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Triaged treatment-based conventional weapon combat wound classification code design and injury spectrum statistical analysis

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ABSTRACT：**Purpose:** To provide evidence for the rapid and efficient classification of combat casualties while simultaneously determining the types of high-incidence fatal injuries that require emergency treatment to support the triage of combat wounds in mass casualty situations. **Methods:** The three-tiered treatment echelon consisting of battlefield on-site first aid, emergency treatment, and early treatment was used to design an expanded combat wound classification code system according to the differential needs of combat wound treatment. Three dimensions of evaluation indicators consisting of likelihood, importance, and suitability were established and an optimized quasi-HHI index was used for the normalization and ranking of expert survey results. **Results:** We obtained exhaustive combinations from the massive number of combat wound factors in combat wound classification codes, constructed injury spectrum frameworks within the different treatment echelons, and identified high-incidence fatal injuries in different treatment echelons. **Conclusions:** Our combat wound classification codes achieved good results in terms of having higher classification speed and accuracy than traditional methods. The high incidence fatal injuries identified by the constructed combat wound spectrum can provide guidance and support when used for the improvement of treatment techniques and upgrading equipment in the Chinese People’s Liberation Army.

Keyword: combat wound classification, injury site, complications, ranking

1. BACKGROUND

Combat wound classification codes have great significance for the timely and accurate assessment of the severity of injury of casualties by helping to standardize combat wound treatment, improve treatment quality, and reduce the rates of mortality and disability. Currently, there are two main casualty classification standards used within the Chinese People's Liberation Army (PLA). The first is the 2006 Combat Wound Treatment Guidelines and the existing combat wound classification method for injury [1, 2]. The second is the 2007 GJB 6032-2007 Combat Wound Classification and Determination Criteria in the Military Standards [3]. These two standards are mainly used at the battlefield on-site stage for the preliminary assessment of injury severity and their content is similar. Combat wound descriptions were divided by injury site, injury category, injury type, and injury severity, for a total of 37 data items. The main problems are insufficient degree of refinement, too little combat wound information being considered, and the system only suitable for on-site rescue. As the techniques involved in subsequent specialist treatment are complex, the 37 items cannot fully characterize the injury. In China, there are other combat wound diagnostic code studies that are mainly used for database construction in medical institutions, but the results are not well suited for implementation in wound treatment during combat [4, 5, 6].

Related international standards include the International Classification of Diseases (ICD), which assigns a unique alphanumeric code for disease classification and description. However, the ICD codes were developed for the description of general diseases and do not quantify trauma severity, fully describe combat wounds, or cover the complex injuries seen in the modern battlefield or combat wounds caused by new weapons [7]. The 2005 Abbreviated Injury Scale (AIS) was developed by the US Association for the Advancement of Automotive Medicine and is a simple method for triaging injuries based on severity. These classification codes mostly cover common diseases and road traffic injuries. Therefore, the accuracy of these codes cannot be guaranteed when applied to combat wounds. Although some codes for penetrating injuries were subsequently added, these are related to low-energy weapons and are not suitable for combat wounds caused by high-energy weapons [8]. In addition, the AIS is a non-continuous coding system and its body regions are not fully based on anatomical classification, so the defined body regions are incomplete. No codes are available for burns, large-area soft tissue injuries, or bilateral limb injuries [9].

The US army has two important combat wound classification systems, namely the deployable medical system patient condition codes (PC-codes) [10] and the Military Combat Injury Scale (MCIS) [11]. The PC-codes integrate all descriptions of specific combat wounds into a whole and mainly originate from previous war casualty data without referencing unified medical codes. Thus, the PC-codes are used for casualty statistics during combat as well as post-combat analysis and simulation[12]. The MCIS code system is a set of anatomy-based combat wound rating code standards that was constructed by an American field surgeon expert team in November 2008. This system assigns a specific code to every combat injury or a group of combat wounds with similar descriptions[13]. This system was constructed after compiling a large volume of historical combat wound data and comparison between combat wounds and modern civilian trauma code systems. The main problems associated with these codes are that the descriptions are overly general and there is no unified combat wound classification axis or severity grading. Therefore, they are not suitable for the coding of actual combat wound data and cannot describe changes in an injured person's condition [14, 15]. During the Iraq War, the US army used PC-codes for preliminary statistical analysis of casualties at the emergency treatment stage and re-analysis using ICD-9-CM was carried out after the casualties reached the field hospital. However, as the criteria for these two systems are different, the information cannot be effectively converted and around 10% of casualty data had to be discarded [10].

