EXAMINATION OF THE EMERGENCY MEDICAL RESPONSE SYSTEM IN KOREA AND SUGGESTIONS FOR IMPROVEMENTS RELATING TO TRANSPORT

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Emergency medical response system in Korea was launched in 1982 for the improvement of national welfare. Emergency medical response system is made up of accident scene phase, transport phase, hospital phase, and communication system. The accident scene and transportation phase are mainly conducted by the 119 Rescue team and the hospital phase takes place at emergency medical centers. The communication system is managed by emergency medical information center.

This research focuses on the examination of current emergency medical response system related to the transport of emergency vehicles and suggests some transport-related ideas to improve the system in Korea. The study aimed to investigate the present emergency medical response system and identify problems, questionnaire survey and literature review were carried. The ideas include the improvement of emergency information flow and the development of preferential treatment methods for emergency vehicles. To improve the emergency information flow, this research studied the bridge between emergency medical information center and traffic information center and proposed the efficient utilization of traffic information for the better treatment of an emergency. When it comes to the movement of emergency vehicles, various preferential treatment methods were suggested.

Key Words: Emergency medical response system, Emergency information, Transport of emergency vehicle, Preferential treatment, Emergency rescue

1. INTRODUCTION

According to the research of the Korea Health Industry Development Institute, the preventable rate of death from trauma is 40.5% and the problem in pre-hospital phase is rated as 57.1% among causes[1]. The main problems in the pre-hospital phase include an inefficient emergency medical response system (EMRS) and transport system.

The Road Traffic Safety Authority reported in 2002 that the number of accidents on highways among the number of accidents in total was 2.82%, but the number of deaths from highway accidents among the number of deaths from all traffic accidents was rated as 7.78%[2], showing that the death rate from highway accidents was higher than non-highway accidents. The higher death rate from highway accidents reveals that the degree of risk on a highway is much higher than that in general and moreover the EMRS for highway accidents is not operated systemically.

For the improvement of EMRS, the Ministry of Health and Welfare has planned to expand financial resources to establish infrastructure for the rapid transport of emergency patients, and to introduce advanced emergency medical centers. In addition, the Ministry of Construction and Transportation and the National Police Agency have tried to redesign locations where traffic accidents frequently occur to secure safe traffic facilities, and to operate a traffic safety inspection system. However, intimate collaboration between medical-related authorities and transport-related authorities has still to be sufficiently established. Accident information collected by transport-related authorities is not delivered to medical-related authorities instantly. Medical-related authorities take full charge of emergency transport and receive little help from the transport-related authorities., hence close cooperation between two authorities is essential to advance EMRS.

This research focuses on the review of present EMRS related to the transport of emergency vehicles and brings some transport related ideas to improve the system in Korea. To investigate the present EMRS and identify problems, a questionnaire survey and literature review were carried out.

This paper is organized as follows. In the next section, we examine the EMRS in Korea. We then identify transport-related problems in EMRS in Korea, and finally, suggestions on transport-related ideas to advance the EMRS are made, followed by the conclusion.

2. EXAMINATION OF EMERGENCY MEDICAL RESPONSE SYSTEM

2.1 Outline of EMRS

EMRS means a systematic organization that provides rapid and efficient medical treatment to patients who need the emergency service[3]. It includes not only treatments in a hospital but also an extended medical service to regional communities. EMRS was begun in order to overcome the distance between emergency sites and medical centers.

The response process from the EMRS can be described as the following 3 phases:

- Accident scene phase: The immediate response of emergency vehicles and persons upon receiving an accident report and on-site treatment of the injured;
- Transport phase: Transportation of injured persons from the accident injury site to a hospital;
- Hospital phase: Prompt and professional treatment in hospital.

A communication system is also needed to interconnect the above mentioned 3 phases effectively.

2.2 EMRS in Korea

EMRS in Korea commenced in Seoul from 1982 through the foundation of the 119 Rescue team from more than 10 fire stations.

