

# PRELIMINARY STUDY ON EMERGENCY AEROMEDICAL TRANSPORT OF ELDERLY PATIENTS FROM OFFSHORE ISLANDS IN TAIWAN

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## SUMMARY

**Background:** Emergency aeromedical transport (EAMT) refers to the handling of patients in emergency using available air transport vehicle(s) for safe and rapid transport to hospital, while providing emergency medical and nursing care in transit. EAMT is a specialty combining aeromedicine, emergency rescue, and clinical skills. Commissioned by the Department of Health, Executive Yuan, the Institute of Injury Prevention and Control of Taipei Medical University set up a National Aeromedical Approval Center (NAAC) in 2002. Over 1,000 patients have been evaluated and given transport from remote areas to major hospitals in Taiwan.

**Methods:** This retrospective study, using data from January 2004 to December 2007, reviewed the reports of patients from Penghu, Kinmen and Matsu, and analyzed the numbers and rates of EAMT, the regional characteristics, the seasonal diseases, and unusual incidences in air transport of aged persons to determine a basis for future research.

**Results:** From 2004 to 2007, 733 adult patients were transported by EAMT under NAAC; most were transferred to major medical centers. In the elderly, the proportion of females was 36.5% compared with 23.2% in the non-elderly. Older patients of all areas accounted for 39.8%, 43.9%, 48.1% and 55.9% of patients each year. More elderly were transported during cold seasons (fall, winter) and more young patients were transported during warm seasons (spring, summer). Trauma accounted for 40.7% of young patients, 33.9% of middle-aged patients, and only 14.3% of old patients, but the frequency of transporting aged trauma patients was still higher than that of non-aged patients. Cardiology, neurology, and neurosurgery accounted for most transported cases in all areas.

**Conclusion:** The growth of population in Penghu and Matsu, with the exception of Kinmen, slowed down, but mean age increased. According to increased demand for transport in Penghu, we also suggest the need for a more independent medical system for further management. [International Journal of Gerontology 2009; 3(2): 114–121]

**Key Words:** air ambulances, emergency aeromedical transport, emergency medical services, healthcare delivery, rural health services

## Introduction

Because of sea or land barriers, the offshore islands and isolated areas of Taiwan lack adequate manpower, equipment, and high-quality medical care. When an acute injury or disease occurs, lives depend on emergency aeromedical transport (EAMT) for rescue. However,



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the cost of EAMT is very high and leads to problems in health policy, health care, and injury prevention. Patients and families have not been required to pay for the cost of EAMT, and the numbers of cases have increased year on year. The annual budget of NT\$200 million has not been able to cover EAMT in offshore islands and isolated areas<sup>1</sup>. The natural restriction arising from geographic barriers, uneven distribution of medical resources and lower economic status have led to inadequate care for emergency diseases and injuries, although the residents pay the same health insurance premiums. As Taiwan is increasingly developing, it is necessary to provide those offshore islands and isolated areas with adequate medical resources, and EAMT is required to fulfill such a role, together with medical professionals. The Institute of Injury Prevention and Control, Taipei Medical University, commissioned by the Department of Health, Executive Yuan, established the National Aeromedical Approval Center (NAAC) in 2002 and dispatched medical specialists to be stationed in the Emergency Command Center of the Fire Agency and National Rescue Command Center, and allowed the consolidation of offshore EAMT and emergency rescue services. It helped to promote consistency and correct decision-making. The specific characteristics of neurology, neurosurgery and cardiology are so different that making decisions on treatment of an individual patient or transport to a major Taiwan hospital is very difficult. In this study, we have tried to analyze the diverse and complicated data and to determine trends in this field, as a reference for official decision-making.

## Materials and Methods

The only place to apply for EAMT is the Rescue Command Center of the Fire Agency, Ministry of the Interior. An airborne transfer must be requested by the attending doctor of the offshore hospital. Applications made by other persons are not accepted to ensure that applications are based only on medical factors without other human relationship factors. A certificate of diagnosis is the basis for evaluation and approval. Using a retrospective method, we studied the EAMT cases from Penghu, Kinmen, and Matsu during 48 months from January 2004 to December 2007. The diseases or injuries allowable for air transport are listed in the Table.

