

QuikClot® Combat Gauze® Use by Ground Forces in Afghanistan

The Prehospital Trauma Registry Experience

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ABSTRACT

Background: QuikClot® Combat Gauze® (QCCG) was fielded in 2008 to replace previous generations of hemostatic products. To the best of our knowledge, despite nearly a decade of use, there are no published data on use among US combatant forces. We describe the use of QCCG by ground forces in Afghanistan and compare patients who received QCCG compared with the remaining population in the database who did not receive QCCG. **Methods:** Data were obtained from the Prehospital Trauma Registry (PHTR). Joint Trauma System personnel linked patients to the Department of Defense Trauma Registry (DODTR) for outcome data, when available, upon reaching a fixed facility. **Results:** Of the 705 patients within the entire PHTR, 118 (16.7%) had documented use of QCCG. Most patients (69.5%) were Afghan; all were male. Lower extremities accounted for the most common site of application (39.7%). Hemorrhage control occurred in 88.3% of encounters with hemorrhage control status documented. Patients receiving QCCG generally had higher rates of concomitant interventions. Of the 705 patients, 190 were linkable to the DODTR for outcome data; 25 of the 28 (89.3%) in the QCCG group were discharged alive compared with 153 of the 162 (94.4%) in the non-QCCG group ($p = .300$). **Conclusion:** QCCG appears to have common use on the battlefield as a concomitant intervention for obtaining hemorrhage control. Patients receiving QCCG had higher rates of gunshot wounds compared with the baseline population and were generally sicker. Hemorrhage control success was like that reported in other military and civilian settings.

KEYWORDS: hemorrhage; gauze; combat; military, QuikClot®; hemostatic

Introduction

Background

Uncontrolled hemorrhage is the major cause of mortality from combat injuries and remains the leading cause of preventable death on the battlefield.¹⁻³ In 2008, the

US military designated QuikClot® Combat Gauze® (QCCG; Z-Medica, www.z-medica.com/healthcare) as its hemostatic dressing of choice for compressible hemorrhage. QCCG is a nonwoven rayon/ polyester fabric impregnated with kaolin, an aluminum silicate that is a potent coagulation stimulator. QCCG demonstrated hemostasis and improved survival in multiple animal models with induced arterial injuries.⁴⁻⁶

A publication written in collaboration between Israeli Defense Forces Medical Corps (IDF-MC) and a US prehospital trauma system reported their experience with QCCG.⁷ Leonard et al.⁷ found QCCG was 89% effective in achieving prehospital hemorrhage control in a predominantly rural setting. Unlike military trauma, however, most of the injuries were secondary to blunt trauma (47%) and were not penetrating (37%). Shina et al.⁸ of the IDF-MC published a case series of 122 patients treated with 133 applications of QCCG in the prehospital setting. They reported 88.6% success for junctional applications and 91.9% for nonjunctional injuries, generally secondary to penetrating trauma (85.2%). Physicians and paramedics embedded within Israeli combat units applied the vast majority of QCCG (82.0%); the remainder of encounters entailed application by medics (5.3%) or lacked documentation (12.8%).⁸ The generalizability of these data to the US military is unclear, given that medical officers in US forces are typically located at aid stations and medical facilities rather than incorporated within front-line maneuver formations as in the IDF.

Goal of This Study

We describe the use of QCCG by ground forces in Afghanistan. Secondarily, we compare patients who received QCCG with the remaining population in the database who did not receive QCCG.

Methods

Patients were casualties in Afghanistan during Operation Enduring Freedom. We obtained prehospital data from the Prehospital Trauma Registry (PHTR), which is

a module of the Department of Defense Trauma Registry (DoDTR); the Joint Trauma System (JTS) compiles and maintains both databases at the US Army Institute of Surgical Research (USAISR). JTS personnel linked patients from the PHTR to the DODTR to obtain fixed-facility treatment and outcome data, when available. The use of de-identified data resulted in an exempt research determination from the USAISR regulatory office.

PHTR Description

The JTS PHTR is a data collection and analytic system designed to provide near-real-time feedback to commanders. The primary purpose of this system is to improve casualty visibility, augment command decision-making processes, and direct procurement of medical assets. Additionally, this system seeks to improve morbidity and mortality through performance improvement in the areas of primary prevention (i.e., tactics, techniques, and procedures), secondary prevention (i.e., personal protective equipment), and tertiary prevention (i.e., casualty response system and Tactical Combat Casualty Care [TCCC]). US Central Command and their Joint Theater Trauma System capture all prehospital trauma care provided on the ground by all services in the Afghanistan Theater. TCCC cards, Department of Defense (DoD) 1380 forms, and TCCC After-Action Reports (AARs) provided the registry data.

