

The Effectiveness of Video-Telemedicine for Screening of Patients Requesting Emergency Air Medical Transport (EAMT)

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Background: Demand for emergency air medical transport (EAMT) services have increased in recent years. However, the high costs of these services have raised questions on the benefit to patient outcomes. In this study, we evaluate the effectiveness of video-telemedicine for the preflight screening of patients for air medical transports.

Method: A prospective cohort study. Medical records of patients transported from the Penghu Islands to Taiwan were retrospectively collected from November 1999 to October 2002 (stage 1). In addition, we collected medical records of patients who were preflight-screened by physicians using video Web cameras from November 1, 2002 through August 30, 2003 (stage 2). The intervention in stage 2 included a set of protocols and screening

criteria for EAMT implemented by the National Aeromedical Consultation Center (NACC). In stage 1, there were no standardized protocols or screening guidelines for EAMT. The EAMT system before implementing preflight screening and telemedicine was mostly based on patient's requests and their health condition determined by the treating medical officers (TMO).

Results: A total of 822 transfers were included in this study. Patient demographic backgrounds in the two groups were similar on gender, age, disease classification, and types of illnesses. Patients in stage 2 were significantly older than those in stage 1. In a comparison of flight frequencies between the two stages, the results revealed a 36.2% reduction of EAMT applications in stage 2. The flight approval rate was 91.2%. The

intervention in stage 2 also presented a significant reduction in cross-zone transport (16.1% to 0.1% to the northern Taiwan region). Within-zone transfers increased from 74.9% to 88.3%. Cost analysis showed that physician triage in stage 2 resulted in a total annual savings on EAMTs of US\$ 448,986.

Conclusions: This study demonstrates the physician-assisted preflight screening using video-telemedicine significantly reduced the frequency of unnecessary air medical transports and consequently led to reduced costs. Video-telemedicine can be an essential tool to support physicians in decision-making for patient screening.

Key Words: Emergency air medical transport, Remote island, Physician triage, Telemedicine, Helicopter, Cost analysis.

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The demand for emergency air medical transport (EAMT) services has increased in recent years. There are increasing numbers of EAMT programs supported by trauma centers to provide efficient management of emergency medical care and

better patient outcomes.^{1–4} However, there are growing numbers of studies questioning the cost-effectiveness of EAMT services.^{5–10} Attempts to reduce costs have been a major concern for hospital administrators as well as the third-party payers.¹¹ A well-defined and integrated triage system has been widely suggested for cost-effective management of emergency air medical transport.^{3,9,11–15}

IMPORTANCE

Previous studies have shown cost effectiveness of telemedicine in emergency care.^{14,16–22} Because of advances in computer technology, video telemedicine has become popular and available. The use of telemedicine has been widely accepted as a cost-effective option in health care, especially in remote areas.^{18,19} Moreover, in a study on the use of telemedicine, Roth et al. (1998) concluded that prehospital transtelephonic triage can effectively reduce costs of medical care and the number of hospital emergency department visits.¹¹ In a similar study, Haskins and colleagues (2002) reported that telemedicine resulted in an approximately 15% decrease in ambulance transport.²³ In the United Kingdom, the first telemedicine link in Northern Ireland showed a dramatic reduction of patients referred to their General Practitioners (GPs) and accident and emergency (A&E) departments.²⁴ A study in Aberdeen also

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demonstrated that 58% of patient transfers can be avoided after the use of telemedical link.^{20,24} Other studies have also reported the reliability and feasibility of telemedicine in emergency care, especially in rural areas.^{21,25-27}

The geographical limitations in Taiwan and unequal development of medical manpower and facilities on remote islands have resulted in a growing need of medical transfers to the main island of Taiwan. A lack of a preflight screening system has resulted in rapid growth of unnecessary flights, which caused increased government expenditures of up to NT \$200,000,000 (US\$ 6,250,000) each year. The rapid growth of EAMTs and the high costs caused Taiwanese healthcare authorities to establish a National Aeromedical Consultation Center (NACC), a physician-based helicopter control center for the preflight screening of patients requesting EAMT services.²⁸

GOAL OF INVESTIGATION

Although there is increasing awareness on cost effective use of telemedicine in emergency care, little is published about the use of telemedicine in reducing unnecessary air medical transport. The increase in the use of EAMT programs as well as its high costs has prompted a need to investigate the real benefit on EAMT. This is the first report to examine the effectiveness of video-telemedicine to reduce costs by preflight screening of EAMT. Our research question is 'would preflight screening using telemedicine result in the reduction of EAMT and enhance the safety of patient transfers'?