The conditions eligible for EAMT are defined by the Department of Health, and are based on the American College of Emergency Physicians Guidelines for Trauma Care Systems<sup>2-4</sup>. Foreign researchers also proposed that review and screening before air transport precludes the complication of low pressure anoxia, and it serves to promote the safety of patients and medical personnel during air transport<sup>5-7</sup>. In the arrangement of flying routes, Kinmen and Matsu areas are assigned to Sunrise Airlines which transports patients to the Taipei area, while the Penghu area is assigned to Airborne Services which transports patients to Kaohsiung City.

The statistical data used in this study (e.g., population, age distribution, death rate) are based on data published by the Ministry of the Interior<sup>8</sup>. All the EAMT cases were entered and filed into a database for statistical

**Table.** *The indication for aeromedical transport*

<p>Injury Severity Score (ISS) less than 12. ISS less than 9 for a child younger than 5 years          Glasgow Coma Scale less than 10, and reduction of more than 2          Unstable vital signs led by penetration or crashing injury of head, neck or trunk          Injury of spine or spinal cord or trauma leading to paralysis of limbs          Complete or incomplete amputation (fingers, toes are excluded)          Two or more features of long bone or pelvis          Ten percent or more degree 2 or 3 burns in special areas, such as face or perineum          Drowning with complication of severe pulmonary symptoms          Failure of organ, requiring active intensive care treatment          Hypothermia requiring immediate active treatment (including invasive therapy)          Adult patient with breathing rate more than 30 or less than 10 per minute, and heartbeat more than 150 or less than 50 per minute          Nervous chest pain, aortic dissection          Highly risky parturient or newborn baby          Other conditions which would have emergency medical care delayed if not through airborne rescue</p>
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analysis using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA), including the following data: (1) basic data of the patient, such as age group and sex; (2) illness/symptom; and (3) information on the hospital to which the patient was delivered, such as level of hospital, location, and month/season. This study set out to analyze the regional characteristics in EAMT of aged patients to provide a basis for a national health policy.

## Results

From 2004 to 2007, 733 adult patients were transported by EAMT under the NAAC system, including 199 patients (27.1%) of a young age (21–40 years), 192 patients (26.2%) of middle age (41–60 years), and 342 patients (46.7%) of old age (older than 60 years).

There were 149 males (74.9%) in the young age group; 151 males (78.6%) in the middle age group, and 217 males (63.5%) in the elderly group. In each age group, there was a higher proportion of males, but the proportion of females increased in the elderly group (Figure 1).

Of the 733 patients, there were 306 (41.7%) patients from Penghu, 321 (43.8%) from Kinmen, and 106 (14.5%) from the Matsu Islands. There were 72 (23.5%), 64 (20.9%), and 170 (55.6%) patients in the young, middle and old age groups, respectively, in Penghu. In Kinmen, there were 80 (24.9%), 107 (33.3%), and 134 (41.7%) patients in the young, middle and old age groups, respectively. There were 47 (44.3%), 21 (19.8%), 38 (35.8%)

patients in the young, middle, and old age groups in Matsu. Elderly patients were the main group in Penghu and Kinmen (Figure 2).

During the 4 years from 2004 to 2007, the total numbers of patients in each year were 191, 221, 133 and 188, including 66, 62, 35 and 36 patients of young age, 49, 62, 34 and 47 patients of middle age, and 76, 97, 64 and 105 of old age. The proportions of elderly patients in all areas between 2004 and 2007 were 39.8%, 43.9%, 48.1% and 55.9%. There was an increasing proportion of aged patients over the 4 years (Figure 3).

