

DOI: 10.13434/j.cnki.1007-4546.2014.0402

## Studyt on the Emergency Medical Service Evaluation and Improvement

WU Hai-long<sup>1</sup>, SU Qiang<sup>1</sup>, ZHU Yan<sup>2</sup>, XUE Lei<sup>2</sup><sup>1</sup> School of Economics & Management, Tongji University, Shanghai 200092, P. R. China<sup>2</sup> Research Center for Public Health, Tsinghua University, Beijing 100074, P. R. China

**Abstract:** The Emergency Medical Service (EMS) system in China from service supply chain perspective is analyzed. Firstly, it reviews service supply chain researches in emergency medical service, and it is found that waiting time, safety, service integration and communication before the emergency surgery are the four indicators to measure the quality of emergency medical service. Secondly, the information barrier-inconsistent information flow-is prominent, which is between emergency in hospital and pre-hospital, after analyzing three different types of flows on service, information and logistics. Besides, comparing with Joint Commission International accreditation (JCI) standards for hospitals in USA, the requirements of service integration and communication in Chinese hospital accreditation are much lower. In the end, a Smart First Aid Information Center (SFAIC) model for first aid service is proposed. This model can be used to enhance information exchanges more effectively between first aid in-and pre-hospital. Moreover, it also shortens pre-surgery time and betters the communication and coordination between service sections. To put it in a nutshell, the improved medical service process can greatly increase emergency medical service quality.

**Key words:** Emergency Medical Service (EMS); service supply chain; service quality; smart first aid information center(SFAIC)

### 1 Introduction

Emergency medical service is an important part in health care, whose task is arduous in limited time. Since 1986, the "120" first aid hot-line established in our country, it has been saving a lot of lives of patients. However, emergency medical service is required higher expectation with Chinese continuously

living standard increasing. At present, our emergency medical service process can be divided in two parts: pre-hospital emergency and in hospital emergency. Pre-hospital emergency process includes four stages: call for help, ambulance arrangement, first aid and transport. Hospital emergency process includes three stages: nursing admissions, clinician aid and specialist consultation. The emergency flow processed one by one. However, the serial process wastes lots of time. Therefore, how to optimize first aid flow arrangement and cut down emergency process time under existing medical conditions becomes an important issue.

---

Received 20 November 2014

The paper is supported by NSFC projects (71090404, 71072026), Research Center for Healthcare Management, SEM, Tsinghua University.

## 2 Literatures review

At present, there is a growing interest in using industrial processes or applying business concepts in health care<sup>[1]</sup>. More specifically, the care providers increasingly turn to the field of operations management (OM) to their conversations supply-based to demand-based service in order to find an effective answer to patient needs<sup>[2]</sup>. Settings that are complex due to the necessary involvement of health care service provider leads to inter-organizational problems that are often discussed under the header of chain care. The idea of a chain of care activities performed by multiple organizations is related to the field of supplying chain management<sup>[3]</sup>.

The terms of "supply chain" is defined in lots of ways. In this paper, supply chains is defined as a way to envision all steps needed from beginning to end in order to deliver products or services to the customer. Having specified the content of the notion of "supply chain", how to manage it in emergency medical service is considered.

Supply chain management (SCM) could be used in emergency medical service management. It is well-known, SCM is related to settings where several companies contribute to the production of one particular product. The emergency medical service of patients requires input from multiple health care providers, such as pre-hospital and in hospital. Poor cooperation between pre-hospital and in hospital will lead to ineffective and unsafe health care. In order to improve service effective, SCM is used to emergency medical service management.

