Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.22, 2014

Technological Innovations and Emergency Medical Services (EMS) in the Ashanti Region: An Evaluation of the National Ambulance Service's Support to Referral Centres

Tetteh, G. K.[1] Nyame, G.[2†] Boateng, F. O.[2*]
1. Technical Directorate, Komfo Anokye Teaching Hospital, Kumasi, Ghana
Email: gktetteh1966@yahoo.com
2. Department of Information Technology Education, University of Education, Winneba,
P. O. Box 1277, Kumasi, Ghana
[†]Email: gnyasane@yahoo.com,
[*]Email: fanbotgh@yahoo.com

Abstract
The practice of Emergency Medical Services (EMS) encompasses the pre-hospital and in-hospital triage, resuscitation, initial assessment and management of undifferentiated urgent and emergency cases until discharge or transfer to the care of another physician or health care professional. This involves the development and deployment of pre-hospital and in-hospital emergency medical systems for rescue processes. Thus, the goal of effective EMS is to provide emergency medical care to all who need it. However, many factors determine the quality of EMS, and that the response time is an important EMS industry benchmark. The study assesses the level of technological innovations as a means of providing quality pre-hospital care to patients in times of emergencies and the acceptance of such practices by Komfo Anokye Teaching Hospital (KATH) – a referral centre. All the 16 National Ambulance Service (NAS) centres in the Ashanti Region in Ghana were considered for the study, with only 93 personnel manning these stations and hence the difficulty for them to attend to concurrent cases of emergencies. Questionnaires were administered on the perceptions and opinions of patients/relatives, doctors and nurses as well as staff of the 16 ambulance service centres about EMS delivery. Systematic random sampling was used to select patients/relatives and ambulance service staff whilst convenience sampling was used to select individuals from the rest of the categories. The use of fixed telephone lines and mobile phones were the primary tools for communication. For quality evidence-based EMS practices, NAS lacked the integration of GIS, GPS and GSM technologies including mobile tablet PCs and software solution to properly discharge their duties.

Keywords: Emergency Medical Services (EMS), referral center, pre-hospital and in-hospital, National Ambulance Service (NAS), innovative technologies, time, 'golden hour', Mobile Data Terminal (MDT)

1. Introduction

Emergency Medical Services (EMS) exist to fulfill the basic principles of first aid intended to preserve life, prevent further injury, and promote recovery. Emergency medical conditions typically occur through a sudden assault to the body or mind, often through injury, infection, obstetric complications and chemical imbalance (McSwain, 1991), and this includes persistent neglect of chronic conditions. Thus, EMS criteria to treat these conditions include rapid assessment, timely provision of appropriate interventions, and prompt transportation to the nearest appropriate health facility by the best possible means to enhance survival, control morbidity, and prevent disability. Hence, the goal of effective EMS is to provide emergency medical care to all who need it (Tannebaum, 2001).

Emergency medical care is that care delivered in the first few hours after the onset of an acute medical or obstetric problem or the occurrence of an injury, including care delivered inside a fixed facility. It must be pointed out that a more accurate approach to view care is to recognize it as a continuum. As emphasized by Navein and McNeil (2003), advances in medical care and technology in recent decades have expanded the parameters of the traditional domain of emergency medical services. Despite the efforts of primary care providers and public health planners, not every emergency is preventable (White *et al.*, 1996). However, actual provision of emergency care may range from delivery using trained emergency professionals to delivery by lay people (Samai and Sengeh, 1997). In Ghana, emergency medical care is given low priority in the health sector as it is equated to ambulance transportation, and neglecting the role of the community and facility care providers with the intent that emergency departments and physicians are the only acute care resources. Besides, few resources are set aside for possible emergencies, and when situations of emergency care arise, they rather result in costly resource deployment (Adu-Ampofo *et al.*, 2002). It must be pointed out that emergency medical systems including computers and their related technologies address a diverse set of diseases that span the spectrum of communicable infections, non-communicable conditions, obstetrics, and injuries. These require an

EMS either in their acute stages such as diabetic hypoglycaemia, septicaemia, premature labour and asthma or in their natural presentation such as myocardial infarction, acute haemorrhage, and injuries (Kalish *et al.*, 2008). In addition, Tiska *et al*. (2004) explained that lack of access to medical care and sustained effective treatments become a threatening plethora to instances of sub-acute episodes and flare-ups.

