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The Impact of Systems of Care on International Health Security

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Abstract

International health security (IHS) prioritizes cross-border threats to nations such as epidemics, bioterrorism, and climate change. In the modern era, however, the leading causes of mortality are not infectious. Cardiovascular disease (CVD) is the leading cause of death worldwide. Over three-quarters of CVD deaths take place in low-income countries, illustrating a disparity in care. Traumatic injury also remains one of the leading causes of morbidity and mortality worldwide, placing a particularly heavy burden upon countries with limited resources. Cerebrovascular disease and acute stroke syndromes are major causes of mortality and disability worldwide. Programs leading to timely revascularization have proven to be the most powerful predictor of disease outcomes. The health of women and children is vital to creating a healthy world. The impact of neonatal resuscitation programs on mortality has been a major force in advancing international health security. Finally, the establishment of emergency medical services (EMS) systems has been shown to improve the health of communities in both high- and low-income nations. In order to address health security on a global scale, government authorities and public health institutions must incorporate access to modern systems of care addressing the major determinants of health and primary causes of mortality.

Keywords: health security, international, trauma, ATLS, ACLS, EMS, NRP, stroke

1. Introduction

International health security is a new and evolving concept within the global health community. Despite apparent differences in understanding and use of the concept in different settings, international health security, in its most general sense, prioritizes cross-border threats to the modern and future achievements of nations such as the emergence of disease epidemics, bioterrorism, and climate change [1]. The gravity of these threats and their potential impact on people the world over has fostered greater health diplomacy between nations. There is greater cooperation and health information sharing now than in any other time in history, allowing for an evaluation of the impact contemporary systems of care may have on international health security. While global public health achievements in large part stem from greater ability to prevent and control the spread of infectious disease, this is not the sole determinate of global health and life expectancy. In the modern era, the leading causes of mortality worldwide are not infectious (**Table 1**). Cardiovascular disease is, in fact, the number one cause of mortality worldwide, inclusive of all ages and demographics. Cerebrovascular disease is the second most common cause of death. Out-of-hospital cardiac arrest, traumatic injury, and peripartum

complications leading to neonatal death continue to have a significant impact on global mortality. Emergency medical services and programs such as ATLS, Advanced Cardiac Life Support (ACLS), and the Neonatal Resuscitation Program (NRP) were created to help deliver essential knowledge and skills to communities with low resources and increased disease burden. In this chapter, we will review the impact of these programs and initiatives aimed at improving health outcomes globally.

2. Methods

An organized procedure was followed to ensure a high quality review of the literature regarding the subject of interest. First, a comprehensive search of peer-reviewed journals was completed based on a wide range of key terms including, but not limited to, "global health," "health security," and "health systems." Databases searched included PubMed, Ovid, and Google Scholar. Next, a search of websites such as the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the National Institutes of Health (NIH) was conducted for policy and review statements on major threats to health security and leading cause of mortality worldwide. Based on these findings, further literature review was conducted using key terms such as "Trauma," "Cardiovascular Disease," "Stroke," "Maternal Health," "ATLS," "ACLS," "EMS," and "NRP." Literature review continued with articles identified as having potential for further review from the references sections of articles previously collected. The literature search ultimately generated 109 articles referenced in this review, which were published between 1980 and 2019. The collective information gained from this literature review was synthesized to identify the impact of programs and initiatives aimed at improving outcomes from the greatest threats to health security. These were organized into sections and are presented as examples of the extent to which these systems of care impact health security internationally.

3. Trauma systems

Traumatic injury is a disease without boundaries; it is one of the leading causes of morbidity and mortality worldwide and places a particularly heavy burden upon countries with limited resources. Road injuries alone killed 1.4 million people in 2016, about three-quarters (74%) of whom were men and boys [3]. Despite greater knowledge of injury causes and prevention, the growing global population, traffic, and urbanization cause morbidity and mortality secondary to trauma to remain a major health concern worldwide. Ensuring timely access to advanced trauma care as an international health security measure requires an organized network of prehospital emergency care and a standardized system of trauma care that can be replicated and delivered to patients in rural community hospitals and major academic tertiary care centers alike.

One of the largest initiatives in improving trauma care to-date has been the Advanced Trauma Life Support (ATLS) course. This training program was developed in 1978 by the American College of Surgeons following the tragic event of an orthopedic surgeon piloting his plane, who crashed into a Nebraska cornfield with his family, killing his wife and severely injuring his three children [4]. Insufficiency in the system of emergency medical care was recounted by this surgeon, who called for a system change to improve the care for trauma victims everywhere. ATLS focuses on the initial stabilization and resuscitation of the trauma patient, referencing the "Golden Hour" as the most important, as 30% of all trauma deaths occur

| Rank	0–4 years	5–14 years	15–29 years	30–44 years	45–59 years	≥60 years	All ages
1	Lower respiratory infections 1,890,008	Childhood cluster diseases 219,434	HIV/AIDS 707,277	HIV/AIDS 1,178,856	Ischemic heart disease 1,043,978	Ischemic heart disease 5,812,863	Ischemic heart disease 7,153,056
2	Diarrheal diseases 1,577,891	Road traffic injuries 130,835	Road traffic injuries 302,208	Tuberculosis 390,004	Cerebrovascular diseases 623,099	Cerebrovascular diseases 4,685,722	Cerebrovascular diseases 5,489,591
3	Low birth weight 1,149,168	Lower respiratory infections 127,782	Self-inflicted injuries 251,806	Road traffic injuries 285,457	Tuberculosis 400,708	COPD 2,396,739	Lower respiratory infections 3,764,415
4	Malaria 1,098,446	HIV/AIDS 108,090	Tuberculosis 245,818	Ischemic heart disease 231,340	HIV/AIDS 390,267	Lower respiratory infections 1,395,611	HIV/AIDS 2,818,762
5	Childhood cluster diseases 1,046,177	Drowning 86,327	Interpersonal violence 216,169	Self-inflicted injuries 230,490	COPD 309,726	Cancers of respiratory system 927,889	COPD 2,743,509
6	Birth asphyxia and birth trauma 729,066	Tropical cluster diseases 35,454	Lower respiratory infections 92,522	Interpersonal violence 165,796	Cancers of respiratory system 261,860	Diabetes 749,977	Diarrheal diseases 1,766,447
7	HIV/AIDS 370,706	Fires 33,046	Fires 90,845	Cerebrovascular diseases 124,417	Cirrhosis of the liver 250,208	Hypertensive heart disease 732,262	Tuberculosis 1,605,063
8	Congenital heart disease 223,569	Tuberculosis 32,762	Drowning 87,499	Cirrhosis of the liver 100,101	Road traffic injuries 221,776	Stomach cancer 605,395	Childhood cluster diseases 1,359,548
9	Protein energy malnutrition 138,197	Protein energy malnutrition 30,763	War 71,680	Lower respiratory infections 98,232	Self-inflicted injuries 189,215	Tuberculosis 495,199	Cancers of respiratory system 1,238,417
10	STDs (except HIV) 76,871	Meningitis 30,694	Hypertensive heart disease 61,711	Poisoning 81,930	Stomach cancer 185,188	Colon or rectal cancer 476,902	Malaria 1,221,432

Table 1.
Most common causes of death worldwide by age group, 2002 (adapted from WHO prehospital trauma care systems) [2].

within 60 minutes of injury [5]. Despite a paucity of data on the effect ATLS has on trauma mortality, existing evidence supports its practice as a means of decreasing mortality and improving systems of care globally [6, 7].

