Physicians in prehospital care: A review of the clinical and economic evidence

Daniel Kapustin[1]; Sparsh Shah[1]
[1]University of Toronto Faculty of Medicine, Toronto, Ontario

Abstract

Prehospital care delivery varies across different geographies. Among the starkest differences is the role of the physician in prehospital care and emergency medical services (EMS). In the 'Anglo-American' model, ambulances are primarily staffed by emergency medical technicians (EMTs), emergency medical responders (EMRs), and paramedics. In contrast, in the 'Franco-German' model, ambulances are commonly staffed by physicians. Physicians can theoretically provide superior prehospital care due to increased level of training, judgement, and competency. However, physician-staffed emergency medical services (PS-EMS) also increase the financial burden on the prehospital care system. This review paper aims to summarize, compare, and analyze the clinical and financial features of these two models in order to identify the best staffing model. The information presented in this paper can aid medical administrators in the decision-making process involved in optimizing their prehospital care delivery system.

Introduction

The role of physician-led prehospital care in the acute setting is controversial. In the United States, Emergency Medical Services (EMS) are predominantly staffed by emergency medical technicians (EMTs), emergency medical responders (EMRs), and paramedics. In the 'Anglo-American' model, EMR training consists of 80 hours of education to provide basic care (management of airway, breathing, and circulation). These are often volunteer crew which may provide basic emergency aid. In contrast, EMT training is in excess of 200 hours and involves practical experience in both ambulances and emergency rooms. Importantly, EMTs can administer medications and care for patients in an ambulance environment while EMRs cannot. Finally, paramedic training requires over 1,000 hours and involves more thorough training on the anatomy, physiology, and pharmacology of patient management. Both EMTs and paramedics are trained with advanced oxygen and ventilation skills, pulse oximetry monitoring knowledge, and medication administration techniques. However, paramedics are additionally trained in advanced invasive management and pharmacological interventions such as endotracheal intubations (ETIs) and the placement of intravenous lines or chest tubes.

In contrast, in countries such as France and Germany, prehospital care is often provided by physicians. In addition to providing care otherwise offered by paramedics and specially trained nurses, emergency physicians and anesthesiologists are particularly adept in airway management and performing cardiopulmonary resuscitation (CPR). Unlike paramedics, who are often trained to follow guidelines and standard operating procedures, physicians have a level of advanced training that allows them to make more adaptable decisions based on the clinical scenario and presentation.[1] Moreover, as a result of extensive experience and training, their implementation of standard procedures may allow for more advanced decision-making on a case-by-case basis. Theoretically, physician-staffed EMS (PS-EMS), under the so-called 'Franco-German' model bear the potential for better survival outcomes due to the higher level of training, however this comes at a higher systems cost and therefore an additional strain on resources.

Though countries including France, Australia, Finland, Israel, and Germany utilize physicians to provide ambulance-based advanced care life support (ACLS), this practice has been abandoned in the United States to maximize physician resource efficiency.[2]

As a consequence of ethical, logistical, and fiscal feasibility, randomized control trials (RCTs) designed to examine patient outcomes between the two models are unlikely to be constructed. Any direct comparison of one country's system to another lends itself to other confounding variables such as organizational, economical, and geographical factors.[3] Nonetheless, there is an abundance of retrospective and prospective studies contrasting the relative efficacy of physician versus secondary operator-provided care on patient outcomes such as survival-to-hospital and survival-to-discharge rates. A consequence of the absence in RCTs, however, is a prevalence of selection bias among available studies. For instance, the largest study from Japan comparing outcomes in 126,000 EMS response cases relies on prehospital physician EMS teams whose availability is restricted to geographical regions around specific emergency centers.[22] It is therefore informative to draw conclusions from data derived in published outcomes throughout a multitude of studies in countries providing emergency ambulance-based care through both physicians and secondary providers.