Triage is the screening of patients in the field or in the receiving area of a fixed facility to determine their relative priority for treatment (Kuehl, 2002). This is initiated with pre-hospital care which involves care provided from the community (scene of injury, home, school, or other location) to the point where the patient arrives at a formal health care facility to receive definitive care. Husum *et al.* (2003) argued that EMS and pre-hospital care are complements in context and that they are deemed to be simple, sustainable, and efficient in triage situations. Certainly, *pre-hospital time*, *notification time*, *scene time*, *response time* and *transport time* are the most prominent indicator variables in EMS. In particular, the availability of telecommunications influences notification time whilst the capabilities of a dispatch center to handle emergency calls influence response time and this includes proper geographic distribution of sites of ambulance dispatch. Thus, a shorter pre-hospital time is a good indicator of quality pre-hospital care (Sampalis *et al*., 1994). As regards these times, communication is essential for both patient referral and emergency transportation in which fixed line telephones and mobile phones have high potential to facilitate communications especially in remote areas or villages. For instance, equipping traditional birth attendants and remote health units with radio receiver sets linked to local hospitals improves response time and reduces maternal deaths (Samai and Sengeh 1997). It is for this reason that emergency care must be appreciated as a system of interdependent components of pre-hospital care, pharmaceuticals, transportation, experienced paramedical personnel, and in-hospital care. Thus, from accident scenes to referral centres, innovative technologies play significant roles in the control and prevention of deaths on the basis of appropriate choice of technologies at each stage of the service chain.

In Ghana, the demand for efficient communication and rapid transportation is more critical in emergency medical care, and that the National Ambulance Service (NAS) is charged with primary objective of providing pre-hospital emergency care to accident victims and conveying such victims to the appropriate health facilities including cases from minor health centres. Thus, paramedic staff, ambulance centres and vehicles must be equipped with state-of-the-art technologies and supplies in order to offer medical treatments on time. It is by this means that the emergency department is brought to the patient readily at the accident scene. Lindström *et al.* (2011) thus stressed that technological advancements in the context of computers and other technologies provide electronic capacities for both ambulance service centers and vehicles in the quest for offering quality pre-hospital care. Fortunately, mobile phones and smart communication devices are relatively cheaper and easy to access for various data processing, storage and communication purposes. Moreover, Lecky *et al.* (2014) explain that the Internet and remote sensing satellites provide formidable platforms for effective use of Geographic Information Systems (GIS) and network connectivity to the accident scenes in respect of gathering patients' information and making adequate preparation for medical treatments at the referral centres.

It is important to emphasize that transportation is an essential component in any EMS system whether formal or informal. Carron *et al.* (2011) observed that the provision of transport facilities for EMS functions is mostly equated to easy access to transport services, but a more intriguing factor is the sophisticated nature of these facilities in terms of advanced technology to support pre-hospital care. Thus, road transport is given much attention than the other transport routes (Macintyre and Hotchkiss, 1999). However, ambulance facilities are still not modernized, inadequate and unreliable for pre-hospital care emergencies (Samai and Sengeh, 1997). In Ghana, this phenomenon had led to many private and non-governmental organizations to take the initiative to provide ambulance services, but on the whole road networks leading to referral centres affect the response and transportation times of ambulances. Air lifting through helicopter services during emergencies help reduce mortality rate especially patients in acute injured situations (Moylan, 1988). Thus, transporting a patient from the location of the acute event to a hospital facility or health centre is a critical element of pre-hospital care, and that locally available resources as well as viable alternatives for transportation can be deployed to improve transportation time be it public or private means of transport service.

2. Procedures and Methods

The study examined the operations of 16 national ambulance centres in the Ashanti Region of Ghana with Komfo Anokye Teaching Hospital (KATH) as the primary referral centre. These ambulance centres are located in Kononogo, Ejisu, Anhwia-Nkwanta, Mamponteng, Kumasi Airport, Sports Stadium, Mankranso, Ejura, Nyinahini, Asokore, Juaso, Tepa, Offinso, Asante Mampong, New Edubiase and KATH (Kumasi). KATH is located in Kumasi, the Regional Capital of Ashanti Region. A mixed method approach (Neuman, 2003) was used to obtain relevant information across the three categories of respondents and the multiple case study strategy (Yin 2003)

