The Application Study on Accurately Search & Rescue of the Wounded on the land battlefield base on “Beidou+ Armored ambulance”

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Abstract. The accurately program of search & rescue of the wounded is designed and an initial design idea of various subsystems is proposed in order to provide theoretical explorations and solutions for making the search & rescue of the wounded on a land battlefield immediate, intelligent and accurate and for lowering the death and disability rates of the wounded. A full combination of skill features and functional advantages is made between BDS and Armored ambulance, which is systematically applied to the search & rescue on the land battlefield. The rationality and feasibility of the program of search & rescue are guaranteed by functional combinations, comprehensive integration and experimental verification. The verification of the program of search & rescue is made in the form of war-game exercises. The result finds that the “BDS + Armored ambulance” pattern of search & rescue can accurately acquire real-time locations of the wounded, immediately provide on-site first-aid services and emergency aid & treatment for the wounded and rapidly receive and transfer the wounded, which demonstrate a better practice and application prospect of health services. As the BDS-3 is to be put into service in 2020, the informationized upgrading and transformation of Armored ambulance will be gradually completed and the “BDS+ Armored ambulance” program of search & rescue will exert a more obvious influence on the search & rescue of the wounded on the land battlefield, which provide a capability support for realizing the idea of “Medical Treatment be with Soldiers”.

1. Introduction
In order to comprehensively improve the wounded searching accuracy against the strange environment and complicated electromagnetic circumstance, achieve completely independent and controllable search equipment system, and combine with medical service guarantee demand in integrated joint operation, the paper designs a “BDS + Armored ambulance” accurate wounded search and rescue plan for land battlefield. The plan gives full play to the medical service guarantee features of armored ambulance “accurate search, rapid docking, effective treatment, and fast delivery” and combines with the technical strengths of BDS in strong anti-interference, wide service scope, and high navigation precision. Those two systems are integrated to be applied to the land battlefield searching against informatization conditions, in the hope to shift the battlefield search ideas and modes from “traditional searching” to “centralized decision-making and intelligent searching”. The battlefield searching scope and integrated
wounded information transmission distance is extended from the “limited territory” to “seamless coverage”. The wounded searching system availability is improved from “limited application environment” to “full-time and full-area”, and the real-time wounded rescue ability from “simple disposal” to “comprehensive diagnosis and treatment”.

2. Analysis of wounded search and rescue ability improvement demand on land battlefield

Directly promoted by the rocketing development of science and technology, the face of war has been dramatically changed. Modern wars are characterized by high informatization level, low launching threshold, wide time span, intense strength and destruction, unmanned, smart and effectiveness oriented. Injuries and deaths among soldiers come to be irregularly distributed in terms of time, space, scale and intensity. Those features pose new and higher requirements for the wounded searching ability on land battlefield. The field soldier rescue system equipped by our army now achieves already three major functions, namely rapid and accurate wounded positioning, real-time life sensing, and wounded identification, and four transformations from paper records to digital ones in state of injury, from artificial transmission to wireless one in injury invoice, passive report to active sensing in casualty, and rough wounded searching to accurate positioning. In spite of those progress, the system is still far from being satisfying in conducting land battlefield rescue tasks against complicated electromagnetic conditions, for its simple searching mode can’t help to master the battlefield trends in a comprehensive and real-time way, and the information interaction means used in the system such as mobile radio communication and radio direction finding have weak immunity and low vitality. When confronted with complicated electromagnetic, topographic and climatic conditions, the present field soldier rescue system system would become unable to locate the wounded, protected wounded information transmission link from being interrupted, and ensure high rapid searching ability on the informatized battlefield. The whole system can even be on the verge of complete paralysis.

The problems mentioned above can be improved with the tactical features of armored ambulance and functional strengths of BDS. In the complicated and ever-changing battlefield environment, armored ambulance can not only rapidly find out and send back the wounded but also act as a front-line mobile searching and rescue command center with the advanced communication, navigation, first-aid, and auxiliary diagnosis systems. It is capable to complete such battlefield tasks as integrated information monitoring, optimal searching planning, and searching commanding. Enjoying unique strengths in real-time battlefield elements monitoring, accurate command and control, and reliable information transmission, BDS can provide lasting reliable services for the users in our country and surrounding areas, including navigation, messaging, and highly accurate time services. While its characteristic messaging function is free from any distance restraint and strong electromagnetic interference, it can be utilized to help the commanders in directly implementing “one to one” or “one to many” commanding task for critical tasks, core departments or even single soldiers.

The general goal is to get promptly informed about any individual injury, visualize the individual movement trajectory on the battlefield, achieve real-time interaction between armored ambulance and individual soldier, and render the battlefield search and rescue tasks assignment and implementation to be controllable at any time. In accordance with the battlefield rescue principle of “rapid search, control, rescue, and delivery” as well as “efficient rescue” need for the wounded, armored ambulance and BDS are combined with each other to build a new-generation battlefield search and rescue system that can improve individual fighting trend and injury monitoring ability, satellite positioning and basic geographical information support abilities, real-time wounded information interaction ability, and immunity of search and rescue system under complicated battlefield conditions. The new system will become an effective means of maximizing the possibility of “preparedness of medical services for soldiers” and reducing the mortality of wounded on battlefield.

