

## Developing Strategies to Address Ambulance Accidents using the Korean In-Depth Accident Study Database

Hee Young Lee<sup>1#</sup>, Jeong Il Lee<sup>1</sup>, Jung Hun Lee<sup>1</sup>, Sil Sung<sup>1</sup>, Chan Young Kang<sup>1</sup>, Kang Hyun Lee<sup>1+</sup>, Young Han Youn<sup>2</sup>

<sup>1</sup> Department of Emergency Medicine, Yonsei University Wonju College of Medicine, 20 Ilisan-ro, Wonju, Gangwon, 26426, Korea

<sup>2</sup> School of Mechatronics, Korea University of Technology and Education, 1600 Chungjeol-ro, Byeongcheoun-myeon, Dongnam-gu, Cheonan, Chungcheongnam-do, 31253, Korea

### Abstract

This study analyzed ambulance crashes in depth using two cases of ambulance crashes among accidents based on the KIDAS (Korean In-Depth Accident Study) database in order to suggest safety regulations for operating emergency vehicles. For each case, the vehicle damage patterns coded by CDC were analyzed along with the on-scene photos and the severity of each patient's injury was evaluated by a trauma score. One case was the private ambulance crashed to the guard rail on a slippery expressway in a rainy day of July 2014, causing one death, one serious injury, and one slight injury among three occupants. Another case was the public ambulance crash which fell over on the right side due to signal violation in October 2014, causing only slight injuries among four occupants. By assessing the problems about ambulance operation in Korea through the analysis of ambulance crashes based on the KIDAS database and comparing with the previous studies, this study suggests a plan for improvement.

**Key words:** ambulance crashes, countermeasure, Korean In-Depth Accident Study(KIDAS)

### 1. Introduction

Emergency Medical Service (EMS) systems have been developed in countries throughout the world as national safety systems to be prepared for urgent situations such as disasters, emergency situations, patient transportation, and patient transportation between hospitals. In addition, as

a means of transportation to operate the systems, ambulances have been utilized and developed in diverse forms by country. However, as national economy develops and people's demand for EMS increases, safety accidents and traffic accidents occur frequently. A recent study by the US National Highway Traffic Safety Administration (NHTSA) reported that approximately 4,500

<sup>#</sup> The 1st author: Hee Young Lee, Tel. +82-33-741-0846, Fax. +82-33-742-3030, e-mail. [hylee3971@yonsei.ac.kr](mailto:hylee3971@yonsei.ac.kr)

<sup>+</sup> Corresponding author: Kang Hyun Lee, Tel. +82-33-741-1612, e-mail. [ed119@yonsei.ac.kr](mailto:ed119@yonsei.ac.kr)

accidents of ambulances operated in EMS systems occurred during 1992 ~ 2011 and that when accidents occurred, the mortality rate of drivers was approximately 4%, that of fellow passengers or patients was 21%, and injuries occurred in 17% of drivers and 29% of patients (NHTSA, 2011). In addition, compared to patrol cars or fire engines, ambulance crashes were shown to have very high mortality rates of occupants. To prevent ambulance crashes, the NHTSA in the USA and the National Health Service (NHS) in the UK have been making great efforts for safety regulations for emergency vehicles and related human resource education. In South Korea too, since the beginning of operation of EMS systems, demand for ambulances has increased sharply and emergency vehicle accidents have been occurring continuously in complicated road traffic situations and diverse incident and accident situations. According to the 2013 statistical report of the National Emergency Management Agency, among the entire 68 fire engine operation accidents, ambulances accounted for the highest percentage with 38 cases (62%) and among the causes of accidents, traffic signal violations were the most frequent (56%) followed by violation of central line (13%), lane violation (13%), failure to secure safety distance (13%), and over-speed (6%) (National Emergency Management Agency, 2014). Despite that the types and number of times of occurrence of accidents increase as such, no study has been conducted on safety accident prevention to be prepared for increases in the emergency vehicles operated and manpower working in domestic EMS systems. Ray, *et. al.*(2005) were reported that ambulance crashes were more likely to occur at four-way intersections and traffic

signals and to occur as angled collisions (Ray, *et. al.*, 2005). Similarly, Kahn, *et. al.*(2001) were showed that ambulance crashes were more likely to occur between noon and 6 pm, to strike another vehicles while going straight, and to occur the fatal injuries in the rear compartment (Kahn, *et. al.*, 2001; Saunders & Heye, 1994). It was presented that the occupational fatality rate among the emergency medical service personnel in the United States was twice than that of the general emergency public service workers (Maquire, *et. al.*, 2002). Therefore, the present study was conducted to analyze the causes and characteristics of two real-world investigated ambulance crashes in the EMS system to utilize the results as an evidence data in pilot study for improvement of safety regulations for the operation of emergency vehicles and for presentation of proper directions of operation.