Over 90% of deaths related to injury occur in low-income countries where the availability of prevention programs, emergency services, and centers capable of prompt, advanced resuscitation is limited. The majority of these deaths are caused by road traffic injuries [8]. Establishing early advanced trauma care is essential to decreasing global morbidity and mortality due to trauma and is, in part, accomplished with the dissemination of trauma education programs [9]. Studies have shown that as the number of ATSL-trained professional increases, the rates of preventable and potentially preventable deaths decreases (**Figure 1**) [10].

One study of trauma-related deaths before and after the implementation of focused trauma education courses in the capital of Rwanda, including ATLS, found the mortality of severely injured patients decreased significantly in the 6 months following their initiation [7]. Another study reported improved management of trauma patients by practitioners from countries throughout East, Central, and Southern Africa after institution of a primary trauma care course [11]. In the Netherlands, the introduction of ATLS resulted in a significantly improved trauma outcome in the first hour after admission [12]. A study on the impact of mandatory ATLS training on processes of care in rural America found improvement after categorization of trauma centers [6]. Improvement in trauma patient outcomes has also been reported after ATLS training in Trinidad and Tobago [13].

Since its inception, ATLS has gone through several iterations. Its principles have become standard of care in over 50 countries worldwide, with over 1 million physicians trained since the mid-1990s [14–16]. ATLS has developed into a global resuscitation program, with confirmed results in terms of improved patient outcomes, processes of care, and teaching.
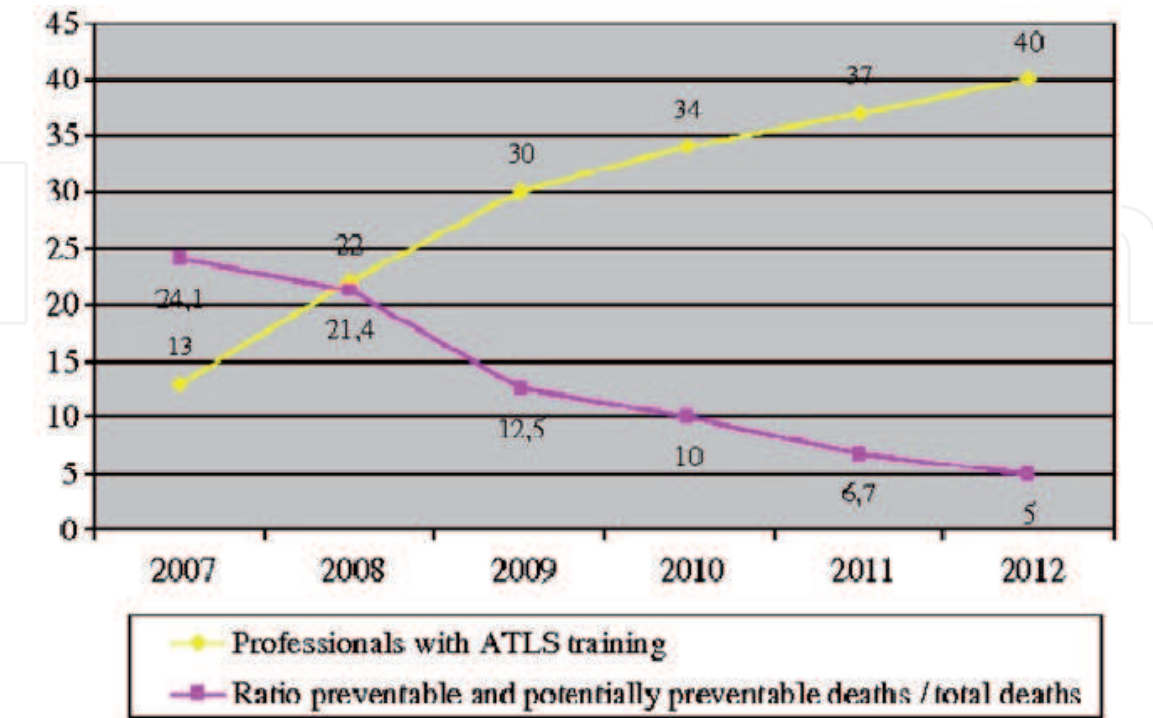
Figure 1.
Change in mortality over time with increasing number of ATLS-trained providers (adapted from Navarro et al. [10]).

4. Cardiovascular care

Cardiovascular disease (CVD) is by far the leading cause of death worldwide. An estimated 17.9 million people died from CVD in 2016, representing 31% of all global deaths, 85% of which are due to heart attack and stroke [3, 17]. Over three-quarters of CVD deaths take place in low-income countries, illustrating a disparity in care and the need for further resource allocation and education. Despite the global burden of CVD, there have been remarkable advances in treatment and prevention. The field of resuscitation has been evolving for more than two centuries with the American Heart Association (AHA) formally endorsing cardiopulmonary resuscitation (CPR) in 1963 [18].

Basic life support (BLS) and advanced cardiac life support (ACLS) guidelines have evolved over the past several decades based on a combination of scientific evidence and expert consensus. The AHA and European Resuscitation Council developed the most recent ACLS Guidelines in 2010 using a comprehensive review of resuscitation literature performed by the International Liaison Committee on Resuscitation (ILCOR). These were updated in 2015 and 2018 [19–26]. The efficacy of these guidelines is well borne out in the literature with clear reductions in in-hospital and out-of-hospital mortality when the most critical interventions (e.g., defibrillation, CPR, and rapid transport to an advanced care) are initiated early (**Figure 2**) [24, 27–31].

Numerous large-scale randomized clinical trials have demonstrated the benefit of timely interventions as well, including antiplatelet therapy, thrombolysis, and cardiac catheterization [17, 32]. Results from these trials have been incorporated into guidelines for inpatient and outpatient cardiac care internationally [33, 34].

Despite these well-established guidelines for the management of ACS, there are still strong differences with regard to the epidemiology, diagnosis, and treatment of patients with ACS, leading to diverging morbidity and mortality rates throughout the globe [17]. Reasons for such differences among different global populations are multifactorial and include differences in population genetics, access to care, diet, socioeconomic status, and treatment modalities employed regionally (i.e., invasive vs. non-invasive strategies) [35, 36]. To address these disparities, much work has been done to universalize treatment protocols by bringing systems of care to areas most in need.

Stent for Life (SFL), a European Association of Percutaneous Cardiovascular Interventions (EAPCI) and Congress of the European Association of Percutaneous Cardiovascular Interventions (EuroPCR) coalition, was established in 2008 as a non-profit international network of national cardiac societies and partnering organizations. The mission of SFL was to address inequalities in ST-elevation acute

	No. (%)							
	2005	2006	2007	2008	2009	2010	2011	2012
Neurologically intact survival	587	768	1194	1294	1495	1543	1677	1710
Defibrillation								
Bystander only	6 (1.0)	34 (4.4)	69 (5.8)	117 (9.0)	143 (9.6)	169 (11.0)	186 (11.1)	217 (12.7)
EMS only	431 (73.4)	560 (72.9)	811 (67.9)	845 (65.3)	974 (65.2)	963 (62.4)	955 (56.9)	959 (56.1)
Combined[a]	5 (0.9)	8 (1.0)	33 (2.8)	47 (3.6)	66 (4.4)	86 (5.6)	101 (6.0)	100 (5.8)
Bystander chest compression	315 (53.7)	438 (57.0)	721 (60.4)	835 (64.5)	974 (65.2)	1050 (68.0)	1125 (67.1)	1179 (68.9)

Figure 2.
Exposure to prehospital bystander interventions among patients who achieved neurologically intact survival. EMS = emergency medical services; [a]patients received both bystander and EMS defibrillation (adapted from Nakahara et al. [27]).

myocardial infarction (STEMI) patients' access to a life-saving revascularization treatment throughout Europe.

Effective from 2008 to 2016 in 23 countries, mainly in Europe, this initiative significantly improved the delivery of guideline-compliant therapy and patient access to primary percutaneous coronary intervention (p-PCI), thereby reducing mortality and morbidity in patients suffering from acute myocardial infarction (AMI) [37, 38]. Since 2017, the Stent—Save a Life Initiative (SSLI) was founded as the global extension and continuation of Stent for Life. The SSLI works to identify regions and countries with an unmet medical need in the optimal treatment of ACS and implement an action program to increase patient access to primary PCI where indicated.

The advancement of international health security is seen in the work of these and similar organizations which work to identify opportunities and challenges in building systems of care in emerging countries, such as India, China, South Africa, and Mexico, where CAD mortality is increasing and becoming a significant healthcare problem [39–42]. Geographic mapping and situational analyses have shown that adherence to STEMI guidelines is influenced by many factors and varies from country to country, from region to region, and no one model fits all communities. Greater understanding of system-level barriers and unique challenges in the regional context will facilitate the development of more effective strategies for improving the treatment and preventing CVD globally.

5. Cerebrovascular disease

Cerebrovascular disease and acute stroke syndromes are a leading cause of mortality and disability worldwide. According to the Global Burden of Disease Study published in December, 2018 the estimated lifetime risk of stroke for a 25 year old during their remaining lifespan is 25% [43]. Stroke is the third leading cause of death and first leading cause of major disability in North America. Over the last several decades developed countries have experienced reductions in stroke-related morbidity and mortality [44]. Mortality from stroke has decreased by 60% in the United States alone, but remains the fifth leading cause of death [45–47]. For most developed countries, this experience has been similar. Over the last 20 years, high-income countries have experienced an age-standardized decrease in incidence, mortality and disease burden (as measured by disability-adjusted life year loss rates) of 13, 37, and 21%, respectively [48, 49]. Nonetheless, Stroke accounts for almost 5% of all disability-adjusted life-years and 10% of all deaths worldwide [50].

While progress has been made in stroke care in developed countries, the global experience of cerebrovascular disease is less encouraging. In 2013, 6.4 million deaths (11.8% of all global deaths) were a result of stroke [51]. Stroke remains the third leading cause of years-of-potential-life lost worldwide [52]. Between 1990 and 2010, the incidence of ischemic stroke increased by 37% and that of hemorrhagic stroke increased by 47%; the total number of deaths attributable to ischemic and hemorrhagic stroke increased by 20% over that same period [48]. By 2030 there could be as many as 12 million stroke deaths, 70 million stroke survivors, and >200 million disability-adjusted life years lost from stroke each year [44]. Not surprisingly, the majority of the burden of disease is borne by low- and middle income countries at the center of the global stroke epidemic [53]. While high-income, developed countries have been experiencing significant declines in stroke incidence in recent years, undeveloped, low-income countries have experienced increases in incidence by as much as 100% [54]. The substantial regional and country-level variation in stroke disease, with hotspots of particularly high-stroke incidence, mortality, and morbidity in Eastern Europe, East and Southeast Asia, Central Africa, and Oceania

has become known as the "Global Stroke Belt" [55]. The most affected countries in the global stroke belt have a >10-fold higher age-standardized stroke mortality rate than the least affected countries [56].

There have been significant advances in stroke care in recent years. Timely revascularization has been by far the most powerful predictor of improved outcome in patients with acute ischemic stroke [57]. Given the time-sensitive nature of therapeutic interventions and the specialized care required by those affected, regional systems of care have evolved in different forms to provide patients the best functional outcomes possible. The emergence of advanced imaging modalities and endovascular interventions have had a significant impact on the organization of acute stroke care, as communities strive to deliver the most up-to-date, evidence-based treatments effectively.

Evidence shows that organized care within specialized stroke units is associated with better quality of care and reduced rates of death and disability [58]. There is significant variation, however, within and between countries in access to stroke care and the organizational models of such care [59]. In several countries, acute stroke services are being centralized into "hub and spoke" systems in which hospital providing different levels of care work together to create a centralized system in which all patients with acute ischemic stroke are taken to specialized centers, rather than the nearest hospital [60]. Research suggests that in countries where such models exist (e.g., the United States, Canada, the Netherlands, Denmark, and Australia), there is greater provision of evidence-based therapies by increasing access to specialist care and thrombolysis [61–63]. Other countries, such as the United Kingdom, have found decreases in mortality and hospital length-of-stay where hyperacute stroke services were centralized to a small number of highly specialized, high-volume centers [64]. In other countries, such as Greece, a centrally administered rotation system for 24-hour on-call services exists for specialized stroke care [65].

In the United States (U.S.), regionalization of care around specialized centers played a large role in stroke dropping from the third to the fifth most common cause of death [55]. In the year 2000, the Brain Attack Coalition recommended the establishment of primary stroke centers (PSCs). Primary Stroke Center certification recognizes hospitals that meet standards to support better outcomes for stroke care. Studies from the American Heart Association/American Stroke Association Get With The Guidelines-Stroke Program have demonstrated that PSC certification improves many key process measures of stroke care [66].

Studies have shown that not only do hospitals with PSC certification experience lower mortality rates but also the mortality benefit appears to be independent of hospital size or time since certification (**Figure 3**) [67, 68]. This suggests that the process of obtaining certification in advanced stroke care alone may improve outcomes, regardless of hospital size. Since 2012, hospitals may become certified as comprehensive stroke centers (CSCs), another designation based on the Brain Attack Foundation's recommendations for establishing systems of stroke care which requires an ability to provide more-complex services, including 24/7 availability of endovascular procedures. According to a large national study of stroke centers in the U.S., CSCs were significantly better at providing prompt acute treatment (i.e., thrombolysis and endovascular clot retrieval) for patients with acute ischemic stroke, but in-hospital mortality was similar between hospital settings [69]. The fact that less technically sophisticated centers provided non-inferior care to larger, more advanced centers has significant implications. For communities with evolving systems of care and in nations where resources are limited, a focus on providing established medical therapies to the most number of people in the most timely manner possible may be more beneficial than investing in expensive advanced technologies.