3. General architecture of “BDS+Armored ambulance” search-and-rescue plan

“BDS+ Armored ambulance” search-and-rescue plan is composed of single soldier information acquisition and transmission subsystem, battlefield trend monitoring and decision-making subsystem,
and medical search and rescue subsystem. The overall architecture of the search-and-rescue plan is illustrated in Fig. 1.

![Fig.1 The overall architecture of the search-and-rescue plan.](image)

### 3.1. System working principle

Single soldier information acquisition and transmission subsystem is made up of two parts: soldier signboard and portable BDS communication terminal. It is mainly used to independently acquire the information about vital signs and accurate geographical location of the soldiers and then report the SOS signal, real-time vital signs and accurate geographical location of the wounded to the battlefield trend monitoring and decision-making system installed on armored ambulance through BDS RDSS link. The SOS signal from the wounded is sent to both Armored ambulance and front corpsmans at the same time.

Battlefield trend monitoring and decision-making subsystem is provided on the military computer of armored ambulance, which can keep monitoring the fighting state of the army. On the one hand, it can judge the injury of single soldier according to the perceived integrated information (including SOS signal, location, and physical indicators), make use of auxiliary first-aid and diagnosis system to automatically and preliminarily assess the severity of the wounded’s injury, combine with locating coordinates of the wounded to form optimal search and rescue plan, and command armored ambulance to carry out independent search and rescue or send the order to the medical search and rescue subsystem. And on the other hand, the system can receive the battlefield (onsite) wounded treatment information and update the wounded injury database in time.

After receiving the SOS signal from the wounded, the corpsmans will rush to the place where the sounded is situated, read the electronic injury invoice with portable machine, perform battlefield (onsite) first-aid on the wounded, classified the wounded by his conditions, gather and divide the wounded that should be sent back, and instruct armored ambulance to accurately reach the gathering site of the wounded so as to load and send back them. It can also accurately position the wounded according to the search and rescue instruction from armored ambulance, and come to the site to carry out onsite rescue as guided by the BDS search and rescue navigation software, and submit the wounded rescue information such as severity of the injury and rescue measures to armored ambulance.
3.2. Primary features of the system

Make an integrated use of such techniques as biosensing, satellite positioning and communication, geographical information system, and intelligent decision support system to build a new-generation battlefield rapid search, rescue and withdrawal system;

Give full play to the performance strengths and technical features of armored ambulance by using it as a mobile rescue platform in the battlefield search and rescue missions and building it into a search and rescue command center so that it can turn into the core and hub for informatized battlefield search and rescue missions;

The search and rescue system dominated by BDS RDSS communication is compatible with GPRS/CDMA communication. The former features outstanding confidentiality, strong immunity, wide coverage, long-distance communication, anti-interference from geographical and climatic conditions, and adaptability to the changing informatized battlefield environment;

Depending on BDS, the wounded can report about his geographical position on the battlefield in a prompt and accurate way. The positioning accuracy and reliability are greatly improved. Under the uniform commanding and dispatching of armored ambulance, it is possible to optimally configure the rescue resources and perform timely and effective treatment on the wounded. Key technologies involved in “BDS+ Armored ambulance” search and rescue plan include vital signs and parameters sensing mechanism, multi-sensor data interaction, BDS-based parameters transmission, BDS-based data interaction, battlefield’s geographical information management methods, battlefield rescue management plan, integrated injury monitoring plan, centralized decision-making and search-and-rescue plan, and wounded information management. It is necessary to develop following devices and software for the system: single-soldier BDS transmission equipment, corpsman’s BDS search and rescue terminal, corpsman’s search and rescue information management software, integrated armored BDS command machine, and integrated wounded information management software. The standards and protocols to be prepared are vital signs and parameters transmission standard and BDS extended communication protocol. The contents of the search and rescue plan are as shown in Fig. 2.

![Fig. 2](image-url)  
Research content about search and rescue program based on “BDS+ Armored ambulance”.
4. Preliminary technical schemes for the subsystems

4.1. Single-soldier information acquisition and transmission subsystem

The single-soldier information acquisition and transmission subsystem composed of the soldier signboard and BDS transmission equipment can keep sensing the vital signs of the wounded, actively send SOS signal, and make use of BDS RDSS link to achieve long-distance transmission of integrated information about the wounded.

The single-soldier BDS transmission equipment is the portable user terminal that is made up of major body, battery, BDS module and Bluetooth. The antenna is responsible for receiving multi-frequency clock satellite signals and sending single-frequency clock signals, BDS module processes signals and controls the message sending and receiving, Bluetooth is connected with vital signs collecting device and combines with in-built software to accept injury inquiry and report. The equipment is suitable to be carried and used by an individual in the battle. On the front, there are alarm and state confirmation keys. When an emergency occurs, the soldier can press down the alarm key to actively send an SOS signal and the state confirmation key after receiving the injury inquiry signal. Its composition is shown in Fig. 3.