## II. Methods

### 1. Design

This study was focused on patients who visited hospital emergency rooms due to vehicle traffic accidents, especially related to ambulance crashes. It was analyzed the real-world investigated photos of damaged vehicles and medical records of injured occupants retrospectively. It aimed to analyze the current regulations for ambulance operation and problems through ambulance crashes in Korea In-Depth Accident Study (hereinafter, KIDAS) database that occurred in the region and present an improvement plan their comparative consideration with previous studies.

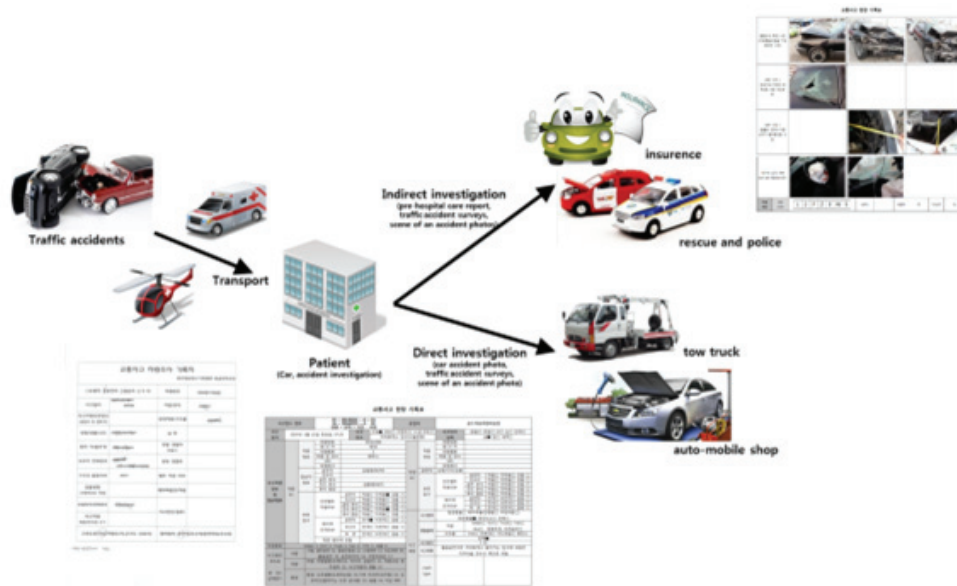


Figure 1. Korea in-depth accident study (KIDAS) investigation system

## 2. Accident field data investigation system

Since 2012, KIDAS database has been introduced the structure of German In-Depth Accident Study (GIDAS) and the core variables of Initiative for the Global Harmonization of Accident Data (iGLAD) (Kim, *et. al.*, 2014). Especially, the real-world accident field data investigation system leading by regional hospitals is as follows (<Figure 1>). Data were collected from patients who visited hospital emergency rooms due to vehicle traffic accidents between August 2012 and February 2015. After getting patients' or protectors' agreement, researchers visited firsthand, the service centers or towing companies where vehicles were kept to collect vehicle damage data or indirectly asked police stations or insurance companies to be provided with initial data on accidents. Documents were prepared from before each actual accident data field investigation to management after the investigation to leave records.

## 3. Data collection

The present study was conducted after getting approval by the research ethics committee of Yonsei University (YWMR-14-5-074).

### 1) Accident information

Among the data collected from 2012 to now, two cases of ambulance crashes occurred in the Gangwon-do region were investigated in-depth. Also among accidents occurred, one case of long distance transport patient accident (death 1, serious injury 1, and slight injury 1) that occurred in on an expressway in the rainy season in July 2014 and another case of accident (slight injuries 4) that occurred in a rush in October 2014 were analyzed.

### 2) Vehicle information

Accident vehicle photos of the front, rear, left side, right side were basically obtained and photos of major collision areas and internal damage areas, evidence of whether the safety belt was worn, and evidence whether the airbag was inflated were

additionally obtained. When judging whether the safety belt was worn that affects the degree of damage to the patient, cases where the patient stated that he/she wore the safety belt or cases where the safety belt was found as having a trace of being scratched or being unfastened when the accident vehicle was investigated recorded as cases where the patient wore the safety belt and cases where the front glass had a trace of damage by the head (Bull's eye fracture) or cases where the statements of the patient and the rescuer were insufficient and the evidence was damaged were recorded as cases where the patient did not wear the safety belt. In addition, to identify more accurate situations, the researcher visited the competent police station to ask the investigator in charge whether the accident was reported and request information on accident situations only for reported cases. Based on the data collected as such, accident vehicle damage information was identified in the form of Collision Deformation

Classification code (hereinafter, CDC code).