Emergency Medical Information Center (EMIC)

In Korea, EMIC was established in 1991. The goal of EMIC is to provide the necessary information to users ubiquitously, and can be reached by the telephone number, 1339. There are 12 EMIC's that it provide a consultation about emergency medical care and guidance to a suitable emergency medical institute. Table 1 shows the manpower in 12 EMIC branches.

Major functions of EMIC are based on Articles 27 and 28 of 'Emergency Medical Treatment Law'. The functions are as follows:

- Providing information about emergency medical treatment and a suitable hospital for an emergency vehicle;
- Management of sickbed information of a hospital;
- Collecting evaluation data of hospital and ambulance managers;
- Coping immediately when there are many patients;
- Observation of infectious disease and new types of disease by analyzing patients' symptoms in emergency medical institutes;
- Other tasks arranged by 'Order of Ministry of Health and Welfare'.

119 Rescue team[5]

EMRS has to be a prompt, professional and well-organized system that meets the requirements of emergency patients. Among the elements of EMRS, the 119 Rescue team plays an important role such as quick transport of emergency patients. The 119 Rescue team generates high productivity with a relatively low cost because it can utilize existing equipment such as ambulances, fire engines, staff and communications apparatus that belong to the fire department.

Table 2 shows the number of ambulances and emergency rescuers in the 119 Rescue team by region in 2002.

According to the statistics of 2002 shown in Table 3, the 119 Rescue team transported 944,775 times with 1,107 ambulances. The total number of transported patients was 982,697 persons, meaningly an average of 2,692 patients were transported per day[6].

According to Suh's report[7], reaction time of emergency vehicles is influenced by social factors and environmental factors. Social factors include demand of transport, method of call, degree of traffic congestion, hospital location, population, etc. Environmental factors include road condition, topography, weather condition, etc. The average dispatching distance for emergency vehicles is 2.3km in Seoul, 4.1km in 5 metropolitan areas, and 7.1km in provinces. Average reaction time of emergency vehicles is 4.2 minutes in Seoul, 5.2 minutes in 5 metropolitan areas, and 7.6 minutes in provinces. It reveals that dispatching distances and reaction times of cities are usually shorter than those of provinces.

As of Jan. 2003, 119 Rescue teams possessed 22 helicopters. Information on operation of 119 Rescue team's helicopters is shown in Table 4. In general, a helicopter

Table 1 Manpower of EMIC[4]

Role	Head	Section Chief	Health Section	Business Section	Communication Section	Public Health Doctor
Number of persons	12	12	70	24	24	48

Table 2 State of 119 Rescue team

Region	Ambulance			Emergency rescuer							
	Total	Special	General	Total	Nurse	EMT			Practical nurse	Training center	
						First degree	Second degree	Certified EMT		Professional	Others
Total	1,107	664	443	4,559	196	517	1,686	15	26	1,546	573
Center	1	1	0	8	1	0	3	0	0	0	4
Seoul	109	48	61	654	24	116	304	4	5	192	9
Pusan	51	23	28	229	20	1	104	4	4	83	13
Daegu	45	32	13	182	9	6	109	0	0	37	21
Incheon	41	16	25	176	4	56	59	0	1	50	6
Gwangju	22	22	0	99	5	11	41	2	0	40	0
Daejeon	26	20	6	122	11	12	62	0	0	37	0
Ulsan	20	12	8	87	7	9	25	1	0	0	45
Gyeonggi	158	87	71	631	13	108	228	0	6	124	152
Gangwon	100	60	40	381	1	0	198	0	0	43	139
Chungbuk	76	59	17	208	0	37	38	0	2	114	17
Chungnam	91	82	9	283	9	51	80	0	2	113	28
Jeonbuk	72	34	38	287	21	8	104	2	4	146	2
Jeonnam	79	51	28	290	23	37	80	1	1	130	18
Gyeongbuk	98	65	33	390	20	25	120	0	0	209	16
Gyeongnam	97	37	60	370	13	22	110	0	1	121	103
Jeju	21	15	6	162	15	18	21	1	0	107	0