Currently, combat wound treatment in the Chinese PLA follows the principles of triaged treatment.

According to the current Regulations on Combat Wound Rescue, The period from the battlefield treatment to the rear hospital treatment is divided into three stages: battlefield on-site first aid, emergency treatment, and early treatment. Battlefield on-site first aid is usually performed by medics and company/battalion resuscitation teams where the scope of techniques applied includes ventilation, hemostasis, bandaging, immobilization, transportation, and basic life support. In the second stage, emergency treatment is usually performed by the brigade (regiment) medical station and techniques include wound inspection and classification, treatment of comatose casualties, treatment of casualties with pneumothorax, emergency treatment of eyeball rupture, encephalocele, bowel prolapse, emergency treatment of spinal injuries, management of large burn areas, shock control, and infection control. Third stage early treatment is usually performed by the mobile medical service and the scope of techniques includes emergency surgery, controlled surgery, debridement, blood transfusion, fluid infusion, and oxygen inhalation. Casualties enter the specialist treatment stage on arrival at the hospital and comprehensive definitive surgery, functional restorative surgery, and plastic surgery are carried out【1】.

This study focuses on the differential treatment needs of combat wound casualties at the three treatment stages which are used as a framework to design an expandable combat wound classification coding system to support triage according to the treatment echelon. On this basis, in order to determine which combat wounds are high-incidence fatal injuries and which casualties in different treatment stages require more attention, this set of combat wound classification codes was used for clustering analysis to screen for high-incidence fatal injuries at different treatment stages[16], and a stratified standardized combat wound injury spectrum based on triaged treatment was constructed. This provides a reference for the timely and effective triaged treatment of combat casualties.

2. METHODS

2.1 Design of combat wound classification codes

Combat wound classification is essentially composed of 5 components: injury site, cause of injury, injury type, injury severity, and combat wound complications[17]. The three-tiered treatment echelon of battlefield on-site first aid, emergency treatment, and early treatment was used as a framework to expand the combat wound classifications for a total of 454 combat wound data items to reflect the characteristics of treatment tasks at each stage, as treatment skill level increases with deepening treatment echelon, and changes in injury severity vary with time and treatment measures.

2.2. Design of injury spectrum statistical indicators

The injury spectrum was designed based on combat wound classification codes. The likelihood of a combat wound being encountered during on-site first aid, the importance of casualty treatment during the emergency treatment phase, and the operability and adaptability of a treatment measure during the early treatment stage were used as bases to design the three-dimensional indicators: likelihood, importance, and suitability. A 5-point scoring system was developed where the higher the score, the better the effects of that indicator[18, 19].

2.3 Survey subjects

For expert selection, in consideration of regional differences, we selected one theater command general hospital from each of the north, south, east, and west, as well as central theater commands. In consideration of the differences between the military branches, one affiliated hospital each from the Army Medical University, Naval Medical University, and Air Force Medical University was selected. The People's Liberation Army General Hospital that covers the entire army was also selected, making a total of 9 hospitals. One clinician with a vice-senior or higher professional title was selected from each of the following: the emergency department, general surgery department, and critical care medicine department of each hospital, making a total of 27 experts. The selected experts each had more than 10 years of clinical practice experience. A portion of subjects (37%) were the chief or deputy-chief of their department. Most experts were from general surgery or emergency departments, with 9 subjects each and accounting for 66.7% of all experts. Other experts included 3 from an orthopedics department, 2 from the department of critical care medicine, and 1 each from thoracic surgery, spinal surgery, and anorectal surgery departments. The majority of the experts (70%) were core members of a hospital field medical team (center), with extensive practical and research experience, and were considered to be authoritative.

2.4 Survey process

One pilot survey and 2 full surveys were conducted in this study. A meeting was held for the pilot survey in which one field surgery expert and one medical logistics expert completed the questionnaire and made an assessment of its rationality, clarity, and objectivity. The questionnaires were revised according to the opinions of the two experts to generate a final questionnaire [20]. In the full survey, the Delphi method was employed, and questionnaires were sent to the 27 experts who were asked to provide quantitative values for each indicator. The results of the first full survey were used to assign one reference value for every indicator, which was taken as a reference for the second full survey so that the overall results were more focused. The expert scores of the second full survey were taken as the final results [21]. In order to ensure the engagement of the experts in participating in the consultation, and to control the duration of the consultation, staff were assigned to carry out close telephone communication with the experts when the questionnaires were distributed to ensure that no questions were missed and no significant errors were made. This also shortened the response time and ensured the quality of the consultation results.