#### 4. Data analysis

##### 1) CDC code

The CDC code is a vehicle damage code devised by the US Society of Automotive Engineers (SAE) that indicates vehicle damage areas, damage shapes, and the degree of damage. The CDC code consisting of seven digits is composed as follows (Figure 2)\*. The first and second digits indicate the position of the initial collision in clock directions. The third digit indicates the position after the change by the collision with indicators for front (F), back (B), left (L), right (R), top (T), under (U). The fourth digit indicates the outer horizontal position of the collision with indicators for left (L), center (C), right (R), left middle (Y), right middle (Z), and entire plane (D) in the longitudinal direction and front (F), middle (P), back (B), front middle (Y), rear middle (Z), and entire plane (D) in the transverse direction. The

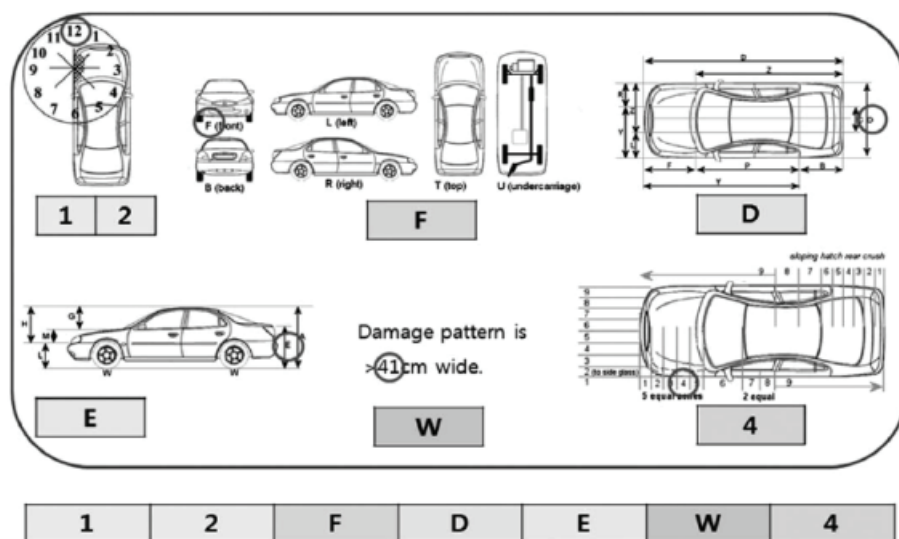


Figure 2. Examples of CDC code for the damaged vehicle

\* Source: Kim, *et al.* (2012). Pilot Study on Construction of a Database for In-depth Analysis of Occupant Injury and Vehicle Damage of Domestic Motor Vehicle Crash Accidents. *J Korean Emerg Med.* 23(3): 315-326.

fifth digit indicates the outer vertical position of the collision with indicators for below the wheel (W), frame (L), from above the frame to the belt line (M), above the belt line (G), below the belt line (E), above the frame (H), and the entire plane (A). The sixth digit indicates the kind of damage that contributed to collision with indicators such as wide area (W), narrow area (N), and overturn (O). Finally, the seventh digit indicates the degree of deformation which is normally judged based on the area that was deformed the most using criteria specified for sedan, truck, and van.

2) AIS/ISS

The AIS is a useful injury scale for classification of the severity of traffic accident patients. The AIS is an abbreviated injury scale established by the Association for the Advancement of Automotive Medicine (AAAM) that classifies injuries with seven digits and eight body area and gives 1 through 6 points to the severity of injuries. AIS

1 indicates the head and neck area including the head and the neck, AIS 2 indicates the face, AIS 3 indicates the chest, AIS 4 indicates the organs in the abdomen and the pelvis, AIS 5 indicates the upper and lower extremities and the pelvis, and AIS 6 indicates external factors such as burns, frostbite, and explosion. The MAIS (Maximum Abbreviated Injury Scale) refers to the maximum AIS value among AIS values given to individual body parts. The ISS indicates injury scores calculated by summing up the squares of AIS values for three body parts with high degrees of injuries. It is expressed with numbers ranging from 1 point to 75 points and patients with 15 points or higher scores are suggested as serious cases.