Determining which staffing model optimizes and balances overall patient outcomes with cost is an important, broad, and systems-level question which can aid in the decision-making surrounding health services organization both in countries with established prehospital care and in countries that are currently building their prehospital care systems. There is no recent analysis currently within the literature that summarizes and contextualizes clinical and economic

evidence for the role of physicians in prehospital care. The goal of this review is to therefore synthesize and provide an updated overview of the relevant evidence comparing the Anglo-American and Franco-German EMS models in terms of provider skill level and patient outcomes, as well as to provide analysis of the economic and logistical considerations involved in the implementation of these models.

Organizations can use the information summarized in this paper to either adopt, modify, or discard PS-EMS based on context specific factors and healthcare needs of a region. To ensure clarity, this paper will refer to systems that employ physicians in pre-hospital care as PS-EMS, and all other providers as non PS-EMS.

Comparison of Emergency Responder Competencies

A systematic search of the literature was carried out using multiple sources, including Medline and Medline in-process/epubs between 1990 and October 3rd, 2017. This search was restricted to articles written in English. The final search terms were in the form of: EMS + PS-EMS + Outcome. To understand differences in outcomes for patients provided care by EMS, we first set out to describe the relative competencies expected of physicians and secondary emergency providers. In 2011, a study by Schuppen et al. in the Netherlands constructed a quantitative inventory describing the diagnostic, therapeutic, and clinical judgement competencies of both physicians and ambulance nurses involved in EMS-provided care. Examples of such competencies relating to a response protocol for 'carbon monoxide poisoning', for example, included Glasgow Coma Scale (diagnostic), IV access (therapeutic), and the consideration of endotracheal intubation (clinical judgement).[4] Through analysis of the National Protocol Ambulance Care, a total of 438 competencies were identified among ambulance nurses. Moreover, while all these competencies were provided by physicians, an additional 62 competencies were specific to physician-provided care, most of which were therapeutic competencies (such as resuscitation and airway management).[4]

While similar results may be expected across healthcare structures, a broader skill base does not necessarily imply physicians maintain greater performance in overlapping competencies with other providers. A Boston EMS comparison of paramedic and physician skill at analyzing 12-lead ECGs demonstrated no significant differences in elucidating the presence of STEMI among patients.[5]

Accordingly, a randomized, prospective mock trial at the University of Pittsburgh compared paramedic and physician agreement for clinical indicators of c-spine injury. Among the 50 studied physician-paramedic pairs, the study demonstrated excellent agreement between both providers when evaluating simulated patients.[6] Likewise, a multi-center study assessing the diagnostic accuracy of paramedics illustrated excellent concordance between emergency physician and paramedic diagnosis accuracy in the evaluation of patients presenting with chest pain or shortness of breath (kappa = 0.54, 0.61 for cardiac and pulmonary diagnosis).[7] Additionally, a study from five regional air ambulances in the UK discovered that tracheal intubation success rates for OHCA by paramedics were equivalent to physician led intubation.[8] These data illustrate the importance of evaluating patient outcomes of in-field performance to better assess differentials in care between physicians and secondary providers.

Evidence Supporting the Franco-German Model

A number of studies have suggested superior patient outcomes in cases where EMS care was provided by medical physicians when compared to secondary providers (EMTs, paramedics, and ambulance nurses). Importantly, a nationwide population-based observational study in Japan consisting of 95,000 patients evaluated survival outcomes among patients experiencing out-of-hospital cardiac arrest.[9] The study determined that advanced care life support during cardiac arrest (which includes CPR, venous access, and intubation) provided by physicians resulted in superior one-month survival (11.6%) when compared to the same care provided by emergency life-saving technicians (ELSTs) (6.7%, $p<0.01$).[9] Furthermore, when pre-hospital care included bystander-initiated CPR, subsequent one-month survival rates for patients managed by physicians (15%) remained significantly greater than for those managed by ELSTs (9.6%, $p<0.01$).[9]

The study also demonstrated greater improvement of neurological performance (as measured by the Glasgow-Pittsburgh cerebral performance category) in patients with ACLS provided by physicians.[9] However, prehospital physician EMS service was limited to specific hospital regions.