2.5 Data processing

The statistical methods used for the analysis of the general expert questionnaire include stratified analysis, principal component analysis, indicator threshold method, and Colaizzi's method of content analysis [22, 23]. As this questionnaire has a structured format, qualitative analysis methods were not suitable. Also, since the survey contained a significant volume of content, stratified analysis was not suitable for pairwise comparative analysis. In addition, there is a need to analyze the concentration of opinions and interactions between the three-dimensional indicators of likelihood, importance, and suitability for combat wound classification codes. Therefore, the Herfindahl-Hirschman Index (HHI) was used as a reference. This index was used by the United States Department of Justice to assess the level of concentration within industries [24]. The formula is

$$HHI = \sum_{i=1}^{N} (\frac{X_i}{X})^2 = \sum_{i=1}^{N} S_i^2$$

where X represents the whole scale of all study object indicators, Xi is one specific study object indicator, Si = Xi/X is the share of the ith object in the entire scale, and N represents the total number of objects. The greater the HHI index, the more concentrated the industry is and the greater the degree of monopoly it has. The lower the HHI is, the more diverse is the market. We adjusted and optimized these parameters so that they reflect the dispersion of likelihood, importance, and suitability of the various factors in combat wound classification and so reflect the differences in the levels of these three indicators, which were recorded as the quasi-HHI index. After the injury spectrum ranking was obtained by using the quasi-HHI index, we used threshold values to screen for injuries that the require most urgent attention at the various treatment stages [25]. The specific calculation method for the quasi-HHI index is as follows:

$$HHI_{like} = \sum_{i=1}^{n} (\frac{x_i}{10} \cdot 100)^2 .$$

3. RESULTS

3.1 Reliability analysis of statistical results

According to their own self-assessment, the expert’s familiarity in this survey Cs was 0.923 and authoritativeness Cr was 0.946. Therefore, the results can be considered to be reliable. In this study, 54 questionnaires were distributed in two rounds, and all questionnaires were found to be valid. Hence, the valid questionnaire recovery rate was 100%. In this survey, the reliability coefficients of the scales were all above 0.7 and highest reliability was 0.833. The normality test for the index scores of the expert surveys showed that the skewness was 0.184, which is close to 0; the kurtosis was −0.459, which is significantly less than 0. The scores showed a sharp peak in their distribution, reflecting consensus among expert opinions[26].

3.2 Injury spectrum statistical results based on combat wound classification codes

3.2.1 Injury site analysis

The focus of treatment at the battlefield on-site first aid stage is on maintenance of vital signs and rapid evacuation of casualties, so only preliminary evaluation of the patient's condition is carried out and the classification of injuries is simplified. Therefore, a 2-digit code was used to indicate 9 body sites at the battlefield on-site first aid stage and likelihood indicators in the expert consultation questionnaires were used. The coefficient of variation of likelihood scores given by the experts were within 0.3, indicating good coordination and consistency in expert opinions. *Table 1 shows the results.*

Table 1 Injury site likelihood indicators at the battlefield on-site first aid stage

Injury site code	Name of injury site	Likelihood	Coefficient of variation	Pi
01	Head (brain)	8.11	0.15	0.11
02	Face	8.44	0.15	0.07
03	Neck	7.67	0.21	0.05
04	Chest (back)	8.50	0.13	0.14
05	Abdomen (waist)	8.38	0.11	0.17
06	Pelvis (perineum)	7.50	0.22	0.03
07	Spine and spinal cord	7.06	0.29	0.02
08	Upper limbs	7.94	0.15	0.15
09	Lower limbs	8.11	0.15	0.26

The injury site code at the emergency treatment stage is a 4-digit number that permits expansion from the 9 body site codes from the battlefield stage to include 62 anatomical structures in total. The quasi-HHI index was used for normalization and combining of the original qualitative indicators (likelihood, importance, and suitability) and is used as a key indicator for injury spectrum ranking. The arithmetic mean plus standard deviation was used to calculate the high priority indicator cutoff and the arithmetic mean minus standard deviation was used to calculate the low priority indicator cutoff. The high priority indicator cutoff was used to select 15 anatomical structures for attention at the emergency treatment stage and their body sites. *Table 2 shows the results.*

We further expanded the 62 body sites at the emergency treatment stage to 268 injury sites that are considered in the early treatment stage. By calculating a high priority indicator cutoff, we selected the top 20 injury sites in the quasi-HHI index ranking, from 6 injury site codes at the early treatment stage. *Table 3 shows the results.*

3.2.2 Combat wound complication analysis

We calculated the quasi-HHI indices over the three-tiered treatment echelon to obtain the final ranking of 61 combat wound complications in the various treatment stages and calculated the high priority indicator cutoff to obtain the top 10 combat wound complications, which is shown in Table 4.