III. Case reports

1. Case I

At approximately 7:00 on a day in July 2014, a private ambulance that was transporting a patient

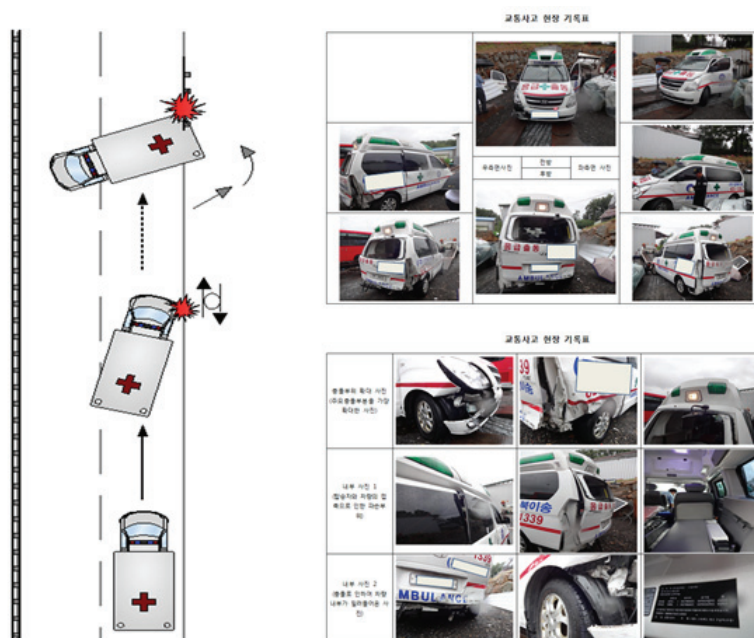


Figure 3. Accident description and pictures of damaged vehicle in case I

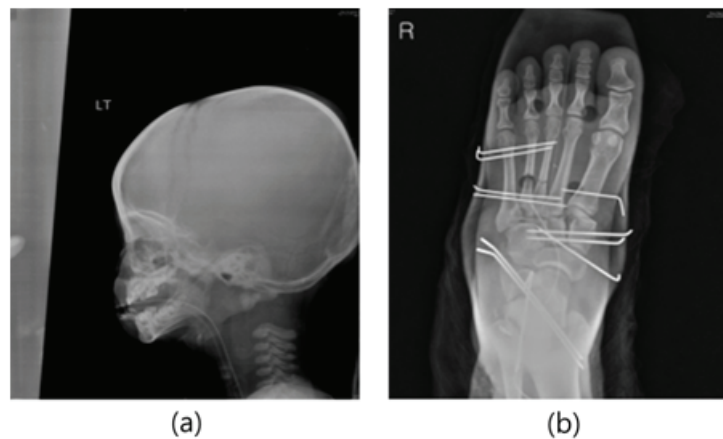


Figure 4. Computer Tomography (CT) images of each occupant in case I ; (a) A's cervical spine (b) B's right foot

to a hospital slipped to collide with the guard rail and rotate thereafter and the occupants were rescued by the 119 emergency agency and transported to the hospital. At the time of accident, there were one year old child patient on the stretcher in the backseat, a 31 year old protector in the protector's seat next to the stretcher in the vehicle and none of the occupants was wearing the safety belt. After the vehicle traffic accident was reported, vehicle damage and human body injury information was collected according to the accident field data investigation system. Through collection of photos of vehicle damage, initial collision CDC code 12FRLE2, and secondary collision CDC code 05RBEW3 were obtained (<Figure 3>).

The occupant (A) had a past history of asthma and was on the way to transfer for treating acute asthma attack by private ambulance. He was lying on the stretcher and was cardiac arrest when arrived at the hospital, his body temperature was 34.0°C. He was expired after cardiopulmonary resuscitation (CPR) in the emergency room. X-ray (C-spine Lateral View) findings after death declaration was the atlas(C1) to axis(C2) dislocations

(<Figure 4> (a)). The occupant (B) that was sitting in the protector's seat next to the stretcher showed initial vital signs as follows; blood pressure 119/73 mmHg, pulse rate 64 per minute, respiration rate 20 per minutes, and body temperature 36.7°C. His ISS was 9 points as mainly lower extremity injuries were shown and he was moved to a general ward after emergency operating (<Figure 4> (b)).

## 2. Case II

At around 10:00 on a day in October 2014, while the ambulance was going straight on a national highway, the ambulance collided with a vehicle in a three-way intersection coming out from the other road by turning left on its right side and the occupants were rescued by the 119 emergency agency and transported to the hospital. At the time of the collision, there were four occupants in the vehicle; one in the driver's seat, one in the passenger seat, one in the center in front of the stretcher in the backseat, and one in the protector's seat next to the stretcher and none of the occupant was wearing the safety belt. After the vehicle traffic accident was reported, vehicle damage and human body injury information was



Figure 5. Accident description and pictures of damaged vehicle in case II

collected according to the accident field data investigation system. Through collection of photos of vehicle damage, initial collision CDC code 02RZEW2, and secondary collision CDC code 00LDAO1 were obtained (Figure 5).

