



Correspondence

Comment on “A new electrocardiogram finding for massive pulmonary embolism: ST elevation in lead aVR with ST depression in leads I and V₄ to V₆”

To the Editor,

We have read with a great interest the article by Zhong-qun et al concerning electrocardiographic (ECG) changes in massive acute pulmonary embolism (APE) [1]. The authors presented 3 patients with APE and deterioration of clinical status during the hospitalization. They pay attention to a combination of the following electrocardiographic features: ST-segment elevation in lead aVR and ST-segment depression in leads I, V₄ to V₆ [1]. This ECG pattern may be helpful in patients with suspected or recognized APE in the rapid identification of high-risk patients who may benefit from thrombolytic therapy or mechanical intervention. In a study that we performed, the number of leads with negative T waves, the presence of right bundle-branch block, and ST-segment elevation in leads V₁ (odds ratio, 3.99; $P = .00017$) and aVR (odds ratio, 2.49; $P = .011$) were independent predictors of complications during hospitalization [2]. All 3 cases presented by Zhong-qun et al display QR (qR) sign (known as Kuschner sign) [3] with the different combination of subtle ST-segment elevation in leads III and/or aVR and/or V₁ and/or V_{3R}. The aforementioned ECG features and ST-segment depression in lateral leads observed by Zhong-qun et al are significantly more common in patients with elevated troponin vs patients with normal troponin level. Our study showed that ST-segment depression in V₄ to V₆ (40% vs 14%; $P = .001$), ST-segment elevation in III (22% vs 7%; $P = .0006$), V₁ and V₂ (43% vs 10%; $P = .0001$), and QR in V₁ (16% vs 5%; $P = .007$) were more common in patients with elevated troponin vs patients with normal troponin level [4]. More recently, we assessed the frequency of ST-segment elevation (STE) in lead aVR in patients with APE [5]. We found STE in lead aVR in 45.3% patients. In comparison with patients without STE, patients with STE in lead aVR had significantly more often systolic blood pressure less than 90 mm Hg on admission (27% vs 10%; $P < .001$) and positive troponin level (64.8% vs 27.9%; $P < .001$). Thrombolytic therapy (14.3% vs 5.6%; $P = .009$) and catecholamines (29.3% vs 7.5%; $P < .001$) were more frequently used in patients with STE in lead aVR. The overall mortality (16.5% vs 6.9%; $P = .009$) and complication rates during hospitalization (38.3% vs 12.5%; $P < .001$) were significantly higher in patients with STE in lead aVR [5]. The STE in lead aVR was significantly more frequent in patients with negative T waves in inferior leads, STE in lead III, STE in lead V₁, ST depression in lead V₄ to V₆, right bundle-branch block, QR sign in lead V₁, and S_I-Q_{III}-T_{III} sign [5].

We conclude that patients with APE and with the presence of STE in lead aVR and ST depression in leads V₄ to V₆ are at very high risk for complications and death during hospitalization. We congratulate Zhong-qun et al for this very important ECG observation.

Piotr Kukla MD, PhD
Department of Internal and Cardiology
Specialistic Hospital, Gorlice, Poland
E-mail address: kukla_piotr@poczta.onet.pl

Leszek Bryniarski MD, PhD
Marek Jastrzębski MD, PhD
I Department of Cardiology and Hypertension
University Hospital, Kraków, Poland

Ewa Krupa MD
Department of Cardiology
Specialistic Hospital of Szczeklik, Tarnów, Poland

<http://dx.doi.org/10.1016/j.ajem.2012.11.029>

References

- [1] Zhong-Qun Z, Chong-Quan W, Nikus KC, Sclarovsky S, Chao-Rong H. A new electrocardiogram finding for massive pulmonary embolism: ST elevation in lead aVR with ST depression in leads I and V(4) to V(6). *Am J Emerg Med* 2012;Sep 20. pii: S0735-6757(12)00389-0. doi: 10.1016/j.ajem.2012.08.001. [Epub ahead of print].
- [2] Kukla P, Długopolski R, Krupa E, Furtak R, Szelemiej R, Mirek-Bryniarska E, et al. Electrocardiography and prognosis of patients with acute pulmonary embolism. *Cardiol J* 2011;18(6):648–53.
- [3] Kucher N, Walpoth N, Wustmann K, Noveanu M, Gertsch M. QR in V1—an ECG sign associated with right ventricular strain and adverse clinical outcome in pulmonary embolism. *Eur Heart J* 2003;24(12):1113–9.
- [4] Kukla P, Długopolski R, Krupa E, Furtak R, Wrabec K, Szelemiej R, et al. The value of ECG parameters in estimating myocardial injury and establishing prognosis in patients with acute pulmonary embolism. *Kardiol Pol* 2011;69(9):933–8.
- [5] Kukla P, Długopolski R, Krupa E, Furtak R, Mirek-Bryniarska E, Jastrzębski M, et al. The prognostic value of ST-segment elevation in the lead aVR in patients with acute pulmonary embolism. *Kardiol Pol* 2011;69(7):649–54.