employed due to the number of cases involved. A sample size of 163 was used constituting 20 Doctors, 50 Nurses, 15 Health Care Assistants, 20 Orderlies – all from the Accident and Emergency Unit of KATH, 38 staff members of the 16 national ambulance centres and 20 patients/relatives transported to KATH by NAS. Systematic random sampling procedure was employed for the case of patients/relatives and staff of NAS. Thus, the 20 patients/relatives transported by NAS and 38 staff members of NAS were all interviewed. During the study period, an average 15 patients were referred and transported to Accident & Emergency centre by private transport. It was established further that only three patients per day were transported to KATH by NAS (Source: Biostatistics Unit of the Accident & Emergency centre – KATH). Prior to the interviews and administration of the questionnaires, the KATH ambulance centre provided an opportunity for a fieldtrip when there was a call for an emergency service. This enabled us to experience the manner they went about their operations and the challenges involved in the provision of medical emergency services. Standardized structured pre-tested questionnaires were administered to the various categories of staff of NAS with a response rate of 90%. Also, the duty roaster of staff of the Accident & Emergency centre was used as team heads and every 3rd and 5th persons on the roster answered the questionnaires. Similarly, every 2nd patient/relative brought in daily during working hours excluding weekends by the NAS answered the questionnaires. Thus, the data collection exercise was done between the hours of 9.00am – 5.00pm each day in the month of June 2014 as and when emergencies were brought in by the NAS. This period was observed to be the busiest times of both NAS and KATH. A hierarchical coding scheme was thus used to code the data prior to their entry for analysis.

3. Results and Discussion

In an attempt to assess the role of the National Ambulance Service (NAS) in managing emergency medical services in the Ashanti Region, the private ambulance services were also considered in the overall provisions of quality and reliable ambulance services to any emergency situation in terms of technologies, structures, processes and procedures. It must be stressed that the main aim of this service is to avoid worsening the health conditions of patients on route to the nearest hospital or health care centre for better definitive care and treatment.

3.1 Forms of Pre-hospital Care

The study identified pulse checking (or blood circulation), oxygen administration, blood administration, intravenous infusion, and cardio pulmonary resuscitation as the main forms of pre-hospital care. The others included treatment for shock and immobilization of pelvic fractures. It was thus clear from the study that the commonest service NAS staff provided just on arrival of emergency scene was always checking of pulse and sometimes handling of shock and pelvic fractures representing 57.9%. Oxygen administration and intravenous infusion featured prominently in many of the emergency cases (Figure 1). Moreover, blood administration was often and sometimes offered to patients representing 26.3% and 73.3% respectively whilst cardio pulmonary resuscitation accounted for 13.2% and 86.8%. However, there was no instance any of these forms never given attention by NAS. This is an indication that the survival of patients in times of emergencies wholly depends on the responsiveness and preparedness of NAS staff alongside the application of innovative technologies, skills, professionalism, reliable and sophisticated ambulance vehicles contributing to stabilizing the conditions of patients (carrying out CPR) before and during transit to a referral centre.