The occupant in the driver's seat complained of pain in both elbows and the occupant in the passenger seat complained of pain in the neck area and pain and numbness in the left arm. The occupant in the center in front of the stretcher in the backseat had lumbar pain, pain in both elbows, and left elbow laceration and the occupant in the protector's seat next to the stretcher complained of pain in the left flank. All the four ambulance occupants were injured slightly and went home as their symptoms were relieved.

#### IV. Discussion

In South Korea, as people's demand for EMS increased and EMS began to be developed, the scope of utilization of ambulance was widened and the number of traffic accidents increased

accordingly. However, although EMS began 2000, no clear guideline for ambulance crashes and safety has been presented yet in South Korea. The present study was intended to examine the present situation of operation of ambulances, problems in accidents, and directions for improvement through the domestic car investigation system. Two accident cases were examined in the study to present the present situation of operation of emergency vehicles in South Korea and several implications for the direction of improvement. Case I is an accident that occurred on an expressway in rain and 1) the cause of the accident 2) the situation of the accident 3) patients' injuries, and 4) the risk of ambulance crashes on expressways were investigated and the direction of improvement was analyzed based on the cause and results through previous studies. The cause of the accident was a side collision as the ambulance that was transporting the patient to a specialized hospital in rain slipped and crashed into the side guard rail on an expressway. The accident vehicle was occupied by the driver, the patient, and the

patient's protector and the occupants were not wearing the safety belt. A study conducted by Gunnarsson, *et. al.* emphasized that more attention should be paid when driving emergency vehicles in rain because higher accident incident rates were shown when the weather was bad and a study conducted by Christopher, *et. al.* reported that in ambulance crashes, occupants' injuries occurred more frequently in patient occupants' spaces than in driver's spaces (Gunnarsson, *et. al.*, 2007; Kahn, *et. al.*, 2001). A study report by the Centers for Disease Control and Prevention (CDC) identified the reason why the degree of occupants' injuries is higher as failure to wear appropriate safety devices such as safety belts and emphasized the necessity of installation of safety devices in ambulances and occupants' wearing the safety devices (Proudfoot, *et. al.*, 2003). Savolainen, *et. al.* (2009) were presented that injuries intended to be most severe at high speeds, when emergency drivers transferred of the patients quickly, so that it was caused the high incidence of traffic accident and injury severity (Savolainen, *et. al.*, 2009). Also, Emergency vehicle drivers were the only group that showed over-involvement in collisions involving time pressure and excess speed (Clarke, *et. al.*, 2009). However, in South Korea, there is no clear safety guideline for matters that require attention when driving ambulances or when patients are in ambulances. In addition, as not many studies have been conducted on domestic emergency vehicle collisions and safety measures, despite that EMS has been provided to the people for several years and the number of times of 119 emergency rushes in South Korea in 2014 reached 2,389,211, there is no appropriate countermeasure

against various ambulance safety accident related problems. A study conducted by Brice, *et. al.* emphasized that to improve such situations, guidelines for data collection systems and safety regulations should be prepared (Brice, *et. al.*, 2012). A study conducted by Jeffrey, *et. al.* stated that the application of new traffic rules intended to prevent safety accidents should be effective in reducing road traffic accidents occurring on actual roads (Brubacher, *et. al.*, 2014). Case II is an accident that occurred in an intersection on a national highway (general road) and 1) the cause of the accident 2) the situation of the accident 3) patients' injuries, and 4) the risk of ambulance crashes in intersections on general roads were investigated and the direction of improvement was analyzed based on the cause and results through previous studies. There were four occupants in the vehicle in total; one in the driver's seat, one in the passenger seat, one in the center in front of the stretcher in the backseat, and one in the protector's seat next to the stretcher and none of the occupant was wearing the safety belt. All the injuries of the occupants were classified into slight injuries. A study conducted by Adam, *et. al.* stated that when ambulances were driven in downtowns, accidents occurred most frequently in intersections and when ambulances were driven in countryside, single vehicle accidents occurred frequently (Weiss, *et. al.*, 2001). They advised that factors that affect accidents occurring in downtowns include intersections, other vehicles, and traffic signals and factors that affect accidents occurring in countryside were environmental factors such as road conditions and weather conditions rather than other vehicles. They also advised that the lack of