In Taiwan, according to the climate, we defined each season as follows: spring consists of March, April,

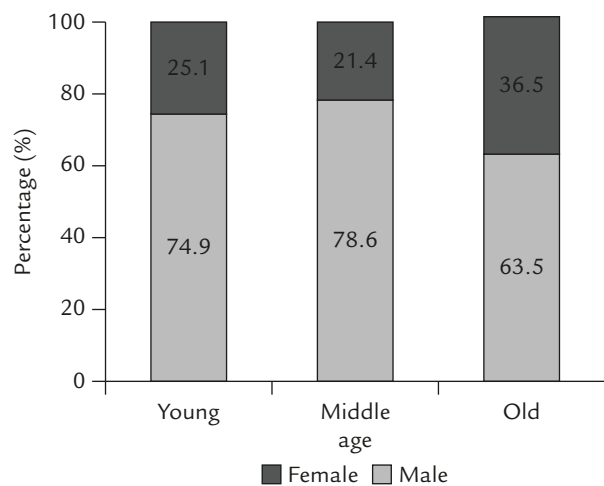


Figure 1. Proportion of male and female patients in each age group.

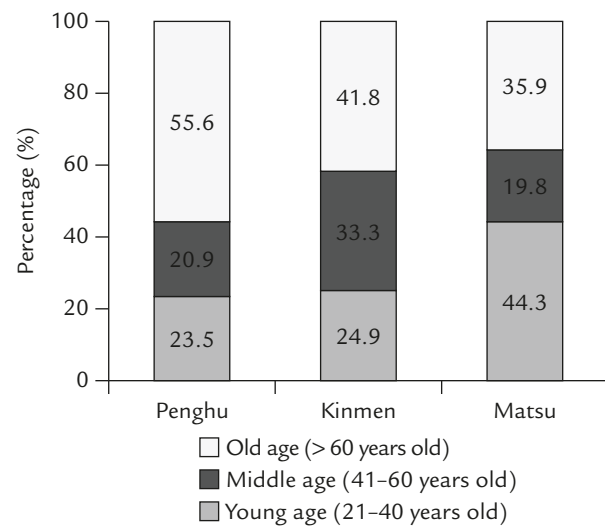


Figure 2. Age distribution of patients from Penghu, Kinmen, and Matsu.

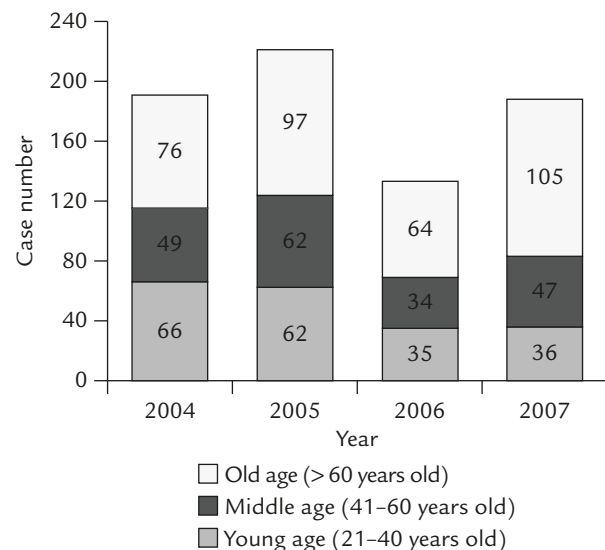


Figure 3. Patients' ages divided by year.

and May; summer consists of June, July, and August; fall consists of September, October, and November; and winter consists of December, January, and February. The numbers of patients transported by EAMT in each season were 184 patients in spring, 188 patients in summer, 184 patients in the fall and 173 patients in winter. The differences between the seasons were not large.

Regarding the seasonal distribution, 50, 58, 45 and 42 patients of young age were transported in spring, summer, fall and winter, respectively; figures for middle age patients were 49, 51, 48 and 44, respectively; figures for elderly patients were 85, 79, 91 and 87, respectively. More old patients were transported during the cold seasons (fall, winter), and more young patients were transported during the warm seasons (spring, summer). The proportion of trauma patients was highest in young people and lowest in elderly patients.

The five major destination hospitals of EAMT patients under the NAAC system were: Taipei Veterans General Hospital (213 patients), Kaohsiung Veterans General Hospital (161 patients), Tri-service General Hospital (111 patients), Kaohsiung Chang Gung Memorial Hospital (77 patients), and Chung-Ho Memorial Hospital (41 patients). These received 82% of all transported patients (Figure 4). Most of the patients transported by EAMT (275 of 306 patients in Penghu, 297 of 321 in Kinmen, 91 of 106 in Matsu) were sent to medical centers in Taiwan's main island.

