricle result in a significant increase in coronary perfusion pressure and return of spontaneous circulation. These findings alone suggest that we may be able to increase the survival of cardiac arrest victims both in the military and civilian arenas. We have subsequently received a grant for a continuation study in traumatic cardiac arrest. To date, we have only enrolled one animal into the left ventricle group in the traumatic arrest study, and it had return of spontaneous circulation which is encouraging. The rate of return of spontaneous circulation in traumatic arrest is very low, and if we are able to demonstrate that compressions over the left ventricle in traumatic arrest is able to increase survival, there may be hope of increasing the survival of our airmen on the battlefield.

8. Number of Animals

Projected Enrollment of Animals at the Beginning of Study: 30

Actual Number of Animals Enrolled: 36

9. Status of Animals Entered Into the Protocol:

The animals entered into the study have been in general good health. We requested additional technique development animals at the beginning of the study because I consulted with several experts in the field and based on my observation of the CPR techniques they have used I felt we needed more animals to refine our technique.

10. Status of Funds:

Our study was funded by the AF SGR. We are under budget and all funds have been allocated for.

11. Reason for Closure:

Objectives of the study were met

12. Specific Problems:

The study went well and we did not encounter any specific problems.

13. Publications and Presentations:

Presentations:

Poster presentation at MHSRS, Ft. Lauderdale, FL, August 2013

Poster presentation at AHA, Dallas, TX, November 2013

These Presentations and Publications have not been cleared by 59 CRD and Public Affairs. –Submitting Forms 3039 with this report.

Publications:

These Presentations and Publications **have/have not (choose one)** been cleared by 59 CRD and Public Affairs.

14. Exceptional Achievements:

This study was selected for oral presentation at MHSRS this year as well as presentation at the American Heart Association Scientific Sessions.

15. Signature of Principal Investigator:



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PROCESSING OF PROFESSIONAL PUBLICATIONS/PRESENTATIONS			
TO: CLINICAL RESEARCH SQUADRON/MSR		FROM: (Name/Office symbol)	
PROTOCOL NUMBER:			
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2. MATERIAL IS FOR <i>(please check the appropriate box or boxes)</i> (ATTACH COPY OF MATERIAL TO BE PUBLISHED/PRESENTED)			
☐	PUBLICATION/JOURNAL <i>(List intended publication/journal)</i>		
☐	PUBLISHED ABSTRACT <i>(List intended journal)</i>		
☐	BOOK CHAPTER OR BOOK <i>(Indicate intended publisher, name, city, country)</i>		
☐	POSTER <i>(To be demonstrated at meeting / Name of Meeting, City, State, and Date of Meeting)</i>		
☐	PLATFORM PRESENTATION <i>(At civilian institutions / Name of Meeting, City, State and Date of Meeting)</i>		
☐	OTHER <i>(Describe; Name of Meeting, City, State and Date of Meeting)</i>		
POINT OF CONTACT			
3. WHO IS THE PRIMARY POINT OF CONTACT AT WHASC? <i>(Last, First, M.I.)</i>			DUTY PHONE/PAGER No.
AUTHORSHIP AND CO-AUTHORS(S) <i>(List in the order they will appear)</i>			
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4. AUTHOR CONTACTED FOR RECOMMENDED OR NECESSARY CHANGES			☐	YES (If yes, give date)		☐	NO
5. COMMENTS							
☐ APPROVED							
SIGNATURE AND TITLE OF REVIEWER						DATE	
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4. COMMENTS							

Ultrasound guided Chest Compressions over the Left Ventricle During Cardiopulmonary Resuscitation Increases Coronary Perfusion Pressure and Return of Spontaneous Circulation in a Swine Model of Cardiac Arrest

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¹Dept of Emergency Med, San Antonio Military Medical Center, San Antonio, TX; ²CREST Program, Wilford Hall Ambulatory Surgical Center, Lackland AFB, TX



Background

Cardiac arrest is the sudden, abrupt loss of heart function. There are approximately 350,000 adult victims in the US and Canada annually, and cardiac arrest is a leading cause of death in many countries¹.

In the civilian setting the most common cause of cardiac arrest is coronary heart disease. On the military battlefield the most common cause of cardiac arrest is trauma.

The quality of chest compressions during CPR is a major determinant of successful resuscitation, however, the survival rate among resuscitated cardiac arrest victims is still low (<15%).

Standard chest compressions are not usually over the left ventricle².

Chest compressions located directly over the left ventricle may improve measures of successful resuscitation.

Objective

Primary Outcome:

Chest compressions directly over the left ventricle will result in an **increased coronary perfusion pressure (CPP)** when compared to chest compressions at the aortic root.

Secondary Outcome:

Chest compressions directly over the left ventricle will result in an **increased return of spontaneous circulation (ROSC)** when compared to chest compressions at the aortic root.