Performance improvement in emergency tourniquet use during the Baghdad surge[☆]

To the Editor,

Recently, we studied emergency tourniquet use, a vital need in war casualties, to stop bleeding, and knowledge generated helped to improve survival at a low risk of morbidity [1–3]. We sought to document the impact of process improvement efforts over time on tourniquet success rates, the use of other hemorrhage control measures in conjunction with tourniquets, and the rate at which prehospital tourniquets were converted to pressure dressings as

[☆] The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 MAY 2013		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Performance improvement in emergency tourniquet use during the Baghdad surge				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Kragh Jr. J. F., Beebe D. F., OâNeill M. L., Beekley A. C., Dubick M. A., Baer D. G., Blackbourne L. H.,				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Table 1
Tourniquet use results by survey period

Variable (unit)	Period				Comparison of period 3 to period 1
	1	2	3	Overall	
Duration (d)	200	167	99	466	
Limb count	309	342	301	952	
Casualty count	232	267	228	727	
Tourniquet device count	428	434	350	1212	
Survival rate (%)	86.6	86.9	90.8	88.0	$P = .16$
Survivor count	201	232	207	640	
Death count	31	35	21	87	
Prehospital use rate (%)	84	86	97	89	$P < .0001$
Use rate before shock onset (%)	96	96	99	97	$P = .035$
Appropriate wound indication rate (%)	96	99	99	98	$P = .021$
Tourniquet use rate distal to a proximal wound (%)	1	1	2	1	$P = .5$
Loose tourniquet use rate (%)	4	8	9	7	$P = .03$
Breakage or malfunction rate (%)	2	1	0	1	$P = .05$
Rate of limbs with only 1 tourniquet used (%)	66	74	89	76	$P < .0001$

doctrine suggests [4]. The 3 sequential periods surveyed corresponded to the precondition, the preparation, and the execution of the Baghdad surge; in comparison with the 2 previously reported periods, we report the third period now. The purposes of the present study are to (1) survey tourniquet use to fill knowledge gaps in casualty care in the current period and (2) compare results of the 3 periods to provide a model of implementing tourniquet use locally to civilian emergency medical systems.

We continued a protocol of a clinical survey of war casualties with tourniquets used at a US military hospital at Ibn Sina Hospital in Baghdad, Iraq [1–5]. The study period of the current report was March 23, to June 30, 2007 (99 days), which was the third sequential period to which the prior 2 were compared [1,2].

In the Third Survey Period, the surveyed group included 228 casualties (213 males [93%], 15 females [7%]). The 350 tourniquets were used on 301 limbs (148 left, 153 right; 204 lower, 97 upper). The case accrual rate was 2.3 casualties with tourniquets used per day for the 99-day survey (228/99, Table 1).

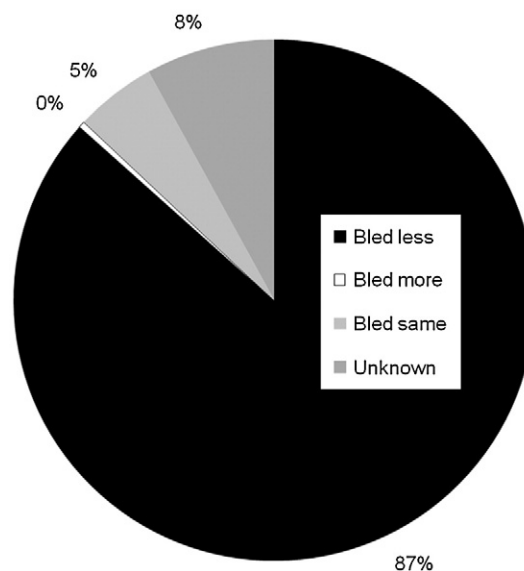


Fig. 2. Proportion of limbs by wound bleeding response to initial tourniquet use.