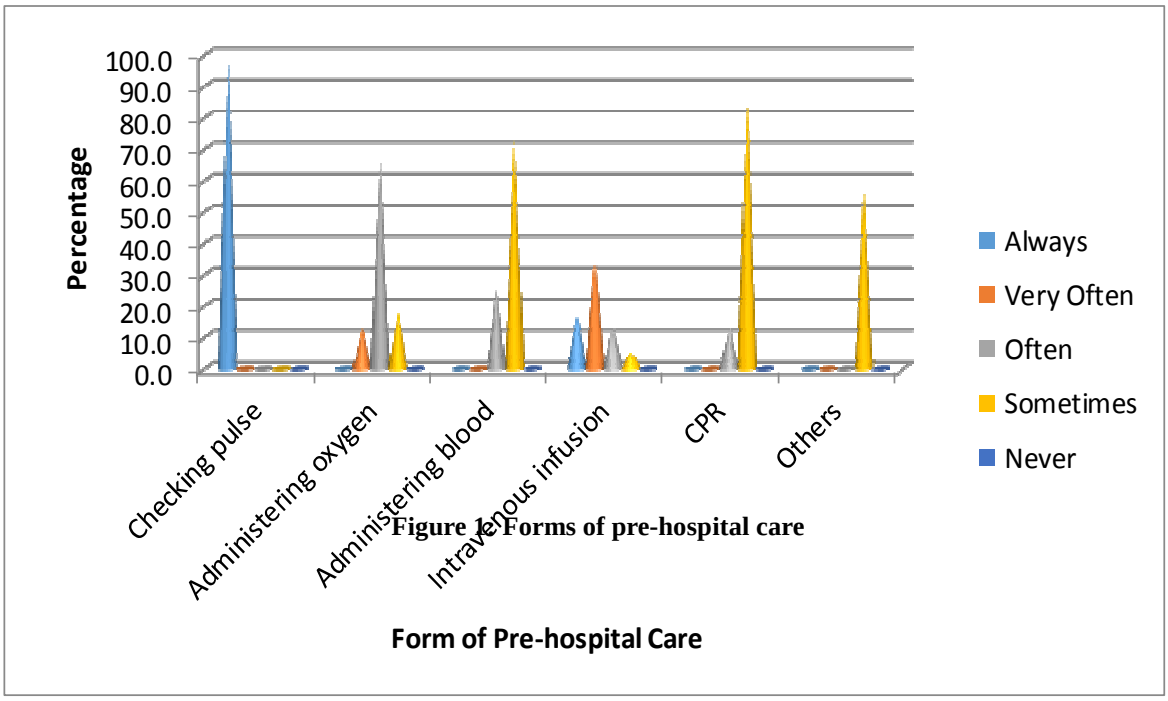

Figure 1: Forms of pre-hospital care

It must be emphasized however that the nature of certain cases determined the kind of services that staff of NAS could offer, and this could be through interaction with patients, other individuals or physical assessment of patients. It was established that 39.5% of emergency cases were through physical assessment whilst 28.9% were through interaction with the patients. Individuals other than patients accounted for 26.3% (Table 1).

Table 1: Modes of determining pre-hospital care

Determinants of pre-hospital care	N	%
Patients/Relatives (N = 39)		
Interaction with patients	11	28.9
Interaction with callers other than patients	10	26.3
Physical assessment	15	39.5
Others	2	5.3
Total	**38**	**100.0**

3.2 Personnel for EMS: NAS and KATH

Personnel have different levels of skills and authorization to provide different interventions in moments of emergencies. Thus, the 16 ambulance centres had a total of 93 members of staff ranging from drivers to station officers with paramedics and control room staff representing 26.9% and 4.3% respectively (Table 2). This indicates that only few emergencies can be responded to by NAS over a period, and hence a negative effect on health conditions of patients including death cases in some instances. Also, the highest professional group that responded to emergencies was nurses representing 47.6%, and usually with the assistance of healthcare assistants representing 14.3% whilst doctors and orderlies accounted for 19.0% each. These nurses and healthcare assistants firstly interact with patients and make adequate preparations prior to diagnosis and treatment by a physician.

Table 2: Personnel involved in the provision of EMS at NAS centre and KATH

Category of Personnel	N	%
NAS Staff (N = 42)		
Managers/Station Officers	16	17.2
Officers 2nd in Command	16	17.2
Operations/Paramedics	25	26.9
Control Room	4	4.3
Drivers	32	34.4
KATH Staff (N = 105)		
Doctors	20	19.0
Nurses	50	47.6
Healthcare Assistants	15	14.3
Orderlies	20	19.0

Moreover, the study established that despite the challenges faced by NAS and KATH in the provision of quality EMS especially in times of motor accidents, pragmatic efforts were made to improve health conditions of patients on arrival at accident scenes and during transit by NAS staff and at the referral centre by KATH staff. Picture coverage of an instance of a motor accident during the study period was included in this study to exhibit roles played by both staff of NAS and KATH during such emergency situations (Figure 2 and Figure 3). However, there were other cases presented to KATH by both private ambulance services and NAS during the study period. These included 40% trauma cases, 35% medical conditions, 15% burns cases, and 5% each on urological and neurological cases. This was evident when 76.2% of the referral staff claimed that they often rely on the services of other ambulance services in the provision of EMS.

Figure 2: NAS staff attending to a patient at an accident scene

Figure 3: KATH staff attending to a patient at the Accident and Emergency Unit

3.3 Role of Time in EMS

Time in EMS operations is as essential as treatments given to patients in times of emergencies such as cardiac arrest or obstetric emergency. In Ghana, response and transportation times affect significantly the survival of patients needing immediate medical care. Also, notification time to emergency scenes was established to be less than an hour. Evidently, the poor nature of the roads and indiscipline on the part of other motorists impeded smooth runs of NAS including private ambulance services. These accounted for a high attrition rate of 26.3%. Thus, referral cases become highly technical and sophisticated demanding greater attention at the Accident and Emergency Unit of KATH. Also, ambulance offload delay in some cases affected patients' conditions, and as pointed out by Cooney *et al*. (2013), this does not only affect patients' survival rate but also the speedy work of clinicians and physicians.