Table 3 Accomplishment of 119 Rescue

Year	Number of ambulance	Number of transport	Number of transported patients	Average transported patients per day	Transported patients per ambulance
2002	1,107	944,775	982,697	2,692	888
2001	1,095	944,435	985,618	2,700	900
Increase(%)	1.1	0.0	-0.3	-0.3	-1.3

Table 4 Operation of 119 Rescue team's helicopters (in 2002)

Region	Number of Helicopter (EA)	Manpower (person)	Number of Operation (times)	Operation Hour (Hour)	Number of Transported Emergency Patient (person)
Center	2	20	194	420	0
Seoul	4	25	528	323	0
Pusan	2	14	141	161	1
Daegu	2	17	211	259	0
Incheon	1	10	74	69	18
Gwangju	1	8	123	161	14
Ulsan	1	7	62	86	1
Gyeounggi	3	23	445	555	4
Gangwon	2	17	261	309	12
Chungnam	1	8	57	73	6
Jeonbuk	1	11	108	147	11
Jeonnam	1	8	193	121	107
Gyeonbuk	1	8	92	73	7
Total	22	176	2,489	2,758	181

is operated by two pilots. In case of an emergency rescue operation, one helper can be added. Two copies of the emergency rescue report should be prepared. One must be submitted to a doctor and the other is kept in the 119 Rescue team for three years.

3. PROBLEMS OF EMERGENCY MEDICAL RESPONSE SYSTEM

A questionnaire survey was given between April 2 to May 16 in 2004 to check the present EMRS and identify any problems. The targets of the questionnaire survey were 30 domestic general hospitals and emergency medical centers. The contents of the questionnaire were divided into two parts; equipment and facilities related to emergency medical treatment and operation of EMRS. Detailed questions are as follows:

- Equipment and facilities related to emergency medical treatment;
  - Number of emergency vehicles owned;
  - Function of extra emergency call centers;
  - Other equipment and facilities related to emergency medical treatment;
- Operation of EMRS;
  - Scenario to respond to an emergency
  - Assignment of staff to cope with an emergency and their roles;
  - Communication with related organizations;
  - Any difficulties to operate EMRS.

Problems identified from the questionnaire survey and literature review are as follows.

3.1 Problems in transport phase

EMIC, 119 Rescue team, and hospitals take charge of EMRS in Korea. EMIC plays an important role in collecting information on emergency medical services in each hospital, receiving emergency calls, requesting the dispatch of an emergency vehicle and connecting communication between ambulance and center. The 119 Rescue team is responsible for the pre-hospital care at the site and the transport of patients. Usually, emergency rescuers who conduct emergency medical treatment at the site or on the way to hospital instead of doctors play the role as EMT. Existing emergency rescuers usually complete the training course in emergency medical service and rescue to acquire emergency rescuer's certification. However, emergency rescuers act passively because they are unable to obtain legal protection against their medical treatment. According to Kim's report[8], 46.1% of total responders were satisfied with the on-site treatment of the 119 Rescue team, and 48.3% of those said that the 119 Rescue team is only concerned with the transport of patients rather than medical treatment. It showed that most users are not fully satisfied with the 119 Rescue team's treatment.

The non-cooperative attitude of road users presents another problem in the transport phase. Usually, other drivers on the road hardly give way to emergency vehicles. Even though they concede their right of way to an emergency vehicle, their behavior is so irregular that it is very difficult for emergency vehicles to get precedence. It was determined that a systematic education of drivers on how to respond to emergency vehicles is lacking. The absence of any kind of preferential treatment for emergency vehicles was pointed out as another crucial problem to be solved.