SCM is widely used in emergency medical service. First, it can be used in medical resource allocation. Van Vactor indicated the efficiency of health care system was quite low, and so he designed medical

service resource allocation system by supply chain management to improve the emergency service system efficiency<sup>[5]</sup>. Secondly, it can be used in medical service operations management. Meijboom et al. thought medical service system was about several organizations and the patient-oriented care provision was the major challenges for health care providers, and he proposed supply chain management to serve these problems<sup>[6]</sup>. Thirdly, it also can be used to improve emergency service care service quality. Sinha et al. showed that, no matter in developed or developing countries, there is always a gap between conditions of national medical service and residents' expectations<sup>[7]</sup>. For improving health service quality, Sinha et al. proposed a 3A framework. Instead of being placed outside the value chain, the customer can participate in various value creating activities throughout the entire supply chain or network<sup>[8]</sup>. The most important changes in emergency medical service chain is that the patient (customer) has been to create value all the time. That is, which the value is not only from supplier to customer, but also from customer to supplier. In one word, the quality of emergency medical service could be enhanced by SCM.

## 3 Evaluation standards

Emergency medical service is a part of health care, so this chain has both the general characteristics of medical service supply chain and the unique characteristics of emergency service chain, such as abruptness, passive and timeliness. This paper proposed the emergency service chain should be evaluated from four aspects, including as waiting time, safety, communication and integration.

Waiting time. The waiting time means the time before emergency surgery in hospital. Generally, long

waiting time for necessary care and restricted access negatively influence the patient's quality of life, because their condition may worsen substantially when waiting to receive treatment<sup>[6]</sup>. Hence, waiting time is critical for treating patient. Such as Acute Myocardial Infarction rescue, if the artery cleaning surgery is implemented within one hour, the mortality rate will be only 3.5%. If the waiting time is between one and two hours, the mortality rate of acute myocardial infarction will increase to 5.6%. If the waiting time is between two and four hours, the mortality rate of acute myocardial infarction will increase to 10.3%. Anderrson et al. found that long waiting time would also lead patient exacerbate tensions and add extra psychological burden<sup>[9]</sup>. Fredendall et al. pointed that the medical service care which made patients wait for a long time was not a good emergency service system<sup>[10]</sup>. Thus, waiting time should be an important indicator for evaluating emergency medical service.

**Safety.** Safety is not only the foundation of any medical activities, but also an important indicator for evaluating first aid services quality. Emergency safety includes medical technology safety as well as service management safety. Service management safety is closely related to its organizational structure. Schoen et al. claimed that errors often occurred between organizations, especially in transfer links between different departments<sup>[11]</sup>. Saltman et al. found that problems of coordination were likely to arise at key interfaces, such as between pre-hospital and in hospital emergency medical services<sup>[12]</sup>. So it should take into consideration to optimize the emergency organization so as to improve emergency safety.

**Communication.** Emergency medical services flow is also a communication process. Generally, good communication can improve services qualities.

ϕvretveit claimed the inefficient referral would lead to decreasing patient satisfaction in lacking of effective communication between doctors and patients<sup>[13]</sup>. Besides, ϕvretveit also noted that patients' satisfaction would easily decrease when they were required to do repeated similar tests or to wait the test result for a long time. Gröne et al. found it would increase the risk of emergency with lacking of effective communication. So the communication should not be an ignored evaluating index<sup>[14]</sup>.

**Integration.** Each step on emergency medical service chain links with one another. The emergency can't be carried out smoothly unless any of steps break down. Conrad et al. noted that a per-unit view prevailed in health care organizations. According to the Conrad et al. study clinicians were often treated to solve problems as soon as possible. So they usually didn't take care of what they had done in their unit part, which had influenced on the complete process<sup>[15]</sup>. Egger described this phenomenon as "an acute mindset", and pointed that it would make patients feel uncomfortable<sup>[16]</sup>. Therefore, Saltman et al. claimed that emergency service should be patient-oriented. Only in this way can we truly improve emergency service quality<sup>[12]</sup>. Bringewatt also noted it couldn't improve medical service level, until we provide suitable and appropriate services for patients<sup>[17]</sup>. Thus, it requires every department on emergency service chain to integrate deeply in order to achieve integration.