	Designated Stroke Center (n = 15,297) No. %	Non-Designated Hospital (n = 15,650) No. %	Adjusted Mortality Difference (95% CI)[a]	P-Value
1 day	90 (0.6)	134 (0.9)	-0.3 (-0.6 to 0.0)	0.04
7 day	665 (4.3)	842 (5.4)	-1.3 (-2.1 to -0.6)	0.001
30 day	1543 (10.1)	1951 (12.5)	-2.5 (-3.6 to -1.4)	<0.001
1 Year	3412 (22.3)	4067 (26)	-3 (-4.4 to -1.5)	<0.001

Figure 3.
Mortality at designated stroke centers and nondesignated hospitals. CI = confidence interval; [a]negative values indicate lower mortality rates at designated vs. nondesignated hospitals (adapted from Xian et al. [67]).

6. Neonatal resuscitation

The health of women and children is vital to creating a healthy world. Ensuring access to appropriate perinatal care is vital to international health security. Despite great progress, there are still too many mothers and children dying—mostly from causes that could have been prevented. Every day, there are approximately 800 deaths from preventable causes related to pregnancy and childbirth, 99% of which occur in developing countries. Despite decreasing rates of childhood mortality worldwide, neonatal deaths account for nearly half of all deaths in children less than 5 years old [70]. Intrapartum-related events such as birth asphyxia contribute to approximately one-quarter of neonatal deaths, many of which can be decreased by simple resuscitative and newborn care maneuvers. Neonatal deaths now comprise ~45% of all childhood deaths in children less than 5 years old, resulting in 2.7 million lives lost each year [71].

The challenge of delivering neonatal resuscitative interventions is complicated by the fact that childbirth often occurs outside of healthcare facilities; up to 60% in some parts of the world [72]. Implementation of properly performed neonatal resuscitation remains low in countries with the highest neonatal mortality rates [72]. Adequate basic neonatal resuscitation can prevent many intrapartum deaths. Studies suggest that an additional 20–40% of lives would be saved with the institution of basic neonatal resuscitation where it is needed most [73, 74].

Understanding the impact that neonatal resuscitation delivered by trained healthcare workers can have on mortality is essential to improving international health security. Implementation of neonatal resuscitation programs has been shown to decrease intrapartum stillbirth rates and early neonatal mortality. Skilled birth attendance and newborn resuscitation are evidence-based interventions directed at the moment when the lifetime risk for mortality is highest [73, 74].

The American Academy of Pediatrics released the Neonatal Resuscitation Program (NRP) in 1997, the first standardized training program for neonatal resuscitation of its kind. The NRP is an educational program that translates the science of resuscitation into practice. The initial goals of the NRP were to promote evidence-based care for newborns and to ensure the presence of at least one professional trained in neonatal resuscitation at every delivery in the United States (US) [75]. Hands-on learning with mannequins and a simple, transportable program structure led to widespread adoption outside the US. The use of NRP has spread globally with countries adapting the program to function within the context of their own healthcare environments [76]. NRP continues to be a driving force for the development of initiatives to reduce newborn mortality by promoting an action-oriented approach that trains a variety of providers, aids in the acquisition of resuscitation equipment, and promotes the

importance of newborn health to proper authorities [77]. Implementation of NRP in various countries has resulted in a reduction in birth asphyxia-related mortality, in addition to increased use of bag-mask ventilation in newborn resuscitation [78, 79].

Drawbacks of the NRP, however, exist, and are primarily related to its complexity, which necessitates training in well-resourced settings. This has also been shown to result in inadequate skills retention after training when the learner does not practice neonatal resuscitation regularly [80]. These and other challenges to the adoption of NRP in low-resource settings may lead to the assumption that resuscitation cannot be accomplished without advanced equipment and facilities [81]. Research over the last two decades, however, has shown that over 98% of babies respond with spontaneous breathing after basic resuscitation, including drying, warmth, stimulation, and bag-mask ventilation [72, 82].

Thus, NRP courses taught in resource-limited settings have been modified to focus on the initial steps of resuscitation while omitting discussion of more complex interventions such as intubation, medications, and umbilical line placement. Adaptations of NRP have improved both educational outcomes and skills when used to teach providers in low-resource settings [79, 83, 84]. They also have led to decreases in perinatal mortality. In a multinational randomized trial of 62,366 births in rural communities, utilization of a modified NRP and newborn care package resulted in a 30% reduction in still birth rates [85]. Such experiences demonstrate that low-resource settings require a curriculum specifically designed and targeted for their needs.

With the goal of equipping caretakers in all practice settings with the basic knowledge and skills necessary to perform adequate neonatal resuscitation, a task force organized by the American Academy of Pediatrics set out to develop a simplified, standardized curriculum based on NRP. The result was the Helping Babies Breathe (HBB) program, which became available in 2010. The HBB curriculum is portable, low cost, and teaches a simpler algorithm than NRP, focusing on stimulation, drying, clearing the airway, and bag-mask ventilation. Instead of spending time evaluating a baby's condition, interventions begin immediately with sequential evaluation of crying, breathing, and heart rate. Elements of essential newborn care are incorporated into the curriculum, including encouragement of breastfeeding, cleanliness, and warmth at delivery. The World Health Organization (WHO) released guidelines on basic newborn resuscitation in 2012, which were largely consistent with the recommendations and action plan of HBB [86].

Educational evaluations of HBB in developing countries have shown the course to be well received since their dissemination workshops in HBB have been shown to improve knowledge and skills in basic neonatal resuscitation immediately after training [87–91]. Most encouraging for the further spread of the program have been studies evaluating differences in performance based on the type of provider. While physicians perform better in pre-workshop assessments of both knowledge and skills of basic resuscitation, after HBB training, nurses perform as well in simulation as physicians [89, 91]. This and similar evidence support the training of doctors, nurses, midwives, and all others involved in newborn care. This is vital as, globally, midwives and other non-physicians care for the majority of deliveries.

Since the introduction of HBB, over 300,000 providers have been trained in 77 countries [92]. Fifty-two countries have established nationally led programs. Analysis of 80,000 births after HBB training demonstrated a 47% reduction in early neonatal deaths and a 24% reduction in fresh stillbirth rates (**Figure 4**) [94].