The authors conclude that patients managed by EMS physicians were therefore managed at hospitals with which these physicians were affiliated, precluding the validity of this data. It is also noteworthy to consider that certain treatments (such as therapeutic hypothermia and percutaneous coronary intervention) are only available at certain Japanese centers. It is difficult to draw sound conclusions from such observational studies due to the presence of these confounders.

In the context of traumatic brain injury (TBI), one unique study comparing outcomes between a helicopter-based PS-EMS and a non-physician staffed ground EMS (GEMS) in Finland determined 42% of patients had good neurological outcome (as measured by Glasgow Outcome Scores) in the PS-HEMS group compared to 28% in the non PS-GEMS group.[10] While the impact of physicians cannot be isolated due to the introduction of a helicopter service, this study indicates that specific implementations of physician management may be superior to non-physician management.

An observational cohort study in Switzerland similarly evaluated mortality in 338 blunt polytrauma patients treated by either EMTs or emergency physicians assisted by EMTs.[11] While the crude mortality of patients treated by physicians (11.2%) was not significantly lower than those treated by patients in the EMT group (14.1%), the number of deaths among patients treated by the EMT group showed a statistical trend exceeding the number of predicted deaths ($p=0.066$) as determined through anatomical characterization of injury severity.[11]

Taken together, these data continue to suggest a trend towards improved patient survival when management occurs under physician care. Importantly, however, such studies do not offer an explanation of the potential contributing factors to this differential in care.

In a retrospective analysis of two helicopter emergency medical services (HEMS) models, one physician-staffed and one which was paramedic-staffed in Australia, the authors analysed outcomes in patients suffering from blunt trauma transported from the site of injury.[12] Adjusted W-score modeling indicated there would be an additional thirteen survivors per 100 patients treated in the physician group compared to the paramedic group.[12] The authors do note that in 42% of patients (n = 67) managed by the physician team,

transfusion with packed red blood cells took place – an intervention which exceeded paramedic protocol.[12] Moreover, the physician team performed a significantly greater number of intubations while the mechanisms of injury and transport distances did not significantly differ between groups.[12] Ultimately, it is reasonable to suspect that differences in patient outcomes may therefore be related to a difference in the number and types of interventions performed by physicians when compared to paramedics.

Nevertheless, there is also evidence suggesting that beyond the additional range of treatments performed by physicians, the performance of physicians may differ from that of paramedics during a given intervention. A 1987 study evaluated mortality outcomes in 574 blunt trauma patients managed by either a flight nurse and paramedic, or a flight nurse and physician pair.13 While both teams were trained to perform the same procedures, patients treated by the flight nurse/physician team demonstrated a mortality rate 35% lower than predicted, as well as significantly lower than that of the flight nurse/paramedic team.[13]

Interestingly, while the patients predicted to die (as per the Trauma and Injury Severity Score, TRISS) within the nurse/paramedic team made up a majority of deaths in this group, several patients managed by the physician/nurse team initially expected to die survived their injuries.[13] The authors attribute this difference to the greater rate of implemented interventions by the physician/nurse team, including IV line insertion, intubation, and thoracostomy.[13]

In summary, evidence regarding advantages of PS-EMS is mixed. Differences among physicians and other emergency responders from the perspective of clinical competency and procedural capability do not appear to translate to appreciable differences in EMS outcomes. However, these data suggest potentially improved patient outcomes for physician-led teams when compared to paramedic-staffed emergency service teams. While the precise mechanism for these differences remains unclear, the outlined evidence suggests that discrepancies in applied interventions and interventional success rate may be at least partially responsible for improvement in patient outcomes.