#### 4 Chinese EMS system analysis

In China, the EMS system includes several departments, such as "120" call center, on-site rescuers and different departments in hospital, which collaborate with each other. Different from traditional supply chain, the medical service chain is a passive

chain. Health care providers usually do not pay for input from the side of the patients; because patients offer inputs or are inputs themselves, processing

occurs almost instantly. The medical service chain includes three flows, i.e., service flow, information flow and logistics, as shown in Figure 1.

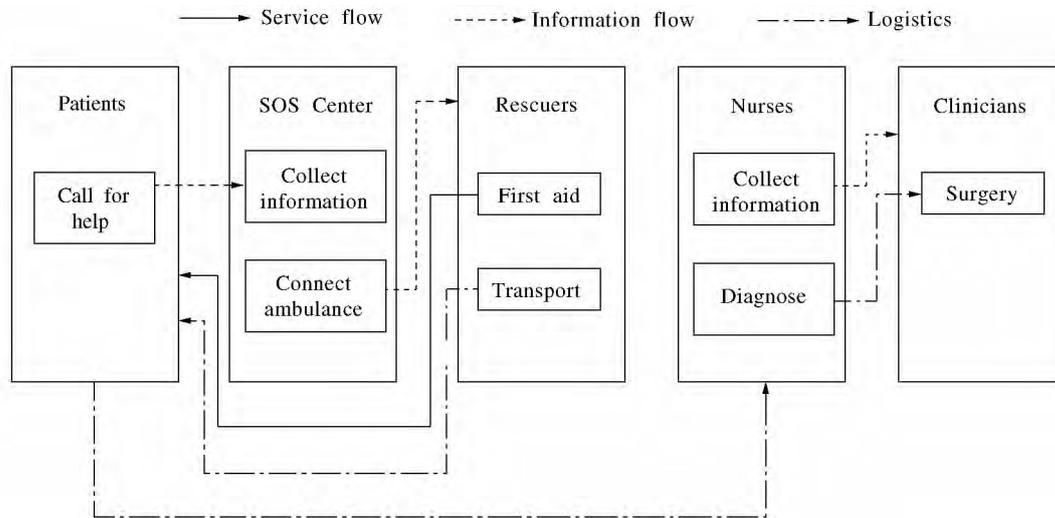


Figure 1 EMS system

The service flow begins with the patient calling for help to “120” call center and then the call center collects information for patients. After that the on-site rescuers rush to the scene according to the patient’s information and provide first aid as well as safety transport service. Once arriving at hospital, nurses will do some physical examinations, preliminary care and initial diagnosis for patients. According to the initial diagnosis, clinicians are arranged for saving patients. Thus, the emergency service flow ends.

The information flow also begins with the patient calling for help. The “120” call center transfers the patient’s information to on-site rescuers. As soon as the ambulance arrives at hospital, patient’s condition information is transferred from rescuers to nurses. For the integrity and accuracy of patient’s information collected from pre-hospital is not enough, nurses should also do some work for getting further information. At last, patients’ information is passed onto clinical for surgery and the emergency

information flow ends.

In this paper, logistics includes service tools and service object (patient). The logistics begins with the ambulance departing from the emergency station to the patient place. When the ambulance transfers the patient to hospital safely, the patient’s information sends to the nurse. And then, the patient is taken to surgery room for further treatment and the ambulance gets back to emergency station. Thus, the logistics ends.

By analyzing the emergency medical service chain, it found that three major problems are faced in our country. Firstly, the communication and collaboration between rescuers and hospital service providers are less effective. The patient’s information, which is collected by pre-hospital emergency, could not be effectively transferred to hospital emergency and used for further treatment. There is a gap between pre-and in hospital. The information flow between pre-hospital and hospital is interrupt. Secondly, as it lacks of

unified information center for managing patient's and health resource information, the information flow delivery depends on logistics and the speed of information flow is very slowly as well. Moreover, the integration of service flow, information flow and logistics is not enough. Therefore, coordination between different departments becomes less effective, resulting in wasting long of emergency time. To put it in a nutshell, the quality of our country emergency service at present is far from satisfied.