4. CONCLUSION

After the combat wound classification codes were designed, we evaluated their practical efficacy in a series of medical logistics exercises. During the evaluation, we selected two battalion/company rescue teams at different time periods to test the use of the classification codes at the battlefield on-site first aid stage. We also selected two brigade treatment sites to evaluate the use of the classification codes at the emergency treatment stage. Within the environment of base training of the mobile medical logistic teams, two field medical teams were selected over different time periods to examine the application of the classification codes at the early treatment stage, focusing on the criteria of coding speed, coding accuracy, and connectivity after the combat wound information was transferred to the specialist hospitals[27].

Eighteen standard casualties were set up according to a 3:2:1 ratio of mild, moderate, and severe wounds, respectively. The battalion/company rescue teams first used traditional injury tickets for casualty classification, then they used our classification code for the task. After this, the teams underwent two sessions of training before using our classification code. Due to the lack of standardized casualty classification procedures at the emergency treatment and early treatment stages, staff at the brigade treatment sites, and the field medical teams were requested to describe injuries based on the general medical treatment standards. Following that, two rounds of casualty classification using our codes were carried out, one before and one after training. The mean coding time for the 18 casualties was measured at different treatment institutions, the results of which are shown in Figure 1.

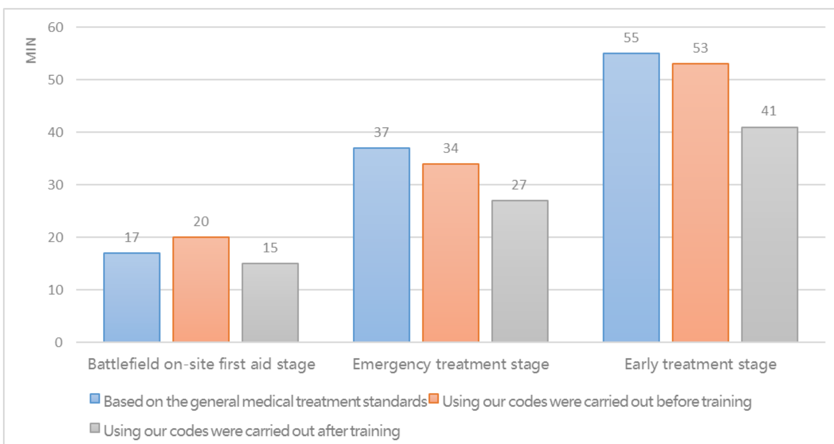

Figure 1. Time needed for casualty classification

Expert surgeons then assessed whether the casualty classification was carried out correctly at each treatment site. The results are shown in Figure 2.

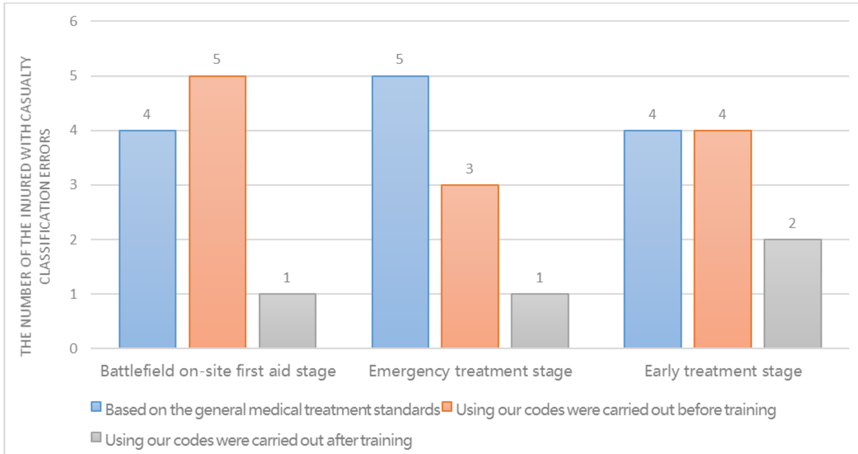

Figure 2. Casualty classification errors

Compared with traditional methods, the time spent on coding was reduced and classification accuracy was improved when using our codes. We further analyzed the classification status of early treatment stage casualties. After casualties that were classified according to the conventional method reached the rear hospitals, the classification of 9 out of 36 casualties treated by the two field medial teams could not be reused because the combat wound information was not standardized and this required the hospital to re-classify and fill in relevant medical documents. In contrast, as our classification method considered the connection between pre-hospital casualty treatment and hospital treatment, the classification results of all 36 casualties could be reused. This greatly improved the efficiency of classification, reduced the workload of hospital staff, and ensured that the injury information was intact and continuous.

