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Thematic analysis of six Asian prehospital emergency medical systems to explore development principles

Amila Ratnayake[a,b], Dinesh Bagaria[c], April B. Llaneta[d], Ratrawee Pattanarattanamolee[e], Bui Hai Hoang[f], Takaaki Suzuki[g], Kenji Fukushima[h], Minh Nguyen[f], Weerasak Phongphuttha[e], Patrick Joseph G. Tiglao[d], Niladri Banerjee[i], Sohan de Silva[j], Srilal De Silva[j], Harshit Agarwal[k], Emelia B. Santamaria[d], Kriangsak Pintatham[l], Xuan Quy Le[m], Shinji Nakahara[n,*]

Abstract

Background: Well-designed and functioning emergency medical service (EMS) can provide equitable access to emergency care to improve health issues, especially in low- and middle-income countries where the majority of deaths are due to conditions that could be treated with emergency care. To address this gap, this study explored the contextually appropriate development process in addition to the system architecture, which is lacking in Global South EMS research.

Method: This study was a thematic analysis of the development of EMS systems in six Asian countries. Experts in emergency care were selected through convenience sampling. Each country described and evaluated its EMS system using a standardized form with 102 EMS items that cover the emergency care system in terms of leadership, governance, financing, community-based activities, prehospital care, and quality assessment. From the descriptions, various themes were extracted focusing on the developmental perspective of EMS in Asia.

Result: The study identified the domain of the developmental focus, best practices, and future strategies for EMS in the Asian region. The identified areas for developmental focus are governance, multidisciplinary collaboration, communication/coordination, community participation, decentralization, equitable access, supply-demand balance, and quality assurance activities.

Conclusion: Countries under investigation achieved progress in planning, implementing, and sustaining EMS through varied strategies in the mentioned focal areas that can be emulated by other countries in this region. Further, their development levels varied according to the extent to which each country realized the development principles identified in this study.

Keywords: Asia, Emergency medical services, Emergency medical systems, EMS analysis tool, EMS system development, Low- and middle-income country

Introduction

Emergency medical services (EMS) play a crucial role in providing timely and seamless emergency medical care to patients, which should be an integral and essential component of contemporary mature health service systems in any country or region, regardless of their economic status.[1–6] The quality and availability of EMS determine the outcome of emergency medical cases, and they crosscut most aspects of healthcare. Therefore, the World Health Organization (WHO) advocates for the development of a robust and equitable EMS system globally.[7,8] The development of a country's EMS is influenced by many factors such as its socioeconomic status, geography, and resources. EMS systems are well developed in the Global North, but the systems in Global South, including in Asia, are still in varying stages of development.[9–12]

Asia is the world's largest continent and accommodates more than 50% world's population. The majority of Asian countries are low- and middle-income countries (LMICs) facing diverse healthcare emergencies like infectious diseases, trauma, obstetric emergencies, and noncommunicable diseases. The EMS systems across Asia are at different developmental phases with a short developmental history in general.[13] Most countries replicated developed systems without taking into account their profile. Previous studies focused on the components of EMS and created evaluation tools to assess the maturities of the contents and neglected vital developmental, maintenance, and quality improvement processes.[14–20] Additionally, such studies did not discuss implementation strategies based on an individual country's profile. To date, well-designed studies to identify principles and strategies for the development of EMS that apply to different countries have not yet been conducted. Hence, there is a need for a

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[a]Uniformed Services University of The Health Sciences, Bethesda, Maryland, MD, USA, [b]Army Hospital Colombo, Colombo, Sri Lanka, [c]All India Institute of Medical Sciences, Ansari Nagar, New Delhi, Delhi, India, [d]College of Medicine–Philippine General Hospital, University of the Philippines, Manila, Philippines, [e]Khon Kaen Regional Hospital, Khon Kaen, Thailand, [f]Hanoi Medical University Hospital, Hanoi Medical University, Dong Da, Hanoi, Vietnam, [g]University of Tsukuba, Ibaraki, Japan, [h]National Center for Global Health and Medicine Hospital, Shinjuku, Tokyo, Japan, [i]All India Institute of Medical Sciences, Basni, Jodhpur, Rajasthan, India, [j]1990 Suwaseriya Foundation Pre-hospital Care Emergency Ambulance Service, Sri Lanka, [k]Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India, [l]Chiangrai Prachanukroh Hospital, Chang Rai, Thailand, [m]Thanh Hoa General Hospital, Thanh Hoa, Vietnam, [n]Kanagawa University of Human Services, Kawasaki, Kanagawa, Japan.

** Corresponding author. Address: Graduate School of Health Innovation, Kanagawa University of Human Service, 3-25-10 Tonomachi, Kawasaki, 210-0821 Japan. E-mail address: snakahara-tky@umin.net (S. Nakahara).*

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comprehensive cross-sectional analysis of the Asian countries' EMS in a structured way to yield principles that apply to local conditions.[13] Such principles can enable policymakers to identify system-wide gaps.

The primary objective of this study was to examine the current status of EMS in the six participating Asian countries using a previously defined tool and conduct a thematic analysis based on intercountry comparisons from the perspective of developing the current immature EMS systems. The secondary objective was to provide insights into how EMS systems can be implemented in a country by leveraging the experience of another country's system.

Methods

Study design

This study was a thematic analysis of EMS development in six Asian countries.[21] Experts in emergency care in each country described and evaluated their EMS system, from which various themes were extracted from the perspective of EMS development in LMICs. The themes included challenges, norms, lessons learned, and targeted directions in EMS development that can be generalized to other settings. Objective descriptions of EMS system components were also extracted and summarized. The study presented the themes based on the positivist paradigm assuming they can be objectively ascertained. Objectivity was ensured by having several analysts working together, and also by having the extracted themes verified by experts in each country. Ethical approval or informed consent was not required as the study was about healthcare systems and did not include human subjects. The data were sourced from the authors' first hand experiences in the EMS system, publicly available policy documents, government reports, and academic papers.

Participating countries

The target countries for the study were recruited through convenience sampling from across Asia by approaching emergency medicine professionals. Of the nine countries (China, India, Japan, Nepal, the Philippines, Singapore, Sri Lanka, Thailand, and Vietnam) approached, experts from six countries, excluding China, Nepal, and Singapore, completed the data collection.

Data collection

Each of the participating countries formed a research team consisting of three experts in emergency care, who collected the data and also assured its accuracy through discussion and reaching a consensus.

The first stage of data collection, which took place between November 2021 and August 2022, was carried out using a standardized form with 102 EMS-related items extracted from an existing assessment tool consisting of 220 items that cover the overall emergency care system in terms of leadership, governance, financing, community-based activities, prehospital care, in-hospital care, referrals, and quality assessment.[18] Relevant documents were cited for the accuracy of the descriptions.

In the second stage, which took place in August 2022, the experts summarized the descriptions and evaluated the EMS system (indicating strengths, barriers/weaknesses, and future directions) using a standardized form (analytic matrix) for the following eight items: country characteristics, EMS organization, governance/financing, policy/planning, first responder/first aid by a bystander, people's awareness and utilization of EMS, human resource development, and quality assurance. The configuration of these items was based on the conceptual structure of the tool used in the first stage of data collection. The descriptions in the matrices were made based on the descriptions in the first stage to ensure their accuracy. Then, the descriptions and evaluations were analyzed.

Analysis team

An analysis team that consisted of three experts in emergency care from three different countries was constituted. To maintain consistency in the analysis, a member of the analysis team conducted primary analysis at each step, and the other two reviewed the results and made any additions and revisions as needed. Finally, a consensus was reached among the three.

Overview of analysis

The analysis was conducted from the perspective of the development of EMS systems in LMICs. The code extraction, comparison, and interpretation were conducted following the structure of the matrix (eight components). The extracted codes were recategorized and summarized according to the thematic contents.

Code extraction

In the code extraction, which took place between August and November 2022, two types of codes were extracted from the matrices: (1) objective descriptions of EMS elements of each country (contents) extracted from the description summaries that were used to describe current EMS situations of a country and make intercountry comparisons, and (2) an interpretation of the extracted challenges, norms, lessons learned, and targeted directions in the EMS development (themes). The majority of the codes were extracted from the themes with some being extracted from the descriptions also. Thematic codes were used to obtain future visions for the development of the EMS system.

In the description code extraction, coding units were the smallest EMS elements that could not be further divided (eg, nationally uniform phone number). In contrast, the thematic codes were not restricted by the size of the smallest units of the system (eg, equitable access to EMS). The extracted codes were named and defined in such a way that they can be applied to other countries and provided with country-specific descriptions.

The code extraction was completed for a country when no further codes could be extracted. For the next country, along with the previously extracted codes, information for the new codes was also extracted if possible. Each time a new code was extracted for the subsequent countries, we returned to the previously analyzed countries to apply the new codes and extract specific descriptions. When the descriptions were unclear or lacked the codes from other matrices, the concerned countries' teams were contacted for clarification. The extracted codes were sent to the research teams of the participating countries for verification.

Thematic analysis

Thematic analysis took place between November 2022 and February 2023. First, intercountry comparisons were made, which highlighted differences in the level of development. The comparisons were then summarized, and the best practices and innovations were also extracted as examples. The comparisons also revealed additional themes, particularly short-term goals to be reached and common challenges. In addition, the ideal and long-term goals that could be reached to the greatest extent possible and the relevant research that should be conducted in the future to achieve these goals were discussed. The study findings were then sent to the research team of the participating countries for critical review.

Second, the extracted codes were categorized from the development perspective. Although the data collection, code extraction, and intercountry comparisons were done based on the conceptual structure that is used to describe the EMS system components, such a structure might not be appropriate to discuss ways to facilitate the

Table 1

Participating Countries' Profiles

	India	Japan	Philippines	Sri Lanka	Thailand	Vietnam
Geographical characteristics	A vast and geographically diverse country. Most of the population lives in rural areas with suboptimal connectivity with urban areas. The northern and eastern parts have difficult terrains in form of valleys and high hills.	An archipelago country consisting of four main islands and nearly 7000 smaller islands, including remote inhabited islands.	An archipelago country with more than 7000 islands and three major islands. There are remote communities in small islands, mountainous areas, and along coastlines.	An island country with mostly flat lands and some mountainous and forest areas.	Mostly flat lands with some hard-to-reach areas such as mountainous areas and remote islands.	Having long coastlines with many inhabited islands.
GNI per capita based on purchasing power parity (international dollar) in 2021	7130	43,740	9210	14,370	18,120	11,080
Total population (million)* in 2020	1380	126	110	21	70	97
Population ages 0–14 years (%)* in 2021	25.7	11.8	30.6	23.2	15.8	23.9
Population ages 65+ years (%)* in 2021	6.8	29.8	5.3	11.2	14.5	8.3
Rural population (%)* in 2021	64.6	8.1	52.3	81.1	47.8	61.9
Urban population (%)* in 2021	35.4	91.9	47.7	18.9	52.2	38.1
Life expectancy (years)* in 2020	70.2	84.6	72.1	76.4	79.3	75.7
IMR (per 1000 live births)* in 2020	27.0	1.8	20.9	5.9	7.4	16.7
Road traffic mortality (per 100,000 population)* in 2019	15.6	3.6	12.0	19.7	32.2	30.6
UHC service coverage index* 2019	61	85	55	67	83	70
Health financing (insurance coverage of EMS)	The public sector is funded by the government and provides free but limited services. Private sectors provide better quality care at a higher cost. Recently, federal and state governments started free basic insurance schemes. The insurance does not cover the EMS cost.	The public health insurance system covers all the residents and medical facilities. Private and public sectors provide the same quality of care at the same official prices. The insurance does not cover EMS costs.	The national health insurance program (PhilHealth) covers health care costs but not EMS transportation. Despite the high coverage (all Filipino citizens are covered) by the insurance, out-of-pocket payment is more than 50%.	The national government funds public hospitals, where patients receive medical care for free. The government also funds the EMS which is also free of charge.	Healthcare cost is covered by health insurance schemes, though three different schemes exist for different occupations. The Universal Health Coverage Scheme (one of the three) covers the EMS cost.	Public health insurance schemes, which differ for different occupations, cover most of the population. The insurance does not cover the EMS cost.
Healthcare provider	Public-private mix	Public-private mix (mostly private)	Public-private mix	The public sector mostly covers the population	The public sector mostly covers the population	The public sector mostly covers the population

*Data source: Each country's statistics or World Bank. Health Nutrition and Population Statistics. https://databank.worldbank.org/source/health-nutrition-and-population-statistics/Type/TABLE/preview/on.

EMS, emergency medical services; GNI, gross national income; IMR, infant mortality rate; UHC, universal health coverage.

Table 2

EMS Profiles of the Studied Countries

	India	Japan	Philippines	Sri Lanka	Thailand	Vietnam
EMS organization	EMRI Green Health Services is operating in the public-private partnership.	Fire Departments and the Coast Guards provide EMS throughout the country.	Local organizations (public or private) run EMS with varying abilities; private organizations (profit-oriented) also provide EMS.	1990 Suwa Seriya provides country-wide EMS as the national lead agency.	Various organizations (hospitals, municipal governments, and charity foundations) run EMS units under the coordination of the CCC.	1-1-5 Emergency Centers (public sector) run the EMS. Some Centers are public; some centers are privatized; some provinces have no center.
Nationally uniform phone numbers	1-1-2 for emergency responses (police, health, disasters, etc) and 1-0-8 for a free-of-charge ambulance service. The numbers are free-of-charge.	1-1-9 for land EMS (fire department) and 1-1-8 for EMS on the sea (coast guard). The calls are free of charge.	A national hotline (9-1-1) has been established based on an executive order. The call is free of charge.	The 1-9-9-0 toll-free number is available nationwide 24/7.	1-6-6-9 as the nationwide single EMS phone number (free of charge).	The nationwide three-digit toll-free number 1-1-5 is used for EMS calls.
Command and control center	No CCC exists.	Fire departments operate the center.	A coordination system has been established but its role as a control center in the EMS is unclear.	The single ECCC dispatches and monitors all ambulances in the entire country.	Usually, provincial hospitals operate the CCCs.	In large cities, an independent CCC operates the EMS. In some areas, a CCC is located in provincial or private hospitals and dispatches ambulances from the hospital.
EMS personnel	EMT-Basic and EMT-Advanced	EMT and paramedic-level personnel	First responders, EMT-basic, and paramedics	EMTs and Pilots: a single EMT in an EMS unit	Various levels of personnel: from emergency responder (first responder) to paramedic levels	An EMS unit consists of a physician, nurse, and driver
Involvement of the private health sector	In some areas, private sectors (hospitals and profit-oriented organizations) are involved in EMS as a public-private partnership.	Private hospitals play the same roles as public hospitals, including care provision and training of EMS personnel. In remote areas, EMS is outsourced to private companies.	Private EMS organizations serve formally as response vehicles and services or simply as patient transport vehicles. Some well-off communities have tie-ups with private EMS providers.	The private sector is not involved in the formal EMS.	Charity foundations and private hospitals also participate in the EMS system to cover the whole population.	The private sector is involved in the running of 1-1-5 centers in some regions.
National lead agency	No national-level EMS agency	Fire and Disaster Management Agency governs the nationwide system.	Department of Health	The 1990 Suwa Seriya Foundation, which is an independent agency under the Ministry of Health.	The National Institute of Emergency Medicine Service (NIEMS)	The Ministry of Health regulates and oversees EMS operations nationwide.

Continued

Table 2 *(Continued)*

	India	Japan	Philippines	Sri Lanka	Thailand	Vietnam
Financing	National and state governments fund the EMS, including public-private partnership schemes.	Municipal governments allocate the budget from the tax revenue.	No specific budget from the national government. The Department of Health provides the budget for hospital-based EMS and Department of Interior and Local Government provides the budget for municipal-based EMS. Private EMS are self-funded.	The national government provides the budget for the establishment and running costs of EMS.	The national and local governments fund the development and maintenance costs. All the EMS service fee is covered by the universal health coverage fund.	The budget for the 1-1-5 center operation comes from the city/provincial health department. Financing mechanisms are weak and EMS are not sufficiently financed.
User charge	Regional variability in the cost. The 108 service is free but other public or private services are not.	Free-of-charge	Most public services are free of charge but not all (user charge is minimum).	Free-of-charge	Free-of-charge	Patient/family should pay for the EMS based on distance.
First responder/first aid training for the general public	The MOHFW has started a first responder training program for the general public (anyone in the scene is a first responder). Trained skills include stopping bleeding, splinting, CPR, and airway management, etc	The first responder system is in a trial phase. Fire departments and the Japanese Red Cross provide first aid training courses, which include CPR and AED use. The number of trained people is increasing.	Volunteer rescue groups provide first aid. First aid training is mandatory at high schools and workplaces. The Department of Health supervises the curriculum of the training.	No first responder system exists. Volunteer organizations and professional colleges conduct community-based first-aid training for the public. There is no policy or coordination for the training programs.	Volunteers are trained as Community Emergency Volunteers (CEV) who provide CPR, stop bleeding, and simple splinting. CPR training is provided at schools and workplaces.	There are no organized activities of the first responders. First aid training is increasing at schools and workplaces. Still, there are few trained people and first aid is rarely provided by bystanders.
Good Samaritan Law	Legal protection has been introduced to those who bring trauma patients to the hospital. There is no legal protection scheme for nontrauma patients.	No such a law exists.	There is no legal protection.	Sri Lanka Penal Code Section 85 protects bystanders providing first aid in good faith.	First Aid law in Thailand allows people to provide first aid and provides legal protection for the bystanders.	No legal protection exists.
Awareness of EMS phone number	Moderate awareness among people. The authorities provide information about the phone number and appropriate EMS use through newspapers, social media, and TV ads.	People's awareness about 1-1-9 (land EMS) is quite high, whereas that about 1-1-8 (marine EMS) is very low. Primary school education about emergencies includes land EMS use but does not include marine EMS.	The awareness is quite low. The national hotline number (9-1-1) is rarely used. In most cases, a local phone number is used. Awareness raising is not active.	School-based awareness-raising programs; media campaigns, social media, and news coverage; awareness-raising among foreign tourists	People's awareness of 1-6-6-9 is moderate. Only half of the EMS calls are made via 1-6-6-9. Several activities are applied: ads on the pharmacy bags, roadside signages, posters, and first aid training including the EMS call number.	Most people know the number 1-1-5. Awareness-raising programs include media campaigns (TV, movies, etc), providing information during first-aid training, and hospital staff retrained for first aid.
Post hoc evaluation of prehospital care procedures	Very limited to a few institutions.	Regional medical control councils perform post hoc evaluation reviews of advanced procedures done by the paramedics.	Might be carried out in each institution.	Case handling is videotaped (randomly, not all patients) and evaluated whether protocols (eg, driving protocol) are followed.	After the operation is completed, nurses of the destination hospitals perform a case-to-case performance evaluation of the prehospital care.	A monitoring system has not yet been developed.

Continued

Table 2 *(Continued)*

	India	Japan	Philippines	Sri Lanka	Thailand	Vietnam
Key performance indicators (KPIs)	Few large EMS organizations record refusal rates (mainly unavailability of ambulances) and response time data.	Key time intervals are recorded and publicized, but not used for quality improvement activities.	Not described	Response time is recorded and evaluated.	Quality improvement activities are being carried out in accordance with the KPI (response time, overtriage/undertriage, and EMS use proportion among critical patients).	There are no KPIs for EMS.

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; CCC, command control center; EMRI, Emergency Management and Research Institute; EMS, emergency medical services; EMT, emergency medical technician; KPI, key performance indicator; MOHFW, Ministry of Health and Family Welfare.

development of immature EMS systems. Some thematic codes were combined or divided as needed; the newly created codes were named and defined. Based on the new categories, the current situations of the participating countries and themes were summarized, particularly generalizable theories and desirable future directions (suggestions and recommendations) applicable to any setting. The findings were sent to the research team of each country for review; based on which, the experts in each country described potential short-term and long-term interventions to achieve the goals.

Results

Table 1 summarizes the characteristics of the participating countries. Geographical characteristics vary from archipelagos to vast land areas, but the existence of remote communities is a common and important feature for EMS system development across the countries. Japan is a high-income country, whereas the others are upper-middle-income countries. The population size, age structure, and urban migration varied enormously among the countries. Japan leads in population aging and urban migration. Health indicators also varied particularly mortality rates, due to traffic injuries that usually require EMS, which was quite high in Thailand and Vietnam. All the countries have good public health systems with universal health coverage (UHC) schemes (universal insurance coverage or free services in public hospitals) and public-private partnerships, whereas EMS cost is also covered by UHC schemes in some countries.

Table 2 shows the key items from the description of the analytic matrices. Organizational structure, financing, human resources including volunteers, people's awareness of EMS, and quality assurance activities varied by country. In particular, people's awareness and quality assurance differed significantly between the immature and mature systems.

Table 3 shows the restructured categories, summary descriptions for the categories, and interpretations. Under the overall theme of the "development process," eight categories were formulated: governance, multidisciplinary collaboration, communication/coordination, community participation, decentralization, equitable access, supply-demand balance, and quality assurance activities.

Table 4 shows examples of the best practices and innovations in the participating countries. Specifically, the following themes and examples were extracted. Governance is the foundation of system development and having legal documents in place clarifies responsibilities and strengthens leadership. Sri Lanka and Thailand exemplified the effects of strong leadership and established their EMS lead agencies upon legislation. Stable budget allocation under strong leadership was exemplified by the coverage of EMS costs by the UHC schemes in Thailand. Multidisciplinary collaboration including public-private partnerships is an important strategy to expand EMS coverage in resource-constrained settings, as exemplified by the interagency collaboration to transport patients from remote areas in Japan and a large EMS organization based on the public-private partnerships in India. Good communication between EMS and people or healthcare organizations, or within EMS, was essential for coordinated EMS activities, as exemplified by the Indian practice of hiring locals to address multilingual communication and utilization of advanced information technologies in Sri Lanka. Community participation also contributed to the expansion of EMS coverage by providing the first contact point in the neighborhood and improving people's awareness about the role of EMS, which was exemplified by the integration of volunteer groups into the formal EMS system in Thailand, awareness raising in Japan, and legal protection of bystanders providing first aid in India. Decentralized EMS development was required to meet the region's specific needs despite the importance of national-level leadership, which was exemplified by India's

Table 3

Descriptions of the Current Situations and Goals to be Pursued

Category	Descriptions	Ideal Situations/Goals and Relevant Research to Achieve the Goals
Development process (subcategories] • Governance • Multidisciplinary collaboration • Communication/ coordination • Community participation • Decentralization • Equitable access • Supply-demand balance • Quality assurance	Participating countries are at various stages of development. All countries are facing a challenge to provide EMS to hard-to-reach areas (eg, remote islands). However, immature EMS systems generally still lack sufficient human and material resources to meet the needs of people who tend not to use EMS. The development process involved the following components to varying degrees across countries: national/local level policy commitment; multidisciplinary collaborations; and international assistance. Generally, the EMS system is developed locally to meet local needs. Some countries have successfully improved coverage with limited resources through their innovations (eg, public participation and deploying a large number of basic-level EMS units). Quality assurance mechanisms are still lacking in immature systems.	Solid EMS development requires policy commitment that can create regulatory and financial basis. Well-coordinated multidisciplinary collaboration is crucial in expanding EMS coverage, particularly in hard-to-reach areas. Private sectors, nonhealth sectors, professional/academic societies, and international agencies should be involved in EMS development. Lessons should be learned from experiences and innovations in other countries that successfully expanded EMS coverage. Gradual development should be sought initially expanding the coverage through the deployment of basic services (volunteers or basic EMS units) and then upgrading the skill levels. All countries, even those with matured EMS systems, should address insufficient service provision in hard-to-reach areas. As the system matures, service coverage and quality should be improved.
Governance (National level policy commitment) • laws • policy • financing • lead agency • guidelines	Most countries have national laws/regulations to govern the EMS system; have national policy documents that articulate the national policy and plans; have evidence-based guidelines in the local language. Policy-making processes are not clear in some countries, but specialists (eg, emergency physicians) are often involved in the policy-making. Various budget sources are utilized depending on the system. Some countries depend on health insurance and others depend on tax revenue.	A legal framework should be established to determine the system structure and secure the budget. The national lead agency should act as a driving force for the system development/ maintenance and policy development; determine the guidelines/ standards; take charge of budget allocation. The policy and a concrete plan for the next few years should be developed based on an analysis of the current situation and documented with clear goal setting. The EMS requires a robust budget base for its sustainability, whether from universal health coverage schemes, other mutual aid schemes, or tax. Wherever the budget base is weak integration of EMS into universal health coverage should be considered.
Multidisciplinary collaboration • Nonhealth sector • Private sector • Development process	Various organizations contribute to the EMS. Even the Coast Guard, military forces, and the police are involved the in emergency transportation of civilians (in nondisaster situations) in hard-to-reach areas. Private sectors also play important roles, providing the same services jointly with the public sector as a public-private partnership, or paid services independently. The development of the EMS system also involved multidisciplinary collaborations.	Competent EMS systems require multidisciplinary collaboration and coordination, depending on local resources. All agencies including nonhealth sectors and private sectors that have abilities to contribute to the care and transport of emergency patients should participate in the EMS system. Whereas the private sector can fill in the gap in public services, the quality and cost of private sector care must be comparable to that of the public sector to assure equitable access. Wherever possible, public-private partnerships should be considered. All relevant organizations with competencies should contribute to the development of the EMS system.
Communication/ coordination • Uniform number • Language used • Command control center (CCC) • Communication means • Final disposal by EMS • Prehospital notification	All countries have a national uniform 3–4-digit number for EMS; however, multiple similar emergency numbers create confusion. Mostly local languages are used for EMS calls and communication with minor (foreign) language is a challenge. Countries with multilingual regions have some experiences in managing this issue. Communication means in the EMS (between EMS units, CCC, and hospitals) is mostly one-to-one (phone or radio). Levels of communication and coordination by the CCC vary by country. Some countries lack coordination in determining the destination hospital and prehospital notification before the patient transfer, whereas some have regular meetings among the stakeholders to facilitate information sharing.	A national uniform phone number for EMS should exist. Emergency call numbers should be simple and multiple numbers for various emergencies should be aggregated to avoid confusion. The CCC should have more competencies to coordinate and facilitate patient transfer and information sharing among the stakeholders. The CCC should be set up regionally to deal with regionally different challenges (eg, multilingual issues). The experiences in multilingual countries can be transferred to other countries. Holding regular meetings among the stakeholders in each region should be considered wherever possible. To transport patients to the right place at the right time, well-designed coordination mechanisms by the CCC, predetermined protocol, and empowerment of EMS personnel are necessary. Advanced information technologies (mobile apps, social networking services, telemedicine, etc) that enable simultaneous information sharing among multiple parties should be more widely used in countries with rich experiences.

Continued

Table 3 *(Continued)*

Category	Descriptions	Ideal Situations/Goals and Relevant Research to Achieve the Goals
Community participation/ empowerment • First aid training for the general public • First responder system • Legal protection of bystander • Incentives • Awareness of the public • Awareness raising	All countries have mechanisms to train the general public, whereas some have a first responder (volunteer) system to increase EMS coverage. Some countries have Good Samaritan Law to protect bystanders providing first aid and provide financial or honorary incentives to the bystanders. Awareness among the public about the EMS phone number varies. Various awareness-raising activities (media campaigns, advertisement, school education, etc) have been implemented, some of which were successful.	Community participation in the EMS whether as callers, bystanders, or first responders (volunteers) should be strengthened as an important element of the EMS system to improve access to emergency care. Training of the general public should be widespread (eg, in school, workplace, and obtaining and renewing driving license), and first responder training should be standardized. A legal framework is necessary to legitimize and protect citizens providing first aid. Bystanders' first aid or support for the patients should be rewarded in some way to mitigate their mental burden even when the patient's outcome is not good. The awareness raising regarding the EMS number should be strengthened. Everyone's awareness should be raised by school education and strengthened via various media campaigns. We should learn from other successful countries and implement their measures.
Decentralization • EMS organization/local lead agency • Personnel • Regional CCC • Local issues	The EMS systems vary by region depending on the local resources and needs. Agencies that lead the EMS or those involved in the system vary. Various types and levels of personnel are deployed. The functions of CCC differ by country and region. CCCs are usually set up regionally (exceptions exist) so that they can deal with local issues, such as varying cultures and languages. Some areas have regular (monthly) meetings among the stakeholders to facilitate information sharing. Regional CCCs can manage multilingual issues, which differ by region.	Although the national law/regulation and lead agency are necessary, the EMS should be set up regionally to meet the regionally different demands (variations in culture, language, and geographical characteristics) based on regionally available resources. Each jurisdiction should have a fully functioning CCC. The organizational structure should be determined based on the local situation. Despite these advantages of decentralization, too much decentralization may result in great interregional differences in the systems making interregional coordination difficult. Further research is required to evaluate the impact of these diversities on EMS functioning.
Equitable access to EMS • Geographical barriers • Economic barriers • Universal health coverage • Language barriers • Consideration of minority groups	Geographical and economic disparities in access exist. EMS coverage varies by country, though all countries have "hard-to-reach" areas. In general, EMS coverage is poor in rural/remote areas; immature EMS systems do not sufficiently cover even urban areas. EMS use is not free-of-charge in some countries causing cost barriers. Language barriers also exist for language minorities (eg, foreigners).	Access disparities should be minimized to achieve equitable access. Geographical disparities should be minimized by increasing the EMS coverage (number of EMS units and dispatch stations). However, ways to overcome the challenge of providing services to "hard-t-reach" areas is an important focus of future research. Cost barriers should be eliminated by making the out-of-pocket payment for the EMS use zero or minimum. If the budget base is weak, covering EMS user costs through universal health coverage (insurance) schemes should be considered. Coverage of minority and disadvantaged groups with poor access to healthcare (socially, economically, culturally, linguistically, or geographically) should be sufficiently considered.
Supply-demand balance • Increasing demands • Appropriate EMS use • Underutilization • Factors hindering EMS use • Overutilization • Resources and capacities of EMS	Supply-demand imbalance exists in some countries because of increased demands due to population growth or aging, or low supplies due to insufficient resources. Underutilization (severe patients do not use EMS) is an issue in immature EMS systems because of low service quality and people's awareness. In contrast, overutilization (nonsevere patients use EMS) is an issue in matured EMS systems. Generally, data on the imbalance are lacking.	In immature systems, a sufficient number of personnel and EMS units should be deployed to address the imbalance, and overall service quality should be improved to address underutilization issues. In order to meet the projected increase of demands due to population growth or aging, system restructuring may be needed (aging is a problem that all countries face now or in the near future). Awareness raising is needed to promote appropriate EMS use, which would address both underutilization and overutilization. Underutilization and overutilization should be monitored.

Continued

Table 3 *(Continued)*

Category	Descriptions	Ideal Situations/Goals and Relevant Research to Achieve the Goals
Quality assurance • Standardized human resource development • Guidelines/protocols for prehospital care procedures • Standards for material and equipment • Physician instruction • Post hoc evaluation and KPIs	Human development is mostly standardized through standardized training and certification/licensing systems. Standards for material and equipment also exist. Some countries have national or regional guidelines/protocols for EMS procedures. Some countries or regions have real-time physician instruction systems (not necessary in Vietnam with physician-staffed EMS). The post hoc evaluation system is generally lacking particularly in immature systems. KPIs for evaluation are not widely used.	Standardization of human resource development is crucial to assure the quality of care: training course, curriculum, certification system, and registration. Particularly for high-level personnel, a board examination and licensing system are necessary. The authorities should strictly standardize these procedures. Guidelines and standards for all aspects of EMS including prehospital care procedures, vehicles, and equipment should be prepared and regularly revised. To assure the quality of prehospital care, physician supervision is preferable for advanced procedures. Although most immature systems do not have evaluation/quality assurance mechanisms, such mechanisms should be fully implemented as the system becomes mature. KPIs should be introduced to clarify the goal to be achieved. Quality assurance should be the research focus, particularly in the EMS under development.

CCC, command control center; EMS, emergency medical services; KPIs, key performance indicators.

management of the local language issues in delivering EMS services. Equitable access to EMS should be the norm, and minorities (ethnic and language) should not be marginalized. Different challenges of supply-demand imbalance can arise at any stage of development and should be prepared for. Once maximum coverage of the EMS service is attained, quality of care should be prioritized.

Table 5 shows potential future strategies created by the research team of each country to improve the EMS systems reflecting the themes extracted in this study and each participating country's situation. Short-term and long-term potential interventions were indicated.

Discussion

This study identified generalizable principles for the development of EMS, which is currently lacking in scholarly literature, despite the diversity among the six Asian countries. Such diversities including geographical, cultural, demographic, or epidemiological differences give rise to various challenges and demands in achieving equitable access to EMS.[10,12,13] For instance, geographical variations impose different challenges for reaching remote communities in the participating countries. Despite variation between countries, we extracted widely applicable developmental principles such as good governance, multidisciplinary collaboration, communication and coordination, community participation, decentralization, equitable access, supply-demand balance, and quality improvements, which could greatly help policymakers, administrators, and stakeholders to understand contextually appropriate development processes to further develop the current immature EMS systems.

Developmental processes should adopt the strategy of introducing new systems on a pilot basis in small areas, evaluating their effectiveness, and then spreading them across the country. Homogeneous development across the country is difficult to achieve, particularly in large countries. Hence, it would be ideal and efficient to apply models that were tried and successfully implemented in some states, across the whole country.[9]

Governance, including leadership and finance, was recognized as an important element of the EMS system in previous studies, resulting in studies that created evaluation tools including such factors or evaluated the systems using the tools. In contrast, this study clarified the differences in system development based on these factors. The strength of the legal base determines the system's development status and the national lead agency acts as a driving force for developing the system.[9,22,23] Therefore, basic strategies to facilitate EMS development should include or start with better legislation that enables steady policy development and budget allocation.

Multidisciplinary collaboration is crucial in conducting complex EMS operations to reach all inhabited places, including remote islands and mountainous areas.[24] Effective collaboration takes various forms and gives an edge in expanding the coverage: e.g., working with government agencies (militaries, police, fire department), international collaboration, public-private partnerships, and involving the people of the community.[9,25,26] These collaborations might fill in the gaps in the EMS, particularly in areas with financial/resource constraints or ever-increasing demands. Successful collaboration requires close communication and prior agreements and protocols between multiple partners.

Good communication and coordination among the stakeholders in EMS systems are crucial and have significant room for improvement. Most countries lack structured processes of patient handover at receiving healthcare facilities mainly due to no prior agreements and protocols for patient transfer, resulting in delays before the patient receives appropriate care. Regular meetings among the stakeholders outside the EMS activities might facilitate good coordination and better comprehensive healthcare.[13]

Community participation in EMS delivery through community/bystander empowerment, education, and legal protection is a promising strategy to effectively expand EMS coverage because expecting EMS to reach the entire population within a sufficiently short time is unrealistic even in mature EMS systems.[25] Additionally, such strategies could bestow community ownership of the community-based system such as emergency volunteer groups, which further strengthens the healthcare system in the community.[27,28] In every country, education of the general public should include the identification of health emergencies, communication to CCC, first aid, and the correct use of EMS services.

Decentralized EMS systems should be sought to reflect the regional differences, whereas national-level leadership should be developed as a driving force to enhance EMS development with a minimum standard of quality of services. A nationally homogeneous system cannot appropriately meet local needs that vary by local culture and environment, except for in small countries like Sri Lanka that could manage a single EMS system.[13]

Equitable access to EMS is a basic human right, though access disparities currently exist because of insufficient development of

Table 4

A Few Examples of Best Practices of the Participating Countries

Development process and governance (Thailand)
Before the establishment of a formal EMS system, volunteers took patients to hospitals. In the 1990s, hospital-based ambulance units were established, and human resource development started. The prototype of the provincial EMS system started in Khon Kaen Province during this period and is currently adopted in each province. However, EMS coverage was inadequate due to an insufficient number of EMS units. The National Institute of Emergency Medicine was established as the national lead agency in 2008 under the Emergency Medicine Act and has provided strong leadership under the law to develop EMS. Volunteer groups who transported patients as informal EMS received 16-hour training and were incorporated into the formal system as basic-level units. In addition, the coverage was dramatically expanded by having basic-level units in subdistrict government offices. The hospital-based units have been organized as advanced-level units. These basic and advanced units operate as a 2-tier system under the command of a single control center.

Governance (Sri Lanka)
The "1990 Suwa Seriya Foundation" was established under the Act of Parliament in 2018, which laid its functions as the lead agency for EMS, defined its financing mechanisms, and positioned it as an organization under the State Ministry of Health. The Board of Directors of the Foundation, consisting of representatives from concerned parties including the Ministry of Health and Ministry of Finance, provides guidance, advice, and support to make this service one of the best national health sector service provisions in the country. The Foundation provides island-wide, free prehospital emergency care under a single state-of-the-art CCC located in the capital Colombo. Treasury through an annual budget allocation provides a stable budget for running the services.

Governance: stable budget for EMS (Thailand)
Thailand's health insurance system consists of three different schemes: the Civil Servant Medical Benefit Scheme, which covers civil servants; the Social Security Scheme, which covers private company employees; and the Universal Health Coverage Scheme, which covers those who are not included in the other two. The cost of emergency transport by the EMS is covered by the Universal Health Coverage Scheme, regardless of the insurance scheme, and there is no co-payment for the patient. The reimbursed price differs depending on the level of EMS units.

Multidisciplinary collaboration: Involvement of military and police (Japan)
In the case of rescue and emergency transportation from islands and mountainous areas, firefighting helicopters and Helicopter Ambulances (Doctor Helicopters) are usually used; but if it is difficult to use them, support from the police, Japanese Coast Guard, and Self-Defense Forces may be requested (The Self-Defense Forces and Coast Guard also have fixed-wing aircraft). Police, firefighters, and the Self-Defense Forces all work together to rescue people in the mountain and water mishaps. Fire and Police departments of each prefecture organize mountain rescue teams and sea rescue teams according to their geographical conditions. The Japanese Coast Guard is in charge of rescue in maritime accidents and emergency medical services in maritime accidents at sea.

Multidisciplinary collaboration: Public-private partnerships (India)
EMRI Green Health Services providing EMS in India as a not-for-profit public-private partnership model since 2005. The primary objective of this organization is to provide quality prehospital care and transport of the patient to the appropriate healthcare facility. At present, it covers 14 States and Union Territories of India. Besides operation, now it is also involved in research and training.

Communication and decentralization: Multilingual issues addressed by local EMS (India)
India has a huge linguistic diversity. Health is a state (regional) subject matter. All the policy and operational decisions are made by the regional authorities. Most of the workforce involved in operational activities is hired locally, which solves the multilinguistic problems in EMS services. But a communication barrier still exists in emergency departments of hospitals where physicians might be working from across the country. In such situations, other local staff works as translators. There are medical and social service officers at a few hospitals, who are useful in easing the communication and cultural barriers.

Continued

Table 4 *(Continued)*

A Few Examples of Best Practices of the Participating Countries

Utilization of information technologies (Sri Lanka)
Island-wide coverage with 15 minutes average response time has been achieved through new information technologies. The centralized CCC assigns ambulances based on information about ambulance availability, monitors all ambulance movements (including unauthorized ambulances), and selects appropriate hospitals for patients based on patient conditions and hospital resources through end-to-end digitized processes including a real-time global positioning system. Various apps are available to support EMS operations: eg, an ambulance navigation system for faster reach to the patient location and an automatic emergency call system to reach the CCC without the free 4-digit call number.

Community participation: First-responder (volunteer) training (Thailand)
The Thai EMS system includes community-level volunteers who provide first aid. The volunteers are called "Community Emergency Volunteers." They receive one-day training on how to: call an ambulance, judge whether to call an ambulance, and provide first aid (resuscitation, stop bleeding, and splinting). Usually, training is given to village health volunteers, security officers, teachers, and community leaders who are willing to help sick or injured people. The Thai government is planning to train 1% of the population as Community Emergency Volunteers.

Community participation: Awareness raising (Japan)
In Japan, the roles of the fire and police departments are included in the educational content of social studies in elementary schools. Additionally, students are also taught how to use phone numbers to report emergencies during disaster drills. In many areas, fire department personnel visit schools to provide instruction. Furthermore, the emergency call numbers (1-1-0 and 1-1-9) are displayed on public telephones with easy-to-understand illustrations, which help inform the public about the numbers. However, the emergency call number of the ocean (1-1-8) is not widely known.

Community participation: Legal protection and incentives (India)
India has a "Good Samaritan Law" protecting the medicolegal and financial liability of a bystander helping any injury victim in good faith, without any duty of care and special relationship. Few states have started honoring such good Samaritans by providing appreciation certificates and financial incentives. There is ambiguity in the application of this law in nontrauma emergencies.

CCC, command and control center; EMRI, Emergency Management and Research Institute; EMS, emergency medical services; UCS, universal health coverage.

the EMS systems. This mandate is reflected in the sustainable development goals 2030 theme "Leaving no one behind." Geographical barriers should be minimized by expanding EMS coverage, and cost barriers should be eliminated by recovering the EMS costs from the universal coverage schemes or tax revenues.[7,8]

Supply-demand balance is rarely achieved. Immature systems lack sufficient supplies and matured systems face a rapid increase in demand due to the aging population. Therefore, expanding services is required in immature systems to fill in the supply-demand gap through an emergency volunteer scheme to train laypersons on basic life support, integration of informal (unauthorized) ambulance units into the formal EMS, and rigorous public-private partnerships.[9,25,26] Development strategies should include initial expansion of the coverage through the deployment of basic services (volunteers or basic EMS units) and then improvements in skill levels and care quality. Concentrating on advanced life support by a highly skilled professional is ill-advised in the LMIC setting. In matured systems, appropriate service use should be promoted to manage rapidly increasing demands due to aging.[29] Service utilization data should be collected to improve the supply-demand imbalance.

Quality assurance activities lag far behind particularly in immature EMS systems because of their focus on system expansion. However, improving care quality is crucial to improve patient outcomes. This requires standardizing care based on guidelines/protocols, certification, and accreditation, and introducing evaluation mechanisms using key performance indicators.[8] Even if the focus is on system building for the time being, there should be a gradual focus on quality improvement.

Table 5

Potential Interventions to Improve Emergency Medical Service Systems in Each Country

	Short-Term Interventions	Long-Term Interventions
India	• To formulate guidelines and ensure their implementation in terms of resource availability, training of the workforce, and locally acceptable operational protocols for providing minimum standards of EMS. • To have the provision of law for legal enforcement to states for ensuring investment and quality improvement of EMS services.	• To make efforts for timely availability of optimum EMS services in far-flung rural and difficult terrains. • Utilization of the enormous EMS workload data for quality national and international research.
Japan	• To determine the destination hospital, the EMS personnel should call the hospitals one by one, which is very inefficient. Centralized patient allocation by command centers does not fit in Japan's healthcare delivery system, which mostly consists of independent private hospitals with poor role differentiation. Information technology to simultaneously share information between hospitals in the region is desirable. • To increase first aid provision and AED use by bystanders, awareness raising and training for the general public should be enhanced.	• The time between the call and the EMS arrival cannot be reduced any further and even tends to increase recently. To improve access to emergency care, a volunteer-based first responder system needs to be developed. • Legal protection for bystanders (including first responders) should be introduced.
Philippines	• There is a need to expand the coverage of national health insurance to cover EMS from the community to healthcare facilities, especially in emergency cases. • Public education and proper implementation of programs to improve bystander CPR, including the use of AED, and first aid training need to be undertaken.	• A law to professionalize and recognize emergency medical technicians will improve the delivery of emergency care services through standardization of training and services provided. Proper compensation will also entice more professionals to stay and serve in the country.
Sri Lanka	• Need to increase resources for EMS operations, such as ambulance fleets and personnel, to reduce the response time. Increasing the fleet from 297 to 437 would bring down the average response time to 8:30 minutes. • Need for further strengthening interagency communication. For example, a connected ambulance, where all data collected in the ambulance (eg, vital signs) are sent and displayed at the CCC and emergency department in the destination hospital, would improve information sharing among the ambulance, CCC, and hospitals.	• To enhance human resource development to upgrade responders from emergency medical technicians to paramedic level to provide advanced life support procedures. • Use of more technological assistance in victim identification at earlier stages: eg, fall detection wearable devices for elderly people and motorcycle occupants
Thailand	• To expand EMS coverage, aeromedical and marine EMS that are currently implemented should be augmented. Such systems can greatly improve access to emergency care in remote areas (the mountainous and remote islands). • People's awareness of the EMS phone number (1-6-6-9) should be further enhanced through public education.	• To strengthen the sustainability of the EMS system, some restructuring is needed. For example, local governments need to be more committed to the management of the command control centers; basic level EMS units should be upgraded to advance level; the Ministry of Public Health should allocate more resources and budget to EMS. • Digital information technologies should be more widely introduced. Especially, the technologies to detect the patient's location and telemedicine for effective online medical direction would improve the quality of prehospital care.
Vietnam	• We need to reorganize the EMS systems in provinces and cities, which are currently not functioning adequately, to make them work. This requires more resource (budget, equipment, and personnel) allocation to EMS, enhancing the functions of the command control centers, retraining the personnel, and seeking an appropriate EMS model for Vietnam. • Enhancing first aid training to lay people to increase first aid provided at the scene.	• To increase EMS coverage, EMS by emergency medical technicians or paramedics should be increased, rather than adhering to the physician-ridden SAMU model. To achieve this, it is necessary to establish a program to train such personnel (to be enrolled immediately after high school graduation). It is also necessary to improve their salaries, create conditions for further education and research, and establish professional associations. • Further improvement and enhancement of functions of the command control centers.

AED, automated external defibrillator; CCC, command and control center; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; SAMU, Service d'Aide Médicale Urgente (a French term meaning Urgent Medical Aid Service).

Limitations

The study has a few limitations. First, this study included only six countries from high- and middle-income levels in the Asian region. It is not self-evident whether our findings apply to low-income countries or other regions. However, we can assume the applicability of our findings to countries with similar service delivery frameworks, financing mechanisms, and epidemiological features of urgent conditions requiring EMS. Second, this study has a cross-sectional nature in intercountry comparisons; and the development process over time was not compared. To determine whether the factors shown as relevant to development actually promote development, future longitudinal observations are needed.

Conclusion

Six countries having a wide range of geographical, socioeconomical, and health indices have achieved commendable progress in

developing functioning EMS systems through multiple challenges. Their development levels depend on the extent to which each country implemented the development principles identified in this study. Countries under investigation achieved progress through a wide range of strategies that can be emulated by other countries in the region.

Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

All authors contributed to data collection, analysis, and interpretation. Ratnayake A, Bagaria D, and Nakahara S drafted the main text; all authors contributed to the descriptions of each country. All authors approved the final version.

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