## 5 EMS system improvement

Management in EMS system. To ensure the safety and quality of emergency medical service, National Health and Family Planning Commission of the People's Republic of China has issued some corresponding regulations. "Three levels hospital accreditation standards" is the main criteria to measure the health care service ability and quality in China. Where expressly provided in Article 1.3.4, hospital should establish a "green channel" between pre-hospital and in hospital emergency for bridging departments effectively. The standards proposed strict rules for hospital emergency procedure. For instance, it requires hospital should set up a multi-sectoral and multi-department coordination mechanism to achieve allocation of medical resources reasonably and guarantee emergency treatment of difficult cases, multiple injuries and combined injuries<sup>[18]</sup>. It also requires hospital should establish the relevant provisions of disease classifications, in order to ensure the emergency operating smoothly. However, the standard has little about pre-hospital emergency and only some handover sheet requirements are involved. Pre-hospital emergency doesn't be incorporated into hospital integration management in this standard. So our emergency medical service system is lacking in

effective management for emergency information communicating and accessing.

Different from our country's medical management, the health care information is put a high value in USA health care management. Joint Commission International under the International Standards for Hospitals devotes to promote specific improvements in patient safety. Since the Joint Commission International accreditation (JCI) standards for hospitals available, it is considered as the uniform standards for evaluating the quality of hospital medical. The JCI standards made clear requirements for information exchange, including medical staff between pre-hospital and in hospital. Where expressly provided in MCI, effective communication within an organization is a leadership issue. Thus, the organization's leaders understand the dynamics of communication among professional groups, structural units such as departments, between professional and non-professional groups, and between health professionals and management, between health professionals and families and with outside organizations, to name a few. The organization's leaders not only set the parameters of effective communication but also serve as role models with the effective communication of the organization's mission, strategies, plans, and other relevant information. JCI also pays an attention on access to care and continuity of care. It proposed the goal of health care organization is to correctly match the patient's health care needs with the services available, coordinate the services provided to the patient in the organization, and then plan for discharge and follow-up. So it noted that the result improved patient care outcomes and increased more efficient use of available resources. What's more, the standard also pays more attention on interaction between patients and clinicians. It

requires when a patient is admitted to an organization for care, staff members then need to completely assess the patient to establish the reason the patient is there. The specific information the organization requires at this stage, and the procedures for getting it, depend on the patient's needs and the setting in which care is being provided, for example, inpatient or outpatient care. Organization policy and procedures define how this process functions and what information needs to be gathered and documented<sup>[19]</sup>.

EMS system improvement. JCI believes the information generated by patient services should be used for hospital management. Because the first-hand patient's information gathered from first-aiders has a very high medical value. Therefore, it could omit unnecessary test process and shorten waiting time before surgery by taking full use of information. What's more, it also can further improve medical service quality and outcomes.

It is well-known, it could improve first aid quality that enhancing the communications between each department on the service supply chain. However, it

is not easy to coordinate the relationship between each other. Ragatz et al. claimed that only when everybody was aware of their partners doing, how they were doing it and why, was it possible to coordinate each other's actions optimally<sup>[20]</sup>. Currently, there are two ways to achieve this goal. One way is by establishing more frequent contact with service chain partners. It should be done in both an informal and formal fashion<sup>[21]</sup>. The other is set up cross-functional or cross-organizational teams<sup>[22]</sup>. Li and Kannan et al. realized that cross-functional or cross-organizational teams facilitated short and direct information lines when the internal-communication needs to cross functional or even organizational boundaries<sup>[23-24]</sup>.

This article proposed A cross-organizational framework theoretical model-Smart Emergency Information Center (SEIC) is proposed, which could reduce communication barriers of the chain among all emergency services aspects. The SEIC includes medical information database, smart diagnostic module, mobile data terminals and data processing module, as shown in Figure 2.