MATERIALS AND METHODS

Study Design and the Selection of Patients

This is a prospective cohort study, which comprised two groups of research subjects; a historical group before the intervention (stage 1) and a second group who received a screening protocol, defined as stage 2. Patients in the control group (stage 1) were defined as patients who were air transported from a remote island of Taiwan to the mainland without receiving preflight screening. The patients in the intervention group were those who receive preflight screening by physicians using a protocol containing screening criteria, and video-telemedical devices. The study period began on November 1, 2002 and ran to August 30, 2003.

Participants included patients from Penghu Islands who received EAMT services during the study period. Patients who took commercial flights to Taiwan without preflight screening were excluded. Participants who did not meet the transport criteria were included in the study.

Settings

The research settings include four sites of wireless local area network (LAN) located in the emergency departments on the Penghu Islands connected to one control center located in the headquarters of National Rescue Command Center in Taipei. The four sites included two district hospitals, Penghu

Military Hospital and Penghu County Hospital, and two remote clinics located in two of the outer islands of Penghu.

Definitions

Penghu Islands

The Penghu Islands comprise archipelago located off the southwest coast of Taiwan in the Taiwan Strait. The flying distance between the Penghu Islands and Taiwan is approximately 200 miles. There were no changes regarding population, manpower, or medical facilities available in Penghu Islands during the study period.

The National Aeromedical Consultation Center

The National Aeromedical Consultation Center (NACC) was established on October 1, 2002. It is a physician-based 24-hour control center that coordinates the transport of injured or critically ill patients between Taiwan and its surrounding islands.²⁸ The main objective of the NACC is to provide criteria-based preflight screening of patients who required air transport from 18 locations nationwide. Currently there are 10 senior consultant physicians and a medical director who participate in consultation. All have backgrounds in emergency medicine, neurologic surgery, critical care medicine, aviation medicine, and "flying doctors" who have participated in EAMT for at least 2 years.

Before the NACC was established, all EAMT services were dispatched without criteria for patients' qualification. Physicians in referring hospitals made requests to helicopters for urgent transport, if, in their opinion, a patient's conditions required it. Once requested, the helicopter was dispatched in all cases except in extreme nonflying weather conditions.

Safety

Cross-strait transport exceeding 250 miles is considered high risk and unsafe. In some cases, cross-zone flights were considered unnecessary if medical centers within the responsible zones had the ability to manage the medical condition.

Unnecessary Flights

For purposes of this study, unnecessary flight is defined by the urgency of the patient's condition. If alternative means of transport, such as transported by ferry or commercial flights is suitable for transport, the EAMT applications would be rejected.

Standard Operation Procedures for Medical Transports

The standard operation procedures (SOPs) were designed by a joint committee comprised of a group of experts including representatives from the National Fire Administration (NFA), senior officers from the Department of Health (DOH), and Civil Aeronautics Administration (CAA), as well as physicians who specialize in emergency medicine, critical care, and aviation medicine. Requests for EAMT must be made by the treating medical officers (TMO) from an island hospital to the NACC. Physicians communicate using the tele-video system. Furthermore, physicians at the NACC

evaluate patients directly through a desktop computer for the initial assessment. Once the application forms are received by the physicians at the NACC, a decision must be made within 15 minutes on whether the patient is fit to fly. Patients in a stable condition or those who do not meet the criteria for transport remain on the island. However, they will receive the same level of care by the TMO, and they are monitored constantly by the NACC.²⁹ Patients in a stable condition but who still need to be transported to major hospitals for further evaluation will travel by ferry or commercial flights to Taiwan. The transport is free of charge, as the health authorities cover transportation cost.

The Video System

The video system is located at the NACC. The system includes receiving terminals that connect 18 remote hospitals with the control center and are connected to a Web cam in the emergency rooms. Physicians at the control center can closely evaluate a patient's condition and his or her medical records including X-ray films and echocardiogram reports through the desktop computer. In case of an emergency, the TMO in the referring hospital can initiate an urgent consultation with the NACC. Once the alarm is given, consultants in the NACC are alerted.