3.4 Road and Traffic Distractions

In Ghana, ambulances mainly use public roads to convey patients to referral centres regardless of the location of accidents or referring health centres. It was clear from the study that the bad nature of the public roads significantly affected the 'golden hour' in respect of potholes characterizing many of these access roads. Moreover, traffic congestion, poor maps, poor residential addresses, impeding structures and poor road signs mostly increased the response time. Besides slowing down movement of ambulances, condition of patients sometimes got deteriorated as a result of the bad nature of the roads and unexpected delays during transit to the referral centre, and this also accounted for a partial increase of 7% attrition rate. This was observed to be cases from mostly district government hospitals, polyclinics, remote health centres, and private clinics and hospitals. Further, irresponsible behaviours of other road users especially motorists increase the transport time as they refused to yield to ambulances when transporting patients to KATH.

3.5 The Role of Private Ambulances

Private ambulances contribute significantly to the overall ambulance services. It was obvious that many privately acclaimed ambulances were really hearse vehicles primarily meant to convey corpses from health centres to cemeteries. They exhibit varying ambulance colours and with very little technologies for life support. Many of these vehicles used same serine just like those of NAS, and this amounted to an abuse of the relevance of the use of serine. This further affected adherence of motorists to national ambulance vehicles. Other vehicles that acted as ambulances in some cases were established to be either a commercial vehicle such as taxi, mini-van ('trotro') or an individual private vehicle. In this situation, many patients were mishandled before and during transit to the referral centre. As a result, the study identified three death cases during the time of the study. Such an involvement of these unqualified vehicles and personnel could be attributed to inadequate ambulances and delays in response to national ambulance services

3.6 Technologies for Pre-hospital Care and Life Support

Provision of modern technological devices and mobile solutions in ambulances optimizes the works of both referral centres and the ambulance services. This is one important means to deploy a solution for the real-time transmission of patient data from ambulances to referral centres prior to patients' arrival at the referral centres. It was clear from the analysis that paramedics still resort to paper records representing 73.7% instead of mobile tablet PCs and Windows operating system that easily work on standard public mobile networks via wireless technology, giving the referral centre more visibility about inbound patients prior to arrival. This provides reliable and standard data for analysis and evaluation on a variety of emergency cases brought to the referral centres.

Communication is paramount to effective and quality EMS delivery. Thus, the communication devices used at the referral centre included mobile phones, networked computers, radio equipment and fixed telephone systems. The use of fixed telephone lines to reach ambulance crew any time on operations dominated representing 67.9%, and this included inter-referral centres. This is followed by mobile phones representing 22.1% with the use of networked computers and radio equipment representing 4.6% and 5.4% respectively. This is perhaps as a result of the dedicated nature of the fixed telephone lines for both internal and external communication purposes. It must be emphasized that these mobile phones were neither dedicated ones nor owned by ambulance centres or referral centres but rather individual paramedics and referral centre staff.

As regards technologies onboard the ambulance vehicles, foldable stretcher, suction machine, automatic defibrillator, and intubation were identified. Three of the ambulance vehicles had broken down and another three had been decommissioned, an indication of poor maintenance practice. In the case of retro-reflective paint technology, the ambulance vehicles exhibit yellow colour more than red with audible and visual light warning technologies frequently used to alert other motorists. Thus, the overall ambulance service equipment was rated to be 37.2% in respect of the adequacy, reliability, availability and ultramodern nature of equipment. This affected

the attrition rate of patients either in transit or on arrival at the referral center. There was no software solution for real-time transmission of patient data from ambulances to the referral centre. The study revealed that 85% of the cases were from community based clinics, hospitals and primary health centres, and that the absence of Mobile Data Terminal (MDT) further affected the 'golden hour' because officers could not synchronize, locate and dispatch the closest available resource to emergency scenes. Besides, paper-based records were sometimes incomplete, inaccurate and illegible, and that the analyses of the data originally recorded were sometimes misrepresentations of actual patients' conditions. Other medical technologies in poor state or absent were Continuous Positive Airway Pressure (CPAP) devices, Intraosseous Infusion Systems (IIS) and cardiac monitors. It was observed that the cardiac monitors were not equipped with Bluetooth technology which is required to allow ambulances and referral centre to share EKG information in real time with doctors, cardiologists, and nurses. In addition, the National Ambulance Service lacked the integration of Geographic Information System (GIS), Global Positioning System (GPS) and Global System for Mobile communication (GSM) technologies for a better time performance.