3.2 Problems in emergency information flow among related organizations

EMIC opened and operated since July, 2000 is not rapidly connected to the moving out of emergency vehicles. It has a trouble to acquire accurate emergency information of the site. The 119 Rescue team belongs to the Ministry of Government Administration and Home Affairs. However, EMIC belongs to the Ministry of Health and Welfare. Therefore, their tasks are separated. According to a survey[9] given to EMIC's employees, only 5% answered that the emergency communication network is very well utilized and 65% of all responders said that it is not used properly. The Employee think that EMIC has a low rate of usage. The absence of cooperation among EMIC, emergency medical service institutes, and the 119 Rescue team is the main reason. The 119 Rescue team and emergency medical service institutes tend not to share information with EMIC.

4. SUGGESTIONS FOR IMPROVEMENTS RELATING TO TRANSPORT

4.1 Treatment of traffic flow at an accident site

When a traffic accident occurs, traffic congestion accumulates until the accident has been cleared, because an accident happens unexpectedly, delay is inevitable. Delay causes a waste in time and energy. In addition, it disturbs the rapid clearance from the accident and patient

transport. Therefore, it is very important to clear delayed traffic within a short time. On highways or primary roads, delivering accident information to drivers via variable message signs could be considered as a good way to reduce delays. Accident and detour information have to be conveyed to drivers so as to discourage them from getting into the accident site, and help to control traffic flow and to reduce delays. It could be also worthwhile to disseminate transportation information related to accident, delay, and detour routes via radio broadcasts.

4.2 Application of preferential treatment method to emergency vehicles

The patient transport phase is mostly conducted on roads except in some special cases. For fast and effective transport, a preferential treatment method for emergency vehicles could be applied. Preferential treatment method for emergency vehicles is one of the subjects that transportation engineering could investigate. For the transport phase on a highway, a preferential treatment method at a toll gate can be considered. Electronic Toll Collection System (ETCS) is installed at several spots (Chunggye, Sungnam, Pangyo) along the outer beltway of Seoul. Vehicles with an OBU(On-Board Unit) can pass through a toll gate without stopping for ticketing or payment. Therefore, if an OBU is placed in emergency vehicles, they do not become involved in delays and queues at toll gates. However, at the most toll plazas in Korea, toll collection is managed manually. Hence delays and queues are prone to exist. An exclusive toll gates or lane for emergency vehicles could be the answer to save a precious time at toll gates.

In case of local arterial streets, an intersection is the most troublesome location during the transport of emergency vehicles. Especially in a metropolitan city, emergency vehicles experience long delays at intersections during the peak hours. For the continuous movement of emergency vehicles, the preferential treatment by signal control at intersections could be considered. However, most signals can be controlled by a local controller located on site. Signal control by relevant staff for each transport of an emergency vehicle is impossible. Therefore, a traffic information center that can manage all traffic signals in the region is needed to provide the preferential treatment. Lately, many local governments are establishing traffic information centers as a part of Intelligent Transport Systems (ITS). If these traffic information centers are able to control all of the local signal controllers, preferential treatment for emergency vehicles would be enabled.

To introduce Car Navigation System (CNS) based on Global Positioning Systems (GPS) to emergency vehicles is another possible idea. EMIC can construct the management server to monitor the location of each emergency vehicle quipped with GPS in real time. It is also possible that a shortest path to the assigned hospital can be conveyed to the emergency vehicle by using real time traffic information. This can reduce a transport time and increase safety by a suggested shortest path.