Criteria for Emergency Transport

The criteria were originally adapted from various resources including the American College of Emergency Physicians (*Guidelines for Trauma Care Systems*^{12,13}), Air Medical Services Committee of the National Association of EMS Physicians (*Prehospital Air Medical Transport: Non-Trauma and Pediatric Consideration*³⁰), transport guidelines from the Association of Air Medical Services²⁹, and regional criteria from Australia.³¹ The criteria were summarized in Table 1.

Data Collection

Data collection comprised chart review at two different times. Stage 1 consisted of EAMT services on the Penghu Islands before the NACC was established when all EAMTs were activated without preflight screening from November 1999 to September 30, 2002.

In stage 2, all EAMT services received preflight screening and involved physicians who were on call at the NACC using video Web-cameras for cross-strait consultation. Medical record data were collected from October 1, 2002 until August 30, 2003.

Data collection included two abstractors who received training on the use of computer software 'SPSS 11.0'. The database was reviewed by the two abstractors for validity and reliability. All data in both stages included patient demographics, disease classification, average flights per months, the frequencies of cross-zone transports, and costs were entered into SPSS for coding and statistical analyses. The research associate in charge of the study developed the data

Table 1 Criteria of EAMT

1. Penetrating injury anywhere on the body between the mid-thigh and the head
2. Amputation or near amputation and required timely evaluation for possible replantation
3. Severe hemorrhage. Included are those patients with a systolic blood pressure of <90 mm Hg after initial volume resuscitation and those requiring ongoing blood transfusions to maintain a stable blood pressure
4. Burns of the skin; >10% of the body surface; or major burns of the face, hands, feet, or perineum; or associated with an airway or inhalation injury
5. Injury to the spinal cord, spinal column, or neurologic deficit
6. Trauma Score <12 or Glasgow Coma Scale score <10 at the scene of the accident or at the referring hospital's emergency department that indicated a severe injury
7. Less than 5 years of age with multiple traumatic injuries
8. Adult with a respiratory rate of <10 or >30 breaths per minute, or a heart rate of <60 or >120 beats per minute
9. Requires mechanical ventilator support or is at risk of having an unstable airway
10. Requires immediate invasive therapy for hypothermia
11. Respiratory rate of <10 or >30, or a heart rate of <50 or >150 per minute
12. Requires immediate transport in a critical care environment to a medical center that can perform organ transplantation or procurement
13. Seizures that cannot be controlled at the referring hospital
14. Acute respiratory failure or respiratory arrest and is not responsive to initial therapy
15. Unstable vital signs
Respiratory rate <10 or >60 breaths per minute
Systolic blood pressure <60 mm Hg in a neonate
Systolic blood pressure <70 mm Hg in a child 2 to 5 years old or systolic blood pressure <80 mm Hg in a child 6 to 12 years

codebook, and the abstractors were blinded to the research questions being tested.

Zones of Responsibility and Flying Distances

There are seven major responsible zones (Fig. 1). The Penghu Islands are included in the southern region, and the flying distance between Penghu Islands and the nearest city (Kaoshiung) in Taiwan is 172 miles. When EAMT is activated, all helicopters take off from the bases in Taiwan to the remote islands and transfer patients back that doubles the flying distances. Flying distances between Penghu and major cities in Taiwan are shown in Figure 1.

Statistical Analysis

The results are evaluated by frequency in each stage. Categorical variables in two groups are compared by χ^2 analysis. All *p* values were two tailed, and a *p* value <0.05 was considered statistically significant.

RESULTS

General Information

In total, 822 transfers were included in the study. The number of uses of EAMT in stage 1 was 685 (84%) and 137

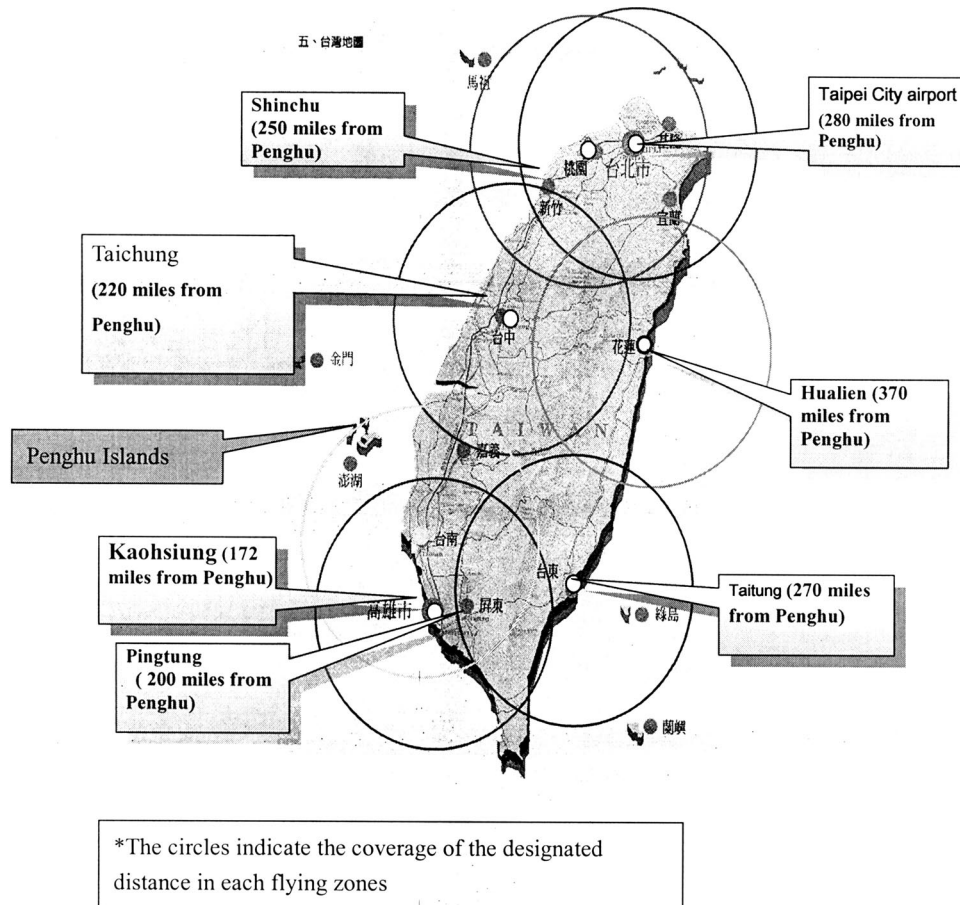


Fig. 1. EAMT responsible zones and average one-way flight distances to the Penghu Islands.

(16%) in stage 2. Patient demographic data for the two cohorts were similar regarding gender, age, disease classification, and types of illnesses (trauma, disease) (Table 2). The

Table 2 Demographic Information of Subjects in the Two Stages

	Stage 1 N = 685 (%)	Stage 2 N = 137 (%)	Total N = 822 (%)
Gender			
Male	452 (66.0)	87 (63.5)	539 (65.6)
Female	233 (34.0)	50 (36.5)	283 (34.4)
Age			
0-15	142 (20.7)	13 (9.5)	155 (18.9)
16-30	74 (10.8)	14 (10.2)	88 (10.7)
31-45	74 (10.8)	19 (13.9)	93 (11.3)
46-60	103 (15.0)	26 (19.0)	129 (15.7)
61-75	188 (27.4)	44 (32.1)	232 (28.2)
>76	104 (15.2)	21 (15.3)	125 (15.2)
Illness category			
Trauma	161 (23.5)	31 (22.6)	192 (23.4)
Major illnesses	524 (76.5)	106 (77.4)	630 (76.6)
Disease classification			
Medical	363 (53)	80 (58)	443 (53.9)
Surgical	171 (25)	39 (29)	210 (25.6)
Pediatric	137 (20)	12(9)	149 (18.1)
OBS/GYN	14 (2)	6 (4)	20 (2.4)

majority of patients were male (65.6%). Over 28% of patients were between 61 and 75 years of age or between 0 and 15 years (18.9%) (Table 3).