The injury spectrum was comprehensively analyzed and sorted according to the scores given by the experts, the quasi-HHI index of hemorrhage was ranked 1st in battlefield on-site first aid, and emergency treatment stages and 2nd in the early treatment stage. Hemorrhagic shock was ranked 3rd in the battlefield on-site first aid, and emergency treatment stages, and 1st at the early treatment stage. This concentration reflects the great deal of attention paid by military field surgeons of the Chinese PLA on hemorrhage during combat wound treatment. Analysis of previous combat data also supported this viewpoint. The combined statistics of the military history of the Chinese PLA showed that 50% of combat wound deaths were due to hemorrhage at the limbs, 10% of soldiers killed in action resulted from trunk and visceral hemorrhage, while 9% of deaths were due to hemorrhage from all 4 limbs. At the Battle of Triangle Hill in the Korean War, 32% of 1136 deaths from the 45th division were due to hemorrhage. In the Sino-Vietnamese War, 50% of deaths at the regimental medical station were caused by hemorrhage and shock【28】.

In terms of the quasi-HHI index, asphyxiation was ranked 2nd, after only hemorrhage, and requires a great deal of attention and immediate treatment by company/battalion emergency medical staff. Past combat data from the Chinese PLA show that respiratory problems caused by coma, inhalation injuries, chemical injuries, severe impact, and direct airway injury account for 5–10% of total casualties, and are the 2nd most important reason for mortality【29】.

The quasi-HHI index for tension pneumothorax is ranked 4th at the battlefield on-site first aid stage and 7th at the emergency treatment stage, while the quasi-HHI indices of open pneumothorax and hemopneumothorax were also ranked in the top 10 for these two treatment stages. Relevant papers showed that the mean time to death for tension pneumothorax and hemothorax is 25–40 minutes【30】. Hence, these injuries are one of the major causes of rapid death in battlefield casualties.

5. Discussion

Based on the results of this study, the combat wound experts of the Chinese PLA have established a “3 rapid and 3 strengthening” concept for combat triage involving: rapid control of life-threatening hemorrhage, rapid administration of life support, and rapid injury control, as well as strengthening the integration between medical logistics and combat, strengthening timely treatment, and strengthening triaged treatment connections. In addition, they have established a new policy of “three points and one chain” consisting of: rapid early stage, precise intermediate stage, and strong late stage for treatment measures. We also developed a new spinning tourniquet, and compressed gauze, which significantly improve the reliability of self-treatment and mutual treatment of hemorrhage and the hemostasis of life-threatening hemorrhage, particularly the problem of hemostasis at junctions. Our study drives the early implementation of fluid resuscitation, airway management, and closed chest drainage, which provide safe and effective measures, and technical support for frontline medical treatment[31].

Here are still some limitations in this study, mainly embodied in as follows. In the detection of the practical application effect of combat wound classification code, 2 of the 3 types of treatment institutions: battlefield on-site first aid, emergency treatment, and early treatment, were selected, respectively, and classification and coding experiment of the combat wounded was carried out only once for each combat wound classification method. The size of experimental subjects and the number of experiments are too small, which may have certain influence on the detection of practical effect. In the next step, this study intends to further expand the application range in the army, and improve the application according to the situation of the army, so as to enhance the practical effect of the study. Moreover, the current relevant academic viewpoints suggest to add a technical link related to surgical resuscitation between the emergency treatment and early treatment of the level II treatment ladder of combat wound. This study should also pay close attention to the changes in this new situation, and fine-tune the location, structure and application objects of some combat wound codes, so that the study can adapt to the new needs of combat and health service support.

Table 2. Top 15 injury sites by quasi-HHI index at the emergency treatment stage

Injury site code	Name of injury site	Injury site code of the level above	Likelihood indicator		Importance indicator		Suitability indicator		HHI Index
			Mean	Coefficient of variation	Mean	Coefficient of variation	Mean	Coefficient of variation	
0302	Throat and trachea	03 Neck	7.96	0.16	8.91	0.05	7.64	0.20	2.01
0304	Neck blood vessels	03 Neck	7.70	0.18	8.91	0.05	7.27	0.24	1.92
0506	Spleen	05 Abdomen (waist)	7.68	0.17	8.57	0.09	7.48	0.23	1.88
0505	Hepatic	05 Abdomen (waist)	7.73	0.17	8.57	0.09	7.29	0.19	1.86
0403	Thoracic cavity	04 Chest (back)	7.96	0.19	7.64	0.17	7.36	0.25	1.76
0404	Lungs	04 Chest (back)	7.82	0.17	8.18	0.12	6.90	0.24	1.76
0105	Scalp	01 Head (brain)	8.39	0.20	6.30	0.30	8.09	0.16	1.76
0405	Trachea and bronchi	04 Chest (back)	7.41	0.22	8.27	0.14	6.86	0.28	1.70
0906	Lower limb blood vessels	09 Lower limbs	7.17	0.23	8.45	0.15	6.81	0.25	1.69
0807	Upper limb blood vessels	08 Upper limbs	7.13	0.22	8.52	0.13	6.64	0.38	1.68
0901	Thigh	09 Lower limbs	7.96	0.15	7.36	0.21	6.90	0.26	1.65
0510	Abdominal blood vessels	05 Abdomen (waist)	6.95	0.24	8.73	0.08	6.19	0.41	1.63
0903	Calf	09 Lower limbs	8.13	0.16	7.09	0.20	6.71	0.26	1.61
0509	Abdominal cavity	05 Abdomen (waist)	7.95	0.25	7.19	0.21	6.80	0.24	1.61
0603	Pelvic bone	06 Pelvis (perineum)	7.61	0.18	7.36	0.25	6.73	0.24	1.57

Table 3. Top 20 injury sites by quasi-HHI index at the early treatment stage

injury site code	Name of injury site	Injury site code of the level above	Likelihood indicator		Importance indicator		Suitability indicator		HHI Index
			Mean	Coefficient of variation	Mean	Coefficient of variation	Mean	Coefficient of variation	
030202	Laryngeal connection	0302 Throat and trachea	8.13	0.42	8.48	0.12	8.30	0.11	2.07
030402	External carotid artery	0304 Neck blood vessels	7.64	0.27	8.84	0.09	8.33	0.18	2.06
030401	Common carotid artery	0304 Neck blood vessels	7.40	0.27	8.84	0.09	8.33	0.18	2.02
040302	Pleural cavity	0403 Thoracic surgery	8.12	0.23	8.31	0.13	8.17	0.16	2.02
030403	Internal carotid artery	0304 Neck blood vessels	7.24	0.25	8.84	0.09	8.25	0.20	1.99
010201	Epidural space	0102 Cranial cavity	7.96	0.25	8.44	0.16	7.75	0.24	1.95
030205	Neck trachea	0302 Throat and trachea	8.04	0.25	8.36	0.15	7.75	0.19	1.95
030406	Internal jugular vein	0304 Neck blood vessels	7.24	0.20	8.60	0.11	8.17	0.20	1.93
030404	External jugular vein	0304 Neck blood vessels	7.64	0.24	8.12	0.14	8.08	0.20	1.90
050502	Right lobe	0505 Liver	7.71	0.24	8.29	0.13	7.70	0.21	1.87
030407	Blood vessels at the root of the neck	0304 Neck blood vessels	7.08	0.26	8.58	0.12	7.96	0.19	1.87
010101	Frontal bone	0101 Skull	7.75	0.24	7.75	0.22	7.78	0.24	1.81
030201	Laryngeal cartilage	0302 Throat and trachea	7.64	0.42	8.04	0.16	7.50	0.18	1.79
050601	Splenic hilum	0506 Spleen	7.21	0.20	8.38	0.11	7.52	0.22	1.79
050501	Left lobe	0505 Liver	7.29	0.23	8.13	0.14	7.70	0.21	1.78
090604	Popliteal artery	0906 Lower limb blood vessels	6.76	0.22	8.52	0.12	7.67	0.18	1.77
040403	Lower lobe	0404 Lung	7.32	0.24	8.12	0.16	7.58	0.22	1.77
090101	Femur	0901 Thigh	7.64	0.21	7.72	0.14	7.67	0.19	1.77
050602	Splenic artery	0506 Spleen	7.13	0.20	8.46	0.10	7.35	0.24	1.76
090603	Femoral artery	0906 Lower limb blood vessels	6.60	0.18	8.60	0.11	7.67	0.18	1.76

Table 4. Top 10 combat wounds by HHI index in the three-tiered treatment echelon

injury site code	Name of complication	Battlefield on-site first aid stage		Emergency treatment stage		Early treatment stage	
		HHI index	Rank	HHI index	Rank	HHI index	Rank
02	Hemorrhage	2.27	1	2.26	1	2.23	2
04	Asphyxiation	2.15	2	2.19	4	2.08	9
14	Hemorrhagic shock	2.11	3	2.22	3	2.27	1
51	Tension pneumothorax	2.10	4	2.10	7	2.01	13
15	Traumatic shock	2.07	5	2.26	2	2.23	3
50	Open pneumothorax	2.02	6	2.10	8	1.98	16
16	Burn shock	2.00	7	2.17	5	2.18	5
03	Coma	1.97	8	2.11	6	2.21	4
53	Hemopneumothorax	1.73	9	2.03	10	1.96	15
52	Hemothorax	1.73	10	2.03	9	1.98	17
21	Acute respiratory distress syndrome	1.17	13	1.78	17	2.18	6
12	Sepsis	1.01	36	1.59	26	2.06	10
24	Multiple organ dysfunction syndrome after combat wound	0.97	38	1.44	36	2.10	7
37	Intracranial hematoma	1.33	20	1.68	19	2.08	8

Ethical Approval and Consent to participate

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Consent for publication

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Availability of data and materials

All the data involved in this paper are annotated in the references.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Bo Peng wrote the article, and Zhen He and Tan-shi Li provided the idea. Shuo Liu and Fei Pan investigated the Haddon matrix and screened and analyzed the data. All authors haveread and approved the final manuscript.

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Figures

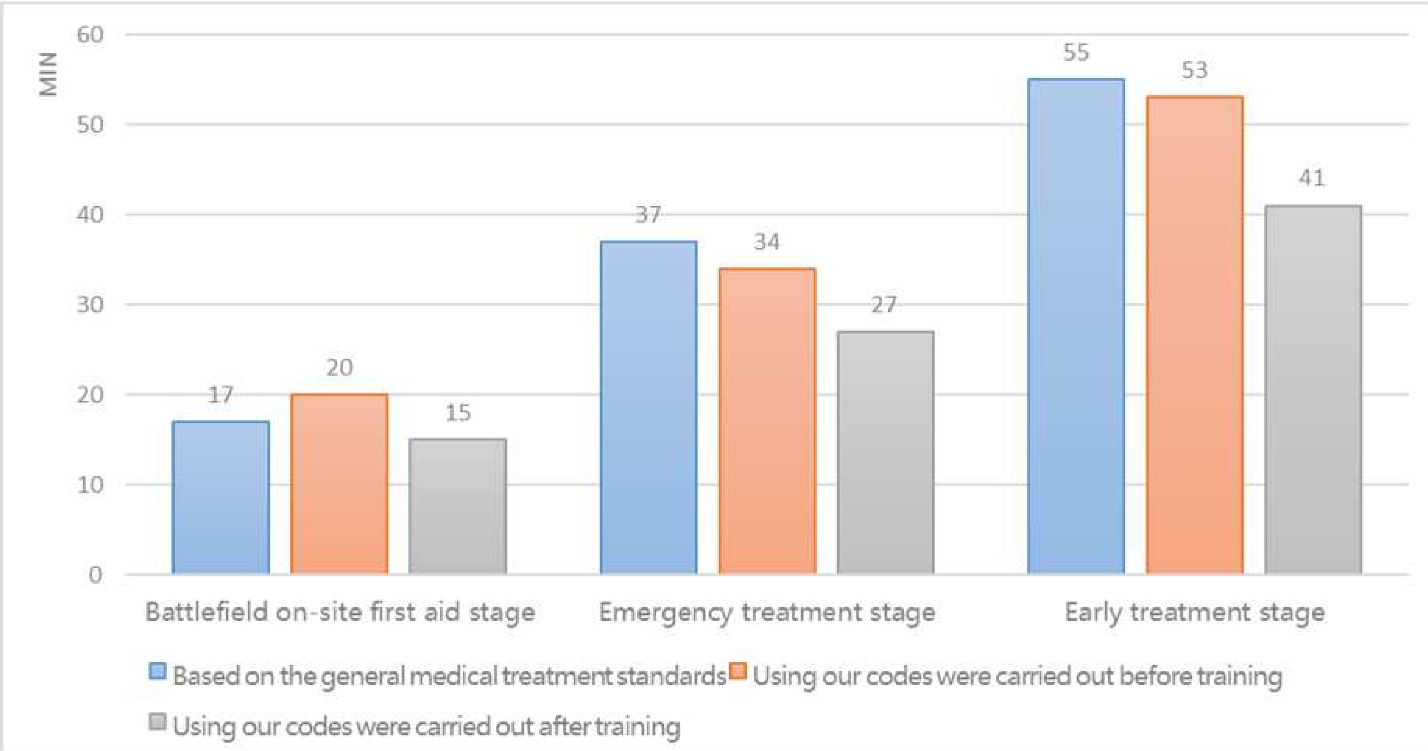

Figure 1

Time needed for casualty classification

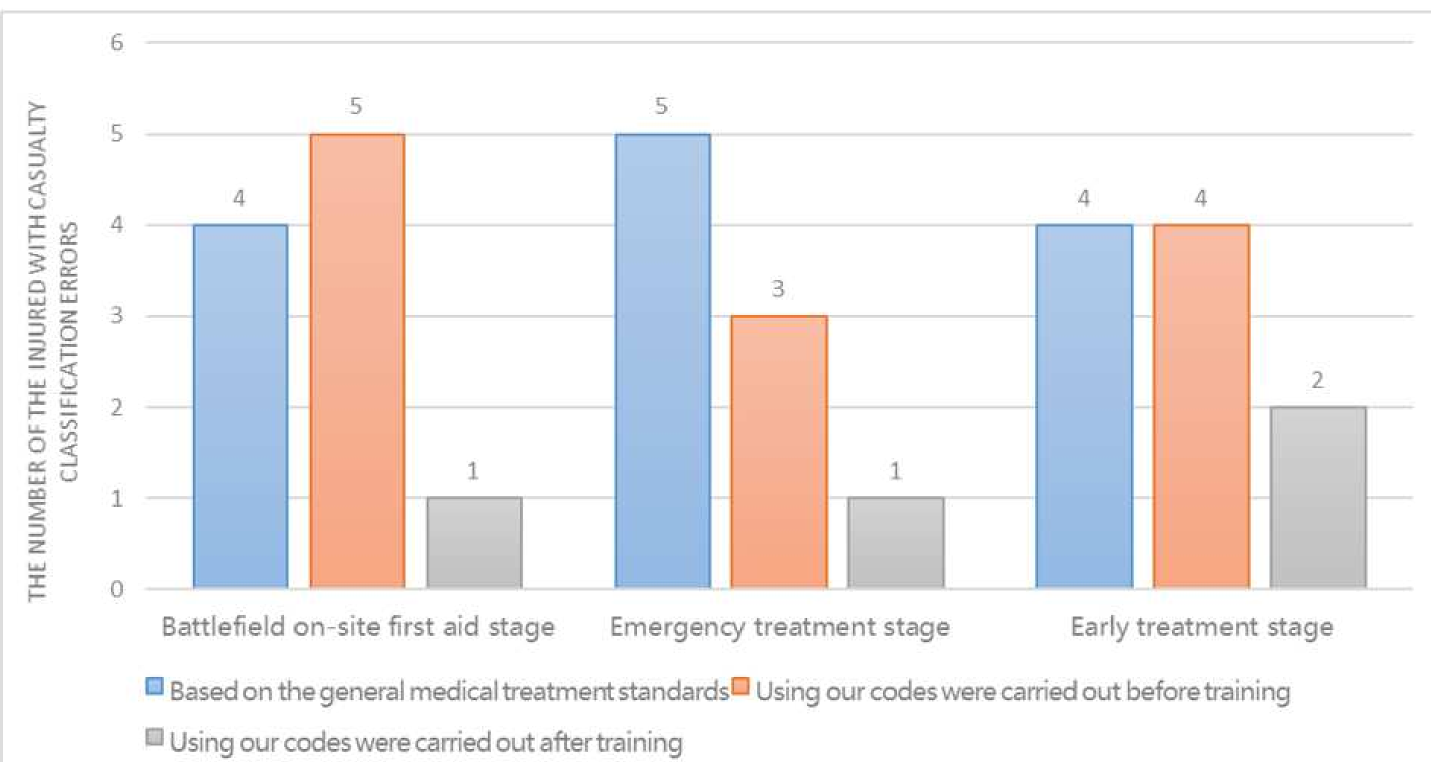

Figure 2

Casualty classification errors