4. Conclusion and Recommendations

The provision of pre-hospital emergency care is very paramount at any level of healthcare delivery. The NAS plays key role in the provision of standardized data on pre-hospital emergency care for analysis and evaluation to aid quick diagnosis and treatment of patients transported to KATH. Lack of effective real-time transmission of patients' data from ambulances to KATH affected the preparation and readiness of doctors and nurses including orderlies in offering treatment to patients on arrival at KATH. This paper recommends evidence-based practice supported by mobile solutions in ambulances (such as tablet PC solution connected to public networks including GPRS) as key to driving efficiencies and improvements in pre-hospital emergency care. Thus, NAS should be provided with the state-of-the-art technologies and the capacity to maintain such technologies including the ambulance vehicles. The integration of GIS, GPS and GSM technologies provides a strong basis for the application of telemedicine in pre-hospital care environment, and this explained the suggestion made by Amadi-Obi *et al*. (2014) in the use of real-time video-based information simplifying the work of physicians and nurses in particular. Quality training of paramedics through regular workshops, seminars, conferences, and international programmes strengthens the NAS in handling all forms of pre-hospital care.

To improve response time, the Ministry of Health, Departments, Agencies, NGOs and other stakeholders should work at improving access to referral centres in terms of good roads, free flow of traffic through the use of Radio Data System (RDS), reliable traffic lights, reliable maps, use of LEDs lights on ambulances, road signs, etc. Further, the NAS should effectively partner the Ghana Police Service and the National Fire Service in establishing policies that holistically improve the response time not only in cases of motor accidents but also other forms of accidents in which life is at stake. Civil education is needed to be given to all road users so as to create more awareness about yielding to ambulances whether private or national. Moreover, the NAS should collaborate with the private ambulance service to offer professional training to help eliminate attrition related problems or reduce death rate. This means that private ambulance vehicles must be thoroughly examined, registered and passed mission test before becoming operational to serve the community, hospitals, clinics and other health centres. Thus, there is the need for a regulatory body together with the NAS to ensure quality EMS delivery.

Also, effective communication through the use of appropriate technologies should be deployed to establish a strong platform for information exchange and delivery between KATH and health care centres, private ambulance service, and NAS. It is important to emphasize that air ambulance should be provided in times of fatal accidents because there are numerous physical impediments and bad behaviours of other road users that disrupt movements of road ambulance. Though the Accident and Emergency Unit of KATH has the facility to allow air ambulance to land on top of the A&E building for quick access to patients and treatment, no such occurrences of using the facility had been recorded. In effect, health authorities need to utilize the facility to minimize or eradicate deaths associated with delays in EMS operations.

References

Adu-Ampofo, M., Mock, C. N., Tiska M., and Boakye G., (2002). Improvements in Pre-hospital Trauma Care in an African Country with No Formal Emergency Medical Services. *Journal of Trauma* 53 (1): 90–97.

Amadi-Obi, A., Gilligan, P., Owens, N. and O'Donnell, C. (2014). Telemedicine in Pre-Hospital Care: A Review of Telemedicine Applications in the Pre-Hospital Environment *International Journal of Emergency Medicine* **7**:29.

Carron, P., Taffe, P., Ribordy, V., Schoettker, P., Fishman, D. and Yersin, B. (2011). "Accuracy of Pre-hospital

Triage of Trauma Patients by Emergency Physicians: A Retrospective Study in Western Switzerland", *European Journal of Emergency Medicine*, 18(2):86-93

Cooney, D.R., Wojcik, S., Seth, N., Corey, V. and Stimson, K. (2013). Evaluation of Ambulance Offload Delay at a University Hospital Emergency Department *Journal of Emergency Medicine* 6:15

Husum, H., Gilbert, M. and Wisborg. T. (2003). Training Pre-hospital Trauma Care in Low-Income Countries: The 'Village University' *Experience Medical Teacher* 25 (2): 142–48.

Kalish, J., Burke, P., Feldman, J., Agarwal, S., Glantz, A., Moyer, P., Serino, R., and Hirsch, E. (2008) "Evaluation of the Effectiveness of Prehospital Tourniquets for Civilian Penetrating Extremity Injuries" *Journal of Emergency Medical Services* Volume 33, Issue 8, Pages 44-46, 49-4650, 52, 54

Kuehl, A. E. (2002), Pre-hospital Systems and Medical Oversight, (3rd edn), National Association of EMS Physicians.

Lecky, F., Benger, J., Mason, S., Cameron, P. and Walsh, C. (2014). The International Federation for Emergency Medicine Framework for Quality and Safety in the Emergency Department, *Emergency Medicine Journal*, 31:2

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar