

Trauma Course for an Aerial Medical Transport System in the Amazon Rainforest of Ecuador

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ABSTRACT

Objectives: Aerial transport of injured patients in rural Southeastern Ecuador is provided by humanitarian organizations with no medical personnel or assistance. We sought to evaluate the feasibility and usefulness of a tailored aeromedical transport (AMT) course for nonmedical personnel (pilot and technicians) in the jungles of Ecuador, where there are no formal medical crew members.

Methods: Fixed-wing aeromedical flights in the Amazon province of Morona Santiago were analyzed to delineate the injury patterns (IP) and reason for transport (RFT). An 8-hour didactic and hands-on AMTC course based on IP and RFT was developed and administered by the Virginia Commonwealth University (VCU) International trauma system development program (ITSDP) and VCU Life Evac with extensive experience in aeromedical education and training. Pre- and post-test course evaluation was used to assess the medical background and knowledge retention of the participants.

Results: A total of 5,716 fixed-wing aeromedical transports between Jan 2003 and Dec 2005 were analyzed. The course was developed based on 1176 (20%) RFT resulting from traumatic injuries. Course structure based on identified IP included 4 didactic lectures and hands-on skill training in aerial physiology, airway management, bleeding control, shock, musculoskeletal injuries, immobilization and patient transport. Fifteen students (4 pilots, 4 engineers, 2 physicians, 4 aerial staff and 1 flight operator) participated in the course. Pre- and post-test evaluations demonstrated significant improvement in knowledge from 53% (average 10.53, STD 1.6) to 73% (average 14.53, STD 2.13) (p -value < 0.0001). Critical deficiencies in information uptake were identified in airway management and flight physiology.

Conclusion: A tailored AMTC may serve as the first step toward the development of a regionally specific aeromedical transport service. Long-term follow-up is needed to evaluate the real impact of this intervention in terms of morbidity and mortality.

Keywords: Rural trauma, Aeromedical transport, Trauma training of nonmedical personnel.

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RESUMEN

Objetivos: El transporte aéreo de pacientes heridos en la zona sureste rural Ecuatoriana es proporcionado por las organizaciones humanitarias sin personal médico o de asistencia. Hemos evaluado la viabilidad y utilidad de un curso de transporte aeromédico (TAM) adaptado para el personal no

médico (piloto y técnicos) en la selva Ecuatoriana, donde no hay miembros médicos de tripulación formales.

Métodos: Fueron analizados los vuelos aeromédicos en aviones de ala fija en la provincia amazónica de Morona Santiago para delinear los patrones de lesiones (PL) y la razón para el transporte (RPT). Un curso TAM práctico y didáctico de 8 horas fue desarrollado con extensa experiencia en educación y entrenamiento aeromédico por la Universidad del Commonwealth de Virginia (VCU), el Programa Internacional de Desarrollo de Sistemas de Trauma (ITSDP) y Life-Evac de VCU. Se utilizó una evaluación pre-y post test para valorar los antecedentes médicos y la retención de conocimientos de los participantes.

Resultados: Se analizaron 5.716 vuelos aeromédicos en aviones de ala fija entre el mes de enero del 2003 y diciembre del 2005. El curso fue desarrollado sobre la base de 1176 (20%) RPT como resultado de lesiones traumáticas. La estructura del curso que fue basada en PL identificados incluyó 4 clases didácticas y prácticas en fisiología aérea, manejo de vía aérea, control de sangrado, shock, lesiones musculoesqueléticas, inmovilización y transporte del paciente. 15 estudiantes (4 pilotos, 4 ingenieros, 2 médicos, 4 técnicos aéreos y 1 operador aéreo) participaron en el curso. El pre y post test demostraron una mejora significativa en el conocimiento del 53% (promedio 10,53, DS 1,6) al 73% (promedio 14,53, DS 2,13) valor $p < 0,0001$. Deficiencias críticas en la captación de la información se identificaron en el manejo de vía aérea y la fisiología de vuelo.

Conclusiones: Un curso TAM adaptado puede servir como el primer paso hacia el desarrollo de un servicio de transporte aeromédico específico a nivel regional. Es necesario un seguimiento a largo plazo para evaluar el impacto real de esta intervención en términos de morbilidad y mortalidad.

Palabras clave: Trauma rural, Transporte aeromédico, entrenamiento en trauma del personal no médico.

BACKGROUND

With more than 5 million deaths every year, violence and injuries account for 9% of global mortality, as many deaths as from HIV, malaria and tuberculosis combined. Eight of the 15 leading causes of death for people ages 15 to 29 years are injury-related.¹⁻³ The America's region account for 11% of global deaths due to trauma with 90% of fatalities occurring in low and middle income countries.^{4,5} This is of significance in the Latin American region where injuries and noncommunicable diseases account for greater than 73% of deaths and 76% of disability adjusted life years (DALYS).^{2,6} The rural areas shoulder much of the burden of injury where rapid urbanization and development is ongoing without the corresponding improvement in infrastructure and health

care systems.^{7,8} Trauma care in rural areas of Latin America remains rudimentary without appropriate injury prevention and control efforts.^{9,10}

Such statistics are reflected in Ecuador where aggressions (homicides, assaults) and motor vehicle crashes are the leading cause of mortality with an attributable fatality rate of 37.5 per 10,000 inhabitants.¹¹ Almost 40% of Ecuador’s population is rural and yet rural trauma remains underestimated and few trauma interventions are targeted to these areas. According to the Ecuadorian Center for National Statistics and Census, trauma is the second greatest cause of morbidity and the fourth highest cause of mortality in Southeastern Ecuador. Despite this there is no formal emergency medical system in the region. Some areas are reachable only by air. The aerial transport of injured patients is provided by humanitarian organizations with no medical personnel or assistance. These organizations use fixed-wing aircraft that land on dirt air strips in the middle of the jungle. Pretransport care is provided by local community members with minimal medical knowledge who contact the humanitarian organization by radio to evacuate the patient. Patients receive minimal care at the site of injury. Transport is carried out by a pilot with no capability of delivering any time of medical assistance.

The lack of immediate care can contribute significantly to mobility and mortality. Several studies have demonstrated that providing basic trauma care training to local first responders decreases mortality in rural settings.¹²⁻¹⁵ This study evaluated the feasibility and utility of a tailored aeromedical transport (AMT) course for nonmedical personnel (pilot and technicians) in the jungles of Ecuador where there are no formal medical crew members.

METHODS

Fixed-wing aeromedical flights in the Amazon province of Morona Santiago were analyzed to delineate the injury patterns and reason for transport. An 8-hour didactic and hands-on aeromedical transport course based on injury patterns and reason for transport was developed and administered by the Virginia Commonwealth University (VCU) International Trauma System Development Program (ITSDP) and VCU’s aeromedical transport Life Evac. These organizations both have extensive experience in aeromedical education and training in rural and austere settings. Local resources and site of injury were also considered. The lecture topic included basic aerial physiology, airway management, musculoskeletal injury, bleeding and shock. The hands-on skills training included hemorrhage control, dressing, bandaging, musculoskeletal immobilization, splinting and patient transport (Table 1).

| Table 1: Lecture and skill sessions |
|--|
| <i>Lectures:</i> |
| Aerial physiology |
| Airway management in remote settings |
| Musculoskeletal trauma management in the field |
| Bleeding and shock—the basics of rural management |
| <i>Skill sessions:</i> |
| Hemorrhage control, dressing, bandaging |
| Musculoskeletal immobilization, splinting |
| Patient transport—from rural to definitive centers |

Onsite skill training was carried out in the field and in the rural airport bunker area to optimize training with the local resources present (Fig. 1). Skills training were directed at basic stabilization and rapid transport of the patient to rural or regional hospitals. Basic support and monitoring of the patient was also stressed, as rapid transport is not always feasible in the Amazon areas where weather variability and mechanical failures are common.

An attending physician in trauma/critical care, an emergency medicine physician, and one surgery resident physician as well as three certified aeromedical specialists led the course. Three medical students assisted with logistics and organization. The course took place over a 2 days period.

Participants were selected from the two humanitarian organizations which render aerial emergency transport in the region. Fifteen students participated in the course, including four pilots, four mechanics, two physicians, one flight operator, and one aerial staff member. All students were required to participate in the entire course and evaluation process.

Pre- and post-test course evaluation was used to assess the baseline medical knowledge and information retention of the participants. Each test consisted of 20 multiple choice



Fig. 1: Onsite training for patient immobilization and transport. Two pilots and 2 technicians transporting patient post-immobilization. The board was designed by the pilots. Torn bed sheets were used for immobilization. Chairs were removed from the aircraft to accommodate the simulated injured patient

questions addressing lectures and hands on skills session topics. A paired t-test was used to compare pre- and post-test scores by individual topic. A p-value of less than 0.05 was considered statistically significant.

RESULTS

5,716 fixed-wing aeromedical transports between Jan 2003 and Dec 2005 were analyzed to determine the injury patterns and the reasons for transport (Table 2). Trauma was the third highest reason for aeromedical transfer. Toxic effect of contact with venomous animals (356 cases, 30%) was the main reason for transfer of traumatic injuries. Other causes included fractures, burns, and multiple injuries. 50 and 26% of patients were under the age of 20 and 10 respectively. Flight time averaged between 36 minutes and 6 hours and differed by mechanism and site of injury. There was no traumatic death recorded during transfer. Data on injury severities and outcomes were not available.

Table 2: Aeromedical transport

| | |
|--|--------------|
| Aeromedical transport | N = 5716 |
| Age (years) | 20 |
| Sex (M/F) | 2/1 |
| <i>Reason for transfer</i> | <i>n (%)</i> |
| Infectious disease | 1341 (23) |
| Respiratory disease | 1229 (21) |
| Injury | 1176 (20) |
| Endocrine/nutrition | 737 (13) |
| Ob-gyn | 574 (10) |
| Gastrointestinal | 513 (9) |
| Genitourinary | 444 (8) |
| <i>Injury type FT avg./range (min)</i> | |
| Head and neck | 101/48-360 |
| Trunk | 111/48-360 |
| Upper extremity | 72/36-270 |
| Lower extremity | 68/36-120 |

The basic trauma course was developed between 2006 and 2007 based on the above injury patterns and local realities of transport time. The course was administered in 2008.