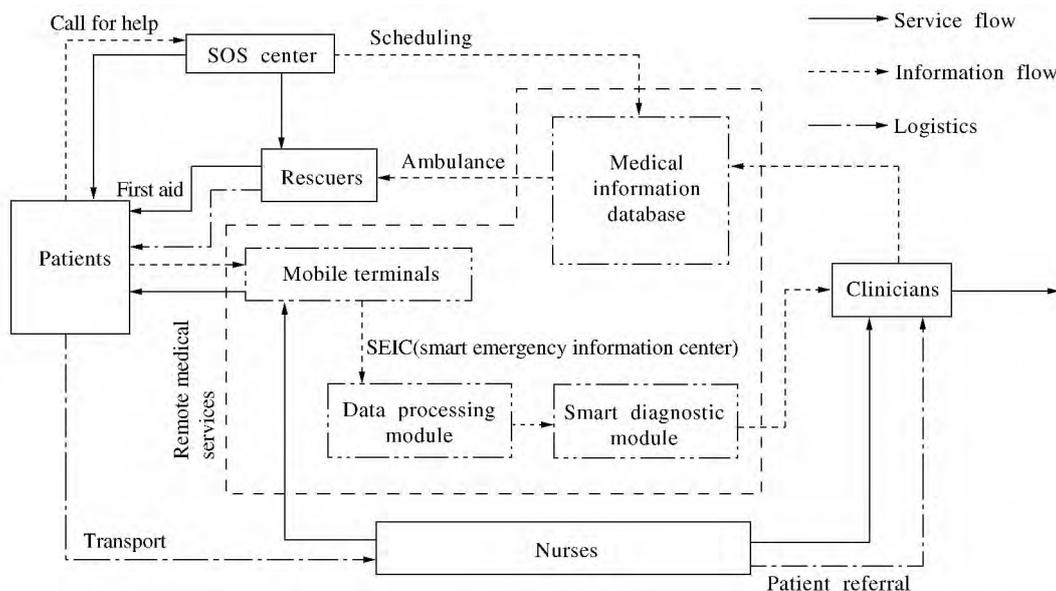


Figure 2 The improved EMS system

The SEIC has integrated the related working group from different departments and it establishes a closer relationship between partners on medical service chain, which enhanced mutual coordination. It ensures the transmission of information integrity, accuracy and timeliness by using common interface. By reducing the noise of medical information, SEIC could protect health safety.

The improved EMS system has efficiently shortened pre-surgery time by changing the serial emergency operations into concurrent ones in some sections. In the original operations, only the target materials were transferred from accident scenes to clinical reception, however, to some extent, the information and service flows were interrupted. They were regained after data collection and rapid diagnosis in first aid hospital when the patients arrived. With the help of the advanced mobile terminal equipment, which made it possible to communicate with the nurses in advance for good preparation during the emergent transfer of the patients, the improved first aid process realized the synchronization of information, service and materials flows in key sections between pre-and in-hospital first aids.

## 6 Conclusion

Traditional EMS system doesn't force on the interaction of medical information. The SFAIC integrates the activities of the different emergency medical services into a channel of medical service chain, which is used to enhance information exchanges between emergency in hospital and pre-hospital. The improved emergency medical process has increased first-aid quality by further shortening pre-surgery time and strengthening communication and coordination between service sections. This article

only analyzes the emergency flow from the theoretical aspect and some practical problems still should be further studied.