Of all 733 patients, 195 (26.6%) were trauma cases; these accounted for 81 of 199 (40.7%) patients in the

young age group; 65 of 192 patients (33.9%) in the middle age group and only 49 of 342 (14.3%) patients in the old age group. It is easy to infer that the elderly experienced fewer traumas. However, when we considered the proportions of aged trauma patients (15% in Penghu, 12.7% in Kinmen, and 10% in Matsu), the frequencies of transporting aged trauma patients were still higher than that of transporting non-aged patients (1.62 times at Penghu, 1.54 times at Kinmen, 2.0 times at Matsu; Figure 5).

Regarding the medical category of EAMT patients, 156 were neurologic, 136 were cardiologic, and 111 were neurosurgical: the three main categories which constituted 54% of the total (Figure 6). The three main categories in the young age group were neurosurgery (44), neurology (28) and orthopedics (28); the three main categories of the middle age patients were neurology (48), neurosurgery (34) and cardiology (33); and the three main categories of the old age group were cardiology

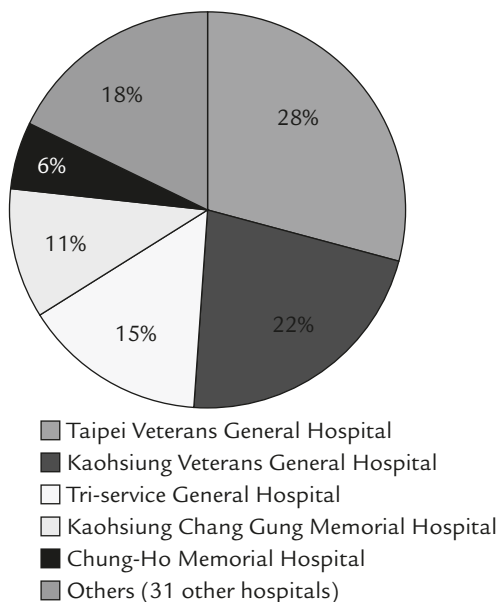


Figure 4. Case percentages of the main destination hospitals.

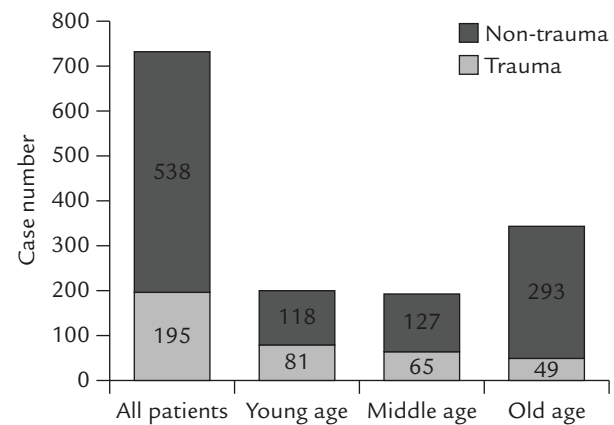


Figure 5. Proportions of trauma patients in each age group.

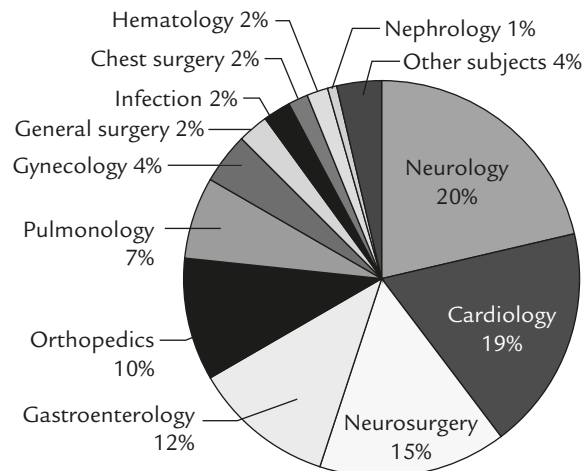


Figure 6. Percentage of patients in each category.