standards for ambulance driving, no use of safety devices, insufficient vehicle management, and insufficient driver training are factors that contribute to vehicle collisions (Sanddal, *et. al.*, 2008). As such, analyses indicated that ambulance crashes occur due to diverse causes, ambulances are exposed to higher risks of collisions than patrol cars or fire engines (Levick, *et. al.*, 2005), and that the actual mortality rate of occupants of ambulances is more than four times the rates of occupants of patrol cars or fire engines (Sanddal, *et. al.*, 2008; Kahane, *et. al.*, 2000). All EMS operating departments should have standards for ambulances' warning systems and standards for responses to warning systems' emergency calls should be established and utilized (Sanddal, *et. al.*, 2010). A study conducted by Catherine, *et. al.* indicated that when an emergency vehicle enters into an intersection, the vehicle should be visually prominent, the vehicle's auditory warning system should be outstanding, and exchanges of glances between drivers are important for safe driving (Custalow & Gravitz, 2004). As such, to prevent accidents, studies should be conducted first in multilateral aspects and safety measures should be prepared through the studies. However, as shown by the results of the present study, in South Korea, studies that will support clear safety guidelines for ambulance operation, education and training courses, certificate courses, speed regulations, warning system regulations, safety device regulations, related laws and policies, and government agencies' regulation systems or penalties are insufficient. Due to such situations, despite that many problems and accidents occur in private ambulance services; the quality of the

services cannot be improved yet. The incidence of ambulance accidents was increased due to insufficient policies about public health, laws and regulations about EMS system, and the lack of knowledge about driving the emergency vehicles (Kızıldag & Aksu, 2008). Therefore, the National Association of EMS Physicians emphasized that to improve the quality, studies should be continuously conducted for improvement of the quality of the services and good cases operation of advanced countries and other regions should be bench-marked and that this will be a good direction for the development of EMS (National Association of E.M.S.P., 2011). A study conducted by Ballam, *et. al.* advised that to establish stable and effective ambulance services, analyzing past accidents to predict accidents that may occur later and prepare countermeasures is important (Ballam, 2011). However, since there is no data that can be used to analyze past accidents or traffic accident data collection system in South Korea, there is no case of study that considered related problems. Conventionally, previous studies on traffic accidents suggested that indicators such as vehicle speed, collision areas, and the degree of vehicle damage would be indicators for EMS members to divide patients into patients with minor injuries, those with severe injuries, and emergency patients at the site (Cleveland, *et. al.*, 2014; Evans, *et. al.*, 2009; Conroy, *et. al.*, 2008). As such, to improve the quality of EMS and systematically develop domestic ambulance safety systems, national standard indicators should be determined through car accident investigation systems based on previous studies to prepare criteria and data construction systems should be

prepared through the criteria. In addition, efforts should be made to bench-mark diverse study cases and successful operation in advanced countries and apply them to domestic EMS systems. Although more cases are necessary to generalize the study, the accident investigation systems began to be used in only some regions not long before. Therefore, data management systems should be established through continuous studies.

## V. Conclusion

A conclusion of the present study is that to prevent the recurrence of accidents occurred in the past, emergency vehicle collision investigation systems should be established and that to secure ambulance safety in EMS systems, education, training, operation guidelines, safety standards, and institutional support are necessary as well as continuous studies to support the foregoing.

## 감사의 글

This research was supported by the Korea Ministry of Land, Infrastructure and Transport. It was also supported by the Korea Agency for Infrastructure Technology Advancement(Project No.: 16PTSI-C054118-08).