## References

- [1] Young T, Brailsford S, Connell C, *et al.* Using industrial processes to improve patient care [J]. *British Medical Journal*, 2004, 328: 162-164
- [2] Hanne T, Melo T, Nickel S. Bringing robustness to patient flow management through optimized patient transports in hospitals [J]. *Interfaces*, 2009, 39: 241-255
- [3] Porter M E. *Competitive advantage: creating and sustaining superior performance* [M]. The Free Press, New York. 1985
- [4] Ford E, Scanlon D. Promise and problems with supply chain management approaches to healthcare purchasing [J]. *Healthcare Management Review*, 2007, 32: 192-202
- [5] VanVactor J D. Strategic health care logistics planning in emergency management [J]. *Disaster Prevention and Management* 2012, 21: 299-309
- [6] Meijboom B, Schmidt-Bakx S, Westert G. Supply chain management practices for improving patient-oriented care [J]. *Supply Chain Management: An International Journal*, 2011, 16: 166-175
- [7] Sinha K K, Kohnke E J. Health care supply chain design: toward linking the development and delivery of care globally [J]. *Decision Sciences*, 2009, 42: 197-212
- [8] Zhang X, Chen R. Examining the mechanism of the value co-creation with customers [J]. *International Journal of Production Economics*, 2008, 116: 242-250
- [9] Andersson G, Karlberg I. Integrated care for the elderly: the background and effects of the reform of Swedish care of the elderly [J]. *International Journal of Integrated Care*,

- 2000 ,1: e01
- [10] Fredendall L D , Craig J B , Fowler P J , *et al.* Barriers to swift , even flow in the internal supply chain of perioperative surgical services department: a case study [J]. *Decision Sciences* , 2009 ,40( 2) : 327-349
- [11] Schoen C , Osborn R , Huynh P T , *et al.* Taking the pulse of health care systems: experiences of patients with health problems in six countries [J]. *Health Affairs* 2005 ,24( 6)
- [12] Saltman R , Rico A , Boerma W. Primary care in the driver's seat?: Organizational reform in European primary care [M]. McGraw-Hill International , 2005
- [13] Øvretveit J. Total quality management in european healthcare [J]. *International Journal of Health Care Quality Assurance* 2000 ,13: 74-80
- [14] Gröne O , Garcia-Barbero M. Integrated care: a position paper of the WHO European office for integrated health care services [J]. *International Journal of Integrated Care* 2001
- [15] Conrad D A , Shortell S M. Integrated health systems: promise and performance [J]. *Frontiers of Health Services Management* , 1996 ,13
- [16] Egger E. Integration the right strategy , despite health executives' increasing apprehensions [J]. *Health Care Strategic Management* , 1999 ,17
- [17] Bringewatt R J. The metamorphosis of chronic care Healthcare's next big hurdle [J]. *The Healthcare Forum Journal* , 1997 ,41: 14-21
- [18] National Health and Family Planning Commission of the People's Republic of China. Three levels hospital accreditation standards [M] , 2011
- [19] Joint Commission International under the International Standards for Hospitals. Joint Commission International Accreditation Standards for Hospital [M] 2011
- [20] Ragatz G L , Handfield R B , Scannell T V. Success factors for integrating suppliers into new product development [J]. *Journal of Product Innovation Management* , 1997 ,14: 190-202
- [21] Tan K C , Lyman S B , Wisner J D. Supply chain management: a strategic perspective [J]. *International Journal of Operations & Production Management* , 2002 ,22: 614-631
- [22] Chen J , Paulraj A. Towards a theory of supply chain management: the constructs and measurements [J]. *Journal of operations management* , 2004 ,22: 119-150
- [23] Li S , Ragu-Nathan B , Ragu-Nathan T S , *et al.* The impact of supply chain management practices on competitive advantage and organizational performance [J]. *Omega* , 2006 ,34: 107-124
- [24] Kannan V R , Tan K C. Just in time , total quality management , and supply chain management: understanding their linkages and impact on business performance [J]. *Omega* , 2005 ,33: 153-162

### Brief Biographies

**WU Hai-long** is a Ph.D candidate in the School of Management and Economics , Tongji University. His current research areas of interests are service quality management and operation management. blairwu1986@163.com

**Su Qiang** is a professor of Tongji University. His research interests include quality management and service operation management. blairwu1986@163.com

**ZHU Yan** is a professor of Tsinghua University. His current research interests include MIS and health care.

**XUE Lei** is an associate professor of Tsinghua University. His current research interests include MIS and statistics.