Transport via helicopter is efficient when patients are in a critical condition or surface transport is impossible. In Korea, transport via helicopter in case of emergency rescue is not fully matured. As we can see in Table 4, the number of transported emergency patients is not so large compared to the operation hours of a helicopter. In my opinion, it is because of the shortage of the absolute quantity of the number of emergency rescue helicopters and the complicated procedure of requesting an emergency rescue helicopter. Therefore, we need to increase the number of emergency rescue helicopters in the near future and to select the location of heliports carefully and ideally. To select the location of a heliport for emergency patients, a kind of technique such as a solution to the facility locations problem could be applied. To introduce a helicopter dispatching system, major cities and regions have to prepare heliports at proper locations and train staff to manage them. A helicopter dispatching system is useful in the following cases; (1) Traffic congestion is so heavy that an emergency vehicle can not travel rapidly; (2) There is no way to approach the site by road; (3) Patients' condition is so critical that an emergency vehicle can not reach a hospital in time.

4.3 Preparation of manual on how to respond to emergency vehicles

It is a good way to educate drivers through a manual on how to respond to emergency vehicles to improve an EMRS. Usually drivers hardly make a concession to emergency vehicles. Even if they concede a right of way to emergency vehicles, their behavior is so irregular that it often makes it more difficult for the emergency vehicle to travel. Therefore, it is desirable to make a manual that guides drivers on how to respond to emergency vehicles, to concede their right of way and to educate drivers with the manual. Questions about the manual could be included in the driver's license test.

The following Fig. 1, 2, 3 show the improved EMRS after implementing the suggestions.

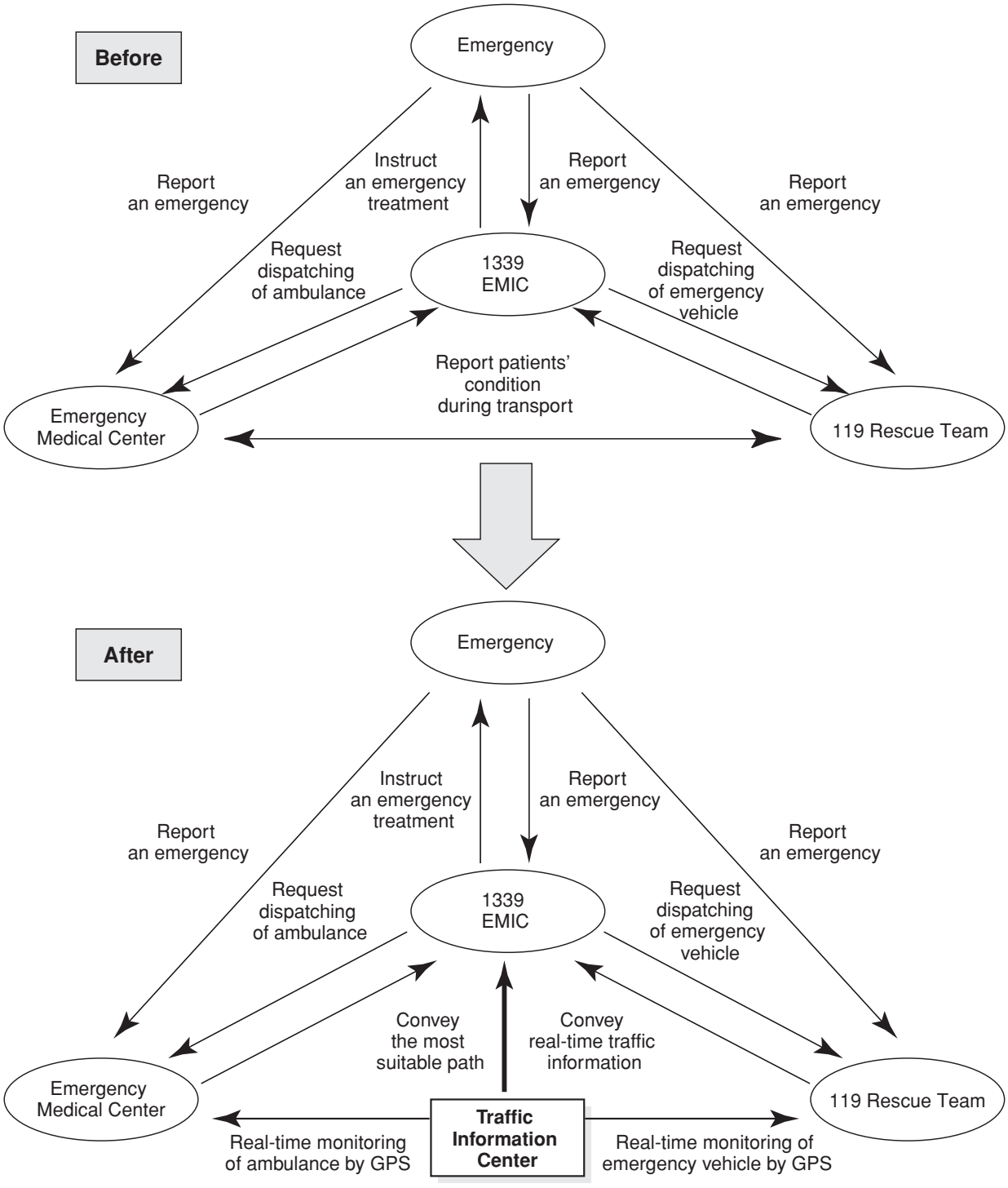

Fig. 1 Diagram of emergency information flow

Fig.1 shows a diagram of emergency information flow. As it appears, the more efficient management is possible with a traffic information center conveying traffic information to an EMIC. First, an EMIC can monitor the real-time position of emergency vehicles through GPS. Secondly, an emergency vehicle can transport patients efficiently using the optimal path guidance from an EMIC.