The 15 student participants included four pilots, four engineers, two physicians, four aerial staff and one flight operator. Pre- and post-test evaluations demonstrated significant overall improvement in knowledge from 53% [average 10.53, STD 1.6) to 73% (average 14.53, STD 2.13) p-value < 0.0001] (Table 3). Comparing pre-test and post-test scores, improvement was noted in all the sessions taught with noted significant improvement on the topic of hemorrhage control (34 to 77%, p-values < 0.0001). Critical deficiencies in information uptake were identified in airway management.

Table 3: Course evaluation—pre vs post

| Subject | Total questions | Pre-test | Post-test | p-value |
|--------------------|-----------------|----------|-----------|---------|
| | | | | |
| Aerial physiology | 165 | 66.1 | 75.8 | 0.0688 |
| Hemorrhage Control | 90 | 34.4 | 76.7 | <0.0001 |
| Airway management | 30 | 36.7 | 46.7 | 0.6010 |
| Patient transport | 15 | 46.7 | 66.7 | 0.4621 |
| Total | 300 | 52.7 | 72.7 | <0.0001 |

DISCUSSION

The development of this course was especially challenging due to our intention of training nonmedical personnel to provide basic trauma care in a very limited setting. The diversity of the participants was such that there was no consistent baseline level of medical knowledge. The course was tailored to the main types of injuries seen in the region with the aim of achieving basic stabilization of patients to ensure safe transfer to local hospitals where medical personnel is available.

Significant emphasis was put on aerial physiology to minimize any additional harm that can be incurred on the patient. This was reflected also by the number of test questions that were posed to ensure knowledge acquisition of basic concepts in aerial physiology. The course did not attempt to be comprehensive. It mainly stressed the minimum required to identify a serious injury, stabilize the patient, and provide rapid transport. The duration of the course was two days which was consistent with other suggested studies on the time needed for basic prehospital training of nonmedical personnel.^{16,17}

Although the results of the post-test scores are encouraging in terms of improving the medical knowledge of aerial EMS providers, the long-term retention, or the change in outcome of the transported patients was not tested. Previous studies have demonstrated that providing basic trauma care training to local first responders decreases mortality in rural settings.¹²⁻¹⁵ A recent evaluation carried out by Kappel et al to evaluate the impact of the American College of Surgery's Rural Trauma Team Development Course (RTTDC) in Western Virginia noted a significant reduction in delays in the transport process of the rural trauma patient.¹⁸ The study was based on the analysis of the process of care and outcome from the West Virginia State trauma registry. A regional trauma registry is currently being instituted in Southeastern Ecuador by ITSDP to evaluate the outcomes and any improvement in appropriateness of patient transport and patient transport time.

Additionally, no formal objective structured clinical examination (OSCE) was carried out. We believe this was a deficiency in our course. The addition of OSCE to the multiple choice questions (MCQ) format has been effectively used to test students and evaluate the improvement in the postcourse period, and to assess clinical performance.¹⁹⁻²² We have also used OSCE evaluations in our basic trauma Course (BTC) administered to rural physicians and noted significant deficiencies that otherwise would have not been revealed with the MCQ alone. Due to time constraint, and to avoid any perceived intimidation for the nonmedical personnel, we were reluctant to administer OSCE in this first aeromedical course. It will be considered in subsequent course administrations and evaluations.

As expected from the type of students selected to participate in the course the highest pretest scores were in aerial physiology as compared to clinical management and transport of the patient. Although improvement was noted in all of the systems, it was concerning that only minimal improvement was noted in the airway management.

Upon further evaluation and review of the test scores with the students, a misunderstanding of the physiological definition and use of the word 'airway' was identified which differ significantly from the 'pilot' understanding of the word airway as it applies to flight management. Such nuances in the development and administration of a rural course to nonmedical personnel are not uncommon. It also highlights the importance of using the test itself as an important tool for education which was carried out in our course.

Finally we believe that training nonmedical personnel in silo may not be effective. Complimentary courses to other health care providers involved in the care of the injured patient are necessary. While this aeromedical course was administered, three additional simultaneous courses were administered to the nurses (basic rural nursing course), the rural physicians (BTC), and the prehospital providers (basic paramedic course). This was logistically challenging. The integration of these courses was carried out to a limited extent. The impact is currently being evaluated. It may prove to be an important step for development of rural trauma systems in the region.

CONCLUSION

A tailored AMTC is the first step toward the development of a regionally specific aeromedical transport service. Long-term monitoring and evaluation are needed to evaluate the real impact of this intervention in terms of reduced morbidity and mortality.

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