Evidence Supporting the Anglo - American Model

In contrast, several studies show that performing advanced care specific to physician competency may not necessarily translate to better outcomes. A large multicenter observational Canadian study compared survival rates of major survivable trauma in three different prehospital trauma care systems with access to a level one trauma center: Montreal, where physicians provide advanced life support; Toronto, where paramedics provide advanced life support; and Quebec City, where emergency medical technicians provide only basic life support.[14] After examination of 9,405 patient outcomes, the assessed overall mortality rates from injuries for physicians were 35%, 28% for paramedics, and 26% for EMTs.[14] Physician-provided care was associated with a significantly increased mortality rate compared to paramedics and EMTs.[14]

However, the authors note significant differences in mean injury severity scores (ISS) and motor vehicle collisions between the three examined cities.[14] In particular, mean ISS scores were noted to be significantly higher for patients treated by a physician, when compared to the other two groups.[14] These confounders make data interpretation difficult, and illustrate the need to consider additional studies in assessing the potential advantages of paramedic or EMT-based care in the EMS environment.

A similar study based in Norway compared clinical outcomes for out-of-hospital cardiac arrest (OHCA) in physician-manned ambulances versus paramedic-manned ambulances.[15] With a study cohort of 917 patients, despite higher quality CPR from physician-manned ambulances (shorter hands-off periods and pre-shock pauses) and an increased rate of intubation among the physician group (88% vs. 77%), there was no significant difference in short-term outcomes (defined as return of spontaneous circulation, and intensive care unit admission) or long-term outcomes (survival-to-discharge) between the two groups.[15] These results challenge the notion that advanced airway management techniques uniquely applicable to physician care are advantageous and afford superior patient outcomes. In fact, a multicenter Ontario prehospital study demonstrated that the addition of advanced-life-support interventions did not improve OHCA survival rates among an already-optimized EMS system.[16]

Apart from survival, long-term quality of life has also been examined as a primary outcome in EMS patients. In South-Western Finland, a PS-HEMS was launched in 1988. Prior to the PS-HEMS, patients were treated by ground-based non PS-EMS. One study compared 81 blunt trauma cases treated by the PS-HEMS to 77 blunt trauma cases treated prior to the establishment of physician staffed HEMS.[17]

In the study, although physicians treated more aggressively (greater rate of intubation and cannulation), there was no difference in long-term survival.[17] Furthermore, a questionnaire relating to quality of life was sent out three years later to the survivors, and showed no difference between the two groups.[17] This evidence stands in agreement with the previously presented data suggesting no significant advantages in mortality rates or quality of life offered by the greater interventional capabilities of EMS physicians. In fact, the authors suggest the introduction of such advanced techniques may allow for longer scene times, excessive fluid therapy, and potential failures in procedures.[17]

Overall, the data presented illustrates the mixed nature of conclusions regarding the superiority of patient outcomes when managed by physicians when compared to secondary emergency providers. In particular, the literature suggests that the advanced interventional capacity offered by physicians may not provide adequate therapeutic benefit to justify the use of physicians over paramedics and EMTs in prehospital care.

Economic Analysis

Managers need to consider cost differences when determining the optimal prehospital care model. A prehospital care system that improves survival but comes with an extremely high cost would be neither practical nor efficient. One of the central arguments against a PS-EMS is the high cost burden of staffing ambulances with physicians. This review will therefore examine the economic studies that exist in order to provide a more comprehensive, practical comparison between the two prehospital care models.

In one Australian study, physician-staffed HEMS were compared to non-PS ground EMS (GEMS). Specifically, the authors compared cost-effectiveness and survival in trauma patients (ISS>12 or TBI) between these groups over an eleven year period.[18] Treatment costs in this study accounted for costs in four phases: treatment in a referral hospital, transport to a trauma centre, treatment during the index hospitalisation, and treatment following discharge.[18] The adjusted in-hospital mortality was determined using a logistical

regression model.[18] The model showed improved survival with HEMS.[18] Furthermore, the incremental cost-per-life-year-saved by using HEMS for all trauma patients was estimated to be $96,524 AUD (~$75,000 USD at present day conversion rate, unadjusted for inflation).[18] However, this cost decreases by approximately $46,000 (~$36,000 USD at present day conversion rate, unadjusted for inflation) for severely injured trauma patients or TBI patients, demonstrating greater effectiveness for HEMS in the setting of more severe injuries.[18] The average value of a statistical life year (VALY) in Australia was $124,095 AUD ($96,000 USD at present day conversion rate, unadjusted for inflation), which is well above the incremental cost per life year using HEMS for trauma patients.[18] Because the incremental cost-per-life-year of the HEMS was less than the Australian VALY, the authors concluded the HEMS model was cost effective for all trauma patients, and even more effective for severe trauma patients.[18] This study suggests that the PS-HEMS may be valuable from both a survivability standpoint and a cost standpoint for severe trauma cases.[18] However, this study is subject to confounding variables, as does not isolate for the effect of physician presence, since it compares helicopter services to ground services. Moreover, it is difficult to isolate HEMS services to only the most severe cases and therefore ensure optimal benefit for cost in this setting.