![Fig.3 The single-soldier BDS transmission equipment.](image)

4.2. Corpsman rescue subsystem

4.2.1. Corpsman’s BDS search and rescue terminal

The corpsman’s BDS search and rescue terminal is mainly composed of following modules: antenna, signal channel, baseband signal processing, information processing and application, corpsman bd search and rescue system. The antenna module incorporates receiving and sending antennas. The antenna processes the received signals to be digital intermediate frequency (IF) signals through low noise amplification, down-conversion and A/D sampling. Two paths of signals are sent to the baseband signal processing module separately.

Made up of RNSS and RDSS baseband chips, the baseband signal processing module is mainly used to conduct such procedures as signal acquisition, code tracking, de-spreading, carrier tracking, frame synchronization, and decoding. After the baseband signal processing is done, RNSS baseband chip outputs the original observation data while RDSS outputs the messages to subsequent information processing module for further processing. The sending process of RDSS is exactly on the contrary to the receiving process: RDSS baseband chip forms the incoming signal format according to the specified padding frame numbering and other information, sends the information to the free space through antenna after encryption, coding, and frequency changer circuit and power amplification.
Information processing module carries out PVT resolving on the original data from RNSS to get the information such as position, speed and time, processes the information output by RDSS baseband chip, outputs key information to application processing module to complete information display, processing or control, or send the data to the peripheral equipment.

4.2.2. Medical search and rescue information management software

The medical search and rescue information management software is composed of BDS transmission and protocol analyzing module and man-machine interaction module in which the latter can achieve such functions as GIS software, messaging, and battlefield rescue management. The structure of medical search and rescue information management software is demonstrated in Fig. 4.

As one of the core modules of the software, BDS transmission and protocol analyzing module provides a transparent transmission channel for the communication between software and BDS devices. Independent encapsulation is realized through dynamic link library, and communication with man-machine interaction module is made possible through a message mechanism.

The man-machine interaction module is a module through which the user can directly operate the devices in order to complete many functions, including positioning, navigation, map, communication and system setting. Under the control of user card service frequency, it is completed through the communication with BDS transmission and protocol analyzing module. The man-machine interaction is in a variety of ways. On the basis of man-machine interaction and equipment features, different ways of interaction such as menu and status bar have been designed and developed so as to render user operation more convenient and comprehensible.

4.3. Battlefield trend monitoring and decision-making subsystem

4.3.1. Integrated BDS armored command machine

In the integrated BDS armored command machine, an antenna unit undertakes the radio-frequency signal transmission function. The antenna receives navigation signals of two frequency points from RNSS and those from RDSS, then sends those signals to the navigation processing panel to complete the acquisition and solving procedures through 30dB low-noise amplifier. In the positioning and
communication by RDSS, navigation processing panel will send signals at frequency point L and amplify them at the power of 30W and transmit them through the antenna after processing with cavity filter so as to complete the communication with the satellite.6

The integrated navigation processing panel undertakes a signal processing function. After the signals are processed, they may be sent to external PC or other display/control terminals through the external interfaces (serial or CAN) for reference or operation purposes by the user.

The integrated BDS armored command machine is generally supplied with 9-32V DC power through external cabling. The power supply is then converted through internal power panel to be two kinds of power: 5V (for navigation processing panel) and 28V (power amplifier).

4.3.2. Integrated wounded information management software

The integrated wounded information management software is composed of BDS transmission and protocol analyzing module, man-machine interaction module, and database. Among those modules, the man-machine interaction module can achieve a lot of functions such as GIS map, system configuration, messaging, and integrated injury information management.

As one of the core modules of the software, BDS transmission and protocol analyzing module provides a transparent transmission channel for the communication between software and BDS devices. Independent encapsulation is realized through dynamic link library, and communication with man-machine interaction module is made possible through Windows message and API function.

Database module is to store and manage the map data, BDS messaging, and wounded rescue information.

The man-machine interaction module is a module through which the user can directly operate the devices in order to complete many functions, including positioning, navigation, map, communication and system setting. Under the control of user card service frequency, it is completed through the communication with BDS transmission and protocol analyzing module. The man-machine interaction is in a variety of ways. On the basis of standard Windows man-machine interaction and equipment features, different ways of interaction such as menu and status bar have been designed and developed so as to render user operation more convenient and comprehensible.

5. Conclusion

Modern wars are characterized by rapid rhythm, high technological content, dramatically raised casualty-related uncertainty, and unprecedentedly difficult and intense medical and logistical guarantee demand. Medical and logistical guarantee is always required to be accurate and efficient. The “BDS+ Armored ambulance” search and rescue plan proposed by this paper is able to conquer the ambient influential factors such as geography and climate, solve the problems concerning small coverage, low vitality and bad immunity in traditional medical and logistical guarantee information and data chain so as to cut down the casualty of frontline medical staff and greatly improve the reliability and accuracy of battlefield search and rescue system. With increasingly informatized armored ambulance and lasting extension and exploration of the fields applied with BDS, the “BDS+ Armored ambulance” search and rescue plan will definitely have a more promising prospect of application. It will become an important means of bringing down the mortality and disability on the land battlefield and improving the morale of the whole army.

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