(89), neurology (80) and gastroenterology (48). Patients transported by EAMT in the cardiology, neurology and neurosurgery categories accounted for 57.8% of cases in Penghu, 69.2% in Kinmen, and 43.4% in the Matsu Islands. Regarding age distribution of each category, the proportion of cardiology, neurology, gastroenterology and pulmonology cases increased with age, but this did not occur for neurosurgery and orthopedic cases (Figure 7).

From 2004 to 2007, there were 41, 69, 76, and 120 patients in each year from Penghu, including 22 (53.7%), 31 (44.9%), 43 (56.6%), and 74 (61.7%) aged patients.

The annual transport frequencies of adult patients were 0.59, 0.97, 1.07, and 1.80 (time/year/thousand people). Thus, the frequencies and the proportions of the aged group increased every year (Figure 8).

The numbers of EAMT patients in the three main categories during the 4 years from Penghu were 73 in cardiology, 46 in neurology, and 45 in neurosurgery. Together, the three categories accounted for 52.8% of all patients, including 52.8% of young age, 46.9% of middle age, and 56.5% of old age. Cardiac and neurologic disease increased with age, but not neurosurgical disease.

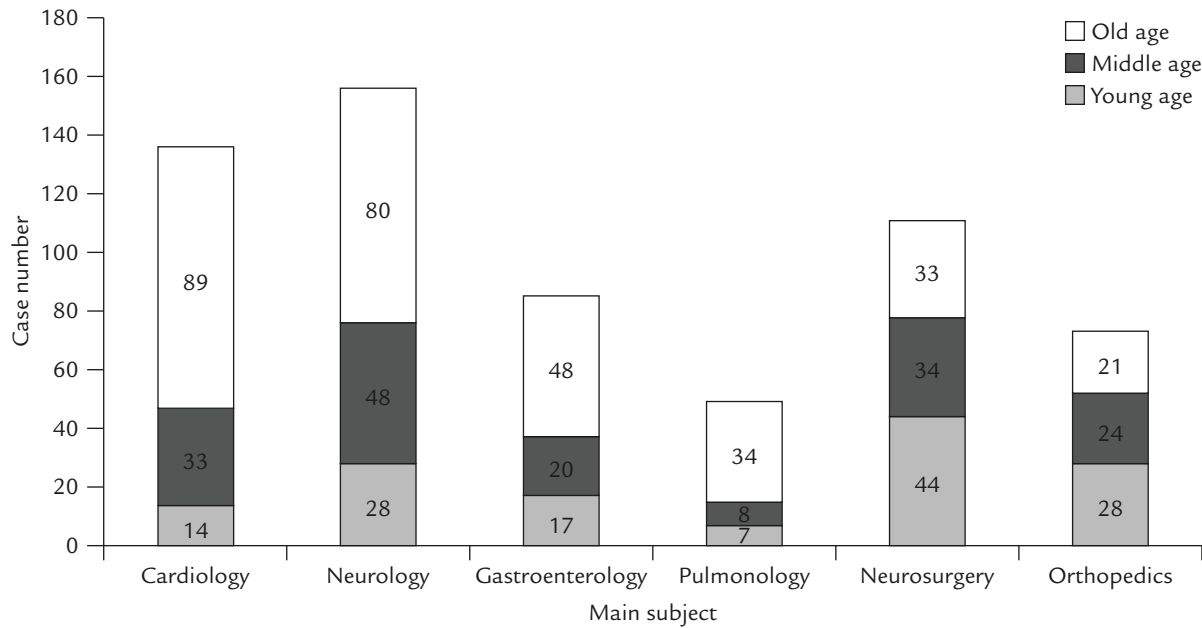


Figure 7. Patient age groups by medical condition.