In addition to tourniquets, field dressings (routine gauze) were used in 62% (188/301) of the casualties (Fig. 1). The high proportion (18%, 55/301) of nonuse (ie, no other hemorrhage control measure used) may indicate that tourniquets were the first option for use during care under fire in compliance with military doctrine that tourniquets are the only hemostatic device to be used while under fire. Response to the tightening of the first tourniquet was that 87% of limbs bled less (262/301), 0.3% of limbs bled more (1/301), 5% of limbs bled the same (14/301), and data were not recorded in 8% of limbs (24/301, Fig. 2). Tourniquets were released a single time in 86% (260/301) of limbs and twice in 11% of limbs (33/301; 8/301 unrecorded). Systolic pressure in 2% (7/301) had 30 mm Hg or more drop in systolic blood pressure after tourniquet release, perhaps indicating loss of hemorrhage control from a distal wound.

The 3 survey periods had a total 727 casualties with 1212 tourniquets (Tables 1 and 2, Figs. 3 and 4). Casualty demographics were similar in each period. From periods 1 to 3, the rate of tourniquets per day rose 65% (2.14–3.54), the rate of limbs with

Table 2
Findings of changes in current vs prior tourniquet use

Changes in tourniquet use
Increased rate of tourniquets used per day
Increased proportion of casualties with tourniquets per day
Increased proportion of limbs with tourniquets per day
Increased diversity of casualties with tourniquets (more nationalities and civilians represented)
Increased proportion of indicated tourniquet use (decreased misses of indicated casualties)
Increased proportion of casualties with prehospital tourniquets used
Increased proportion of casualties with tourniquets used before shock onset
Increased proportion of appropriately used tourniquets
Increased proportion of loose tourniquets
Increased proportion of commercial tourniquets used (decreased improvised tourniquets)
Increased proportion of limbs with hemorrhage control by effective tourniquet use
Increased proportion of limbs with only one tourniquet needed
Decreased proportion tourniquet used with tourniquet breakage or malfunction

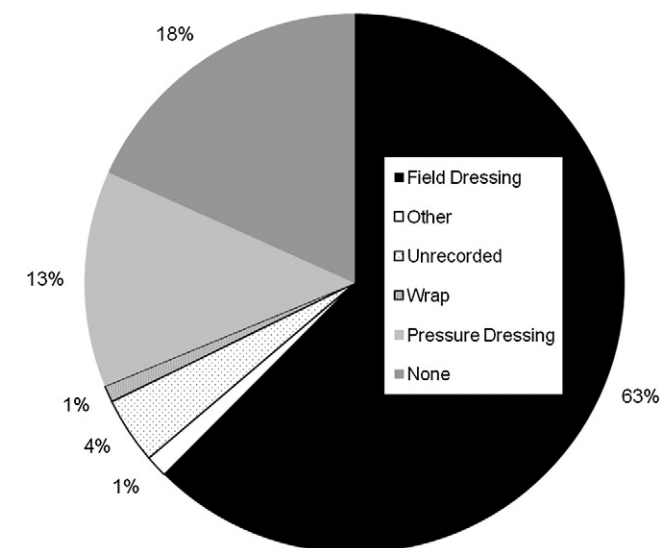


Fig. 1. Proportion of limbs with tourniquets and other hemorrhage control measures.

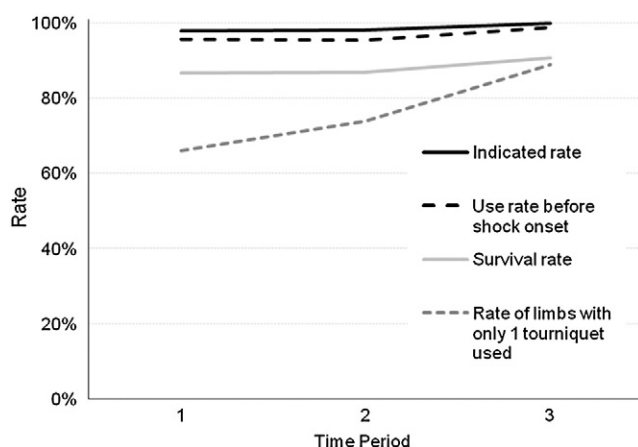


Fig. 3. Trend rates of tourniquet use and outcome by period.

tourniquets per day rose 97% (1.55–3.04), and the rate of casualties with tourniquets per day rose 99% (1.16–2.30).

The main finding of the current study is that the results indicate growing breadth, depth, and utility of emergency tourniquet use. For example, more frequent and earlier use of emergency tourniquets was associated with improved clinical performance. The work of serious quality improvement in tourniquet use was incremental, arduous, and sustained in what has been described as the most chaotic and stressful environment imaginable for doing science [6]. The military services used tourniquets more often in later periods to try saving all lives possible by not missing anyone needing limb hemorrhage control [3]. As we managed the military's emergency tourniquet program, we monitored the miss rate of US casualties with isolated limb exsanguination (including no tourniquet use and death), and the rate has been nearly zero for some time now. Lessons learned from the current study, if broadcast widely, may improve performance elsewhere.