The mean age of the total sample group was $47.15 \pm SD 27.53$. Patient mean age significantly differed between the groups. Patient mean age in stage 2 was older (51.7 ± 23.47) than those in stage 1 ($46.23 \pm SD 28.21$, $t = -2.135$, $p = 0.033$) (Table 3). The majority of patients had major illnesses (76.6%, $n = 630$).

Frequencies of EAMTs

During stage one, 685 flights were activated representing an average of 19.6 flights per month. In comparison, 137 flights were requested in stage two, but only 125 flights were approved representing an average of 12.5 flights per month, less than stage one. The reduction rate of flights between two stages was 36.3%.

Responsible Zones and Flight Distances

In the first stage of this study, about 74.9% of patients were within-zone transferred to the southern region (Table 4) and 16.1% were transferred to the northern region. We also found that one patient (0.1%) was inappropriately transferred to the eastern region, a remote region with limited medical

Table 3 Results of Grouped Sample *t* Test on Mean Age

	N	Mean	Standard Deviation	Standard Error of the Mean
Stage 1	685	46.2336	28.21660	1.07810
Stage 2	136	51.7426	23.47039	2.01257

t test for Equality of Means

<i>t</i>	<i>df</i>	Significance (two-tailed)	Mean Difference	Standard Error of the Difference	95% Confidence Interval of the Difference	
					Lower	Upper
-2.135	819	0.033	-5.5091	2.58073	-10.57470	-0.44344

Table 4 Distribution Differences of Receiving Hospitals

Receiving hospitals by regions	Flying Distances to Penghu (miles)*	Stage 1 N = 685 (%)	Stage 2 N = 137 (%)	Total N = 822 (%)	<i>p</i> -Value (two-sided)
Northern region	280	110 (16.1)	2 (1.5)	112 (13.6)	0.000 χ^2 test
Central region	220	42 (6.1)	12 (8.8)	54 (6.6)	
Southern region (responsible zone)	172	513 (74.9)	121 (88.3)	634 (77.1)	
Eastern region	370	1 (1)	0 (0)	1 (1)	
Within-island transfer	20	19 (2.7)	2 (1.5)	20 (2.4)	

* The flying distances are calculated by one-way routes designated by CAA in Taiwan.

facilities; and the flying distance exceeded 370 miles. In stage 2, cross-zone transfers were mostly disapproved.

During stage 2, the percentage of patients transferred to the northern region had decreased (from 16.1% to 1.5%) and within-zone transfers to the southern region increased from 74.9% to 88.3%. This finding suggests that most patients were transported to the nearest major hospital within responsible zones.

In addition, there were 12 patients who did not meet the criteria for transfer, including four patients who remained on the island who received the same level of care by the TMO and were constantly monitored. In addition, eight patients were in a stable condition and were transported by scheduled commercial flights or regular shuttle ferries between remote islands and major cities in Taiwan. None of these 12 patients developed any medical complications. The rationale for disapproval is shown in Table 5.

Cost Analysis

Cost analysis is based on the sum of the reduced expenditure for the decreased flights in stage 2. The average cost

Table 5 Rationales for Disapproval of Flights

Rationale	No. of Patients (n = 12)
Condition stable, no need for immediate transfer	4 (33.3%)
Transferred by scheduled commercial flight	4 (33.3%)
Transferred by shuttle ferry	4 (33.3%)

for each repatriation was NT \$200,000 (US\$ 6,250); Therefore, the sum of the reduced cost of EAMTs each month was

$$\$6,250 \times (19.6 - 12.5/\text{mo}) = \text{US\$ } 44,375/\text{mo or}$$

$$\text{US\$ } 532,500 \text{ per year.}$$

Direct Costs

The fee for physician manpower in Taiwan is not as good as it is in the United States. However, the cost of air transportation is very similar with that in every country. The annual budget of NACC including physician manpower is 13,000,000 NTD (US\$ 406,250). This study collected data from Penghu Islands with four remote locations and NACC takes care of 18 remote locations nationwide. The cost of set up of the telemedicine system including the equipment of 18 locations is 6,500,000 NTD (US\$ 203,125) and the system is estimated to be functional for 5 years (60 months). In this study we have used telemedicine equipment for 10 months. The cost of transport by scheduled commercial flight (\$120 for round trip) and regular shuttle ferry (\$70 for round trip) is quite inexpensive. There are 21 daily regular flights from Taiwan mainland to Penghu Island and 1 to the other 2 small islands. Therefore, the saving of cost in total has to deduct the above cost and is

$$\$532,500 - (\$406,250 \times 4/18 \times 10/12) - (\$203,125$$

$$\times 4/18 \times 10/60) - (\$120 \times 4) - (\$70 \times 4) = \$448,986$$

Indirect Costs

The indirect cost includes (1) increasing cost of medical care in the mainland and (2) the saving cost of productivity

loss because of disability from the patients and loss of future productivity because of premature death immediately repatriated by this system. Both of them are very difficult to estimate.