Studies in developing countries where HBB was adopted have shown a decrease in perinatal mortality and in stillbirth rates [93, 95]. A systematic review evaluating whether the implementation of a standardized formal neonatal resuscitation training program in low- and middle-income countries improved neonatal outcomes
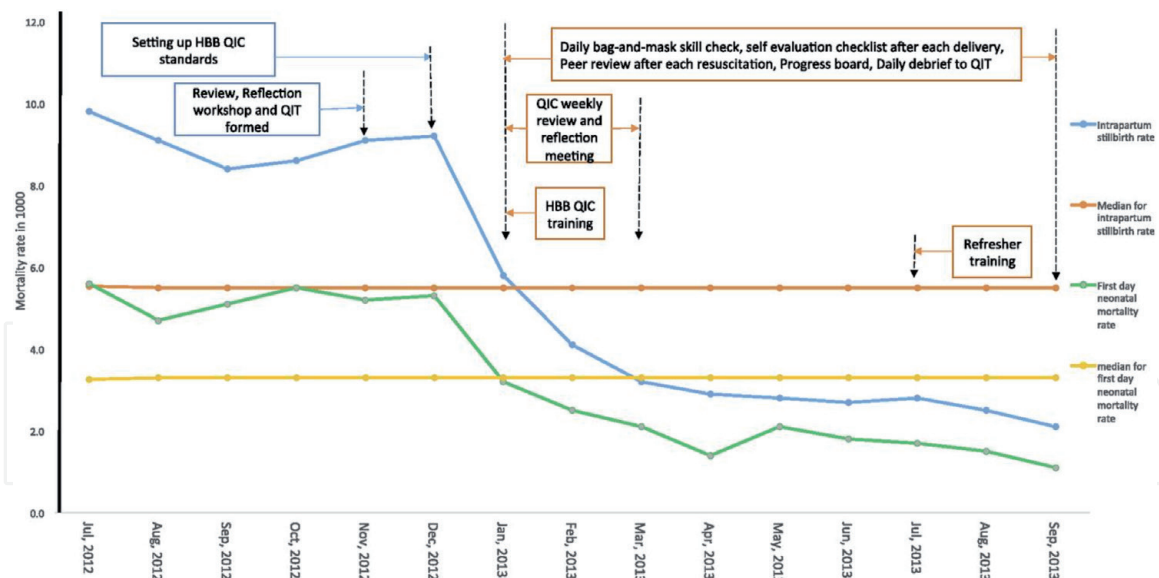
Figure 4.
Stillbirth and intrapartum mortality rates overtime during implementation of HBB in a Nepalese tertiary care center. QIC = quality improvement cycle; QIT = quality improvement team (adapted from Kc et al. [93]).

found that early neonatal mortality (first week of life) decreased by 15% and reduction of 28-day mortality by 45% [96].

On a global scale, many successes have been achieved with the implementation of neonatal resuscitation: decreased neonatal mortality, decreased still birth rates, and increased use of alternative providers. Despite the successes of implementation of neonatal resuscitation education, training providers in and of itself is insufficient to close the gaps in quality of newborn care. An estimated two-thirds of the world's 2.7 million newborn deaths may be prevented with basic pre- and postnatal care [97]. While there may be successes to celebrate, there is still much work to be done to improve newborn care and reduce neonatal mortality globally.

7. Emergency medical services

An emergency medical service can be described as a comprehensive system, which provides the arrangements of personnel, facilities, and equipment for the effective, coordinated, and timely delivery of health and safety services to victims of sudden illness or injury [98]. The goal of EMS is to provide timely health care for out-of-hospital medical emergencies in order to prevent unnecessary mortality or long-term morbidity [2].

Timely access to healthcare in an emergency situation is a fundamental component of health security. Prompt provision of prehospital emergency care coupled with rapid movement of the ill and injured to a health-care facility can save lives, reduce the incidence of short-term disability, and markedly improve long-term outcomes. The World Health Organization regards EMS system as an integral part of any effective and functional health care system [99]. In developed nations, emergency medical service (EMS) has evolved into a key link in the chain of survival for those suffering out-of-hospital illness or injury, and contributes significantly to the overall function of a healthcare system and health of a society. The birth and evolution of emergency medical services has, however, been a very slow process and has occurred on different timelines around the world.

Although modern EMS initially developed during Napoleon's time to aid injured soldiers, few major changes occurred in EMS until the 1960s. The adaptation of prehospital care and transport principles from the military to the civilian arena

accelerated after the Vietnam War, as returning veterans helped raise awareness of the disparities in care. By the end of the conflict, gunshot victims had better chances of survival in the jungles of Vietnam than they had in the streets of major cities across America. Between 1960 and 1970, a number of medical, historical, and social forces converged, leading to the development of a more structured EMS system in the United States and abroad [100].

Since the 1970s, emergency health care delivery has evolved from two different models with different philosophies and distinct features, referred to as the Anglo-American and Franco-German models of care [2]. Although the categorical distinctions between these two models were more obvious leading up to the twentieth century, modern EMS systems around the world have evolved along one of these two frameworks while adopting various components of the other.

The Franco-German model is based on a "stay and stabilize" philosophy where advanced medical care is brought to the patient. Emergency services are run by physicians who respond to patient's homes or the scene of an accident where they provide advanced care. Patients are either stabilized and provided follow-up directions or are transported to the hospital for admission. This results in fewer EMS transports and fewer patients being seen and treated in emergency departments. This approach to prehospital care, where EMS is an extension of the hospital, is widely implemented in continental Europe (e.g., France, Germany, Greece, Malta, and Austria) where emergency medicine is a young specialty.

By contrast, the Anglo-American model of EMS care is based on a "scoop and run" philosophy [101]. The objective in this model is to rapidly bring patients to the hospital with less time spent on prehospital treatment and interventions. Here, EMS services are allied with public safety services such as fire or police departments rather than public health services or hospitals [102]. Specialized emergency medical technicians (EMTs) and paramedics provide direct patient care with remote physician oversight. In countries where this model prevails, emergency medicine is well developed and recognized as a separate medical specialty [103]. Patients are transported to emergency departments (EDs) where the majority of evaluation and treatment is begun. Patients are then either discharged or admitted to the wards for further treatment. Examples of countries utilizing this model include the United States, Canada, New Zealand, and Australia.

While both models of EMS share a similar focus for the severely ill and injured (i.e., stabilization and transport), it is the delivery of non-life-threatening care where the greatest difference is found. Whereas the Franco-German model places more emphasis on treating patients in their homes and avoiding transport when possible, the Anglo-American model transports the majority of patients for evaluation in an emergency department [104]. Given the significant differences in these systems, much comparative research has been done on patient outcome and cost-effectiveness between the two models. Outcomes, however, are difficult to interpret because of the disparate nature of each model. Each operates in a different context with different goals. The lack of unified standards makes direct comparison difficult and there is no evidence that one model is better than the other [105–107].

Unfortunately, to this day, the capacity to provide the most basic level of prehospital emergency care is lacking in many countries around the world. While EMS providers have developed an extended role in dealing with medical emergencies and have access to advanced clinical technologies in some countries, in others their education and training is much more limited due to a lack of funding, resources, and organizational guidance. Regardless of how simple or sophisticated a prehospital care system may be, the essential elements of an effective model are not outside the capabilities of developing nations. These elements, shown to decrease morbidity and mortality, include prompt communication and activation of the prehospital

emergency response system, immediate system response, and simultaneous treatment and transport to formal medical care [99]. It is important to note that there is little evidence that advanced prehospital interventions benefit more than a small subset of the most critically ill or injured. Studies have shown that the majority of cases require treatment within the skill set of responders trained only in basic life support [102]. This has major implications for nations with limited resources, where advanced life support materials and programs may harm a system by diverting precious resources from less glamorous, but more effective measures that benefit a larger number of people. Ultimately, the model chosen for creating and administering an EMS system best suited to a particular demographic will be influenced by regional resources, culture and values, but should always be the result of local and national governments working together toward a common goal of greater health security [108].

8. Future concerns

In an increasingly interconnected world, the potential for threats to international health security such as pandemics, bioterrorism, and radionuclear exposure are of increasing concern. The research and design of medical countermeasures in the form of vaccines, antimicrobials, therapeutics, and diagnostics that address the public health and medical consequences of chemical, biological, radiological, and nuclear events is an area of active research and development. In 2014, the United States in partnership with international organizations and nearly 30 partner countries launched the Global Health Security Agenda (GHSA) to accelerate progress to improve prevention, detection, and response capabilities for public health emergencies [109]. The GHSA calls for improved global access to medical countermeasures and establishes as a target the development of national policy frameworks for sending and receiving medical countermeasures from and to international partners during public health emergencies. International health countermeasures such as vaccines, antidotes, and decontamination supplies are now stockpiled by several countries to protect their own populations and by international organizations such as the WHO for the benefit of the international community (typically those with limited resources). Much work remains, however. During the H1N1 influenza pandemic in 2009, legal, regulatory, logistical, and funding barriers slowed the spread of vaccine and revealed how implementing health security measures on a global scale remains a significant challenge [109]. While imperfect in its implementation, the network established by the GHSA continues to evolve and help combat future threats to international health security. Greater efforts are needed to develop a framework to deploy medical countermeasures internationally, thus increasing global capacity to respond to public health emergencies.

9. Conclusion

The concept of health security means different things to different people. In developed nations, the concept is that of addressing threats to public health such as the spread of disease and bioterrorism. In developing nations, threats to health also include access to care and modern therapies. In order to address health security on a global scale, government authorities and public health institutions must incorporate access to modern systems of care addressing the major determinants of health and primary causes of mortality into the focus of international health security. In this chapter, we have discussed how organized systems of care stand to improve the

health of communities on a global scale. With greater emphasis on establishing these and other systems in developing countries, greater health security can be brought to communities that need it most.

Abbreviations

ACLS	advanced cardiac life support
ACS	acute coronary syndrome
AHA	American Heart Association
AMI	acute myocardial infarction
ATLS	Advanced Trauma Life Support
BLS	basic life support
CDC	Centers for Disease Control and Prevention
CPR	cardiopulmonary resuscitation
CSC	comprehensive stroke center
CVD	cardiovascular disease
EAPCI	European Association of Percutaneous Cardiovascular Interventions
ED	emergency department
EMS	emergency medical services
EMT	emergency medical technician
EuroPCR	Congress of the European Association of Percutaneous Cardiovascular Interventions
GHSA	Global Health Security Agenda
HBB	Helping Babies Breath
IHS	international health security
ILCOR	International Liaison Committee on Resuscitation
NIH	National Institutes for Health
NRP	Neonatal Resuscitation Program
PSC	Primary Stroke Center
p-PCI	primary percutaneous coronary intervention
SFL	Stent for Life
STEMI	ST-elevation acute myocardial infarction
SSLI	Stent-Save a Life Initiative
WHO	World Health Organization

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References

[1] Aldis W. Health security as a public health concept: A critical analysis. Health Policy and Planning. 2008;**23**(6):369-375

[2] Al-Shaqsi S. Models of international emergency medical service (EMS) systems. Oman Medical Journal. 2010;**25**(4):320-323. Available from: http://www.omjournal.org

[3] World Health Organization, Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2016. 2018

[4] Styner JK. The birth of Advanced Trauma Life Support (ATLS). The Surgeon. 2006;**4**(3):163-165

[5] Soreide K et al. Epidemiology and contemporary patterns of trauma deaths: Changing place, similar pace, older face. World Journal of Surgery. 2007;**31**(11):2092-2103

[6] Olson CJ et al. Influence of trauma system implementation on process of care delivered to seriously injured patients in rural trauma centers. Surgery. 2001;**130**(2):273-279

[7] Petroze RT et al. Can focused trauma education initiatives reduce mortality or improve resource utilization in a low-resource setting? World Journal of Surgery. 2015;**39**(4):926-933. Available from: https://www.springer.com/journal/268

[8] WHO. World Report on Road Traffic Injury Prevention. WHO; 2004

[9] Mock C et al. Strengthening trauma systems globally: The essential trauma care project. The Journal of Trauma. 2005;**59**(5):1243-1246

[10] Navarro S, Montmany S, Rebasa P, Colilles C, Pallisera A. Impact of ATLS training on preventable and potentially preventable deaths. World Journal of Surgery. 2014;**38**(9):2273-2278

[11] Ologunde R et al. Do trauma courses change practice? A qualitative review of 20 courses in East, Central and Southern Africa. Injury. 2017;**48**(9):2010-2016

[12] van Olden GD et al. Clinical impact of advanced trauma life support. The American Journal of Emergency Medicine. 2004;**22**(7):522-525

[13] Ali J et al. Cognitive and attitudinal impact of the Advanced Trauma Life Support program in a developing country. The Journal of Trauma. 1994;**36**(5):695-702

[14] van Vugt AB. 'Advanced trauma life support' in Netherlands. Nederlands Tijdschrift voor Geneeskunde. 2000;**144**(44):2093-2097

[15] Scharplatz D, Sutter PM, Ummenhofer W. ATLS (advanced trauma life support) in Switzerland. Swiss Surgery. 2000;**6**(6):343-346

[16] Rastad J, Lindebert T. "Advanced trauma life support" in Sweden. A flying start for trauma education. Läkartidningen. 1996;**93**(30-31):2660-2661

[17] Kampfer J et al. Long-term outcomes after acute myocardial infarction in countries with different socioeconomic environments: An international prospective cohort study. BMJ Open. 2017;**7**(8):e012715

[18] DeBard ML. The history of cardiopulmonary resuscitation. Annals of Emergency Medicine. 1980;**9**(5):273-275

[19] Field JM et al. Part 1: Executive summary: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and

emergency cardiovascular care. Circulation. 2010;**122**(18 Suppl 3): S640-S656

[20] Hazinski MF et al. Part 1: Executive summary: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2010;**122**(16 Suppl 2): S250-S275

[21] Neumar RW et al. Part 1: Executive summary: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015;**132**(18 Suppl 2): S315-S367

[22] Link MS et al. Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015;**132**(18 Suppl 2):S444-S464

[23] Nolan JP et al. European Resuscitation Council Guidelines for Resuscitation 2010: Section 1. Executive summary. Resuscitation. 2010;**81**(10):1219-1276

[24] Monsieurs KG et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 1. Executive summary. Resuscitation. 2015;**95**:1-80

[25] Soar J et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult Advanced Life Support. Resuscitation. 2015;**95**:100-147

[26] Soar J et al. 2018 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. Resuscitation. 2018;**133**:194-206

[27] Nakahara S et al. Association of bystander interventions with

neurologically intact survival among patients with bystander-witnessed out-of-hospital cardiac arrest in Japan. JAMA. 2015;**314**(3):247-254

[28] Rea TD et al. Temporal trends in sudden cardiac arrest: A 25-year emergency medical services perspective. Circulation. 2003;**107**(22):2780-2785

[29] Aufderheide TP et al. Implementing the 2005 American Heart Association guidelines improves outcomes after out-of-hospital cardiac arrest. Heart Rhythm. 2010;**7**(10):1357-1362

[30] Malta Hansen C et al. Association of bystander and first-responder intervention with survival after out-of-hospital cardiac arrest in North Carolina, 2010-2013. JAMA. 2015;**314**(3):255-264

[31] McEvoy MD et al. The effect of adherence to ACLS protocols on survival of event in the setting of in-hospital cardiac arrest. Resuscitation. 2014;**85**(1):82-87

[32] Ribeiro HB, Lemos PA. Seeking actual benchmarks in acute coronary syndromes for European countries: Insights from the EURHOBOP registry. Heart. 2014;**100**(15):1147-1148

[33] Ibanez B et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). European Heart Journal. 2018;**39**(2):119-177

[34] Hamm CW et al. ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. The Task Force for the management of acute coronary syndromes (ACS) in patients presenting without persistent ST-segment elevation

of the European Society of Cardiology (ESC). Giornale italiano di cardiologia (Rome). 2012;**13**(3):171-228

[35] Orlandini A et al. Outcomes of patients in clinical trials with ST-segment elevation myocardial infarction among countries with different gross national incomes. European Heart Journal. 2006;**27**(5):527-533

[36] Jakobsen L et al. Dimensions of socioeconomic status and clinical outcome after primary percutaneous coronary intervention. Circulation. Cardiovascular Interventions. 2012;**5**(5):641-648

[37] Kristensen SD et al. Implementation of primary angioplasty in Europe: Stent for Life initiative progress report. EuroIntervention. 2012;**8**(1):35-42

[38] Laut KG, Kaifoszova Z, Kristensen SD. Status of Stent for Life initiative across Europe. Journal of Cardiovascular Medicine (Hagerstown, Md.). 2011;**12**(12):856-859

[39] Gupta R. Burden of coronary heart disease in India. Indian Heart Journal. 2005;**57**(6):632-638

[40] Huo Y. Current status and development of percutaneous coronary intervention in China. Journal of Zhejiang University Science B. 2010;**11**(8):631-633

[41] Schamroth C. Management of acute coronary syndrome in South Africa: Insights from the ACCESS (acute coronary events—A multinational survey of current management strategies) registry. Cardiovascular Journal of Africa. 2012;**23**(7):365-370

[42] Velazquez Monroy O et al. Morbidity and mortality by ischemic heart disease and stroke in Mexico. 2005. Archivos de Cardiología de México. 2007;**77**(1):31-39

[43] Feigin VL et al. Global, regional, and country-specific lifetime risks of stroke, 1990 and 2016. The New England Journal of Medicine. 2018;**379**(25):2429-2437

[44] Feigin VL et al. Global burden of stroke and risk factors in 188 countries, during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. Lancet Neurology. 2016;**15**(9):913-924

[45] Ten great public health achievements—United States, 1900-1999. MMWR. Morbidity and Mortality Weekly Report. 1999;**48**(12):241-243

[46] Ten great public health achievements—United States, 2001-2010. MMWR. Morbidity and Mortality Weekly Report. 2011;**60**(19):619-623. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6019a5.htm

[47] Kochanek KD et al. Mortality in the United States, 2013. NCHS Data Brief. 2014;(178):1-8

[48] Krishnamurthi RV et al. Global and regional burden of first-ever ischaemic and haemorrhagic stroke during 1990-2010: Findings from the Global Burden of Disease Study 2010. The Lancet Global Health. 2013;**1**(5):e259-e281

[49] Bennett DA et al. The global burden of ischemic stroke: Findings of the GBD 2010 study. Global Heart. 2014;**9**(1):107-112. Available from: https://pubmed.ncbi.nlm.nih.gov/25432120/

[50] Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: A systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;**390**(10100):1151-1210. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32152-9/fulltext

[51] Global, regional, and national age-sex specific all-cause and cause-specific

mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;**385**(9963):117-171

[52] Wang H et al. Age-specific and sex-specific mortality in 187 countries, 1970-2010: A systematic analysis for the global burden of disease study 2010. Lancet. 2012;**380**(9859):2071-2094

[53] Lopez AD et al. Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. Lancet. 2006;**367**(9524):1747-1757

[54] Feigin VL et al. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: A systematic review. Lancet Neurology. 2009;**8**(4):355-369

[55] Kim AS, Cahill E, Cheng NT. Global stroke belt: Geographic variation in stroke burden worldwide. Stroke. 2015;**46**(12):3564-3570

[56] Johnston SC, Mendis S, Mathers CD. Global variation in stroke burden and mortality: Estimates from monitoring, surveillance, and modelling. Lancet Neurology. 2009;**8**(4):345-354

[57] Rha JH, Saver JL. The impact of recanalization on ischemic stroke outcome: A meta-analysis. Stroke. 2007;**38**(3):967-973. Available from: https://www.ahajournals.org/doi/full/10.1161/01.str.0000258112.14918.24, https://www.ahajournals.org/doi/abs/10.1161/01.str.0000258112.14918.24

[58] Organised inpatient (stroke unit) care for stroke. Cochrane Database of Systematic Reviews. 2007;(4):Cd000197

[59] de Sousa DA et al. Access to and delivery of acute ischaemic stroke treatments: A survey of national scientific societies and stroke experts in 44 European countries. European Stroke Journal. 2019;**4**(1):13-28

[60] Higashida R et al. Interactions within stroke systems of care: A policy statement from the American Heart Association/American Stroke Association. Stroke. 2013;**44**(10):2961-2984

[61] Prabhakaran S et al. Prehospital triage to primary stroke centers and rate of stroke thrombolysis. JAMA Neurology. 2013;**70**(9):1126-1132

[62] Swartz RH et al. A system-based intervention to improve access to hyperacute stroke care. The Canadian Journal of Neurological Sciences. 2017;**44**(5):475-482

[63] Douw K, Nielsen CP, Pedersen CR. Centralising acute stroke care and moving care to the community in a Danish health region: Challenges in implementing a stroke care reform. Health Policy. 2015;**119**(8):1005-1010

[64] Morris S et al. Impact and sustainability of centralising acute stroke services in English metropolitan areas: Retrospective analysis of hospital episode statistics and stroke national audit data. BMJ. 2019;**364**:l1

[65] Theofanidis D, Fountouki A. An overview of stroke infrastructure, network, and nursing services in contemporary Greece. The Journal of Neuroscience Nursing. 2017;**49**(4):247-250

[66] LaBresh KA et al. Hospital treatment of patients with ischemic stroke or transient ischemic attack using the "Get With The Guidelines" program. Archives of Internal Medicine. 2008;**168**(4):411-417

[67] Xian Y et al. Association between stroke center hospitalization for acute ischemic stroke and mortality. JAMA. 2011;**305**(4):373-380

[68] Man S, Schold JD, Uchino K. Impact of stroke center certification on mortality after ischemic stroke: The