DODTR Description

The DODTR, formerly known as the Joint Theater Trauma Registry, is the data repository for DoD trauma-related injuries. The DODTR includes documentation regarding demographics, injury-producing incidents, diagnoses, treatments, and outcomes of injuries sustained by US/non-US military and US/non-US civilian personnel in wartime and peacetime from the point of injury to final disposition.

Development of Data Set

We collected data on vital signs, level of medical provider training, antibiotic and analgesia medications, evacuation status, mental status, mechanism of injury (MOI), battle injury (BI) versus non-battle injury status, affiliations, and select concomitant procedures. We used the first set of recorded vital signs when multiple sets were available. For the purposes of determining the medical provider, we recorded the “highest-level” provider documented in their chain of care in the following order: medical officer (physician or physician assistant), medic (including up to paramedic level), non-medic first responder. We considered air evacuation to be a higher-level platform than ground evacuation when more than one method was used. We placed all Afghans into a single category for this analysis to include military, federal, local police, and civilians. We performed the analysis based on the assumption that rendered

care is documented accordingly. Using the PHTR data, we searched for all patients with documented use of QCCG. For anatomical location determination, we reviewed AARs in the PHTR; when this was not detailed, it was inferred from the primary anatomical injury location documented. We reviewed AARs within the PHTR to determine whether hemorrhage control was likely successful versus likely failed, when possible.

Data Analysis

We performed all statistical analysis using Microsoft Excel (version 10; Microsoft, <https://www.microsoft.com>), SPSS (version 24; IBM, www.ibm.com), and JMP Statistical Discovery from SAS (version 13; SAS Institute, <https://www.sas.com>). We compared study variables between patients receiving QCCG, using a Student *t* test for continuous variables, Wilcoxon rank-sum test for ordinal variables, and χ^2 test for nominal variables.

Results

From January 2013 through September 2014 (the lifespan of the PHTR), there were 737 encounters contained within the PHTR. Of these, 24 people were killed in action, five were dead on arrival, and three were enemy prisoners of war, all of whom we excluded. This left 705 subjects available for search within the research database.

Within the research database, there were 118 subjects (16.7%) with documented QCCG use. Table 1 compares the demographic data of the group receiving QCCG versus the remainder of subjects in the database who did not receive QCCG (non-QCCG group). Except for respiratory rates, vital signs were not significantly different between the two populations (Table 2), although a trend toward differences was noted for mean heart rate and systolic blood pressure.

Of the 118 casualties with QCCG use, 22 had use at two locations, and one had use at three locations (Figure 1). Of note, one subject had 12 packages of QCCG packed into one pelvic wound. For QCCG applications with hemorrhage control status documented (103 of 141), 88.3% achieved hemorrhage. Table 3 compares common interventions between the two groups.

Of the 705 casualties, 190 were linkable to the DODTR for outcome data. In the QCCG group, 25 of the 28 (89.3%) with outcome data were discharged alive. In the non-QCCG group, 153 of the 162 (94.4%) with outcome data were discharged alive ($p = .300$).

Because most injuries in the QCCG group were battle-related gunshot wounds (GSW), we conducted a sub-analysis of all GSWs classified as BIs (e.g., excluded unintentional discharges) within both groups. We found

Table 1 Demographics of Study Patients

		QCCG Group (<i>n</i> = 118), %, No.	Non-QCCG Group (<i>n</i> = 587), %, No.	<i>P</i> Value
Mechanism of injury	EXP	22.0 (26)	54.3 (319)	<.001
	GSW	72.0 (85)	30.0 (176)	
	GSW + EXP	0.9 (1)	1.0 (6)	
	Other/Unknown	5.1 (6)	14.7 (86)	
Affiliation	Conventional	17.0 (20)	26.1 (153)	<.001
	SOCOM	14.4 (17)	25.9 (152)	
	Afghan	68.6 (81)	48.0 (282)	
Battle status	Battle injury	95.8 (113)	90.1 (529)	.049
	Non-battle injury	4.2 (5)	9.9 (58)	
Evacuation status	Urgent	79.7 (94)	59.5 (349)	.001
	Priority	15.2 (18)	19.2 (113)	
	Routine	4.2 (5)	14.0 (82)	
	Unknown	0.9 (1)	7.3 (42)	
Highest evacuation platform	Air	18.6 (22)	16.2 (95)	.791
	Ground	12.7 (15)	13.8 (81)	
	Unknown	68.7 (81)	70.0 (411)	
Highest provider level	Medical officer	65.3 (77)	52.6 (309)	.066
	Medic	28.8 (34)	35.8 (210)	
	NMFR	1.7 (2)	2.9 (17)	
	Unknown	4.2 (5)	8.7 (51)	

EXP, explosive; GSW, gunshot wound; SOCOM, Special Operations Command.

Table 2 Vital Signs

Vital Sign	QCCG Group	Non-QCCG Group	<i>P</i> Value
Mean heart rate (per min)	96.2 (104, 25.5)	91.3 (442, 22.5)	.053
Mean systolic blood pressure (mmHg)	112.0 (103, 23.4)	116.5 (432, 23.6)	.082
Mean respiratory rate (per min)	21.8 (100, 9.0)	19.9 (439, 7.2)	.023
Mean pulse oximetry (%)	96.7 (88, 4.8)	97.0 (348, 4.2)	.529
Alert	78.8 (93)	69.9 (410)	.125
Verbal	7.6 (9)	8.5 (50)	
Pain	3.4 (4)	4.6 (27)	
Unresponsive	9.3 (11)	12.4 (73)	
Unknown	0.9 (1)	4.6 (27)	

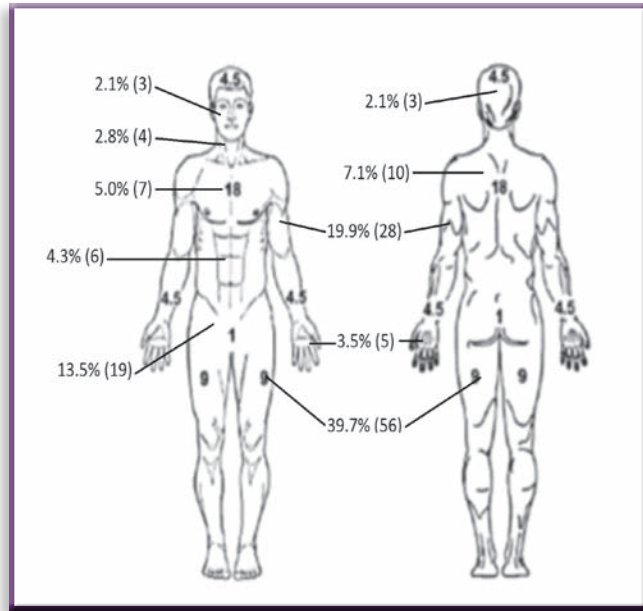
significantly higher rates of interventions for hypothermia (73.5% versus 60.7%; *p* = .044) and pain medications (83.1% versus 66.3%; *p* = .005). We found a trend toward lower rates of chest-seal (18.1% versus 28.1%; *p* = .081) and chest-tube use (6.0% versus 12.9%; *p* = .094), and a trend toward higher rates of pressure-dressing use (47.0% versus 34.8%; *p* = .060), higher rates of tourniquet placement (32.5% versus 23.0%; *p* = .104), and better mental status (alert: 81.9% versus 67.8%; unresponsive: 8.4% versus 12.1%; *p* = .107). We found no differences in affiliation (*p* = .419), evacuation status

(*p* = .807), evacuation platform (*p* = .492), rates of needle decompression (*p* = .488) and antibiotic use (*p* = .261), highest provider level (*p* = .425), discharge status (*p* = .737), heart rate (*p* = .605), systolic blood pressure (*p* = .328), respiratory rate (*p* = .919), and pulse oximetry values (*p* = .635).

Discussion

In this retrospective study from the PHTR, we describe use of QCCG and compare casualties receiving QCCG

Figure 1 QCCG use by anatomic location (image borrowed from DD1380 form)



with casualties not receiving QCCG within the database. To the best of our knowledge, it represents the first analysis of the US military experience with QCCG under combat conditions.

Most QCCG applications were to the extremities and pelvis, which corresponds to the anatomy most exposed to the blast and penetrating trauma seen in the recent conflicts.³ We noted higher rates of hemorrhage control

success in the extremities compared with the trunk (Table 4). We also noted higher rates of GSWs, with a trend toward worsening vital signs and significantly high rates of concomitant interventions. Casualties receiving QCCG appeared to be generally more critically ill compared with the baseline population. Although there was statistical differences between some of the vital signs, these are likely of little clinical significance. On sub-analysis, most of the differences noted disappeared or were no longer statistically significant. This is likely due to a more limited sample size, because multiple trends were still noted. The number of chest interventions was notably higher in the non-QCCG group, which is likely due to the chest injuries being generally not amenable to QCCG placement; rates of tourniquet and pressure dressing use was higher in this group, however, which is more fitting with predominant use in extremity or pelvic injuries.

Hemorrhage is the leading cause of preventable death on the battlefield,¹⁻³ thus interventions targeting hemorrhage control are of the utmost importance. Leonard et al.⁷ reported hemostatic control in 89% of patients, which is similar to our documented success of 88.3%.⁹ This proportion of successful applications is similar to Shina et al.⁸ involving civilian trauma in the United States. In contrast, Shina et al.⁸ noted the most common application was to the head and face, whereas, in our dataset, the lower extremities were the site of most common QCCG application. This is likely related to the high rates of blunt trauma in the civilian setting compared

Table 3 Concomitant Intervention Rates of the Two Groups

Intervention	QCCG Group, % (No.)	Non-QCCG Group, % (No.)	P Value
Pressure dressing	55.1 (65)	25.7 (151)	<.001
1+ Tourniquet ^a	39.8 (47)	23.2 (136)	<.001
Needle decompression	9.3 (11)	5.5 (32)	.109
Chest seal	16.9 (20)	12.8 (75)	.226
Chest tube	4.2 (5)	4.6 (27)	.863
Pain medication	78.0 (92)	52.0 (305)	<.001
Antibiotic	52.5 (62)	32.4 (190)	<.001
Hypothermia	67.8 (80)	44.1 (259)	<.001

^aDoes not denote that tourniquet use was on the same anatomical location as the QCCG use.

Table 4 Comparison of Hemorrhage Control Rates by General Anatomic Location

Body Location	Hemorrhage Control Status, % (No.)			P Value
	Yes	No	Unknown	
Head/neck/face (n = 10)	80.0 (8)	0 (0)	20.0 (2)	.026
Upper extremity (n = 33)	75.8 (25)	3.0 (1)	21.2 (7)	
Trunk ^a (n = 42)	42.9 (18)	11.9 (5)	45.2 (19)	
Lower extremity (n = 56)	71.4 (40)	10.7 (6)	17.9 (10)	

^aIncludes chest, back, abdomen, and pelvis/groin.

with the high-powered GSW and blast injuries seen on the battlefield. Moreover, personal protective equipment (e.g., helmet, body armor, shrapnel guards) reduces the areas exposed for potential injury.

The MOI differed between our dataset and the two previously reported datasets. Penetrating trauma was the predominant MOI in the IDF study⁷ (85.2%), which is higher than the 72.9% noted in our QCCG-group. Shina et al.⁸ noted the majority of QCCG use was due to blunt trauma. Comparatively, our population receiving QCCG were almost exclusively GSW and blast related. It is worth noting the IDF typically has physicians in more far-forward locations, and the battlespace and trauma system vary from that seen in Afghanistan. Although most casualties in both groups had a medical officer involved in their chain of care, it is unlikely they were involved at or near the point of injury compared with the IDF.

Despite limitations in this data set, the remarkably similar success rates for hemorrhage control compared with other published data support the use of QCCG in the prehospital combat setting. Future research should examine training methods to most effectively use this intervention in conjunction with other hemorrhage control strategies as the technology continues to advance.

The primary limitation of our study is limited data capture. The prehospital battlefield setting poses unique challenges for clinical investigation.¹⁰ The combat environment is chaotic and many units coordinate and participate in the management of a combat casualty. In 2012, the DoD created the PHTR to fill the gap in missing data before reaching a fixed facility.¹¹ However, given the challenges of proper documentation in combat situations, the data are often incomplete and not necessarily reflective of what happens at the point of injury. We operated under the assumption that if an intervention was not documented, it did not occur. Despite this, we do not believe that higher documentation rates would have had significantly altered the findings.

Conclusion

QCCG appears to have common use on the battlefield as a concomitant intervention for obtaining hemorrhage control. Casualties receiving QCCG had higher rates of GSWs compared with the baseline population, and generally were sicker. Hemorrhage control success was like that reported in other military and civilian settings.

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Disclaimer

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 Air Force, the Department of the Army, or the Department of Defense.

Disclosure

The authors have nothing to disclose.

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