Methods

26 swine (25-32kg) were randomized to either standard (aortic root) compression site or left ventricle compression site

Millar catheters placed in RIJ and aorta (via LFA)

- CPP = DBP (aortic) – DBP (R atrium)

Each animal was secured in a V-shaped trough

The location of the aortic root and the middle of the left ventricle were marked using TTE (area of maximal compression was later verified with TEE during BLS)

Thumper device was lowered over randomization position

VF was induced using a 3 sec, 60Hz, 100mA AC current applied across the precordium

- Indicated by time zero

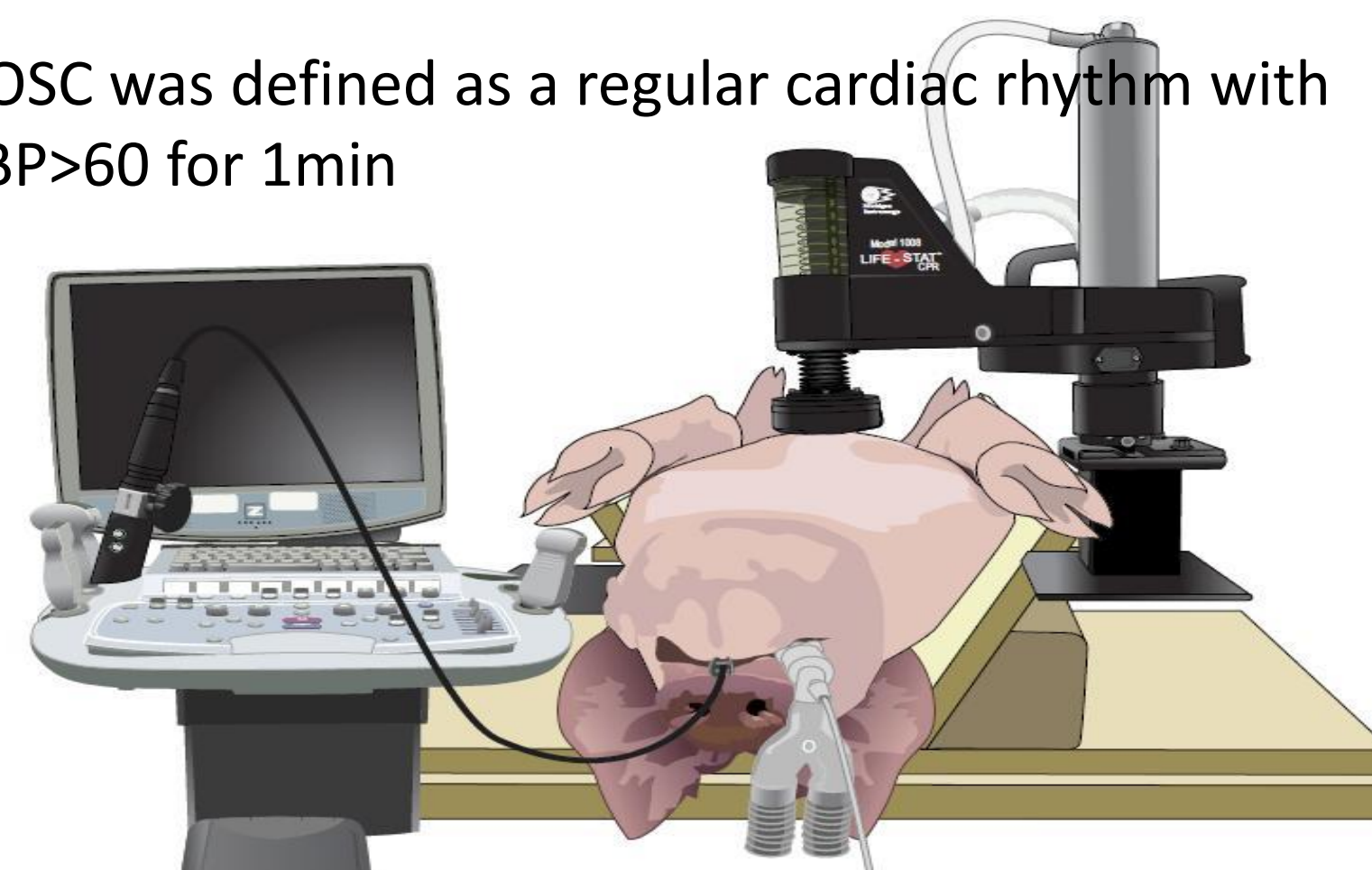
ETT was disconnected from the ventilator