Medicare cohort from 2009 to 2013. Stroke. 2017;**48**(9):2527-2533

[69] Man S et al. Comparison of acute ischemic stroke care and outcomes between comprehensive stroke centers and primary stroke centers in the United States. Circulation. Cardiovascular Quality and Outcomes. 2018;**11**(6):e004512

[70] Kamath-Rayne BD et al. Neonatal resuscitation in global health settings: An examination of the past to prepare for the future. Pediatric Research. 2017;**82**(2):194-200

[71] Gaffey MF, Das JK, Bhutta ZA. Millennium development goals 4 and 5: Past and future progress. Seminars in Fetal & Neonatal Medicine. 2015;**20**(5):285-292

[72] Wall SN et al. Reducing intrapartum-related neonatal deaths in low- and middle-income countries— What works? Seminars in Perinatology. 2010;**34**(6):395-407

[73] Kamath-Rayne BD et al. Resuscitation and obstetrical care to reduce intrapartum-related neonatal deaths: A MANDATE study. Maternal and Child Health Journal. 2015;**19**(8):1853-1863

[74] Lee AC et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and Delphi estimation of mortality effect. BMC Public Health. 2011;**11**(Suppl 3):S12

[75] Halamek LP. The genesis, adaptation, and evolution of the Neonatal Resuscitation Program. NeoReviews. 2008;**9**:142-149

[76] Niermeyer S. From the Neonatal Resuscitation Program to Helping Babies Breathe: Global impact of educational programs in neonatal resuscitation.

Seminars in Fetal & Neonatal Medicine. 2015;**20**(5):300-308

[77] Deorari AK et al. The national movement of neonatal resuscitation in India. Journal of Tropical Pediatrics. 2000;**46**(5):315-317

[78] Gill CJ et al. Effect of training traditional birth attendants on neonatal mortality (Lufwanyama Neonatal Survival Project): Randomised controlled study. BMJ. 2011;**342**:d346

[79] Xu T et al. The impact of an intervention package promoting effective neonatal resuscitation training in rural China. Resuscitation. 2014;**85**(2):253-259

[80] Carlo WA et al. Educational impact of the Neonatal Resuscitation Program in low-risk delivery centers in a developing country. The Journal of Pediatrics. 2009;**154**(4):504.e5-508.e5

[81] Little G, Keenan W, Singhal N, Niermeyer S. Helping Babies Breathe: Evolution of a global Neonatal Resuscitation Program for resource-limited areas. NeoReviews. 2015;**15**:369-380

[82] Newton O, English M. Newborn resuscitation: Defining best practice for low-income settings. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2006;**100**(10):899-908

[83] Bookman L et al. Educational impact of a hospital-based Neonatal Resuscitation Program in Ghana. Resuscitation. 2010;**81**(9):1180-1182

[84] Trevisanuto D et al. Effect of a neonatal resuscitation course on healthcare providers' performances assessed by video recording in a low-resource setting. PLoS One. 2015;**10**(12):e0144443

[85] Carlo WA et al. Newborn-care training and perinatal mortality in

developing countries. The New England Journal of Medicine. 2010;**362**(7):614-623. Available from: https://www.nejm.org

[86] World Health Organization, Guidelines on Basic Newborn Resuscitation. 2012

[87] Goudar SS et al. Stillbirth and newborn mortality in India after Helping Babies Breathe training. Pediatrics. 2013;**131**(2):e344-e352

[88] Arabi AM et al. Skills retention in Sudanese village midwives 1 year following Helping Babies Breathe training. Archives of Disease in Childhood. 2016;**101**(5):439-442

[89] Hoban R et al. 'Helping Babies Breathe' training in sub-Saharan Africa: Educational impact and learner impressions. Journal of Tropical Pediatrics. 2013;**59**(3):180-186

[90] Musafili A et al. Evaluating Helping Babies Breathe: Training for healthcare workers at hospitals in Rwanda. Acta Paediatrica. 2013;**102**(1):e34-e38

[91] Seto TL et al. Educational outcomes of Helping Babies Breathe training at a community hospital in Honduras. Perspectives on Medical Education. 2015;**4**(5):225-232

[92] Berkelhamer SK, Kamath-Rayne BD, Niermeyer S. Neonatal resuscitation in low-resource settings. Clinics in Perinatology. 2016;**43**(3):573-591

[93] Kc A, Wrammert J, Clark RB, Ewald U, Vitrakoti R, Chaudhary P, et al. Reducing perinatal mortality in Nepal using Helping Babies Breathe. Pediatrics. 2016;**137**(6):e20150117

[94] Msemo G et al. Newborn mortality and fresh stillbirth rates in Tanzania after Helping Babies Breathe training. Pediatrics. 2013;**131**(2):e353-e360

[95] Bellad RM et al. A pre-post study of a multi-country scale up of resuscitation training of facility birth attendants: Does Helping Babies Breathe training save lives? BMC Pregnancy and Childbirth. 2016;**16**(1):222

[96] Pammi M et al. Newborn resuscitation training programmes reduce early neonatal mortality. Neonatology. 2016;**110**(3):210-224

[97] Sobel HL et al. Immediate newborn care practices delay thermoregulation and breastfeeding initiation. Acta Paediatrica. 2011;**100**(8):1127-1133

[98] Moore L. Measuring quality and effectiveness of prehospital EMS. Prehospital Emergency Care. 1999;**3**(4):325-331

[99] Sasser S, Varghese M, Kellerman A, Lormand JD. Prehospital Trauma Care Systems. World Health Organization; 2005. Available from: https://www.who.int/violence_injury_prevention/media/news/04_07_2005/en/

[100] Shah MN. The formation of the emergency medical services system. American Journal of Public Health. 2006;**96**(3):414-423

[101] Dick WF. Anglo-American vs. Franco-German emergency medical services system. Prehospital and Disaster Medicine. 2003;**18**(1):29-35; discussion 35-37

[102] Pozner CN et al. International EMS systems: The United States: Past, present, and future. Resuscitation. 2004;**60**(3):239-244

[103] Arnold JL. International emergency medicine and the recent development of emergency medicine worldwide. Annals of Emergency Medicine. 1999;**33**(1):97-103

[104] Roudsari BS et al. International comparison of prehospital trauma care systems. Injury. 2007;**38**(9):993-1000

[105] Hay HI. EMS in New Zealand. Emergency Medical Services. 2000;**29**(7):95-97, 109

[106] Dib JE et al. Analysis and applicability of the Dutch EMS system into countries developing EMS systems. The Journal of Emergency Medicine. 2006;**30**(1):111-115

[107] Riediger G, Fleischmann-Sperber T. Efficiency and cost-effectiveness of advanced EMS in West Germany. The American Journal of Emergency Medicine. 1990;**8**(1):76-80

[108] VanRooyen MJ, Thomas TL, Clem KJ. International emergency medical services: Assessment of developing prehospital systems abroad. The Journal of Emergency Medicine. 1999;**17**(4):691-696

[109] Marinissen MJ et al. Strengthening global health security by developing capacities to deploy medical countermeasures internationally. Biosecurity and Bioterrorism. 2014;**12**(5):284-291