## References

- Ballam, E. 2011. Ambulance Crash Roundup. A Review of Emergency Vehicle Crashes during 2010. *EMS World*. 40: 74-75.
- Brice, J. H., J. R. Stidnek, B. L. Bigham, C. Martingill, C. B. Custalow, E. Hawkins, and L. J. Morrison. 2012. EMS Provider and Patient Safety during Response and Transport: Proceedings of an Ambulance Safety Conference. *Prehosp Emerg Care*. 16: 3-19.
- Brubacher, J. R., H. Chan, P. Brasher, S. Erdelyi, E. Desapriya, M. Asbridge, R. Purssell, S. Macdonald, N. Schuurman, and I. Pike. 2014. Reduction in Fatalities, Ambulance Calls, and Hospital Admissions for Road Trauma after Implementation of New Traffic Laws. *Am J Public Health*. 104: 89-97.
- Clarke D. D., P. Ward, C. Bartle, and W. Truman. 2009. Work-related Traffic Collisions in the UK. *Accid Anal Prev*. 41: 345-351.
- Cleveland, N., C. Colwell, E. Douglass, E. Hopkins, and J. S. Haukoos. 2014. Motor Vehicle Crash Severity Estimations by Physicians and Prehospital Personnel. *Prehosp Emerg Care*. 18: 402-407.
- Conroy, C., G. T. Tominaga, S. Erwin, S. Pacyna, T. Velky, F. Kennedy, M. Sise, and R. Coimbra. 2008. The Influence of Vehicle Damage on Injury Severity of Drivers in Head-on Motor Vehicle Crashes. *Accid Anal Prev*. 40: 1589-1594.
- Custalow, C. B. and C. S. Gravitz. 2004. Emergency Medical Vehicle Collisions and Potential for Preventive Intervention. *Prehosp Emerg Care*. 8: 175-184.
- Evans, S. L., M. L. Nance, K. B. Arbogast, M. R. Elliott, and F. K. Winston. 2009. Passenger Compartment Intrusion as a Predictor of Significant Injury for Children in Motor Vehicle Crashes. *J Trauma*. 66: 504-507.
- Gunnarsson, B., H. Svavarsd Ttir, S. Dason, A. Sim, A. Munro, C. Mcinnes, R. Macdonald, K. A. Ångquist, and M. B. M. Nordstr. 2007. Ambulance Transport and Services in the Rural Areas of Iceland, Scotland and Sweden. *J Emerg Prim Health Care*. 5: 5.
- Kahane, C. J. 2000. *Fatality Reduction by Safety Belts for Front-seat Occupants of Cars and Light Trucks: Updated and Expanded Estimates Based on 1986-99 FARS Data*.
- Kahn, C. A., R. G. Pirrallo, and E. M. Kuhn. 2001. Characteristics of Fatal Ambulance Crashes in the United States : An 11-year Retrospective Analysis. *Prehosp Emerg Care*. 5: 261-269.
- Kim, Si Woo, Jae Wan Lee, and Young Han Youn. 2014. A Study on the Construction of the Database Structure for the Korea In-Depth Accident Study. *Trans. KSAE*. 22: 29-36.

- Kızıldağ H. B. and A. Aksu. 2008. Kavsaklarda Gestlg Virajlar ve Sollama Kuralları. In Eks, i A, (ed.). *Ambulans Sürüş, Teknikleri Eğitim Kitabı*. Ankara. *Anıl Matbaacılık*. 93-100.
- Levick, N. and J. Swanson. 2005. Managing Risk and Reducing Crashes: Implementing a Driver Performance-measuring Device in Ground Ambulances. *Prehosp Emerg Care*. 9: 108.
- Maguire B. J., K. C. Hunting, G. S. Smith, and N. R. Levick. 2002. Occupational Fatalities in Emergency Medical Services: A Hidden Crisis. *Ann Emerg Med*. 40: 625-632.
- National Association Of, E.M.S.P. 2011. Ambulance Diversion and Emergency Department Offload Delay. *Prehosp Emerg Care*. 15: 543-543.
- National Emergency Management Agency. 2014. *2013 Annual Statistics Reporting*.
- National Highway Traffic Safety Administration. 2011. *Fatality Analysis Reporting System (FARS) 1992-2010 Final*.
- Proudfoot, S. L., N. T. Romano, T. G. Bobrick, and P. H. Moore. 2003. Ambulance Crash-related Injuries among Emergency Medical Services workers-United States, 1991-2002. *MMWR: Morbidity and Mortality Weekly Report*. 52: 154-156.
- Ray F. A. and D. G. Kupas. 2005. Comparison of Crashes Involving Ambulances with Those of Similar-sized Vehicles. *Prehosp Emerg Care*. 9: 412-415.
- Sanddal, N. D., S. Albert, J. D. Hansen, and D. F. Kupas. 2008. Contributing Factors and Issues Associated with Rural Ambulance Crashes: Literature Review and Annotated Bibliography. *Prehosp Emerg Care*. 12: 257-267.
- Sanddal, T. L., Sanddal, N. D., Ward, N. and Stanley, L. 2010. Ambulance Crash Characteristics in the US Defined by the Popular Press: A Retrospective Analysis. *Emerg Med Int*. 2010: 7. Article ID 525979. doi:10.1155/ 2010/525979.
- Saunders C. E. and Heye C. J. 1994. Ambulance Collisions in an Urban Environment. *Prehosp Disaster Med*. 9: 118-124.
- Savolainen P. T., D. Chandra, G. Kakan, K. Indrajit, and L. N. Teja. 2009. Lamb A. Investigation of Emergency Vehicle Crashes in the State of Michigan. *USDOT Region V Regional University Transportation Center Final Report*.
- Weiss, S. J., R. Ellis, A. A. Ernst, R. F. Land, and A. Garza. 2001. A Comparison of Rural and Urban Ambulance Crashes. *Am J Emerg Med*. 19: 52-56.
- Korean References Translated from the English*
- 김시우, 이재완, 윤영한. 2014. 한국형 교통사고 심층조사 DB 체계 구축에 대한 연구. 22(2): 29-36.