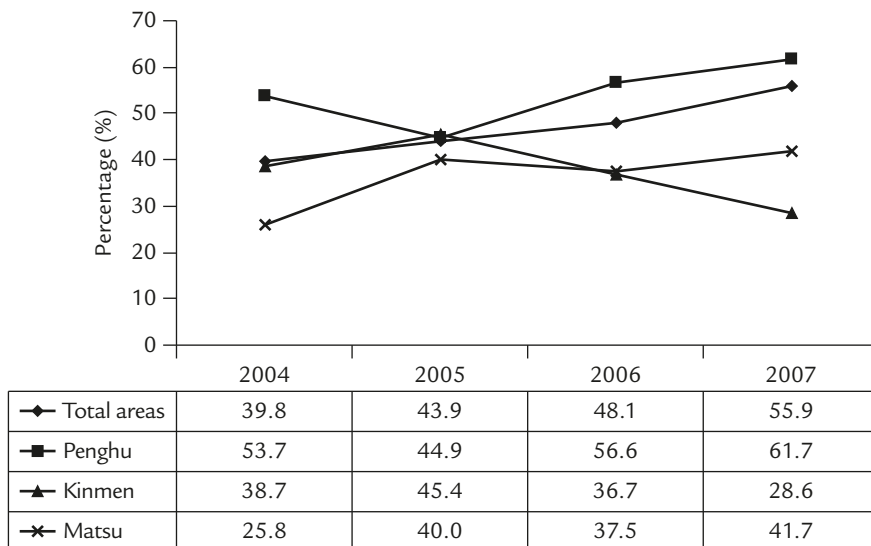


Figure 8. Percentages of aged patients in each year.

In each year from 2004 to 2007, there were 119, 97, 49, and 56 patients, respectively, who were transported from Kinmen, including 46, 44, 18, and 16 aged patients. The annual transport frequencies of adult patients were 2.44, 1.78, 0.81, and 0.86 (time/year/thousand people). Annual proportions of aged patients during the 4 years were 38.7%, 45.4%, 36.7%, and 28.6%. Because the relationship between Kinmen and Xiamen cities have become closer in recent years, the population of Kinmen had a large increase from 64,456 people in 2004 to 81,547 in 2007, but frequency of intercity transport decreased.

During the 4 years, the three main categories of patient transported from Kinmen were neurology (87), cardiology (52) and neurosurgery (57). These accounted for 49.6% of all patients, 42.5% of the young age group, 69.1% of the middle age group, and 71.0% of the old age group. The proportion of patients transported in the cardiology and neurology categories also increased with age.

Each year from 2004 to 2007, there were 31, 55, 8 and 12 patients who were transported by EAMT from Matsu, including 8, 22, 3 and 5 aged patients. The annual transporting frequencies of adult patients were 4.25, 6.66, 1.03, and 1.52 (times/year/thousand people). The proportions of elderly patients during the 4 years were 25.8%, 40.0%, 37.5%, and 41.7%. Matsu is different from Kinmen in that there is only a hospital on the main island, and five different medical institutes on different islands. There were 23 neurology patients, 22 orthopedic patients, and 11 cardiology patients. The three main categories made up 43.0% of all patients. In these, 52.8% were aged patients. The proportion of neurology patients increased with age, but the proportion of orthopedic and neurosurgery patients did not.

## Discussion

The study of Caldow et al.<sup>9</sup> highlighted the French army's use of aircraft for transporting trauma patients during World War I, and similar systems for transporting patients from remote areas have been employed since the 1960s in Scotland. The EAMT system in Taiwan was created in October 2002; later, Kinmen and Matsu were included in January 2004. All missions of this official system are classified as rescue at the scene (under the National Fire Agency) and hospital-to-hospital transport (under the NAAC). The chief members of the rescue

team are emergency medical technicians or paramedics, but doctors still play an important role in communicating between hospitals.