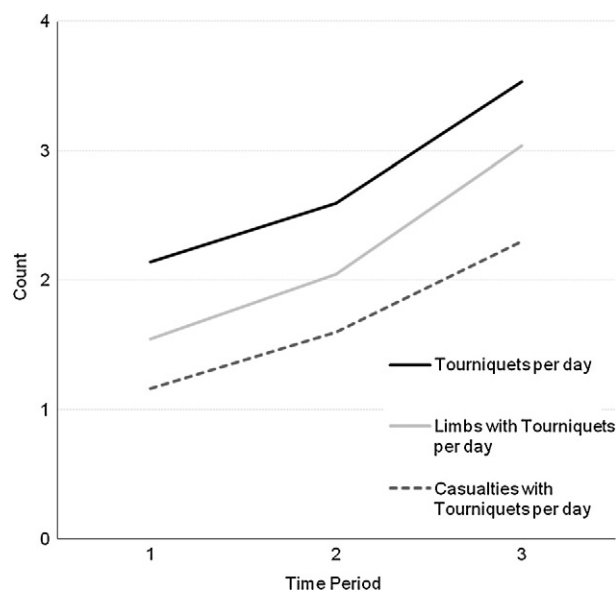


Fig. 4. Tourniquet use rates by period.

Another finding of the current study is that trends of tourniquet use earlier, more often, and more effectively in the care of casualties were associated with improved clinical performance and outcomes. The increased rate of tourniquets used per day and per casualty indicated a growing reliance on tourniquets for hemorrhage control on the current battlefield.

Given the large number of emergency tourniquets already purchased by civilians, the results of the present study provide an opportunity to inform and improve care outside military use. Specifically, these data support emphasis on early use. The experience of Arizona's Pima County deputy sheriffs' response to the shooting of 19 people in 2001 near Tucson offers anecdotal evidence that these devices can be used successfully by nonmedical first responders [7]. More frequent and earlier use of emergency tourniquets was associated with improved clinical performance. These findings fill specific knowledge gaps in casualty care to help refine best practices, first-aid doctrine, and tourniquet training.

John F. Kragh Jr. MD

US Army Institute of Surgical Research

Fort Sam Houston

TX 78234-6315, USA

E-mail address: John.kragh1@us.army.mil

Dorothy F. Beebe RN

Department of Preventive Medicine

Landstuhl Regional Medical Center

CMR402, APO, AE 09180

Michelle L. O'Neill RN

Department of Nursing

Tripler Army Medical Center, Tripler AMC

HI 96859-5001, USA

Alec C. Beekley MD

Department of Surgery

Jefferson University, Philadelphia 1

PA 19107, USA

Michael A. Dubick PhD

David G. Baer PhD

Lorne H. Blackburne MD

US Army Institute of Surgical Research

Fort Sam Houston

TX 78234-6315, USA

<http://dx.doi.org/10.1016/j.ajem.2012.11.030>

References

- [1] Kragh Jr JF, Walters TJ, Baer DG, et al. Survival with emergency tourniquet use to stop bleeding in major limb trauma. *Ann Surg* 2009;249(1):1–7.
- [2] Kragh Jr JF, Walters TJ, Baer DG, et al. Practical use of emergency tourniquets to stop bleeding in major limb trauma. *J Trauma* 2008;64:S38–50.
- [3] Kragh Jr JF, Littrel ML, Jones JA, et al. Battle casualty survival with emergency tourniquet use to stop limb bleeding. *J Emerg Med* 2011;41(6):590–7.
- [4] National Association of Emergency Medical Technicians. In: McSwain NE Jr, Salomone JP, Pons PT, editors. *PHITS Prehospital Trauma Life Support: Military Version*. 6th ed. St. Louis, MO: Mosby; 2007. p. 501–19.
- [5] Beekley AC, Sebesta JA, Blackburne LH, et al. Prehospital tourniquet use in Operation Iraqi Freedom: effect on hemorrhage control. *J Trauma* 2008;64(2):S28–37.
- [6] Bohannon J. The war in Afghanistan. War as a laboratory for trauma research. *Science* 2011;331(6022):1261–3.
- [7] Robbins T. In Tucson's "silent chaos," rare medic kits were key. *National Public Radio, All Things Considered*, Jan 28, 2011. <http://www.npr.org/2011/01/28/133307999/in-tuscons-silent-chaos-rare-medic-kits-were-key>. accessed Sept. 8, 2011.