Another study from the Netherlands calculated the cost effectiveness of a physician-staffed HEMS compared to a paramedic-staffed GEMS services.[19] The authors incorporated emergency department costs, operating costs, costs of diagnostics, and outpatient department visit costs in the calculation using cost-per-unit multiplied by volume.[19] They determined that the incremental cost-effectiveness ratio for using physician-staffed HEMS over paramedic-staffed EMS was €28,327 ($35,000 USD at present day conversion rate, unadjusted for inflation) per quality-adjusted-life-year (QALY) for severely injured trauma patients.[19] These costs are lower than the Australian study, and further support the cost effectiveness of a PS-HEMS. Of note, restriction of these services to only severely injured trauma patients is difficult in practice and case severity may not be easily determined. It is therefore important to consider that such cost-benefit analysis assumes optimized service delivery.

Furthermore, use of QALY over VALY adds more rigour into the costing analysis as quality of life is a factor incorporated into the analysis. However, this study also suffers from the same limitations as the Australian study; the cost analysis does not isolate the additional cost of a physician, rather, the costs of the entire helicopter service is incorporated. Moreover, these two studies comparatively looked at the physician versus paramedic model, but not specifically at the cost of a paramedic model. Indeed, there are inherent advantages and additional costs to a helicopter service, and closer comparisons are needed to address physician and mode-of-transport factors independently.

Interestingly, one study took a comprehensive cost analysis of HEMS against ground-based EMS in both Cornwall and in London, regardless of whether it was physician-staffed or not.20 In this study, estimated unit costs for building the components of each system were added, including capital, maintenance such as fuel and supplies, staffing, and systemic costs.[20] They concluded that the addition of a HEMS did not improve trauma patient survival, and that there were no cost-benefit advantages.[20] This may suggest that the financial and survival improvements found in the previous two studies from Australia and the Netherlands may be partly related to the impact of physician presence, rather than the helicopter service itself.

Furthermore, an older study from Arizona performed a focused cost benefit analysis on the use of a paramedic, and determined that the cost-per-life-year-saved for paramedic care was $8,886 USD for OHCA.[21] Despite being unadjusted for inflation, this cost is significantly less than the cost-per-life-year of the implementation of HEMS in the aforementioned studies, which may in part explain the popularity of the Anglo-American model. Specifically, it appears that life-saving care can be delivered at a much lower cost, and the Anglo-American model asserts that the optimal role of physicians is in hospitals rather than ambulances.

For these studies, it is important to realize that a significant limitation is that costs are estimates and that they are assessed within the context of a particular healthcare system. This may not be generalizable outside of the respective countries. However, costs were rigorously analyzed in all studies and included the ongoing costs of medical care post-hospital. Nevertheless, further costing studies regarding PS-EMS in the literature is limited, especially when compared to survival studies. Although costs can vary from region to region and can be difficult to estimate, they are an important parameter when determining the optimal model. Despite some studies which suggest that PS-EMS is ineffective, there is evidence in the literature that shows a survival benefit associated with having physicians respond to trauma and OHCA. However, the cost burden has been one of the main arguments against PS-EMS implementation, rather than lack of survival improvement. Having more costing analysis performed in a variety of regions can help anchor managers to a costing estimate of a PS-EMS compared to a non-PS-EMS. Further economic analysis regarding the cost effectiveness of a physician in prehospital care setting is therefore needed.