Under the US system, there is usually a specialist nurse or doctor on the aircraft. The European system uses well-trained technicians or doctors. Training is classified into three levels in Italy. Matsumoto et al.<sup>10</sup> reported that since October 2001, several "doctor-helicopter systems" have been implemented in Japan. This system allows an "on-site emergency department" to initiate certain forms of emergency management prior to arrival at a hospital. Their missions include emergency rescue at the scene. Medical staff on the aircraft in our system are usually a nurse or a technician, but only for transfer from hospital to hospital. In fact, Caldow et al.<sup>9</sup> proposed that well-trained paramedics could make high-quality EAMT missions. In our system, during the 4 years from January 2004 to December 2007, there were no reported flight or medical errors. With this system, up until 2007, the cost of transferring patients from remote islands also decreased from over NT\$200 million per year to NT\$50 million in 2007.

According to the data published by the Ministry of the Interior, Taiwan's aged population increased from 9.2% to 10.2% in 4 years. However, medical resources have not had the same growth, and the increasing proportions of aged patients transported by EAMT will become a progressively heavier burden. Making a good balance in budgeting between transporting or improving local medical resources is difficult but necessary.

An analysis in the Spanish Canary Islands by Lubillo et al.<sup>11</sup> in 2000 revealed that the three main categories of transported patients were also cardiology, neurology, and neurosurgery. In our data, these categories are also the main ones in Penghu, Kinmen and Matsu (Figure 9).

The Penghu area includes 64 islands, with a land area of about 126 km<sup>2</sup>. As in other remote areas, the emigration of young people from Penghu has occurred for long time. The annual mean population from 2004 (92,253) to 2007 (92,390) had nearly no growth, and the proportion of aged people was 14.65–15.0%. From the official statistics, the mean age of all Penghu people in each of the 4 years was 37.0, 37.9, 38.0, and 38.7 years old; the Penghu population kept aging (Figure 10). There were five hospitals and other small clinics, with 116 doctors and 391 hospital beds in total. Besides Makung Island, the main island of Penghu, there were two transporting stations in two small islands, Wang



An and Chi Mei. When patients from the two islands are in a relatively stable condition, they can be transported to Makung Island in ships. However, when the illness is apparently not manageable, transporting the patient to Makung Island is not much faster or safer than transport to a hospital in Taiwan's main island. This is why applications from Wang An and Chi Mei requested transport to Taiwan's main island more than to Makung Island.

The transport frequencies showed significant increases every year in Penghu, although there was no growth in population. With limited medical resources, it is particularly difficult to resolve complicated health problems.

The data indicated that cardiology, neurology and neurosurgery cases accounted for 49.6% of all patients from Penghu. Taking into account the cost of transporting staff, fuel and maintaining servicing of helicopters or aircraft, each mission requires over NT\$300,000. The

total cost is much higher if we add the cost for transport, accommodation, and medication of patients and their families in Taiwan's main island. Thus, the government should seriously consider creating an independent medical system in Penghu, including, in particular, cardiology, neurology and neurosurgery.

Kinmen, which is 360 km from Taiwan's main island, includes 12 islands and has a land area of about 150.5 km<sup>2</sup>. Because the relationship between Kinmen and Xiamen is improving, there are more and more visitors going to Kinmen, and the mean population increased from 60,983 in 2004 to 81,457 in 2007. Although the proportion of the elderly (> 60 years old) decreased, the mean age of the total population each year was 36.9, 37.5, 38.1 and 38.6 years. The elderly population increased from 11,577 to 13,877, an increase of nearly 20%. According to the official data, the total number of visitors to Kinmen in 2007 reached over 460,000. There were only 18 doctors with 193 hospital beds in Kinmen in 2007. The ratio of medical staff to total population is the lowest in Taiwan, and there are no doctors specializing in cardiology, neurology or neurosurgery. Kinmen consists of Kinmen Islands and Lieh Yu Island. As Lieh Yu does not have an airfield suitable for landing, patients from Lieh Yu are mainly referred by Kinmen Hospital, Department of Health.