Limitations

One of the limitations of this study was there was no information regarding patient follow-up in stage 1 because of a lack of protocols or monitoring of patient conditions during air transfer in stage 1. Although, in stage 2 of the study, physicians in the NACC provided records of patient monitoring during and after the EAMT. Hence, it was impossible to compare patient outcomes between two stages. We also encountered a major difficulty in retrieving copies of medical records from more than 36 receiving hospitals in the 15 provinces of Taiwan. As in the first stage of the study, most patients were transferred to hospitals without proper selection or evaluation by the receiving hospitals.

DISCUSSION

Overview of the Findings

This study demonstrates several major findings. First, the intervention in stage 2 resulted in a significant (36.3%) reduction in unnecessary air medical transport. Second, the reduced EAMT applications as a result of physician triage created a total government annual savings of up to US\$ 448,986.

Geographical Background

Emergency air medical transport in Taiwan has experienced increasing demand in recent years. The geographical limits between Taiwan and its surrounding islands have pushed the growing need for EAMT.²⁸ The situation is particularly relevant in the Penghu Islands with 90,000 residents located off the southwestern coast of Taiwan. Expenditures for helicopter emergency air medical services (HEAMS) in Penghu have increased in recent years. For example, in 2002, more than 300 flights were activated from the Penghu Island resulting in an increase of government annual expenditure of up to NT \$60 million (US\$ 1,875,000). One reason for the increase in EAMT flights may have been because of its free charge paid by the Taiwanese Health Authority. Another reason might have been because of the increasing trend in lawsuits resulting from physician shortages. Consequently, transferring patients to the mainland might have been considered a solution to the above problems as healthcare facilities are better developed on Taiwan.

Benefits of Telemedicine

There are an increasing number of studies focusing on the use of telemedicine for a wide range of emergency medical care situations including sea rescue,^{26,32} telephone-assisted cardiopulmonary resuscitation,³³ management of acute stroke,²⁵ as well as other areas of prehospital and hospital emergency medical care.^{15,27,34} Telemedicine is

thought to have the potential to improve patient care, especially for those who reside in remote areas.^{22,35} With the use of digital Web cameras and wireless LANs, physicians can interpret radiographs, electrocardiograms, and other laboratory reports, which allow them to provide extra assistance to medical professionals in remote areas.

Cost Issues

The high cost of helicopter transfers presented in this study, as well as the extensive flying distance (200–400 miles) between remote islands and mainland Taiwan add extra risks for air medical transport. In our study, the interventions in stage 2 resulted in a significant reduction of EAMT applications. The use of a cross-strait multi-telemedicine system for preflight screening significantly reduced the incidence of unnecessary transport. Our results of an approval rate of 91% and the 36.3% reduction in the rate of EAMT applications in this study are consistent with a report released by Haskins, who suggested that the use of telemedicine may result in a 15% reduction in ambulance transports.²³

Before the establishment of NACC, almost all patients had been transported by air whenever local physicians requested. There had been no triage criteria. After the implementation of NACC with a telemedicine system, primary care physicians on the remote islands have to perform basic triage. Doctors in NACC review the application document for EAMS and discuss with the local physician if the patient requires emergency chartered helicopter or if the patient can be scheduled for commercial flight or regular shuttle ferry.

Crucial Roles of Physician Triage

The physicians in the NACC played crucial roles in this aspect. One of the major roles the physicians is being a gatekeeper for EAMT approval and transport quality. The system, including the protocols used, screening criteria, and the use of video telemedicine, is thought to have caused the reduction of EAMT applications. The video telemedicine system allows clear communications between physicians in the remote islands and the control center; hence physicians in the remote islands need to evaluate the necessity of urgent transfers before formal EAMT application.