Discussion

A brief overview of the literature indicates there may be improved short-term and long-term outcomes with physician staffed EMS when compared to non-PS-EMS, specifically in trauma and OHCA. However, these benefits are not consistent across studies. Such differences may be attributed to potentially increased confidence and clinical judgement of physicians. Moreover, a large number of the studies compare a PS-HEMS to a ground-based non PS-EMS. This is because many countries, when making a switch from ground-based EMS to HEMS, undertook novel staffing protocols to establish physician-staffed services. This makes it difficult to directly compare physician impact on survival outcomes, as the addition of a helicopter service alone can improve outcomes.

Nevertheless, the few studies that directly compared physicians to paramedics still demonstrated an improvement in survival outcomes, mostly in more severe injury cases. Further studies directly comparing PS-EMS to non-PS-EMS without the confoundment of switching from GEMS to HEMS would help elucidate the impact of physicians on the morbidity and mortality in the prehospital care setting. Ultimately, the literature supports PS-EMS for the prehospital management of patients who are critically ill and experience severe trauma or TBI. Whether this ought to translate to widespread implementation of a PS-EMS is unclear; however, this

evidence may suggest a need for prehospital care systems to provide PS-EMS to cases which have been determined a priori to maintain a high likelihood of severe injury.

Although controversial, several studies show improved technical skills and patient outcomes with the addition of a physicians to prehospital care. However, data regarding cost is limited. Even if there is a morbidity and mortality benefit to PS-EMS, healthcare managers also have to factor in costs of a PS-EMS for such a large intervention. Differences in systems, salaries, culture, investments, switching costs, and geography make costing analysis and comparison difficult amongst different regions. Based on the available data, we cannot conclude with certainty whether PS-EMS system is more cost effective than a non PS-EMS. Having multiple studies performed in different regions under different systems can help narrow down cost estimates of PS-EMS in relation to survival benefits, yet it is still important to keep in mind that in reality there will always be limitations for such comparisons. Unlike drug trials, managers and administrators cannot achieve a definitive quantitative answer on superiority of one option against the other, but rather factor in the available numerical data in conjunction with their own applicable economical, political, social, and technological landscape to inform such decisions.[22]

Established health systems should critically analyze the literature and take into account their own contextual factors to decide whether to remain with their current system or adopt/forego a PS-EMS. Emerging prehospital care systems should act similarly, assessing resources available and the goals of their system in order to determine the model that best suits their needs.

Although further costing studies as well as studies directly comparing physicians to alternative healthcare providers would prove valuable, there are also numerous cultural barriers which may facilitate or prevent adoption of either model across countries. It is important to recognize that implementing large scale shifts in prehospital care delivery against cultural norms will always be difficult, despite further evidence showing benefits of one model over another.

Overall, this paper takes an updated look at the evidence comparing the use of a PS-EMS system to a non-PS-EMS based system. Studies at a few centers have shown no improvement, or even deterioration in care with physicians when compared to paramedics or EMTs. However, the breadth of literature shows physicians have additional competencies that may translate to improved morbidity and mortality in prehospital care, but the data is often challenging to interpret and includes confounding factors. One consistent finding is that PS-EMS may be beneficial when injuries are more severe. Although the practicality of ensuring appropriate matching between staffing and injury severity may prove to be difficult, managers who oversee EMS may consider a rapid triage method for EMS dispatchers that can effectively identify more serious injuries. Costing analysis evidence may demonstrate some economic benefit in the use PS-EMS, however, these studies are limited and do not adequately isolate for the effect of the physician as they often compare a non PS-GEMS system to a PS-HEMS. Given that several factors determine an EMS system, it can be extremely difficult to isolate simply for the type of staffing model. The literature surrounding this topic can benefit from further cost-benefit analysis that performs a direct comparison between PS-EMS and non PS-EMS based services. An alternative would be to develop projections or simulation models that estimate the costs of both staffing models, which can help isolate for PS-EMS versus non PS-EMS. Ultimately, healthcare managers should rely on data from the literature in combination with their own systems' needs, goals, and resources to determine the optimal prehospital care model in their own region.

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