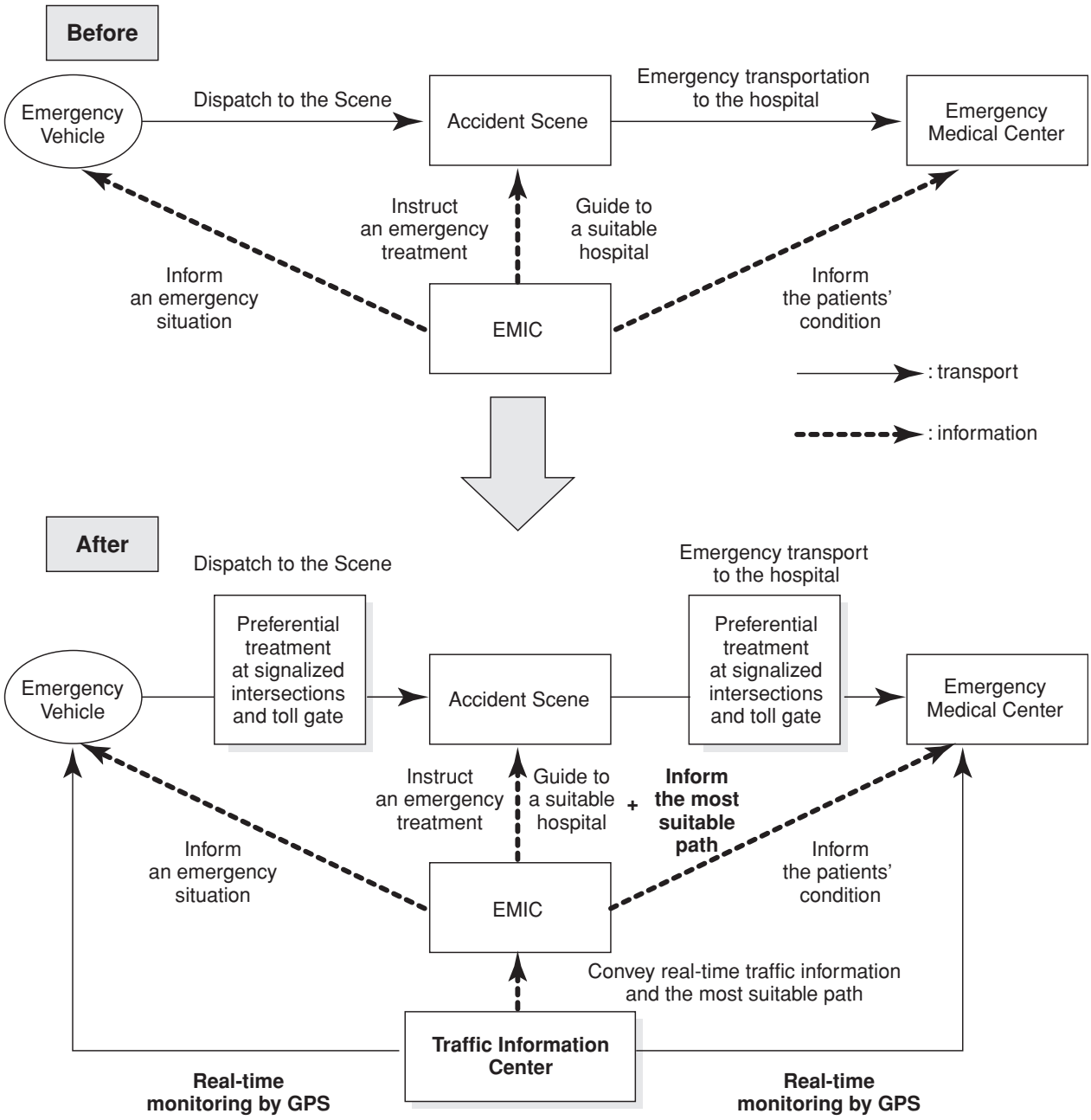

Fig. 2 Diagram of transport phase

Fig. 2 shows the transport phase when adopting preferential treatments. An emergency vehicle can obtain a right of way at signalized intersections and toll gates by the preferential treatment. It makes the transport phase faster and more efficient.