Apart from the EAMT system for emergency patients, Kinmen has regular military aircraft transporting goods and relatively stable patients to Taiwan's main island, so the demand for EAMT is lessened. With the development of tourism and economic activity in the future, and with the anticipation of a closer relationship between the cities of Kinmen and Xiamen, the transport

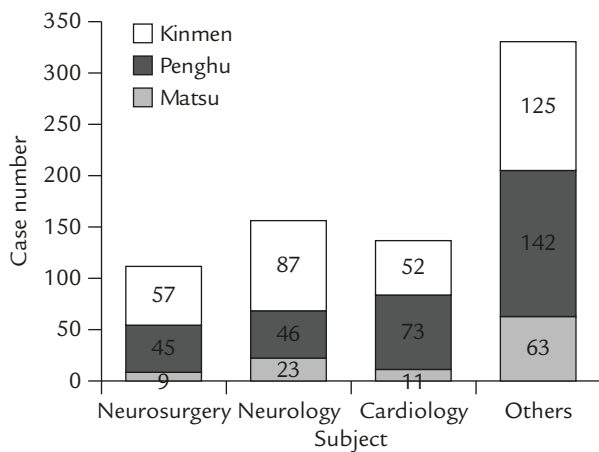


Figure 9. Patient location and medical condition.

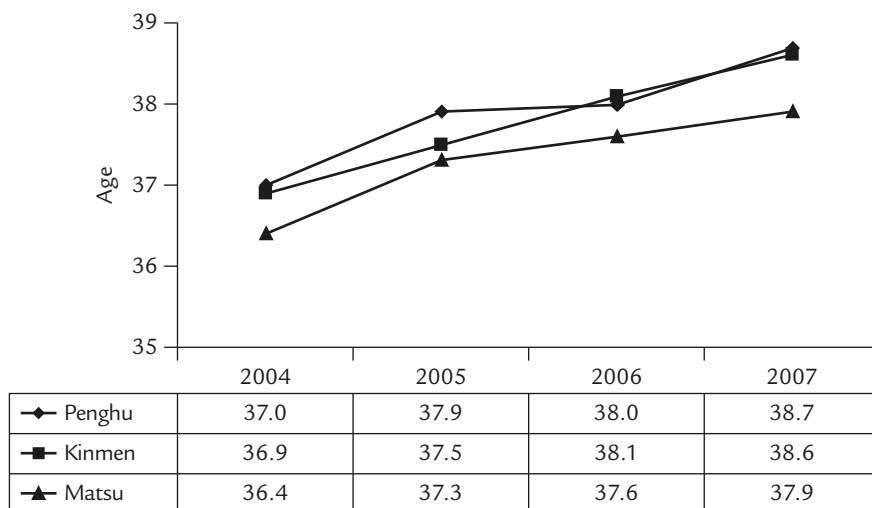


Figure 10. Mean age in each year of patients from Penghu, Kinmen, and Matsu.

of emergency patients to Xiamen by ship for further management may be evaluated.

The Matsu Islands comprise 36 islands with a land area of about 29.5 km<sup>2</sup>. The population was 8,806 in 2004 and 9,946 in 2007. The proportion of aged people (10.0% in 2004; 9.8% in 2007) showed no major change from 2004 to 2007, but the mean age of the total population each year was 36.4, 37.3, 37.6 and 37.9 years. The populations of Matsu continued to age as in Penghu and Kinmen. Unfortunately, there is only one small hospital with nine doctors and 38 hospital beds in Matsu. Because of the relatively few cases in Matsu, transport of patients to Taiwan's main island directly may persist for a few years.

Emergency rescue operations with helicopters have been used for many years. The practices, protocols, and land-based communication systems have been steadily optimized. Proven practices and systems are worth following to provide medical care for rural and medically underprivileged areas. However, such resources may be abused if there are no governing rules. Monitoring the effects of the EAMT systems, reviewing standards for the transporting systems, and evaluating procedures via video have formed a "gatekeeper" effect. Under such a system, a local physician would avoid overexploiting the use of airborne transport. With cost-effectiveness analysis and rules for eligible conditions in place, any unnecessary waste of resources will be adequately reduced.

In conclusion, Penghu, Kinmen and Matsu areas all shared problems of aging populations, increasing numbers of visitors, and restricted medical resources. The three main categories of emergencies were cardiology, neurology and neurosurgery cases. Internal medical diseases increased with age, but surgical disease did not. We hope that the preliminary studies on EAMT can be a useful reference for further decision-making.

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