Physicians in the NACC also provide support, guidance, and medical consultation to island-based physicians through our video system. The results of this study suggest that consultation with NACC physicians provides support to the already overburdened medical manpower on the remote islands. Sometimes physicians will suggest that the local physician do some kind of intervention on patients, such as chest tapping for assisting in the decision-making process and evaluating the adequacy of the management given or endotracheal intubation for safety of air transportation. Previous studies suggested that preflight medical screening of patients may assure both the patient and physician of the safety of air travel and prevent minimal complications such as in-flight morbidity and emergencies.^{36,37} On the other hand, patients in an

unstable condition being ground-transported by ambulance can minimize the chance of second problems such as hypoxemia and the consequent complications that might occur if they were transported by air.³⁶

Difference Between NACC With Video-Telemedicine and Telephone With Fax Transmission

Patients who received treatment by physicians on the remote islands do not always have strong confidence. Most physicians on remote islands are in general practice and do not have specialized training, such as in neurologic surgery. For example, in the case of head injury, the local physician and the doctor in the NACC with video link can not only examine the patient simultaneously but also can interpret X ray, computed tomography scan, etc. This significantly enhanced the confidence of patients and the quality of management. The present study demonstrates that the implementation of this system is beneficial not only in medical care but also from an economic perspective. It overcomes the lack of emergent and critical care expertise by extending the availability of physician expertise from Taiwan mainland. The patients may have confidence not only in the quality of care but also feel comfortable because they know that in any kind of situation they will be taken care continuously including EAMS.

Transferred by Fixed Wing or Ground and Sea Modalities

For the time being, the scheduled commercial flight and regular shuttle ferry do not accept any critical patient. The reasons are (1) the airlines and boat companies do not like to take the risk of medicolegal problems and (2) the cost of equipping aircraft and ferries with stretchers cannot be covered, even if the family were to buy 10 tickets for each patient.

Follow Up of the Patients

The eight patients who were transported by commercial airlines and shuttle ferries with their family had been followed up. All of them were in stable condition and came back to their home island and followed in outpatient department (OPD) by local physicians.

Our results show that patients requiring EAMT services were mostly elderly with major illnesses. Another benefit of the preflight screening is, apart from the benefit of reducing unnecessary transports, every critical patient is ensured of receiving sound, efficient, safe, and quality transport to major tertiary hospitals in Taiwan. Physician triage in this study resulted in fewer cross-zone transfers, and most patients were transferred to major tertiary medical centers or teaching hospitals. Of those who did not meet the criteria for emergency transfer, alternative forms of transport were arranged. The above results indicate the achievement of safer and better quality EAMT services in the second stage of this study period.

Dilemmas of Decision Making

The majority of patients in this study were categorized as having major illnesses. In our experience, patients with a major illness, i.e. stroke, ischemia, heart attack, or major burns, need to be evacuated from the small islands at the earliest possible time. It might be difficult to determine whether a patient with a minor stroke can safely remain on the island or requires immediate transfer to more advanced facilities. This often causes dilemmas in decision making for emergency transfers. In this study, the majority of patients were aged 61 to 75 years and 0 to 15 years, which suggests extra caution for possible transfer risks. In addition, the TMO might insist on an urgent evacuation because of the family's pressure or other factors such as medicolegal problems or personnel shortages.

The criteria for air medical transfers also have limitations. The American College of Surgeons (1993) states that 50% overtriage is necessary to allow 10% undertriage to avoid improper transport of seriously injured patients to hospitals other than major trauma centers.³⁸ The objectives of the criteria are mainly to assist physicians in critical evaluation for making decisions on patient transfer in a timely way.

In conclusion, physician triage with the use of telemedicine significantly reduced the frequency of air medical transport. We verified the benefit of telemedicine that permits physicians in the control center to make accurate assessments and decisions concerning emergency air transport. The results of this study further demonstrate the benefits of EAMT protocol and the use of telemedicine for producing potential cost savings, as well as assisting physicians in performing preflight screening of patients for safer and much-needed EAMT services. The reduced costs as well as fewer cross-zone transports suggest an improvement in better-directed transports and effective management of EAMT services in Taiwan.

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