Animals remained in VF for 10mins without intervention

- BLS was initiated at 10mins
- ACLS was initiated at 20mins

CPP was measured over the duration of the experiment

ROSC was defined as a regular cardiac rhythm with SBP>60 for 1min



Results

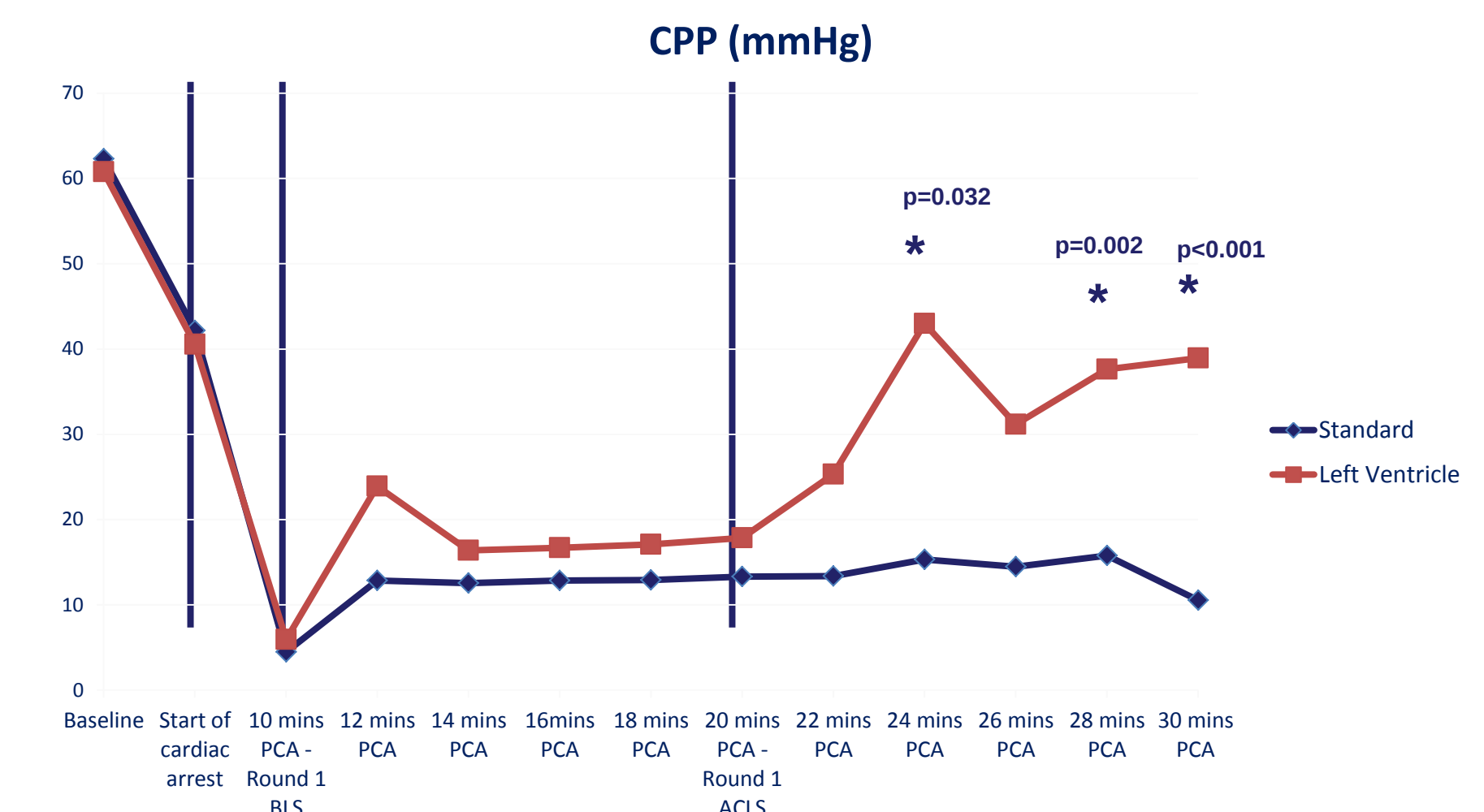


Figure 1. CPP at baseline, during VF arrest, BLS, and ACLS.

*= statistically significant

ROSC Reached (%)	LV	Standard
ROSC	9 (69.2)	0 (0.00)
No ROSC	4 (30.8)	13 (100)

Table 1. Difference in ROSC between Standard and Left Ventricle groups. p<0.001

Conclusions

We detected an increase in CPP during ACLS when chest compressions are performed over the left ventricle

Animals with compressions over the left ventricle were also more likely to have ROSC.

References

1. Travers AH, et al. Part 4: CPR overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2010;122(suppl 3):S676-84.
2. Hwang SO, et al. Compression of the Left Ventricular Outflow Tract During Cardiopulmonary Resuscitation. Acad Emerg Med. 2009;16(10):928-33.



**Wilford Hall Ambulatory Care Center
Institutional Animal Care and Use Committee (IACUC)**
59 Clinical Research Division/SGVUS
2200 Bergquist Drive, Bldg 4430
Lackland AFB, TX 78236-5300

NOTICE OF ACTION REGARDING IACUC REVIEW

Date: 22 Jan 14

TO: Capt Kenton Anderson/SG03D

Your **Final Report** was reviewed by the WHASC IACUC during the **15 Jan 14** meeting. The Committee's decision is provided below:

FWH20110158A "Quality of cardiopulmonary resuscitation when directing the area of maximal compression by transesophageal echocardiography during cardiac arrest in swine (sus scrofa).", **PI: Capt Kenton Anderson/SG03D**
(Reason Closed: Objectives of the study were met)

The committee voted that this item be approved as written. A reminder will be sent to the PI regarding PA clearance.
FOLLOW-UP: Closed

Name of Official
MARIA E. DOMINGUEZ

Title/Office Symbol/Phone
Protocol Support/SGVUS/2-6095

Signature

Maria E. Dominguez

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