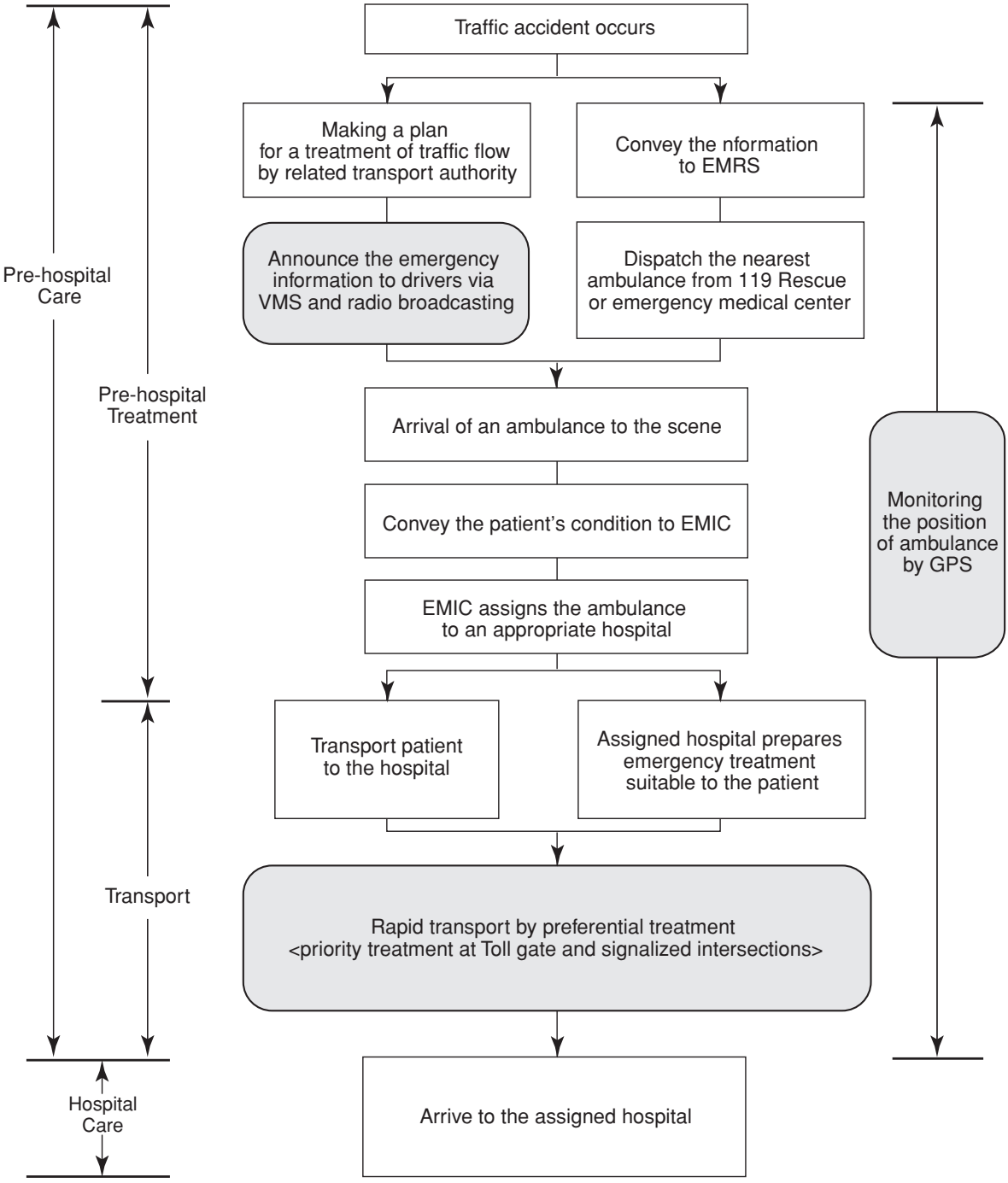

Fig. 3 Application of the transport-related improvement to EMRS

Fig. 3 shows an EMRS that is improved by the transport-related treatment. Improvements are shown in each phase.

5. CONCLUSION

The purpose of this research was to review the current EMRS related to transport emergency vehicles and

to suggest some transport-related ideas as a solution to existing problems. Although the EMRS in Korea has been greatly improved since 1982, it does not provide full satisfaction to users. In this paper, problems were detected in the transport phase and in the emergency information flow among related organizations. To solve those problems, several transport-related improvements were suggested. These improvements included the treatment of traffic flow at the accident site, application of preferential treatment methods to emergency vehicles, and preparation of amanual on how to respond to emergency vehicles. To apply these suggestions, further detailed studies such as a concrete introduction plan of these improvements, cost-benefit analysis of these suggestions, agreements on each role among medical-related organizations are essential.

REFERENCES

1. Health and Medical Treatment Statistics. Korea Health Industry Development Institute. (2003).
2. Traffic Safety Statistics. The Road Traffic Safety Authority. (2003).
3. Han-Seung Yang. Research of Emergency Medical System in Korea. Gangnam University. (2000).
4. Art.7 of the Law about Arrangement and Management of Rescuer. Ministry of Government Administration and Home Affairs. (2000).
5. Gyeong-Mo Lee. Study of Advanced Pre-hospital Phase in Emergency Medical Response System. 15th Fire Administration Congress. (2003).
6. Administrative Data and Statistics of Fire Institute. Ministry of Government Administration and Home Affairs. (2002).
7. Gil-Joon Suh. Pre-hospital Trauma Care System in Seoul by 119 Rescue Services. "The Journal of The Korea Society of Emergency Medicine" 12(2). (2001).
8. Meung-Ryong Kim. Perception of Satisfaction with Future of 119 Rescue in the View of the User. "The Journal of The Korea Society of Emergency Medicine" 14(4). (2003).
9. Soon-Joo Wang. Analysis of Operational Result of the 1339 Emergency Medical Information Center. "The Journal of The Korea Society of Emergency Medicine" 13(4).(2002).