Received: Dec. 15, 2016 / Revised: Jan. 11, 2017 / Accepted: Jan. 17, 2017

## 한국형 자동차사고 심층분석 데이터베이스의 구급차 사고사례 분석을 통한 응급차량 안전사고 대책방안

국문초록 최근 미국 응급의료서비스(Emergency Medical Service, EMS) 체계에서의 응급차량관련 사망사고 시 운전자의 74%, 동승자의 82%에서 발생한다고 보고되었고, 이를 예방하기 위한 응급차량의 안전규칙과 인력교육에 대한 많은 연구가 진행되고 있다. 국내의 2013년 소방방재청 통계에서는 소방차량 운행사고 전체 68건 중 구급차가 38건(62%)으로 가장 많았고, 사고 원인은 신호위반(56%), 중앙선침범(13%), 차로위반(13%), 안전거리 미확보(13%), 과속(6%) 순으로 보고했으나, 국내에서는 아직 응급차량의 사고에 대한 심층 연구는 진행된 바가 없다. 본 연구는 KIDAS DB 내 응급차량 사고의 원인과 특징을 분석하여 응급차량 운행에 대한 안전수칙을 제고하고, 운영방향을 제언하였다. 자료는 2012년부터 현재까지 강원도 지역에서 발생한 구급차 사고 2건을 심층 조사하였고, 사례는 2014년 7월 장마기간에 고속도로에서 발생한 장거리 이송환자 사건 1례(사망 1명, 중상 1명, 경상 1명), 2014년 10월 긴급출동 중 발생한 사고 1례(경상 3명)였다. 본 연구에서는 실사고 구급차 사고조사를 통해 선행 연구와의 비교 고찰 후 개선방안을 제언한 것에 의미가 있으며, 구급차 안전에 대한 교육, 훈련, 운영지침, 안전기준 등의 개선을 위한 지속적 연구가 필요하다.

주제어 : 구급차사고, 대책방안, 한국형 자동차사고 심층분석

- 
- Profiles
- Hee Young Lee** : He received B.S., M.S. from Yonsei University, Korea in 2012. He is a graduated student on Ph.D. course of the Department of Emergency Medicine at Yonsei University Wonju College of Medicine. He is interested in automotive medicine, biomechanics and sports medicine(hylee3971@yonsei.ac.kr).
- Jeong Il Lee** : He received M.S. from National Kongju University, Korea. He is a graduated student on Ph.D. course of the Department of Emergency Medicine at Yonsei University Wonju College of Medicine. He is interested in Emergency Medical service(promise2527@naver.com).
- Jung Hun Lee** : He received M.S. from Yonsei University, Korea in 2014. He is a graduated student on Ph.D. course of the Department of Emergency Medicine at Yonsei University Wonju College of Medicine. He is interested in automotive medicine and biomedical informatics(jhsky830@naver.com).
- Sil Sung** : She graduated from Kangwon National University Emergency Department in 2013. She has a master's degree in medicine from Yonsei University Wonju College of Medicine. She is interested in Emergency medical service, Triage and Disaster medicine(susilk@naver.com).
- Chan Young Kang** : He received BSPH from Korea National University of Transportation. He is an EMT(paramedic) majored in University and working on a master's degree in Emergency Medicine at Yonsei University Wonju College of Medicine. He is interested in EMS, Injury(Trauma), Disaster Medicine, and Automotive Medicine(emt1165001@hanmail.net).
- Kang Hyun Lee** : He has acquired the doctor's degree of science in emergency medicine at Ajou University and is currently serving as an Professor of Emergency Medicine, at school of medicine in Wonju Yonsei University. He has the concern about emergency traumatology, sports medicine, and emergency medical system. He has authored many domestic and international articles, especially including "Injury Analysis of a 25-passenger Bus Left-quarter Turn Rollover Accident" and "Clinical Characteristics and Prognostic Factors of Geriatric Patients Involved in Traffic Accidents"(ed119@yonsei.ac.kr).
- Young Han Youn** : After received Ph.D at the department of mechanical engineering in Michigan State University in 1988, he has been worked as automotive safety engineer at MGA Research Corp. N.Y. Since then, he has been involved many research projects such as new vehicle developments, crashworthiness as well as accident prevention technologies and vehicle safety policies. He is professor of school of mechatronics engineering in KoreaTech University. Recently, his major interest field is the establishment of Korea In-Depth Accident Study database(yhyoun@koreatech.ac.kr).